CAPSTONE Seeds

COVER CROPS

2019

ADDING VALUE

Why grow cover crops? The answer is simple: Although the cover crop does not produce a marketable product, its benefits for the succeeding crops are a good return on investment.

So in short, **cover crops increase farm profitability.**

ABOUT COVER CROPS

Cover crops have been used to improve soil and the yield of subsequent crops since antiquity. Chinese manuscripts indicate that the use of green manures is probably more than 3,000 years old. Green manures were also commonly used in ancient Greece and Rome. Today, there is a renewed interest in cover crops, and they are becoming important parts of many farmers' cropping systems.

THREE DIFFERENT TERMS are used to describe crops grown specifically to help maintain soil fertility and productivity instead of for harvesting: green manures, cover crops, and catch crops. The terms are sometimes used interchangeably and are best thought of from the grower's perspective.

A GREEN MANURE CROP is usually grown to help maintain soil organic matter and increase nitrogen availability.

A COVER CROP is grown mainly to prevent soil erosion by covering the ground with living vegetation and living roots that hold on to the soil. This, of course, is related to managing soil organic matter, because the topsoil lost during erosion contains the most organic matter of any soil layer.

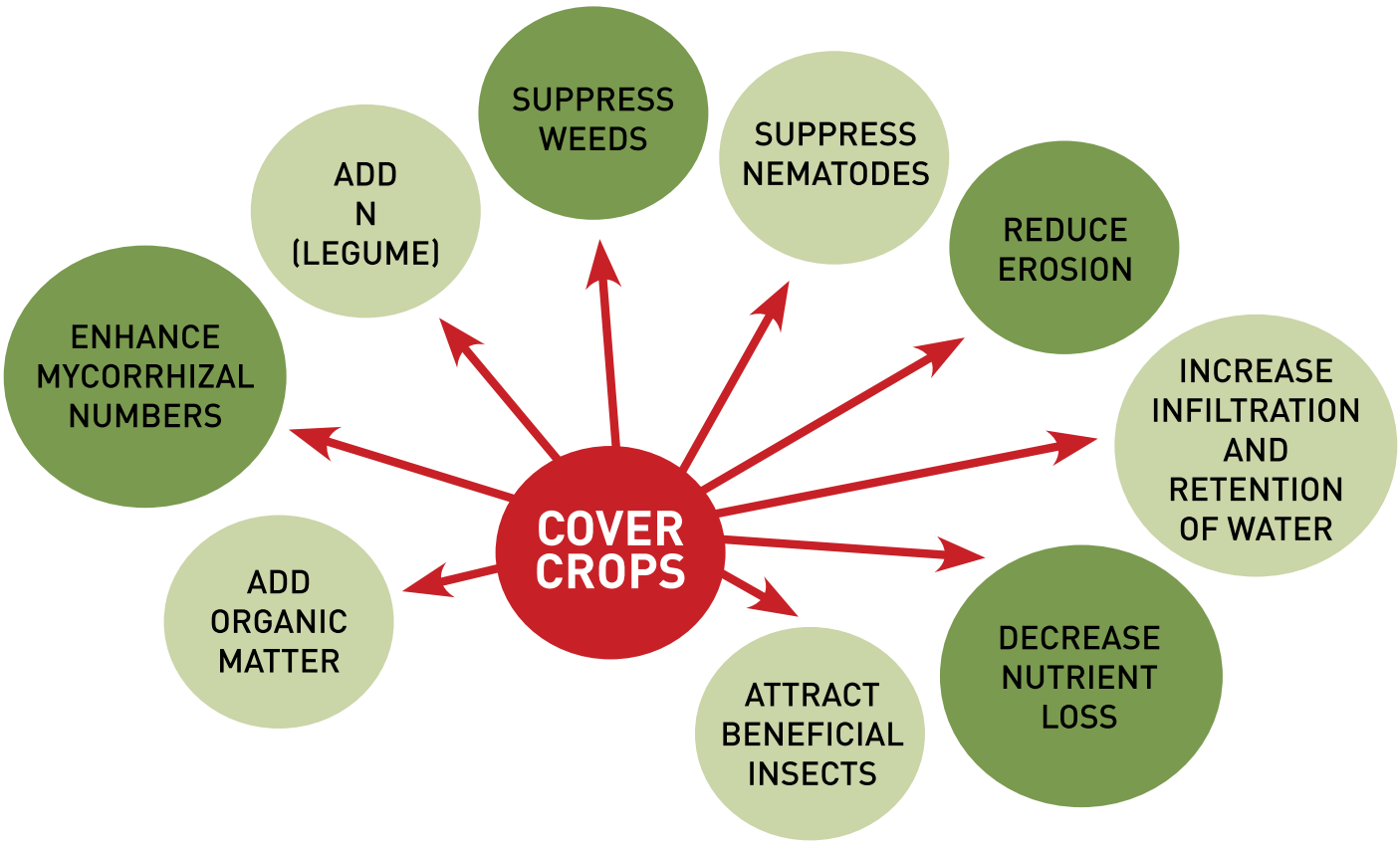
A CATCH CROP is grown to retrieve available nutrients still in the soil following an economic crop and prevents nutrient leaching over the winter.

Sometimes which term to use is confusing. We usually have more than one goal when we plant these crops during or after our main crop, and plants grown for one of these purposes may also accomplish the other two goals. The question of which term to use is not really important, so in our discussion below, the term cover crop will be used.

Cover crops are usually killed on the surface or incorporated into the soil before they mature. (This is the origin of the term green manure.) Since annual cover crop residues are usually low in lignin content and high in nitrogen, they decompose rapidly in the soil.

