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Look, Ma! No Weeds: Early Season Weed Control

Part 3 of 3: In-row cultivation

It's as much about the technique—and being able to adapt to fickle weather—as it is about the tools.

By Klaas and Mary-Howell Martens

(with help from Peter Martens)

Posted March 17, 2005


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Knowing just when to use just the right tool for just the right weed is critical to early season weed control.

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Get weeds before they become established and the battle is nearly won.

[Part 3: In-row cultivation](#)

It's as much about the technique—and being able to adapt to fickle weather—as it is about the tools.

Farm-at-a-Glance



In-row cultivation is the last piece in effective non-chemical weed control on an organic farm. In many ways, cultivation is the 'crown jewel'; it is here where the skill, ability, observation and timing of a good operator makes or breaks the effort (much more so than the choice of any particular piece of equipment).

Successful organic weed control is the sum of all operations and cultural management. The purpose of the cultural methods (crop rotation, soil fertility management, sanitation, good seed, cover crops, etc.) and early season weed control (blind cultivation) is to achieve the greatest possible crop-weed size differential, especially when there are many acres to be cultivated. The last stage, in-row cultivation, is the final performance in the whole package of organic weed control strategies.

From the very start, it is important to consider in-row cultivation as a 'cleanup' procedure, not as the primary weed control. Well-timed early weed control is absolutely essential to reduce the size of the weed population before it becomes a threat to the crop. Even with a good job of blind cultivation, there are usually some escapes (weed seeds that get away and resprout), and,

Peter Martens--at 16, already a veteran in the field--and his friend Shawn cultivate corn in June 2004. Peter (left) drives a Ford 5000 with an International front cultivator with trip shanks and Glencoe rear cultivator with C shanks. Shawn drives a John Deere 3020 with John Deere front cultivator with trip shanks and a homemade track digger with Danish tines.

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The Martens' Farm

Location: about 60 miles southeast of Rochester, NY, on the western shore of Seneca Lake

Important people: Klaas and Mary-Howell Martens, Peter, Elizabeth, and Daniel. Plus Robert Hall (employee/asst farm manager)

Years farming: We've farmed this farm together since 1991. Klaas has farmed all his life.

Total acreage: 1500

Tillable acres: 1300

Soil type: Honeoye Lima silt loam

Crops: corn, soybeans, spelt, wheat, barley, oats, triticale, red kidney beans, sweet corn, snap beans, cabbage, edamame soybeans

Livestock: sheep, pigs, chickens for our own use

Regenerative farm practices: diverse long term crop rotations that incorporate legumes and small grains, under seeding all small grains with red clover, actively increasing soil organic matter

Marketing: corn & small grains are sold to Lakeview Organic Grain LLC, our organic feed business. Soybeans, red kidney beans, and spelt sold to brokers and processors. Some spelt is sold as kosher organic spelt. Sweet corn, snap beans and edamame are sold to processors who freeze them under brand name labels. Cabbage is made into sauerkraut and packed under the Cascadian Farms label. Some of the oats, wheat and barley are being grown from Foundation Seed to produce Certified Organic Certified Seed.

especially when wet weather prevents proper timing, there may be lots of escapes. Subsequent in-row cultivation is then necessary to provide clean, productive fields.

When it is necessary to in-row cultivate crops that are very small, it is impossible to do a good job on more than a few acres per day. Weeders allow delaying the first cultivation until the crop is large enough to cultivate deeply and rapidly. Many organic farmers don't have weeders, don't have the right weeders, or don't know how to operate them to get optimum weed control. The first two articles in this series describe basic weed control principles and blind cultivation techniques and equipment.

Cultivation also provides many other beneficial effects far beyond the weeds. Indeed, cultivation is very important for aerating the soil, stimulating crop root growth, conserving soil moisture, and providing insulation from the hot sun with a loose, dry soil mulch.

Few conventional farmers who cultivate their crops spend much time adjusting their cultivators. Herbicides take care of most of the weeds, and skilled cultivator operators are hard to find. Many conventional farmers feel that if they can keep the machine between the rows and avoid taking out too much crop, then they can 'cultivate'. This careless approach will not work on organic farms. Indeed, we prefer not even to consider that type of field operation 'cultivation' at all. Getting the weeds between the rows is the easy part! The real art and skill of cultivating is whether you can also get the weeds within the row without excessively damaging the crop plants.

