

Weed the Soil, Not the Crop

by Anne & Eric Nordell

Many sustainable growers subscribe to the philosophy of “feed the soil, not the plant.” Our whole farm approach to weed management follows the same line of thinking — only we call it “weed the soil, not the crop.” Instead of relying on the cultivator or the hoe to save the crop from the weeds, we use cultural practices, including cover cropping, bare fallow periods, rotation and shallow tillage to reduce the overall weed pressure in the soil.

One result of this proactive strategy is we no longer depend on the cultivator or the hoe to grow certified organic produce. “Weeding the soil” has also enabled us to use reduced tillage and living mulches without compromising weed management.

Weed-free conditions did not happen overnight. It took five years — and a good bit of patience and observation — to see a dramatic reduction in weed pressure. Successfully weeding the soil also required all of the following principles and practices.

Deterring certain types of weeds by changing the soil environment. We fallow half of the market garden each year for the benefit of the vegetables and to the detriment of the weeds. Giving the land a rest from vegetable production somehow changes the soil biology so that “cultivated” weeds are less likely to grow. We can enhance this “rotation effect” by utilizing mature cover crops in the fallowlands to discourage two major types of weeds.

For example, one set of weeds seems to flourish where the soil is in poor condition due to crusting, compaction or lack of organic matter. It is almost as if nature sends in the weeds to repair the damage. Cover crops can serve the same purpose by fiberizing the soil surface with fresh additions of organic matter and by rebuilding soil structure through the aggregating effect of their extensive

root systems. The key is devoting a full fallow year to cover cropping in order to put the “soil-building weeds” out of business before planting the vegetables.

By contrast, a soil management program that is based primarily on animal manure or compost may lead, over the years, to the excessive or imbalanced fertility levels and high rates of nutrient release that favor “high-fertility weeds.” In this case, nature seems to be using these well-adapted plants to mop up surplus nutrients and prevent them from polluting the environment.

Overloading the soil with quickly available fertility is generally not a problem when relying on mature cover crops to maintain soil quality. That is because the well-developed cover crops recycle nutrients already existing in the soil and release this fertility relatively slowly as their residues decompose. Conditioning the soil with a fallow year of cover crops discourages both soil-building and high-fertility weeds from growing.

Using the bare fallow to reduce the number of weeds in the soil. Our goal is to grow two mature cover crops in each fallow year preceding vegetable production. Typically, we grow one cover crop in the spring and one in the fall. Between the first cover crop and the second is a window of opportunity to use tillage to reduce the number of weeds in the soil. The length of this bare fallow period, and the type and intensity of tillage required, depends on the life cycle and growth characteristics of the most pressing weeds.



Perennial weeds. We have found the most effective way to set back deep-rooted perennial weeds is to use the mold-board plow to sever the taproot deep in the ground and to completely bury the weed's crown. Usually little follow-up tillage is necessary to finish off taprooted weeds such as dock, dandelions and thistles, if we plow them down deeply at the weakest point in their life cycle, that is, when these perennials are approaching maturity but before they set viable seed.

For rhizomonous perennial weeds such as quackgrass, shallow plowing or chiseling is preferable to deep mold-board plowing. The idea is to bring the rhizomes up to the surface of the soil to dry out in the sun rather than burying the tenacious roots deeply in the earth out of reach of most tilling equipment.

Generally it is necessary to work the fallowlands every two to three weeks to completely dehydrate the rhizomes and prevent them from rerooting. Secondary tillage tools that have a lifting and shaking action are ideal for this job, such as a springtooth harrow with closely spaced teeth or a field cultivator equipped with wide sweeps. These tools will be more effective if a chain link style of flexible pasture harrow is attached to the back to thoroughly shake the soil off of the uprooted sod clumps and to lay the rhizomes on top of the soil. Cutting tools such as discs or rotovators tend to multiply rather than kill the rhizomes.

Even in wet weather, the summer fallow can be used to weed the soil of rhizomonous perennials as long as cultivation is repeated frequently enough to

prevent the weeds from growing. Slowly but surely, this method will deplete the energy reserves of the rhizomes.

Keep in mind that two to three months of tillage may be necessary to finish off the quackgrass or other rhizomonous weeds. For this reason, good soil conservation practices should be considered before attempting an extended bare fallow in order to prevent wind or water erosion. Likewise, it is also important to establish a thick cover crop at the end of the summer fallow to precondition the soil, provide protection overwinter, and smother out any surviving rhizomes.