BENEFITS OF COVER CROPS

Cover crops provide multiple potential benefits to soil health and the following crops, while also helping maintain cleaner surface and groundwater (figure 10.1). They prevent erosion, improve soil physical and biological properties, supply nutrients to the following crop, suppress weeds, improve soil water availability, and break pest cycles. Some cover crops are able to break into compacted soil layers, making it easier for the following crop's roots to more fully develop. The actual benefits from a cover crop depend on the species and productivity of the crop you grow and how long it's left to grow before the soil is prepared for the next crop.



Above diagram: Cover crops have multiple benefits

ORGANIC MATTER

Grass cover crops are more likely than legumes to increase soil organic matter. The more residue you return to the soil, the better the effect on soil organic matter. The amount of residue produced by the cover crop may be very small, as little as half a ton of dry matter per acre. This adds some active organic matter, but because most of it decomposes rapidly after the crop is killed, there is no measurable effect on the total amount of organic matter present. On the other hand, good production of hairy (grazing) vetch or crimson and other annual clovers like Persian cover crops may yield from 1 1/2 to more than 4 tons of dry weight per hectare. If a crop like winter rye is grown to maturity, it can produce 3 to 5 tons of residue.

A five-year experiment with clover in California showed that cover crops increased organic matter in the top 2 inches from 1.3% to 2.6% and in the 5cm to 10cm layer from 1% to 1.2%. Some researchers have found that cover crops do not seem to increase soil organic matter. Low-growing cover crops that don't produce much organic matter may not be able to counter the depleting effects of some management practices, such as intensive tillage. Even if they don't significantly increase organic matter levels, cover crops help prevent erosion and add at least some residues that are readily used by soil organisms.

Cover crops help maintain high populations of mycorrhizal fungi spores during the fallow period between main crops. The fungus also associates with almost all cover crops, which helps maintain or improve inoculation of the next crop. (As discussed in chapter 4, mycorrhizal fungi help promote the health of many crop plants in a variety of ways and also improve soil aggregation.) Cover crop pollen and nectar can be important food sources for predatory mites and parasitic wasps, both important for biological control of insect pests. A cover crop also provides a good habitat for spiders, and these general insect feeders help decrease pest populations. Use of cover crops has reduced the incidence of thrips, bollworm, budworm, aphids, fall armyworm, beet armyworm, and white flies. Living cover crop plants and their residues also increase water infiltration into soil, thus compensating for the water that cover crops use.

THE EFFECTS OF BIOLOGICALS

There are three primary effects that biologicals have on plants: communication between the plant and the microbe, changes in plant gene expression and physiological changes.

One thing we've learned is that different microbial organisms communicate differently. For example, there's a plant root growing through the soil: When it needs nitrogen, it releases a chemical signal into the soil, and if Bradyrhizobium is present, it will migrate to the plant. Once in the rhizosphere, the Bradyrhizobium releases a signal, causing the plant to curl a root hair around the Bradyrhizobium. This is the beginning of the nodulation process to make nitrogen.

This is just one of many communication mechanisms between plants and microbials. In the case of Trichoderma, it emits signals to plant roots, which then trigger changes in gene expression in the plant. The gene expression relies on signaling cascades, meaning one change has a compound effect, triggering other key systems in the plant.

An example of how a plant might respond at the molecular level is changing its biochemical pathways. As the Trichoderma colonizes the roots, it sends a signal to the plant, telling it to upregulate whole biochemical pathways. One such pathway is the Reactive Oxygen Cycling pathway, which is what plants use to purge free radicals, or toxins, from their cells. If the plant can't eliminate the toxins, DNA and protein can become damaged leading to decreased photosynthesis and yield.

Reactive oxygen species also cause damage in human systems; however, we can take vitamins and consume high antioxidant foods, such as dark chocolate and red wine, to rid us of these toxins. The difference is that plants can't take vitamins and instead use their own biochemistry to convert these free radicals to a harmless state.

By upregulating the biochemical pathway, as in the example above, the plant cells are better able to mitigate stress, such has drought, high heat, disease and so on, thus enabling the plant to perform at its highest potential even in the presence of stress. While the effect of biologicals on plant performance appears simple, the colonization, signaling, and plant responses suggest a synergy that is elegant in its complexity.

COVER CROP MANAGEMENT

There are numerous management issues to consider when using cover crops. Once you decide what your major goals are for using cover crops, select one or more to try out. Consider using combinations of species. You also need to decide where cover crops best fit in your system—planted following the main crop, intercropped during part or all of the growing of the main crop, or grown for an entire growing season in order to build up the soil. The goal, while not always possible to attain, should be to have something growing in your fields (even if dormant during the winter) all the time. Other management issues include when and how to kill or suppress the cover crop, and how to reduce the possibility of interference with your main crops either by using too much water in dry climates or by becoming a weed in subsequent crops.

A) Root of forage radish

B) Root holes (bio-drilling) and root remains in spring following fall forage radish.

C) Horizontal cracks with rye (left) and vertical cracks with forage radish (right)

Figure 10.4.
Brassica cover crop roots. Photos by Ray Weil

COVER CROP SELECTION AND PLANT PARASITIC NEMATODES

If nematodes become a problem in your crops (common in many vegetables such as lettuce, carrots, onions, and potatoes, as well as some agronomic crops), carefully select cover crops to help limit the damage. For example, the root-knot nematode (M. hapla) is a pest of many vegetable crops, as well as alfalfa, soybeans, and clover, but all the grain crops—corn, as well as small grains—are nonhosts. Growing grains as cover crops helps reduce nematode numbers. If the infestation is very bad, consider two full seasons with grain crops before returning to susceptible crops. The root-lesion nematode (P. penetrans) is more of a challenge because most crops, including almost all grains, can be hosts for this organism. Whatever you do, don't plant a legume cover crop such as hairy vetch if you have an infestation of root-lesion nematode—it will actually stimulate nematode numbers.