Timing is everything

When the crop rows are clearly visible and the corn plants are 8 to 10 inches tall, or soybeans are in the third trifoliate stage, it is time to begin in-row cultivation. On most New York organic grain farms, usually two cultivation passes are required. The first pass is the most critical to determine the season's weed control, but the second pass is often necessary to eliminate the weeds that were stimulated to grow by the first cultivation, to 'hill up' the crop, and to further aerate the soil.

The stage of the weeds and the weather usually dictate how we time our cultivations. The period of greatest vulnerability for most weeds comes at a different time after planting than that of the crop plants. Because crop seeds are generally large and are planted deeper than most weed seeds, their window of maximum vulnerability mismatches that of the weeds. We have to take this difference into account when developing our weed control strategy.

The vulnerability of plants to mechanical disturbance goes through a predictable cycle, starting with a seed that has not yet started to germinate. At that stage, seeds are virtually indestructible by anything other than biological activity. Until a seed imbibes water and begins to grow, weeders and cultivators have little effect. A seedling is most vulnerable from the time it germinates until after the plant has fully emerged from the soil. Once the cotyledons are fully extended and true leaves begin to develop, the seedling again becomes harder to injure. The exact timing of these stages varies between species; generally, once plants are past the unifoliate stage, most seedlings are much more difficult to damage.

Timing is indeed everything. Unfortunately, knowing the correct timing and being able to move forward are not always the same thing because of challenging weather conditions. Often, we have to do the best we can; by combining the effects of two blind cultivation passes with one to two in-row cultivation passes, we have much more flexibility with sub-optimal conditions (and usually this results in good weed control). This is an important point to make, since there is an oft-repeated fallacy out there that organic farmers have to cultivate many, many times during a

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season for adequate weed control. This is not true! It is the timing and skill with which the operations are performed that is most critical, not the number of passes made. If everything else is done right, and if blind cultivation is timed correctly with the right equipment, one to two passes with a row cultivator should be sufficient for good weed control in organic row crops.

Badly timed weedings can actually make the weeds worse. Making a large number of poorly timed or poorly executed passes will result in failure, no matter how many trips are made over the field.



When the first blind cultivation is timed just right, the weeders can be run very aggressively and will achieve almost complete control over the

first flush of weeds. When this happens, the second blind cultivation can wait until the crop is large enough to allow another aggressive weeding. However, if our first blind cultivation leaves too many escapes or if the first weeding fails to sufficiently decrease the second flush of weeds, we may have to do our second weeding before we really want to and then may have to come in with the cultivator before the crop plants are really big enough. Cultivating crops that are too small is slow, difficult and requires much fatiguing concentration to avoid injuring the crop plants.

These soybeans had to be cultivated much earlier than the Martens' would have liked. Rain prevented them from doing the first weeding when it should have been done, and cultivating was slow-going.

It is important to remember that whenever soil is disturbed, a new flush of weeds will be stimulated to germinate. Fortunately, these later weeds are much easier to control, but they still must be considered in the timing of cultivations and weeding operations.

Tines have changed

Most cultivators built in recent years were not well-designed to control weeds in the row. While it is sometimes possible to do a reasonably good job with a modern rear-mounted cultivator, when the conditions are difficult or weeds are heavy, the shovels next to the row can't be adjusted with enough precision nor can it be operated close enough to the row to take out the in-row weeds.

Front-mounted or belly-mounted cultivators, or pusher cultivators on bi-directional tractors, are far easier to keep on the row and work close enough to the crop plants. The operator needs to be able to easily see all of the cultivator shovels. Carefully watching the soil flowing around the front cultivator shovels and crop plants helps the operator to keep the shovels adjusted precisely where they need to be. It is important to continually adjust speed and down-pressure on the go to respond to variations in soil conditions across the field and to always keep the action of the cultivator as aggressive as possible without excessive crop

damage. This is not possible when the operator can't look at the cultivator while steering the tractor.

Danish or S-tine teeth will allow the greatest operating speed, they are not easily damaged by rocks, they will handle the most crop residue without plugging and they are relatively inexpensive, but they do not penetrate as well in hard soil and large-rooted weeds may slip around the flexible teeth, thereby avoiding damage. When this happens, putting on narrower shovels will make them penetrate deeper and give better control. Of different types of cultivator teeth, the operator has the least control over the action of the flexible Danish tine teeth.

