Cover Cropping:
On-farm, Solar-powered Soil Building

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Sustainable farmers and gardeners know that the soil needs to be "fed" regularly in order to continue yielding good crops. *Organic matter* (carbon-based materials derived from living organisms) and *nitrogen* (N) are especially subject to depletion from intensive production, and must be replenished annually. There are two ways to accomplish this. One way is to haul compost, aged manure, mulch hay and other nutrient-rich organic materials into the field and spread them. That can run into a lot of labor and/or fuel costs. The other way is to sow cover crops and let them produce the organic matter and N in place, using solar energy!

Contents:

What is a Cover Crop?

A *cover crop* is any crop grown primarily to protect, maintain or enrich the soil. When intensive tillage and bare fallowing practices led to severe wind and water erosion in the Midwest and Great Plains during the 20th century, the Soil Conservation Service encouraged producers to keep their fallow fields covered with living vegetation or dead plant residues as much as possible, even if it meant planting crops that would not be harvested for food, fodder or fiber. This was the original meaning of "cover crop."

Forward-thinking farmers soon learned that cover crops also "feed" the soil, and that nitrogen-fixing *legume* cover crops add sufficient N to reduce the need for fertilizer N and enhance yields of the next crop. Others noticed improved soil tilth, better moisture conservation, or reduced pest or weed problems after adding cover crops to their rotations. Several other terms for cover crops reflect the other functions of these valuable plant species on the farm. A *green manure* is a cover crop that is tilled into the topsoil to add organic matter and feed the soil life. A *smother crop* is a cover crop grown in order to suppress or choke out weeds. A *catch crop* is planted after harvest of a heavily-fertilized production crop to "mop up" and conserve leftover mineral N and other soluble nutrients.

Why are Cover Crops important?

Cover cropping has become a cornerstone of sustainable agricultural systems throughout the world because these solar-powered soil builders:

- replenish soil organic matter.
- feed and support the soil life.
- fix atmospheric N into plant-available soil N (legumes only).
- make other nutrients more available, especially phosphorus (P).
- help maintain nutrient balance on soils already rich in P and potassium (K).
- protect the soil from wind and water erosion.
- protect the soil surface from compaction, hot sun and raindrop impact.
- enhance soil tilth (crumb structure), aeration, drainage and moisture-holding capacity.
- suppress weeds.
- enhance crop diversity, reducing pest and disease problems.
- provide food and habitat for beneficial insects.
- many cover crops can also provide food or livestock fodder.

Cover crops feed and support the tremendous diversity of bacteria, fungi, protozoa, earthworms and other organisms that are so vital to soil health and fertility. They do so both while growing and after they are tilled into the soil, mowed down or frost-killed. Like most living plants, cover crops donate a significant portion (perhaps 10 percent) of their photosynthetic product to the soil life in the form of *root exudates* that nourish and stimulate beneficial microorganisms such

as mycorrhizae that help plants absorb P, micronutrients and moisture. Then the soil life enjoys a "grand feast" when the cover crop is turned under or mowed. A good winter cover crop might generate three or four tons per acre (dry weight) of organic matter by the end of May, and a summer annual cover crop can do so within 65 days after planting! For each ton above ground, add another half ton in roots plus exudates. That's a *lot* of organic matter – as much as there is in 25 tons of fresh dairy manure. One good cover crop can replenish much of the soil organic matter that is decomposed during a season of intensive crop production.

Leguminous cover crops fix atmospheric N through their symbiotic nitrogen-fixing root nodule bacteria *(Rhizobia)*. Annual legumes such as peas, vetches, crimson clover, soybeans or cowpeas typically fix 50 to 150 lb N per acre, sometimes as much as 250 lb. In a pure legume cover crop, about half of that N may be released quickly in plant-available form – sometimes too quickly, so that some is lost to leaching.

Growers often plant a mixture of a grass (cereal grain, ryegrass, millet or sorghum-sudan hybrid) and a legume for slow-release N. The mixture may produce more biomass, form more soil organic matter and suppress weeds more effectively than either component alone. The two components complement each other in other ways. Sturdy grains provide support for viny legumes; fine grass roots improve topsoil crumb structure while deep heavy legume taproots open the subsoil and enhance drainage; and the biculture may provide home for a greater diversity of beneficial insects and soil microorganisms.

When a field might have *too much* soluble N left over after a cash crop, a heavy-feeding non-legume such as winter rye, sorghum-sudangrass or forage radish can be planted to take up and store the excess N, so that it does not get lost to leaching and pollute groundwater. Rye can take up 70 lb N per acre over winter, while sorghum-sudan, pearl millet and radish might absorb 100 lb or more in late summer and fall.

Cover crops combat weeds in two ways: *competition* and *allelopathy*. A good stand of buckwheat, millet or cowpea can cover the ground completely in two to three weeks after planting, putting emerging weeds in the shade and choking them out. Fast-growing cover crops pre-empt soil moisture and nutrients so weeds grow little and form few seeds.