However, sudan grass, sorghum-sudan crosses, and ryegrass, as well as pearl millet (a grain crop from Africa, grown in the U.S. mainly as a warm-season forage crop) have been reported to decrease nematode numbers dramatically. Some varieties appear better for this purpose than others. The suppressive activity of such cover crops is due to their poor host status to the lesion nematode, general stimulation of microbial antagonists, and the release of toxic products during decomposition. Forage millet; sudan grass; and brassicas such as mustard, rapeseed, oilseed radish, and flax all provide some biofumigation effect because, when they decompose after incorporation, they produce compounds that are toxic to nematodes. Marigolds can secrete compounds from their roots that are toxic to nematodes.

NEMATODES AND COVER CROPS

Plant parasitic nematodes behave in different ways, some feed externally on plant roots whilst others invase the roots internally. Severe nematode damage can cause the crop to be unmarketable and reduce crop yields. Crop rotation by growing no-host crops will help reduce nematode populations reaching damaging levels. A cover crop is also a very effective way to controlling nematode populations aswell as returning valuable nutrients to the soil.

CROP SOLUTION SUMMARY

TYPE OF NEMATODE	CROPS AT RISK	RESISTANT COVER CROP	PREVENTATIVE METHODS	HOST PLANTS
Beet Cyst Nematode Hs*, Hb*	Sugar beet Fodder beet Beetroot Oil seed rape	Oil seed radish Mustard	Prevents weeds Crop rotation	Spinash Fodder rape All brassicas Fat hen
Root Knot Nematode Mc*, Mf*, Mn*	Potato Carrot Parsnip	Oil seed radish	Fallow Short cycle host cropping	Ryegrass Maize Carrot Parsnip Rye, Potato
Stem Nematode Dd*	Potato Sugar beet Onion Carrot	Oil seed radish	Clean and healthy seeds and plants	Potato Sugar beet Onion Lucern
Root Lesion Nematode Pp*	Carrot Parsnip Some legumes Maize	Tagetes	Crop rotation	Potato Wheat Maize
Potato Cyst Nematodes (PCN) Gr*, Gp*	Potato	Oil seed radish Mustard	Crop rotation Resistant varieties	Potato Nightshade

MIXTURES OF COVER CROPS

Although most farmers use single species of cover crops in their fields, mixtures of different cover crops offer combined benefits. The most common mixture is a grass and legume, such as winter rye and hairy vetch, oats and red clover, or field peas and a small grain. Other mixtures might include a legume or small grain with forage radish or even just different small grains mixed together. Mixed stands usually do a better job of suppressing weeds than a single species. Growing legumes with grasses helps compensate for the decreases in nitrogen availability for the following crop when grasses are allowed to mature. In the mid-Atlantic region, the winter rye–hairy (grazing) vetch mixture has been shown to provide another advantage for managing nitrogen: When a lot of nitrate is left in the soil at the end of the season, the rye is stimulated (reducing leaching losses). When little nitrogen is available, the vetch competes better with the rye, fixing more nitrogen for the next crop.

A crop that grows erect, such as winter rye, may provide support for hairy vetch and enable it to grow better. Mowing close to the ground kills vetch supported by rye easier than vetch alone. This may allow mowing instead of herbicide use, in no-till production systems. *For mixture examples see page 23*

PLANTING OF COVER CROPS

If you want to accumulate a lot of organic matter, it's best to grow a cover crop for the whole growing season (see figure 10.5a), which means no income-generating crop will be grown that year. This may be useful with very infertile or eroded soils. It also may help vegetable production systems when there is no manure available and where a market for hay crops justifies a longer rotation.

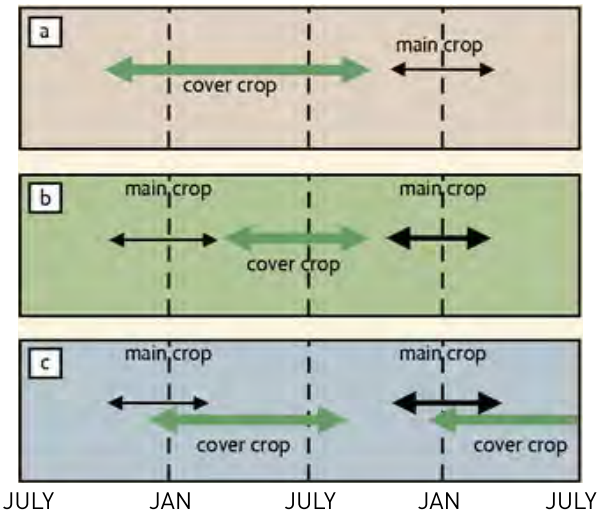


Figure 10.5. Three ways to time cover crop growth for use with summer crop

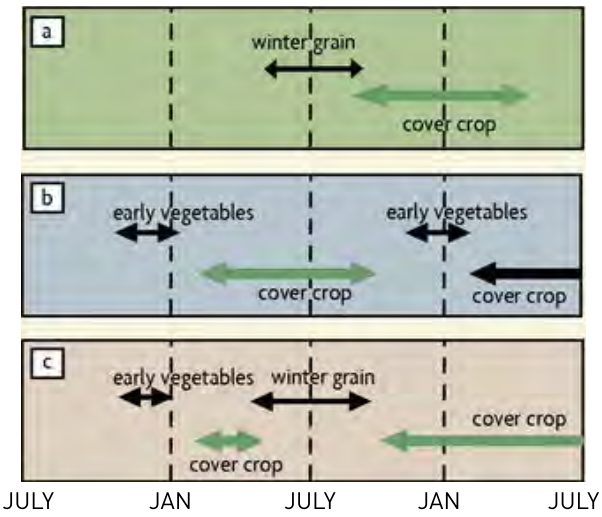


Figure 10.6. Timing cover crop growth for winter grain, early vegetable, and vegetable-grain systems.

PLANTING AFTER ECONOMIC CROP HARVEST.