C-shank cultivator teeth are more rigid and give the operator better control over the action of the shovels. These may be the best teeth for hard or rocky soil and for heavy infestations of quackgrass and other weeds with underground rhizomes. They are less likely to plug in grassy conditions than trip shanks but much better able to take out large weeds than Danish tines.

Trip-shank teeth are the most rigid and allow for the slowest progress, but they give the operator superior weed control and adjustment ability. These are also the most expensive, large rocks can break the trip-shanks, and it takes a more experienced operator to make the necessary adjustments to get the full benefit of trip-shank teeth.

There are many different types and widths of points that can be put on the different cultivator teeth. Danish tine cultivator teeth offer the least opportunities to vary point type, while trip-shank teeth offer the greatest choice. The most versatile type of points are probably half sweeps next to the row and full sweeps between the row. Each type of point works best under specific conditions and on certain weed species. For example, a type of point called a 'beet knife' is particularly effective on nutsedge. Narrow spikes may sometimes be used to advantage to aerate waterlogged soil.



We use a double cultivator arrangement, with trip-shanks on the front cultivator and half sweeps next to the row

A Ford 5000 sporting an International front cultivator with trip shanks and Glencoe rear cultivator with C shanks.

to get good weed control within and immediately next to the row. The rear-mounted cultivator, which has C-shank teeth with full sweeps, covers the between-row area. While this combination is slower than a single Danish tine cultivator, it gives excellent control of most types of weeds, even under an unfavorable crop/weed size differential. Other New York organic farmers have had success with rear-mounted Danish tine cultivators with 5 shanks and 2 1/2-inch duck feet points between each row. If the ground is hard or there is a quackgrass problem, 1-inch spikes angled forward to dig deeper can be used.

Cultivating technique

There are as many 'right' ways to set a cultivator as there are farmers who can get their fields clean of weeds. Every farmer who is good at cultivating develops their own unique combination of equipment, settings and special 'tricks' that are especially well-suited to the soils, crops, and conditions found on that farm. No two farmers will do the job exactly alike, yet each one can be a master in his own right. Until the late 1940s, cultivating was a skill that every farmer had to possess. The skill was passed down from one generation to the next. Every community had 'good' farmers who could be called upon for advice when you weren't quite getting the weeds (or for any other problem that you might encounter).

Our communities have lost countless farmers who held this important knowledge with no one to pass it on to. Our mentor is an older farmer named Clifford Petersen. He set a very high standard and has no tolerance for weedy fields. He often told us that when his son complained that it took him too long to get the cultivator adjusted right, he would say "If you don't think you've got time to do the job right, think about this: Every weed you miss now is one you will go back and pull!" It took Klaas three years before he could cultivate a field well enough to win a compliment from Cliff. Cliff often said that he couldn't tell someone how to cultivate right, he had to show it.

However, this attention to detail and perfection must be balanced with a view of the whole farm and an honest assessment of how much time it will take to cover all the acres adequately. Taking too much time to get every last weed in one field may make it impossible to cover all the rest of the acres on time. It's important to keep the whole crop in perspective and not spend too much time making the first few fields immaculate. You also have to know when to stop and say you have done your best. Tractor operations after canopy closing will usually crush and tear crop plants excessively and may be of no further benefit, as shade from crop leaves will kill weeds trapped under the canopy.

If at all possible, it really helps to work with an experienced farmer to learn to evaluate how the soil should flow past the cultivator teeth, how much side pressure on the row is best, how much dirt should be pushed into the row to bury the weeds, how to make the proper adjustments, and how hard you can treat the crop without hurting it. The real art of cultivating is learning how to make the right observations and then figuring out how to match those observations to making appropriate—and changing—adjustments.

There is a big advantage in being able to get on a perfectly adjusted cultivator when you start out and to see how the soil flows when a real master has set the shovels to match the crop and soil conditions. As adjustments are needed, it is much easier make the right ones when you have seen what 'working right' looks like. Once we know exactly how we want the machine to achieve, it is much easier to get and keep it there.



