



Mechanical Weed Control **FIELD GUIDE**



— THE LAND —
CONNECTION



INTRODUCTION

For a successful growing season, it helps to be prepared to tackle all that the season may bring. Invariably, that includes a plan for managing the weeds in your field. Mechanical weed control can be an effective and efficient way to reduce weeds in your operation. This field guide was written for the production vegetable or row crop grower growing beyond the hand-scale. It is meant for those that have designed their fields and spaced their plantings to accommodate a tractor and tractor mounted tools. Inside these pages, we will explore the components and considerations for utilizing mechanical weed control.

SECTION I - *Setting Yourself up for Success*

Successful weed control means thinking several steps ahead. Proper planning with regards to cultural controls, planting, cultivation, and equipment will allow you to reach your goals. Two main goals exist for weed control:

1. Lower the number of weed seeds in your soil (to do this, practices should either decrease the number of seeds entering the soil or increase the number of seeds leaving the soil through germination and express termination).
2. Promote a size difference of either root size or shoot size between your crop and all weeds that do germinate (see fig. 1).

The **Cultivation Pyramid** (fig. 1) shows the many steps that build upon each other to eradicate weeds. In planning weed control for a field or for a crop – great farmers think seasons into the future, designing their cultural practices to target problem weeds, and then matching their crops to the conditions they've created in each field.

Just like many things in life, proper weed control is a cohesive process, with several steps that depend on the previous step for success. Each step matters, and the degree of success for each steps adds or subtracts from the final effect.

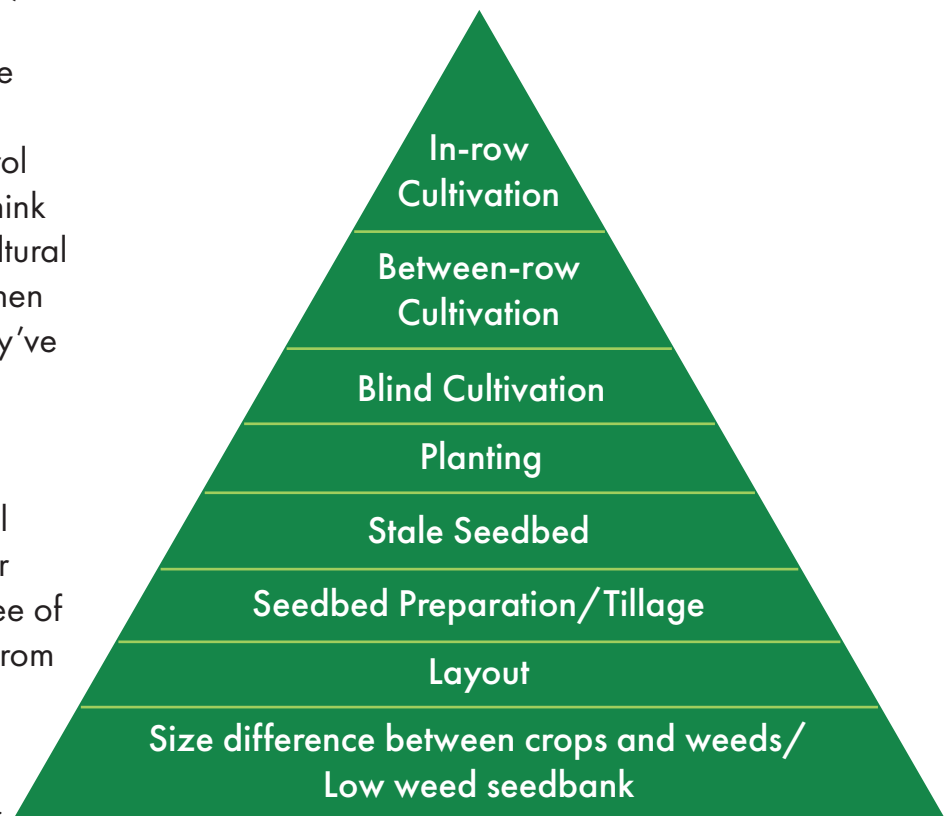


fig. 1: *The Cultivation Pyramid.*



Here are some things to consider as you build your weed control plan for the upcoming season(s):

CULTURAL CONTROL

Questions to consider:

- Which weeds give you the most problems?
- What are the life-cycles of those weeds? (know thine enemy)
- How does the weed's life cycle interfere with the life-cycle of your crop?
- At what points in the life-cycle is each weed most susceptible to death by tillage? For example, annual weeds are most susceptible at white-thread stage.
- What time of year does each weed germinate and set seed?
- Upon noticing that the weed is flowering or setting seed, how long do you have to kill that weed before all those seeds become viable?
- Which of your crops can handle greater weed-pressure, and which require your most weed-free conditions?
- Are you able to match the depth of your tillage to the conditions? i.e. can you till deeply to bury weed seeds if needed, or till shallowly so as to kill germinated weeds but not bring up more seeds from below.
- Will seedbed preparation create suitable tilth when you only till to the depth where you are placing seed (i.e. planting to moisture)?