Most farmers sow cover crops after the economic crop has been harvested (figure 10.5b). In this case, as with the system shown in figure 10.5a, there is no competition between the cover crop and the main crop. The seeds can be no-till drilled instead of broadcast, resulting in better cover crop stands. We recommend against the use of tillage prior to cover crop seeding, as it negates most of the benefits of the cover crop. In milder climates, you can usually plant cover crops after harvesting the main crop. In colder areas, there may not be enough time to establish a cover crop between harvest and winter. Even if you are able to get it established, there will be little growth in the fall to provide soil protection or nutrient uptake. The choice of a cover crop to fit between main summer crops (figure 10.5b) is severely limited in colder climates by the short growing season and severe cold. Winter rye is probably the most reliable cover crop for those conditions. In most situations, there are a range of establishment options. South Africa not having such long Winters enables farmers to consider alot of other species as a cover crop.

Cover crops are also established following grain harvest in late spring (figure 10.6a). With some early-maturing vegetable crops, especially in warmer regions, it is also possible to establish cover crops in late spring or early summer (figure 10.6b). Cover crops also fit into an early vegetable–winter grain rotation sequence (figure 10.6c).

INTERSEEDING

The third management strategy is to interseed cover crops during the growth of the main crop. Cover crops are commonly interseeded at planting in winter grain cropping systems or frost-seeded in early spring. Seeding cover crops during the growth of economic crops (figure 10.5c) is especially helpful for the establishment of cover crops in areas with a short growing season. Delaying the cover crop seeding until the main crop is off to a good start means that the commercial crop will be able to grow well despite the competition.

Figure 10.7. Winter rye interseeded with maturing soybeans.

Good establishment of cover crops requires moisture and, for small-seeded crops, some covering of the seed by soil or crop residues.

Winter rye is able to establish well without seed covering, as long as sufficient moisture is present (figure 10.7). Farmers using this system usually broadcast seed during or just after the last cultivation of a row crop. Aerial seeding, "highboy" tractors, or detasseling machines are used to broadcast green manure seed after a main crop is already fairly tall. When growing is on a smaller scale, seed is broadcast with the use of a hand-crank spin seeder.

INTERCROPS AND LIVING MULCHES

Growing a cover crop between the rows of a main crop has been practiced for a long time. It has been called a living mulch, an intercrop, polyculture (if more than one crop will be harvested), and an orchard-floor cover. Intercropping has many benefits. Compared with bare soil, a ground cover provides erosion control, better conditions for using equipment during harvesting, higher water-infiltration capacity, and an increase in soil organic matter. In addition, if the cover crop is a legume, a significant buildup of nitrogen may be available to crops in future years.

Figure 10.8. A wide cover-free strip and living mulch, which is also used for traffic.

Another benefit is the attraction of beneficial insects, such as predatory mites, to flowering plants. Less insect damage has been noted under polyculture than under monoculture.Growing other plants near the main crop also poses potential dangers. The intercrop may harbor insect pests, such as the tarnished plant bug. Most of the management decisions for using intercrops are connected with minimizing competition with the main crop.

Intercrops, if they grow too tall, can compete with the main crop for light, or may physically interfere with the main crop's growth or harvest. Intercrops may compete for water and nutrients. Using intercrops is not recommended if rainfall is barely adequate for the main crop and supplemental irrigation isn't available. One way to decrease competition is to delay seeding the intercrop until the main crop is well established. This is sometimes done in commercial fruit orchards. Soil-improving intercrops established by delayed planting into annual main crops are usually referred to as cover crops. Herbicides, mowing, and partial rototilling are used to suppress the cover crop and give an advantage to the main crop. Another way to lessen competition from the cover is to plant the main crop in a relatively wide coverfree strip (figure 10.8). This provides more distance between the main crop and the intercrop rows.

COVER CROP TERMINATION

No matter when you establish cover crops, they are usually killed before or during soil preparation for the next economic crop. This is usually done by mowing (most annuals are killed that way) once they've flowered, plowing into the soil, using herbicides, rolling and crimping in the same operation, or naturally by winter injury. In many cases it is a good idea to leave a week or two between the time a cover crop is tilled in or killed and the time a main crop is planted. Studies have found that a forage sorghum cover crop is especially allelopathic and that tomatoes, broccoli, and lettuce should not be planted until six to eight weeks to allow for thorough leaching of residue. This allows some decomposition to occur and may lessen problems of nitrogen immobilization and allelopathic effects, as well as avoiding increased seed decay and damping-off diseases (especially under wet conditions) and problems with cutworm and wireworm. It also may allow for the establishment of a better seedbed for small-seeded crops, such as some of the vegetables. Establishing a good seedbed for crops with small seeds may be difficult, because of the lumpiness caused by the fresh residues. Good suppression of vetch in a no-till system has been obtained with the use of a modified rolling stalk chopper. Farmers are also experiencing good cover crop suppression using a crimper-roller that goes ahead of the tractor, allowing the possibility of notill planting a main crop at the same time as suppressing the cover crop. Although not recommended for most direct-seeded vegetable crops, this works well for many agronomic crops.

MANAGEMENT CAUTIONS

Cover crops can cause serious problems if not managed carefully. They can deplete soil moisture; they can become weeds; and—when used as an intercrop—they can compete with the cash crop for water, light, and nutrients.

In drier areas and on droughty soils, such as sands, late killing of a winter cover crop may result in moisture deficiency for the main summer crop. In that situation, the cover crop should be killed before too much water is removed from the soil. However, in warm, humid climates where no-till methods are practiced, allowing the cover crop to grow longer means more residue and better water conservation for the main crop. Cover crop mulch may more than compensate for the extra water removed from the soil during the later period of green manure growth. In addition, in very humid regions or on wet soils, the ability of an actively growing cover crop to "pump" water out of the soil by transpiration may be an advantage. Letting the cover crop grow as long as possible results in more rapid soil drying and allows for earlier planting of the main crop. Some cover crops can become unwanted weeds in succeeding crops. Cover crops are sometimes allowed to flower to provide pollen to bees or other beneficial insects.