Our 16 year old son Peter has been cultivating on our farm for the past

Front view of John Deere front cultivator with trip shanks and a homemade track digger with Danish tines.

four years. Last summer, he taught his friend Shawn to cultivate. The two of them covered many acres together, the camaraderie, cooperation and their iPods keeping boredom and monotony to a minimum. Peter's cultivation experience has been gained during the past five excessively wet years; through these tough conditions, he has learned to achieve acceptable weed control even when it is very difficult to do anything 'right'.

When soil is very dry, it is tempting to run the cultivator shallower to 'save' moisture or to stop cultivating altogether, because corn curls right after it is cultivated when in the air is dry. Don't give in to this temptation! Remember that weeds can push back up out of dry soil unless they are buried fairly deep. Escaped weeds are far more damaging to crop yield in dry weather than when there's sufficient rain. The soil that the cultivator hills up around the row provides a dry mulch and stops water from being brought to the surface and lost by capillary action. Soil moisture in the hill is much higher than in uncultivated soil, and the crop grows far more roots in the loose soil of the hill than when the soil is left uncultivated.

Conventional wisdom says that cultivating deep and disturbing roots in dry soil hurts the crop. We have never seen any evidence to support this assumption. We find that new roots grow quickly into the loose soil left by cultivator shovels and the crop responds with a spurt of growth. Many organic farmers say that a pass with the cultivator has the same effect on the crop in dry weather as a half inch of rain.

Adjusting to change

There are many adjustments that can be made while cultivating to match the effect of the machine to the conditions and needs. Choosing the appropriate adjustments is not easy to summarize because conditions constantly change, across the field, in different crops, in different soils, even over the course of a day as the weather and moisture conditions change.

In general, there are five main cultivator adjustments possible:

1. tractor speed
2. angle of the shovels, laterally and horizontally to the row
3. depth of the shovels
4. down pressure on the gangs, on cultivators with springs
5. distance of the shovels from the row

Relatively little adjustment is possible with Danish tines other than varying speed and depth and by changing the type of the points. With C-shanks, it is possible to change the angle to the soil and to the row slightly, but because they are springs, this adjustment changes in the soil as the cultivator moves. This is not a major problem when the cultivator is set deep and working between the rows, but it limits the success of controlling weeds within the rows. Trip-shanks allow wide adjustment of the angle of the points, both to the row and to the soil.

Depth of the point is also easily adjusted. Because trip-shanks are rigid, the adjustments remain constant while cultivating. For example, by twisting the shank toward the row, a much greater amount of soil will be pushed into the row. Conversely, by twisting the shank away from the row, the soil thrown into the row is reduced. Changing the angle of the point to the soil can adjust for hard or soft soil. Under the right soil conditions, setting the points at an extreme angle to the soil can create a bulldozer effect, squeezing the crop row tightly with soil and thereby killing many weeds growing between the crop plants (and burying the rest).

Peter says that it is very important to have a well-equipped toolbox on the tractor, complete with all the sizes of wrenches you might need, along with Vise Grips, hammers and spare shovels. This permits in-field adjustment and repair, saving considerable amounts of time and aggravation. Usually, we try to avoid cultivating in overly wet conditions. When weeks of nonstop rain come at critical times of the year, we sometimes have to go into very wet fields to save the crop. Having a log chain along can be a real convenience during the wet, muddy summers we have known recently.

When cultivating, Peter tries to drive as fast as he can without damaging the crop. This aggressive cultivating takes out the most weeds and, when done well, does little damage to the crop. Higher speed also throws up more of a hill in the row, which can stimulate a greater amount of axillary rooting (especially in corn) and can be more effective in conserving soil moisture. Peter feels that one of the biggest challenges is to correctly identify the 'guess rows', or the end rows of the planter where the spacing can vary. Guess rows are called by different names in other parts of the country. If these rows are not correctly accounted for, the cultivator will take out crop.



Peter is also careful to do daily preventative maintenance before starting each day, thoroughly servicing both the tractors and the cultivators. He and Shawn make sure that

Rear cultivator at work in a field of corn: Aggressive, or high-speed cultivating, throws up more of a hill in the row, which can stimulate a greater amount of axillary rooting (especially in corn) and can be more effective in conserving soil moisture.

all the grease fittings are filled, all the joints are tightened, and all parts are in proper alignment before they begin each morning. Peter also takes mental notes on each field while cultivating, noticing where there are special weed problems or conditions, and he regularly enters these observations into the master field notebook.