Allelopathy occurs when natural substances exuded by the roots or leached from the foliage or residues of one plant inhibit the germination or growth of another. Winter rye, oats, sorghum-sudangrass, buckwheat, forage radish and some leguminous cover crops have demonstrated strong allelopathic inhibition of major weed species. Including cover crops in a rotation can reduce weed problems and the frequency of cultivation for weed control.

The importance of soil coverage – by live vegetation or dead mulch – cannot be overstated. Even partial cover can reduce wind and water erosion substantially. When the soil is completely covered by foliage or mulch, erosion stops under all but the most extreme conditions. Cover crops also protect the soil surface from the drying effects of direct sun and the compacting effect of raindrop impact. When soil lies bare for weeks on end, hot sun and pounding rains soon create a compacted "dead zone" or crust – compare that to the softer, more open soil surface under a cover crop or mulch.

Finally, leaving strips or patches of cover crop in the field to bloom can provide vital food (nectar and pollen) and habitat to predators and parasites of major insect pests. This can be an important "farmscaping" strategy. Commercially available "beneficial blends" – mixtures of plants that flower throughout the season and support beneficial insects – usually include vetches, clovers, small grains or other cover crops along with certain wild and cultivated flowers and herbs.

When to plant Cover Crops

Grow cover crops whenever the soil would otherwise be unoccupied:

- In the early fall, after summer vegetable or row crops are harvested
- In the early spring, before planting a mid summer vegetable
- In the summer after an early spring crop is harvested

Hardy winter annual cover crops like rye, wheat, winter barley, hairy vetch, crimson clover and Austrian winter pea are planted at the end of summer or early fall, and grown into the following spring to provide soil protection and weed suppression over winter. *Cool-season semi-hardy annuals* such as oats, bell

beans, purple vetch and most varieties of field pea can be planted in early spring ahead of midsummer cash crops, or in late summer after harvesting early crops. *Summer annuals* like buckwheat, millets, cowpeas, soybeans and sorghum-sudan hybrids are frost-tender and grow vigorously in summer heat. They are well suited for generating biomass and suppressing weeds during summer fallow periods after early vegetables or before fall vegetables. *Hardy perennials* such as red, white and alsike clovers, alfalfa, timothy, orchardgrass and perennial ryegrass are grown for two or three years to restore "tired" soils that have suffered declining organic matter or fertility from intensive production. Red or white clover, or the biennial sweetclovers, can also be grown for about one year to add N and relieve hardpan. For details on seeding rates, depths and time of planting for various cover crops, see the table in information sheet #3-06, *Cover Crops for All Seasons*.

Some growers seek to eliminate bare soil altogether by *overseeding* cover crops into established vegetable, row or grain crops. The cover crop grows slowly under the cash crop, then more rapidly after it is harvested. This works best with some clovers, especially red and white clover, which are somewhat shade tolerant.

How to grow Cover Crops

Cover crops are generally easy to grow. Once they are established cover crops should grow vigorously with little care. Be sure to choose the right cover crop for the time of year and use good planting technique. Winter rye and vetches will do great planted in early fall, but will perish in summer heat. At the other extreme, heat loving crops like cowpea and sorghum-sudangrass will not thrive if planted when the soil is cooler than 65-70°F. This might be two or three weeks *after* the spring frost-free date.

Correct seeding rate and depth and good seed-soil contact are essential to get a solid stand that will emerge promptly and outcompete the weeds. Drilling is the best method. On the garden scale, a manually pushed garden seeder can effectively drill the seed. For most cover crops make rows about 6 inches apart. (See the information sheet #4-06, *Using a Manually-Pushed Garden Seeder for Precision Cover Crop Plantings on the Small Farm*.) Cover crops can also be broadcast-seeded, but care must be taken to ensure an even distribution, and to incorporate seed into the soil – about ¼ to ½ inch for small seeds (millet, clovers, radish) and 1-1½ inches for larger seeds (vetches, cereal grains, peas, soybeans). Small seeds may benefit from rolling or culti-packing for seed-soil contact. Simply scattering seeds on the soil surface and hoping that the rain will germinate them usually results in poor stands. On the garden scale rake seeds in to the appropriate depth. On a larger scale, broadcasting evenly with a spin-seeder and incorporating with a rototiller set to a shallow depth can give fine stands. For details on seeding rates, depths and time of planting for various cover crops, see the table in the information sheet #3-06, *Cover Crops for All Seasons*.

When you plant a legume remember that it will fix nitrogen only if its roots can associate with the correct species of *Rhizobium.* The desired bacteria may or may not already be present in your soil. It is always wise to invest a few dollars in the appropriate *Rhizobium* inoculant. Apply the inoculant just before seeding according to package instructions.

Cover crops tolerate a relatively wide range of conditions. If you want to ensure a vigorous, high-biomass crop be sure it has enough moisture and nutrients. If soil fertility is low it pays to apply a little aged manure, compost or organic fertilizer before planting, as a larger cover crop will boost soil fertility faster and choke out weeds. If conditions are dry at planting then irrigate if practical. Just one good watering will get the crop up, and it should be self-sufficient thereafter under all but the most severe drought conditions.