However, if the plants actually set seed, the cover crop may reseed unintentionally. Cover crops that may become a weed problem include buckwheat, ryegrass, crown vetch, and hairy vetch. On the other hand, natural reseeding of subclover, crimson clover, or velvet bean might be beneficial in some situations.

Finally, thick-mulched cover crops make good habitat for soil organisms—and also for some undesirable species. Animals like rats, mice, and snakes (in warm climates) may be found under the mulch, and caution is recommended when manual fieldwork is performed.

SELECTION OF COVER CROPS

BEFORE GROWING COVER CROPS, ASK YOURSELF SOME QUESTIONS:

- What type of crop should I plant?
- When and how should I plant the crop?
- When should the crop be killed or incorporated into the soil?
- When you select a cover crop, you should consider the soil conditions, climate, and what you want to accomplish by answering these questions:
- Is the main purpose to add available nitrogen to the soil, or to scavenge nutrients and prevent loss from the system? (Legumes add N; other cover crops take up available soil N.)
- Do you want your cover crop to provide large amounts of organic residue?
- Do you plan to use the cover crop as a surface mulch, or incorporate it into the soil?
- Is erosion control in the late fall and early spring your primary objective?
- Is the soil very acidic and infertile, with low availability of nutrients?
- Does the soil have a compaction problem? (Some species, such as sudan grass, sorghum, pearl millet, sweet clover, and forage radish, are especially good for alleviating compaction.)
- Is weed suppression your main goal? (Some species establish rapidly and vigorously, while some also chemically inhibit weed seed germination.)
- Which species are best for your climate? (Some species are more winter-hardy than others.)
- Will the climate and water-holding properties of your soil cause a cover crop to use so much water that it harms the following crop?
- Are root diseases or plant-parasitic nematodes problems that you need to address? (Winter [cereal] rye, for example, has been found to suppress a number of nematodes in various cropping systems.)

In most cases, there are multiple objectives and multiple choices for cover crops.

TYPES OF COVER CROPS

Many types of plants can be used as cover crops. Legumes and grasses (including cereals) are the most extensively used, but there is increasing interest in brassicas (such as rape, mustard, and forage radish) and continued interest in others, such as buckwheat. Some of the most important cover crops are discussed below.

LEGUMES

Leguminous crops are often very good cover crops. Summer annual legumes, usually grown only during the summer, include soybeans, cowpeas, and beans. Winter annual legumes that are normally planted in Autumn and counted on to overwinter include winter field peas, crimson and other annual clovers, hairy (grazing) vetch, and subterranean clover. Some, like crimson clover and field peas, can overwinter only in regions with mild frost. Hairy (grazing) vetch is able to withstand fairly severe winter weather. Biennials and perennials include red clover, white clover, sweet clover, and alfalfa. Crops usually used as winter annuals can sometimes be grown as summer annuals in cold, short-season regions. Also, summer annuals that are easily damaged by frost, such as cowpeas, can be grown as a winter annual in the dfrost free areas.

One of the main reasons for selecting legumes as cover crops is their ability to fix nitrogen from the atmosphere and add it to the soil. Legumes that produce a substantial amount of growth, such as hairy (grazing) vetch and crimson and persian clover, may supply over 100 pounds of nitrogen per acre to the next crop. Legumes such as field peas, bigflower vetch, and red clover usually supply only 30 to 80 pounds of available nitrogen. Legumes also provide other benefits, including attracting beneficial insects, helping control erosion, and adding organic matter to soils.

INOCULATIONS

If you grow a legume as a cover crop, don't forget to inoculate seeds with the correct nitrogenfixing bacteria. Different types of rhizobial bacteria are specific to certain crops. There are different strains for alfalfa, clovers, soybeans, beans, peas, vetch, and cowpeas. Unless you've recently grown a legume from the same general group you are currently planting, inoculate the seeds with the appropriate commercial rhizobial inoculant before planting. The addition of water or milk to the seed-inoculant

mix helps the bacteria stick to the seeds. Plant right away, so the bacteria don't dry out. Inoculants are readily available only if they are commonly used in your region. It's best to check with your seed supplier a few months before you need the inoculant, so it can be specially ordered if necessary. Keep in mind that the "garden inoculant" sold in many garden stores may not contain the specific bacteria you need; so be sure to find the right one for the crop you are growing and keep it refrigerated until used.

WINTER ANNUAL LEGUMES

CRIMSON CLOVER is considered one of the best cover crops for the southeastern United States. Where adapted, it grows in the fall and winter and matures more rapidly than most other legumes. It also contributes a relatively large amount of nitrogen to the following crop. Because it is not very winter-hardy, crimson clover is not usually a good choice for the regions where significant frost occurs. In northern regions, crimson clover can be grown as a summer annual, but that prevents an economic crop from growing during that field season. Crimson clover does not grow well on high-pH (calcareous) or poorly drained soils.

FORAGE PEAS are grown in colder climates as a summer annual , planted in spring and as a winter annual over large sections of the country. They have taken the place of fallow in some dryland, small-grain production systems. Also called Austrian winter peas and Canadian field peas, they tend to establish quickly and grow rapidly in cool moist climates, producing a significant amount of residue—2 1/2 tons or more of dry matter. They fix plentiful amounts of nitrogen, from 100 to 150 or more pounds per acre.