Annual Weeds. Eradicating perennial weeds may require long periods of tillage, but if done properly, the extended summer fallow is usually a one-time affair. Weeding the soil of annual weeds, on the other hand, requires much less tillage but may take a number of years as the seeds remain viable in the soil for a long time.

The fallow-year management makes it possible to speed up the process in two very different ways: first, the intensive use of cover crops increases biological activity and the natural decay rate of annual weed seeds in the soil; second, the bare fallow period can be used to intentionally germinate and kill several generations of annual broadleaf weeds.

Fallowing Half of the Market Garden Each Year

	Field A	Field B	Field C	Field D
Year 1	Fallow	Crop	Fallow	Crop
Year 2	Crop	Fallow	Crop	Fallow

Fallowing Year Management

Year 1: Fallow	Spring	Cover Crop	
	Summer		Bare Fallow
	Fall		Cover Crop
Year 2: Crop	Spring	Crop	
	Summer		
	Fall		

Grouping the Vegetables by Planting Date to Facilitate Shallow Tillage

Year 1	Cover Crop	Spring	Cover Crop		
	Bare Fallow			Summer	Bare Fallow
	Winterkilled Cover Crop			Fall	Overwintering Cover Crop
	Shallow Tillage			Spring	Shallow Tillage
Year 2	Early Vegetables	Summer	Late Vegetables		
		Fall			

Our tillage strategy for the annual weeds is just the opposite of that for the perennials. Instead of loosening and drying the soil to dehydrate the roots, our goal is to produce a firm, moist seedbed in order to sprout the small-seeded annuals. This means settling the soil with a disc, harrow and/or roller as soon as possible after incorporating the first cover crop of the fallow year. If it is practical to work the cover crop shallowly into the surface of the soil, so much the better, as this practice will help insure adequate moisture for germinating the small seeded weeds while creating a mulch to protect the soil.

Just as soon as the annual weeds sprout, we shallowly cultivate the fallowland in order to kill the weeds before they have a chance to get well established. After making sure that the young weedlings have died, we refirm the soil with a roller or cultipacker to germinate another batch of weeds. We repeat this process every 10-14 days over the course of the six-week bare fallow period, which usually begins at the end of June and concludes with the planting of the second fallow year cover the second week of August. This procedure will effectively remove several generations of warm-season annual weeds such as pigweed and lamb's-quarter from the top 2 inches of the soil.

Shallow Tillage. We take advantage of the bare fallow-period midsummer to reduce the seed bank of annual weeds in the surface of the soil. If we till deeply the next year before planting the cash crops, new weed seeds will be brought to the surface and grow with the vegetables. Therefore, it is critical to limit tillage to the top 2-3 inches of the soil when preparing a seedbed for produce.

We facilitate shallow tillage by segregating *early* planted crops and *late* planted crops in different fields. Rotating between *early* and *late* vegetables transforms the every-other-year fallow system into the four-year, four-field rotation shown in the accompanying chart.

Before *early* vegetables, established in April and May, we use a cover crop that reliably dies back over winter. The dead top growth and root system of a "winterkilled cover crop," such as oats and Canadian field peas, makes it possible to use shallow tillage early in the

Rotating the Vegetables by Planting Date, EARLY and LATE

	Field A	Field B	Field C	Field D
Year 1	Fallow	Early Vegetables	Fallow	Late Vegetables
Year 2	Late Vegetables	Fallow	Early Vegetables	Fallow
Year 3	Fallow	Late Vegetables	Fallow	Early Vegetables
Year 4	Early Vegetables	Fallow	Late Vegetables	Fallow

spring to prepare a seedbed in time for planting the first market garden crops of the season.

We often use a light-weight disc to chop up the mulch of winterkilled cover crop residues into smaller pieces before undercutting the spring weeds and forming the planting beds with a field cultivator equipped with large, widely-spaced sweeps. Other tools which can handle a lot of residue may work just as well for this job as long as tillage is restricted to the surface of the soil to prevent bringing up new weed seeds to germinate with the *early* planted vegetables.