How to manage Cover Crops

There are several ways to manage a cover crop once it is grown and it is time to plant vegetables. The most common is to till it into the soil and let it break down for a few weeks before planting. This is easier to do if the green manure is still succulent, or if it has been frost-killed over winter, leaving a weathered residue that breaks down easily. If you are faced with several feet of dense, stemmy cover crop, mow it first, let it wither for a few days, then work it in. Incorporate cover crops with a rotary or reciprocating spader, rototiller, field cultivator or chisel plow. Inverting the soil with a moldboard plow can place the green matter too deep where it undergoes a slow anaerobic decay, creating toxins that inhibit plant growth, rather than the desired active soil organic matter.

Note that when a green manure is incorporated

a burst of biological activity follows that can inhibit newly-planted crops for the first couple of weeks. Thus it usually does not pay to plant *immediately* after a live cover crop is incorporated, even if the seedbed looks clean. When this adverse effect subsides conditions then become quite favorable as beneficial microbes take over.

Another way to manage the cover crop is to mow or roll it down when it is flowering or in early seed formation. This kills many (though not all) annual cover crops and forms an *in situ* mulch through which vegetable starts, seed potatoes or large crop seed may be planted with a no till planter. For more information on cover crop based organic no-till systems see the information sheets *No-till and Conservation Tillage Cover Crop Mulch Systems for Organic Vegetable Production,* and #3-06, *Cover Crops for All Seasons.*

At the garden scale a really dense cover crop can be difficult to incorporate with hand tools. Try cutting it with a scythe, weed whacker or sickebar mower and using the clippings to mulch another bed, or to make compost. Till up the root mass, wait a week or two, and plant the bed. Or try a no-till or strip-till approach, stockpiling the clippings to reapply later as mulch, once the soil has warmed up and your vegetables or flowers are established.

Cover Crop Information Resources:

Preston Sullivan, 2003. *Overview of Cover Crops and Green Manures*. ATTRA National Sustainable Agriculture Information Service, 16 pp. Available at *www.attra.ncat.org/attra-pub/covercrop.html*.

George Kuepper, 2001 (updated 2004). *Pursuing Conservation Tillage Systems for Organic Crop Production.* ATTRA National Sustainable Agriculture Information Service. Available at *www.attra.ncat.org/attra-pub/organicmatters/conservationtillage.html.*

Managing Cover Crops Profitably, 2nd Edition, Sustainable Agricultural Network, Handbook Series No. 3, National Agricultural Library, Beltsville, MD 20705-2351. 212 pp. www.sare.org/publications/.

Additional articles and research reports on cover crops can be found on the web sites of the Organic Farming Research Foundation (*www.ofrf.org/research/reports.html*.), the Organic Ag Information service (*www.organicaginfo.org*), the SARE program (*www.sare.org/projects/*), and New Farm (*www.newfarm.org*).

Resource persons include:

Professor Ron Morse, Department of Horticulture, Virginia Tech, Blacksburg, VA 24061, tel. 540-231-6724; e-mail *morser@vt.edu*;

Dr. Keith Baldwin, P.O. Box 21928, North Carolina A&T State University, Greensboro, NC 27420, tel. 336-334-7957; e-mail *kbaldwin@ncat.edu*.; and

Mark Schonbeck, 439 Valley Drive NW, Floyd, VA 24091, tel. 540-745-4130; e-mail *mark@abundantdawn.org*.

Cover Crop Seed Sources:

Local feed-and-seed stores and Southern States usually carry rye, oats, clovers, buckwheat, and sometimes foxtail millet, ryegrass, soybean, cowpea or vetches.

Adams Briscoe Seed Company, P.O. Box 19, Jackson, GA 30233-0019; 770-775-7826; *www.abseed.com.* Good source for various millets, sorghum-sudan hybrid, cowpeas, and high biomass forage soybeans.

Peaceful Valley Farm and Garden Supply, P.O. Box 2209, 125 Clydesdale Court, Grass Valley, CA 95945; 888-784-1722; *www.groworganic.com.* Carries several varieties of vetch, field peas, bell beans, and tropical legumes like sunnhemp and lablab.

Seven Springs Farm, 426 Jerry Lane NE, Check, VA 24072; 540-651-3228; *www.7springsfarm.com.* Carries winter rye, oats, hairy vetch, crimson clover, Austrian winter pea, and buckwheat.

Southern Exposure Seed Exchange, *www.southernexposure.com*. Organic seed for a limited number of cover crop varieties, with plans to expand in the future.

Important note for certified organic growers: Peaceful Valley and Seven Springs Farm carry organic cover crop seeds when these are available. When ordering from Adams Briscoe and other seed companies, be sure to request untreated seed, as treated seed (other than legumes pre-inoculated with Rhizobium only) contain fungicides and/or insecticides that are not allowed for organic production.

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