Forage peas - Morgan and Jupiter

HAIRY (GRAZING, OR COMMON) VETCH is winter-hardy enough to grow well in areas that experience cold winters. Where adapted, hairy vetch produces a large amount of vegetation and fixes a significant amount of nitrogen, contributing 100 pounds of nitrogen per acre or more to the next crop. Hairy vetch residues decompose rapidly and release nitrogen more quickly than most other cover crops. This can be an advantage when a rapidly growing, highnitrogen-demand crop follows hairy vetch. Hairy vetch will do better on sandy soils than many other green manures, but it needs good soil potassium levels to be most productive.

SUBTERRANEAN CLOVER is a warm-climate winter annual that, in many situations, can complete its life cycle before a summer crop is planted. When used this way, it doesn't need to be suppressed or killed and does not compete with the summer crop. If left undisturbed, it will naturally reseed itself from the pods that mature below ground. Because it grows low to the ground and does not tolerate much shading, it is not a good choice to interplant with summer annual row crops.

SUMMER ANNUAL LEGUMES

BERSEEM CLOVER is an annual crop that is grown as a summer annual in colder climates. It establishes easily and rapidly and develops a dense cover, making it a good choice for weed suppression. It's also drought tolerant and regrows rapidly when mowed or grazed. It can be grown in the mild climates during the winter.

COWPEAS AND DOLICHOS LAB LAB are native to Central Africa and do well in hot climates. Cowpeas and Dolichos Lab Lab, however are severely damaged by even a mild frost. It is deep rooted and is able to do well under droughty conditions. It usually does better on low-fertility soils than many other cover crops.



Cowpeas - Brown Mixed, Black Eyed, Bechuana White, Glenda and IT18

SOYBEANS, usually grown as an economic crop for their oiland protein-rich seeds, also can serve as a summer cover crop if allowed to grow until flowering. They require a fertile soil for best growth. As with cowpeas, soybeans are easily damaged by frost. If grown to maturity and harvested for seed, they do not add much in the way of lasting residues or nitrogen.

VELVET BEAN (mucuna) is widely adopted in tropical climates. It is an annual climbing vine that grows aggressively to several feet high and suppresses weeds well (figure 10.2). In a velvet bean–corn sequence, the cover crop provides a thick mulch layer and reseeds itself after the corn crop. The beans themselves are sometimes used for a coffee substitute and can also be eaten after long boiling. A study in West Africa showed that velvet bean can provide nitrogen benefits for two successive corn crops.

SUNHEMP (CROTOLARIA JUNCEA KING OF GREEN MANURE CROPS)

Sunhemp was introduced into the sugar industry in the late 1920's and was used as a natural source of nitrogen until the advent of artificial fertilizers such as Urea, during the 1930's. The plant is very hardy, grows rapidly and can produce up to 10 tons of above ground dry matter bio-mass per hectare. Sunhemp is a tall herbaceous annual plant with bright yellow flowers with roots that form numerous lobed nodules. It is preferable to then mow the crop and leave the residue on the soil surface to decompose. This protects the soil and cuts down on unnecessary tillage.

Sunhemp has been used extensively as a soil improvement or green manure crop in the tropics because of its ability to produce large amounts of biomass in as little as 60 to 90 days. Because of this, it has the potential to build organic matter levels and sequester carbon. It can also fix large amounts of nitrogen. Used as a cover crop, sunhemp can improve soil properties, reduce soil erosion, conserve soil water, and recycle plant nutrients and is also resistant to root-knot nematodes.

Green Manuring crops can be used in rotation with sugarcane and other crops to promote soil sustainability. Adding organic matter to any soil will improve it. It has a binding effect in the case of a light soil and in the case of a clay soil it makes it more porous. It will help drain soils that are too wet and will help hold water in soils that are too dry. Once the crop has been eradicated, the soil should be disked. Sunhemp has added actual nitrogen of about 80 kg/ha to the soil.

BIENNIAL AND PERENNIAL LEGUMES

ALFALFA is a good choice for well-drained soils that are near neutral in pH and high in fertility. The good soil conditions required for the best growth of alfalfa make it a poor choice for problem situations. Where adapted, it is usually grown in a rotation for a number of years (see chapter 11). Alfalfa is commonly interseeded with small grains, such as oats, wheat, and barley, and it grows after the grain is harvested. The alfalfa variety Nitro can be used as an annual cover crop because it is not very winter-hardy and usually winterkills under northern conditions. Nitro continues to fix nitrogen later into the fall than winter-hardy varieties. However, it does not reliably winterkill every year, and the small amounts of extra fall growth and nitrogen fixation may not be worth the extra cost of the seed compared with perennial varieties.

CROWN VETCH is adapted only to well-drained soils, but it can be grown under lower fertility conditions than alfalfa. It has been used successfully for roadbank stabilization and is able to provide permanent groundcover. Crown vetch has been tried as an interseeded "living mulch," with only limited success at providing nitrogen to corn. However, it is relatively easy to suppress crown vetch with herbicides to reduce its competition with corn. Crown vetch establishes very slowly, so it should be used only for perennial cover.

SWEET CLOVER (yellow blossom) is a reasonably winter-hardy, vigorous-growing crop with an ability to get its roots into compacted subsoils. It is able to withstand high temperatures and droughty conditions better than many other cover crops. Sweet clover requires a soil pH near neutrality and a high calcium level; it does poorly in wet, clayey soils. As long as the pH is high, sweet clover is able to grow well on low-fertility soils. It is sometimes grown for a full year or more, since it flowers and completes its life cycle in the second year. When used as a green manure crop, it is incorporated into the soil before full bloom.

WHITE CLOVER does not produce as much growth as many of the other legumes and is also less tolerant of droughty situations. (New Zealand types of white clover are more drought tolerant than the more commonly used Dutch white clover.) However, because it does not grow very tall and is able to tolerate shading better than many other legumes, it may be useful in orchard-floor covers or as a living mulch. It is also a common component of intensively managed pastures.