In preparation for *late* vegetables, we can take advantage of the soil building attributes of an overwintering cover crop, such as rye and hairy vetch, because there will be plenty of time to kill and breakdown this live cover with shallow tillage before these *late* planted crops go in the ground. We actually use two dif-

Cover Crops Used During the Early Years

Year 1	Rye	Spring	Rye
	Bare Fallow	Summer	Bare Fallow
	Oats & Peas	Fall	Rye & Vetch
	Shallow Tillage	Spring	Shallow Tillage
Year 2	Early Vegetables	Summer	Late Vegetables
	Rye	Fall	Rye

ferent types of shallow tillage to accommodate the extra long planting window for *late* vegetables and the life cycle of the overwintering annual cover crops.

For *late* crops planted in June, we begin shallowly tilling the live cover as soon as conditions permit the first part of April. At this time of year the overwintering cover is just beginning its vigorous, vegetative phase and can be very challenging to kill

with a disc or field cultivator. We find it more efficient and effective to completely undercut the overwintering cover crop by moldboard plowing as shallowly as possible, no more than 2-3" deep.

Keep in mind that the "skim plowed" sod may require 5-6 weeks, and several passes with the disc or harrow, before it is sufficiently decomposed for planting the *late* vegetables. The six-week decomposition period provides another opportunity to use tillage for weeding the soil by intentionally germinating and killing

simply by knocking it down and crimping it with a disc or a roller.

Again, we plan on at least six weeks, and several passes with the disc or field cultivator, before planting the *late* vegetables in July and August. In this case, the six week delay is necessary for all the extra biomass to breakdown and to restore the soil moisture that the live cover crop has removed from the ground. While the primary objective of shallow tillage is to prevent bringing new weed seeds up to the surface, it also works

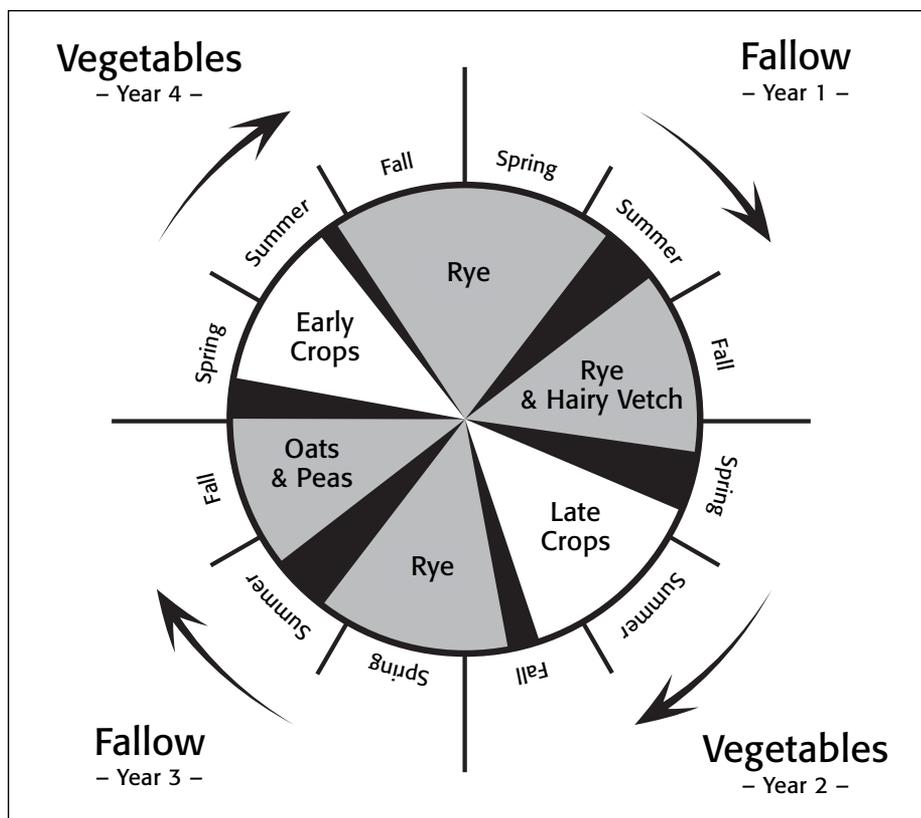
year cover crop rotation depicted in "The Cover Crop Clock." Note the significant amount of time devoted to soil-building cover crops, highlighted by the gray shading. We emphasize small grain cover crops because these inexpensive, weed-competitive covers are easy to establish, grow well on minimal residual fertility, and their fibrous root systems and top growth seem particularly well suited to conditioning our crust-prone silty soils.