Peter has noticed that soil conditions really affect the ease and effectiveness of cultivation. When soil has had a chance to dry out gradually after a rain, the soil is looser and there are substantially fewer lumps, which allows for greater cultivator speed and a larger hill. Conversely, if the soil is wet, slabby or when the surface dries too fast after a rain, soil lumps or soil ribbons ('turds' in farmer slang) develop and roll onto the plants, doing more crop damage and requiring the cultivator to go much more slowly. If you have to cultivate in wet conditions, twisting a piece of wire around the shovel can help break up the slabs of dirt.

Another logical but often-overlooked point in successful cultivation, was suggested to us by Cliff Peterson. For the second

cultivation in a field, he recommends driving the opposite direction on each row. It is important to remember the pattern of the first cultivation and reverse the direction for the second cultivation. This can get weeds that were not fully removed in the first cultivation and can compensate for gaps in cultivator coverage.

Plan on spending a lot of time when you first get out in the field, adjusting the cultivator to get it to work right for the particular field conditions. As Cliff told Klaas when we were starting out, “‘Almost’ isn’t good enough!” Don’t be satisfied with ‘almost’! In most cases, the first cultivation pass ‘makes or breaks it’; the results of the first pass will usually determine whether you are going to have a clean field or not. If you miss the weeds in the row the first time, cultivating more often later in the season will not make up for it.

Adjustments will need to be done continuously through the day as soil moisture and field conditions change and as shovels wear or go out of adjustment. All rows need to be watched for adjustment needs. As you move along, watch all the rows, don’t just lock in on only one row. If you don’t watch all the rows, you can go along quite a ways—and can do lots of crop damage and miss lots of weeds—before you realize something is wrong.

It is essential to really focus on the rows and the job while cultivating because even a slight drifting in one row can rapidly result in large sections of the corn or bean row being very effectively hoed out. For this and numerous other reasons, we don’t like to use cab tractors to cultivate, because we can better see the rows and the cultivators—and respond must faster—if we are not so isolated. However, we have installed canopies on all the cultivating tractors for operator comfort and safety.

Cultivating can be a very hot, boring job, especially when the crop plants are small. For the sake of the operator’s health and attention span—and the health of the crop—it makes good sense bring a water bottle, and to stop if you get sleepy. Staying alert is important. This is both for the sake of safety and for doing a decent job of cultivating. We’ll be the first to admit that cultivating can be very monotonous. The ‘glamour’ of cultivating is much more in the theory and the results than in the actual doing. Stopping for 10 or 20 minutes to nap in the shade is time well-spent if you are having trouble staying alert. Having a snack and some caffeinated beverage can help, as can listening to music or a good ‘book on tape’ on a head-set cassette player. Carry a cell phone if possible to call for repair parts, a snack, or relief when needed.

Just a reminder—alcohol and gasoline don’t mix. Our community has an oft-repeated story of a farmer who didn’t believe this to be true and drove his cultivator over the edge of a deep gully twice (with trees fortunately catching the very relaxed farmer and his tractor). Another local farmer can gauge which of his men stayed out too late the night before by the number of ‘lightning strikes’ in the newly cultivated rows the next day.

Icing on the cake

Our friends Eric and Ann Nordell, who farm about 7 acres of market vegetables with horses in northern Pennsylvania, have done such a good job of cultural weed control that they don’t really need to cultivate to get rid of weeds. Their soil is essentially weed seed free, due to conscientious use of cover crops, mulches, and rotation. Yet the Nordells still cultivate their crops to achieve the other important benefits of cultivating. Eric says they cover crop for weed control and cultivate to control moisture.

We agree and have noticed how crops will green up and ‘jump’, growing noticeably taller soon after each cultivation. Loosening and letting air into the soil keeps it aerobic and stimulates soil

organisms. It also stimulates nitrogen mineralization and nutrient cycling in the soil, and the CO2 that escapes from loose, freshly cultivated soil enhances crop growth.

In-row cultivation is in many ways the heart of what makes an organic farm productive and successful, especially on grain farms where weeds are the primary challenge. However, like the heart of an organism, cultivation works best when it is part of a complex and well-coordinated choreography of soil improvement, crop rotation, cultural methods, and other mechanical weed control operations, along with cooperation with the weather.

When all that happens, the healthy weed-free rows of organic crops are indeed a beautiful sight. 

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