RED CLOVER is vigorous, shade tolerant, winterhardy, and can be established relatively easily. It is commonly interseeded with small grains. Because it starts growing slowly, the competition between it and the small grain is not usually great. Red clover also successfully interseeds with corn in the Northeast.



Clover - Haifa White, Quinquelli Red, Kenland Red, Pavo Red, Chieftain White, Oregon Red

GRASSES

Commonly used grass cover crops include the annual cereals (rye, wheat, barley, oats), annual or perennial forage grasses such as ryegrass, and warm-season grasses such as sorghum–sudan grass. Nonlegume cover crops, which are mainly grass species, are very useful for scavenging nutrients—especially N—left over from a previous crop. They tend to have extensive root systems, and some establish rapidly and can greatly reduce erosion. In addition, they can produce large amounts of residue and, therefore, can help add organic matter to the soil. They also can help suppress weed germination and growth.

A problem common to all the grasses is that if you grow the crop to maturity for the maximum amount of residue, you reduce the amount of available nitrogen for the next crop. This is because of the high C:N ratio, or low percentage of nitrogen, in grasses near maturity. The problem can be avoided by killing the grass early or by adding extra nitrogen in the form of fertilizer or manure. Another way to help with this problem is to supply extra nitrogen by seeding a legume-grass mix.

ANNUAL RYEGRASS (not related to winter rye) grows well in the autumn and winter if established early enough. It develops an extensive root system and therefore provides very effective erosion control while adding significant quantities of organic matter. It may winterkill in cold climates. Some caution is needed with annual ryegrass; because it is difficult to kill, it may become a problem weed in some situations.

WINTER RYE, also called cereal or grain rye, is very winter-hardy and easy to establish. Its ability to germinate quickly, together with its winter-hardiness, means that it can be planted later in the fall than most other species, even in cold climates. Decomposing residue of winter rye has been shown to have an allelopathic effect, which means that it can chemically suppress germination of weed seeds. It grows quickly in the fall and also grows readily in the spring (figure 10.3). It is often the cover crop of choice as a catch crop and also works well with a roll-crimp mulch system—in which the cover crop is suppressed by rolling and crimping at the same time and crops are seeded or transplanted through the mulch (see figure 16.7).

OATS are winter-hardy and provides a natural mulch the following spring and may help with weed suppression. As a mixture with one of the clovers, oats provide some quick cover in the autumn. Oat stems help trap snow and conserve moisture, even after the plants have been killed by frost. Black oat is very popular with farmers in South America, where it is mulched for no-till row crops.



Oats - Saia, Overberg, Kompasberg, SWK001, Cedarberg, Witteberg, Targa, Red Dawn

PEARL MILLET - SPEEDFEED should be planted in October, November or December. Speedfeed is good herbage for dairy cattle, growing calves and horses. There is no danger of prussic acid poisoning. Speedfeed has a very fast germination rate. Speedfeed tolerates poor or acid soils better than maize and forage sorghum.

Speedfeed has a higher sugar content and improved rust tolerance. Speedfeed is also noted as being very drought tolerant and a warm season annual grass adapted to sandy soils and well-drained heavier soils. Speedfeed is economical — it has a plant population of 5-8kg/ha and can be used for grazing, hay and green chop and silage.

FORAGE SORGHUM - MULTICUT can be used for grazing, hay, silage or green chop and is excellent dry matter production and it has a high protein and energy content. Multicut has been bred to surpass many of the existing hybrids in dry matter production, protein and energy content, disease and drought tolerance. It is also for rapid re-growth under heavy grazing and unfavourable growing conditions.

Under optimum conditions multicut will utilize available nutrients and moisture to maximise dry matter and protein production and good management produces high tonnages with superb feed values. Multicut can be grazed, cut for hay, silage or fed as green chop and has a quick initial growth with grazing from 3 - 6 weeks after planting. The re-growth and tillering is rapid and it can grow 50mm a day and to a height of 3 m. Multicut can be looked on as stress insurance, recovering well after dry spells and responding rapidly to any available moisture. Multicut will ratoon after hail or insect damage. Because of its versatility, it can be used as high energy feed for high producing dairy or beef cattle, as well as maintenance rations for breeding stock.

OTHER CROPS

BUCKWHEAT is a summer annual that is easily killed by frost. It will grow better than many other cover crops on low-fertility soils. It also grows rapidly and completes its life cycle quickly, taking around six weeks from planting into a warm soil until the early flowering stage. Buckwheat can grow more than 2 feet tall in the month following planting. It competes well with weeds because it grows so fast and, therefore, is used to suppress weeds following an early spring vegetable crop. It has also been reported to suppress important root pathogens, including Thielaviopsis and Rhizoctonia species. It is possible to grow more than one crop of buckwheat per year in many regions. Its seeds do not disperse widely, but it can reseed itself and become a weed. Mow or till it before seeds develop to prevent reseeding.

BRASSICAS used as cover crops include mustard, rapeseed, and forage radish. They are increasingly used as winter or rotational cover crops in vegetable and specialty crop production, such as potatoes and tree fruits. Canola grows well under the moist and cool conditions of late fall, when other kinds of plants are going dormant for winter. Forage radish has gained a lot of interest because of its fast growth in late summer and fall, which allows significant uptake of nutrients. It develops a large taproot—1–2 inches in diameter and a foot or more deep—that can break through compacted layers, allowing deeper rooting by the next crop (figure 10.4).

FORAGE RADISH will winterkill and decompose by spring, but it leaves the soil in friable condition and improves rainfall infiltration and storage. It also eases root penetration and development by the following crop.

CANOLA AND OTHER BRASSICA crops may function as biofumigants, suppressing soil pests, especially root pathogens and plant-parasitic nematodes. Row crop farmers are increasingly interested in these properties. Don't expect brassicas to eliminate your pest problems, however. They are a good tool and an excellent rotation crop, but pest management results are inconsistent.