The dark shaded areas in the clock represent periods of tillage before planting the vegetables, after harvest and during the bare fallow. Alternating between the fallow-year cover crops and *early* and *late* vegetables creates a tillage rotation that interrupts the life cycle of many different kinds of market garden weeds on a regular basis.

The chart "Variations on the Four-Year Cover Crop Rotation" illustrates several modifications to the original four year cover crop rotation, such as adding clover at different places in the rotation to provide more nitrogen and improve insect habitat management, or shifting the bare fallow period to the start of the fallow year to weed the soil of cool-season weeds. We only mention these variations here to emphasize the importance of adapting the rotational cover cropping plan to the inevitable changes in insect and weed pressure that develop over time.

Keeping New Weeds Out of the Soil. Weeding the soil with cultural practices will not be 100 percent successful if weeds are allowed to set seed or new weeds are introduced into the fields. For this reason, we back up the long-term cultural strategies of cover cropping, rotation, bare fallow periods and shallow tillage with short-term preventative practices such as cultivation, hand-weeding, composting and mowing.

For example, we make an effort to mow the headlands, farm lanes and waste areas bordering the market garden frequently enough to prevent the grasses and weeds from going to seed and blowing into the vegetable fields. We also mow the spring cover crops in the fallow fields two or three times before plowing them down to begin the bare fallow period midsummer. Clipping the top growth whenever it reaches 2 to 2.5 inches in height makes it much more manageable



a generation or two of annual weeds. The six week delay also allows plenty of time to finish off any remnants of the live cover that survive skim plowing, and for the pathogenic and allelopathic by-products of decomposition to subside before planting the June vegetables.

For *late* crops established in July and August, we let the overwintering cover crop grow until it is waist high the third week of May. At this point in the cover crop's life cycle its energy has shifted from vegetative growth to reproduction by pushing seedheads and starting to flower. This close to maturity, we can kill the overwintering annual cover crop

against the nature of two different kinds of weeds. Restricting tillage to the top 2-3" of the soil discourages soil building weeds by preserving the soil structure created by the cover crop's root system and by improving soil tilth through the concentration of the cover crop's above ground biomass in the surface of the soil. Shallow tillage also deters weeds that prefer anaerobic conditions by keeping the decay process close to the surface where the soil is more likely to be warm and well aerated.

Rotational cover cropping. Tailoring the cover crops to the planting dates of the vegetables sets in motion the four-

to incorporate the biomass with a plow or a disc while preventing winter weeds from making viable seed before turning under the cover.

We have found that timely mowing of the spring cover crops is especially effective for controlling weeds in the mustard family. However, for low-growing winter weeds such as chickweed or dandelions, plowing under the cover crop before the weeds are in full bloom is much more effective than repeated mowing.

Another important aspect of keeping the cover crops weed-free is using clean seed. We make sure to clean the small grains purchased direct from local farmers with our old, hand-cranked fanning mill. Cover crops purchased from commercial seedhouses should come with labels verifying no more than 0.05 percent weed seed and preferably less. Even with these precautions, it is important to scout the cover crops regularly for weed surprises, and to either remove the weeds by hand before they go to seed or to turn under the cover crop prematurely, whichever is more efficient in terms of labor and time management.

New weed seeds can also be introduced to the farm in mulching materials, feed, manure and bedding. Consequently, we make a point of finding weed-free sources of straw mulch and feed, and we compost the small quantities of horse manure we use to enhance the growth and decomposition of the fallow year cover crops.

Actually, we think composting reduces weed pressure in two significant ways. First, aerobic composting kills most weeds passed through in the manure or bedding. Just as important, the composting process stabilizes the nutrients in the manure so that when spread in the fields the nutrients are released relatively slowly. In this respect, compost, in moderation, is much less likely to stimulate high-fertility weeds to grow than raw manures or fast-acting, water-soluble fertilizers.

Although we no longer need the cultivator or the hoe to grow certified organic produce, mechanical and manual weed control was essential for growing good crops during our first years on the farm. Cultivation and hand-weeding were also critical for preventing weeds from going to seed in the vegetables. Looking back,

it would appear that “weeding the crop” played a supporting role in “weeding the soil.”

To be truthful, we still cultivate most of the crops in the market garden at least once or twice before seeding a living mulch in the pathways. However, our primary objective for stirring the soil is moisture preservation, not weed management.