BLACK MUSTARD - Brassica nigra does not fix atmospheric nitrogen, it does sequester nitrogen from the soil, which is then returned back to the soil when the plants senesce. Black mustard is allelopathic, effectively inhibiting growth of weeds when it is thickly sown. The main use of mustard as a cover crop is in orchards, where it is known to inhibit infestations of aphids and spider mites. Where autumn-sown mustard is mown, the plant remains make a desirable mulch for growing spring crops and vegetables. Gas is released during decomposition acting as a biofumigant. Generally these levels are higher than in white mustard. Isothiocyanate (ITC) is a natural gas released from all brassicaceous plant tissues. The gas is produced when plant cells are damaged (by crushing or chopping) and compounds called glucosinolates (present in all brassicas) come into contact with an enzyme (myrosinase) in the presence of water.

OILSEED RADISH (Raphanus sativus or R. sativus var. Oleiferus) Originally developed, as the name implies, for oil production. Oilseed radish establishes and grows quickly during cool weather. It can be planted early in the spring and autumn to provide fast cover and a green manure crop for cash crops. Oil seed radish has a thick, deep root that can help break up compacted soil layers and scavenge nitrate that has leached beyond the rooting zone of other crops. Oilseed radish is also a highly digestible forage for early and late season grazing.

- Fast growth in spring or autumn provides quick ground cover to protect against soil erosion and smother weeds.
- Thick, deep taproot can break up compacted soil layers and scavenge nitrate from deeper soil layers.
- Can be used as a cover crop and livestock forage.
- May have an allelochemical effect following decomposition that can help control soil-borne pests, including insects, weeds and nematodes.
- Good dry matter yield for increasing organic matter content of the soil.

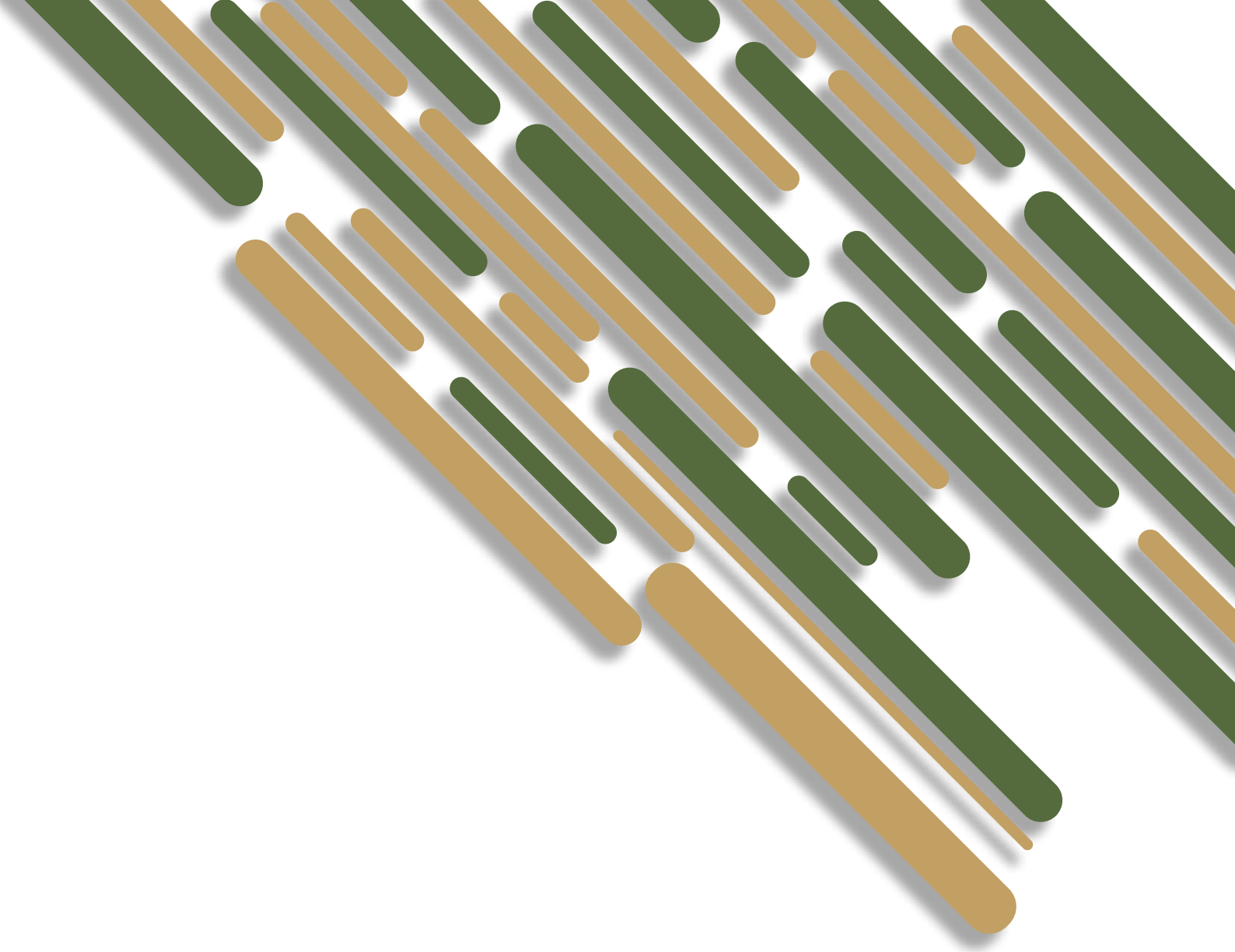
EXAMPLE OF AN ANNUAL WINTER MIXTURE

*1 BAD - 5 EXCELLENT

EXAMPLE OF A WINTER MIXTURE WITH EXCELLENT FORAGEABILITY

*1 BAD - 5 EXCELLENT

Cover Crops in Bergville, KZN, 2018



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