We also continue to walk the vegetable rows as necessary to remove any weeds

that threaten to make viable seed even if they are not interfering with the growth of the crop. This proactive task becomes much easier and faster — even recreational — after reducing overall weed pressure through the use of rotational cover cropping and the bare fallow periods.

Implementing the System. When we started farming together here in the mountains of north-central Pennsylvania in 1983, we had to put together the weed-the-soil system from scratch.

Variations on the Four-Year Cover Crop Rotation

Year 1	Spring	Interseeded Rye	Rye	Interseeded Rye
	Summer	Oats	Buckwheat	Peas
	Fall	Bare Fallow	Oats (Winter Kill)	Bare Fallow
Year 2	Spring	Peas (Winter Kill)	(Surface Till) Early Crops	Oats on Ridges (Winter Kill)
	Summer	(Surface Till) Early Crops (Overseed clover)	(Surface Till) Early Crops (Interseed vetch)	(Ridge Till/ No Till) Early Crops (Interseed buckwheat)
	Fall	Clover	Rye	Rye
Year 3	Spring	Bare Fallow	Bare Fallow	Bare Fallow
	Summer	Bare Fallow	Italian Ryegrass & Clover	Bare Fallow
	Fall	Rye & Vetch	Rye & Vetch	Rye & Vetch
Year 4	Spring	(Skim Plow) Late Crops	(Skim Plow) Late Crops	(Surface Till) Late Crops
	Summer	(Interseed Rye)	(Interseed Rye)	(Interseed Rye)
	Fall	Interseed Rye	Rye	Interseed Rye

Neither one of us had any experience growing vegetables for market, although we both had worked on farms where cultural practices were employed for managing the weeds.

We used an extended summer fallow during the first year on the farm to get rid of the quackgrass and other perennial weeds that infested the market garden site. Then we implemented the rotation of cultural practices illustrated in "The Cover Crop Clock." In one four-year cycle, we virtually eliminated soil-building weeds such as plantain and Queen Anne's lace as well as high-fertility warm-season annuals such as lamb's-quarter and pigweed.

Depending on the condition of the soil and the number and types of weeds in the seed bank, it may take two or three times through the rotation to see such a dramatic reduction in weed pressure. On the other hand, we know of growers who have reduced hand-weeding in onions to just a few hours per acre within two to three years of implementing this system.

We believe there are several reasons why these experienced farmers were so successful at using this whole farm approach to weed the soil. First, they had already acquired the skills and equipment necessary to execute the cultural practices effectively. That is, they had the means and the ability to establish thick, weed-competitive cover crop stands, to manage the bare fallow periods properly to reduce the weed seed bank in the soil, and to create suitable seedbeds for vegetables using shallow tillage.

Second, these growers possessed the insight and flexibility to adapt the bio-intensive system to the site-specific requirements of their own operations. For example, we know of two tractor farmers who have simulated the surface tillage techniques we developed for a team of two horses simply by adjusting their rototators to work the top 2 inches of the soil. In both cases, the use of permanent wheel tracks has eliminated problems with compaction for the vegetables despite repeated passes with the tractor and no deep tillage.

Farmers implementing the four-year cover crop rotation in milder climates have discovered that frost-tender sorghum-sudangrass, Japanese millet and forage soybeans die back more reliably over winter than the more cold-tolerant oats and Canadian field peas we routinely use for a winterkilled cover crop.

Other factors that will influence the design of the rotational cover cropping plan include:

- Soil type, condition and fertility.
- Climate, rainfall and length of growing season.
- Land configuration, field access and irrigation.
- Available equipment and labor.
- The life cycle and growth habits of local weeds.
- The cultural requirements and planting schedule of the vegetables.

If implementing the system sounds daunting at first, keep in mind that fallowing half of the market garden each year provides a lot more time and space for trying out new ideas and making

mistakes than growing vegetables intensively year-in and year-out. Psychologically, we found that everything became so much easier when we set aside a whole growing season just for building the soil and reducing weed pressure.

More articles on the Nordells' whole-farm approach to weed management are available in their booklet, *Weed the Soil, Not the Crop*, price \$10 plus \$3 S&H. An accompanying DVD is also available, cost \$15 plus \$3 S&H. To order, send check or money order to Anne or Eric Nordell, 3410 Rt. 184, Trout Run, Pennsylvania 17771.



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