Steps to take:

- Realistically match your crop and planting technique to the weed population in your field. For example, land with a higher weed density could receive more transplanted crops than direct-seeded. By beginning with a larger size-difference in both root and shoot than weeds, transplanted crops can compete better.
- Develop a plan to combat the different kinds of weeds you're facing in your fields while keeping the two goals of weed control in mind. For example, "I will implement _____ practice to target _____ weed so as to reduce the numbers or their seeds in the soil."

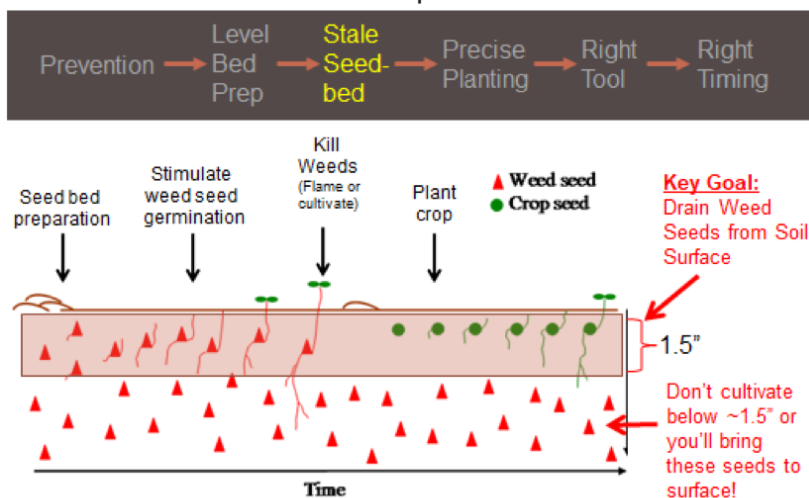
PLANTING

Questions to consider:

- Have you implemented a stale seedbed (fig. 2) to drain weed seeds from the soil?
- Have you reduced the depth of tillage in your final seedbed-tillage pass to 2" or less to reduce the germinating weeds?
- Have you prepared the best seedbed that you can (in uniform tilth and soil nutrition), and are you prepared with irrigation so that your crops will jump up and outgrow weeds?
- Have you calibrated your seeder properly so that it seeds at the proper density to allow plants to develop a dense canopy as soon as possible?



- Have you double-checked the spacing of your seeding units before and during planting, so that your seeds are a dead-on match to your row-spacing and also match the placement of future weeding tools?
- Are you planting your seeds to a uniform depth so that they all emerge at the same time?
- Are you increasing your planting density above conventional recommendations (~5-10%) to account for crop death due to cultivation?



A stale seedbed (fig. 2)- most weed seeds germinate from the top 1.5-2" of soil – weed seeds buried deeper than this will not germinate. Constrain your tillage/cultivation before and during crop growth to this top 1.5-2" to avoid bringing new weed seeds up.

fig. 2: diagram of a Stale Seedbed. Merfield, C. N. (2013). *False and Stale Seedbeds: The most effective nonchemical weed management tools for cropping and pasture establishment*. Lincoln, New Zealand: The BHU Future Farming Centre: 23. Amended by D. Brainard and S. Hitchcock Tilton.

BLIND CULTIVATION

The goal of blind cultivation is to remove the initial flushes of weeds when they are very small and most sensitive to disturbance. Blind cultivation takes advantage of the difference in size and sprouting depth between crop and weed seeds. Most weed seeds are smaller than crop seeds, and they germinate shallower in the soil. At these early stages, breaking contact between the tiny roots and the soil will kill most weed seedlings.

Consider acquiring a tine-weeder, rotary-hoe, or flame-weeder (according to your conditions). These tools allow you to weed the entire planting area after planting but before crop emergence, and help continue creating the size difference you want between your crop and weeds.

- A **rotary-hoe** is semi-effective in crustier soils, whereas a tine-weeder is not effective with soil crusting. A rotary-hoe is most effective for use in stale seedbedding (before crop is planted) and for more vigorous direct-seeded crops such as corn and beans.
- **Flex-tines** are very effective in combination when run behind other cultivation tools. For example, run a mid-mount or front-mount cultivator with a flex-tine harrow in the rear. Flex-tine harrows are also effective in the 10-14 day window after transplanting.
- A **flame-weeder** is the ideal tool for killing weeds without disturbing the soil and bringing more weed seeds to the surface. It is more effective on broad-leaved weeds than grasses.

NOTE: In order to kill the maximum number of weeds you will end up killing a small percentage of your crop. Typically you will kill about 10% of your crop if you use mechanical weed control properly.



EQUIPMENT

Things to consider:

- Make sure your row-spacing leaves you enough space to run all the weeding tools you need.
- Consider the limitations of potential tools — parallel linkages from an S-Tine cultivator do not have enough space to function well at row spacings less than 15 inches. (fig. 3)
- It will be best in many ways NOT to plan on adjusting cultivators for every crop - plan your systems with consistent row-spacings for most crops.
- Tool carrier is crucial - your weeding tools need to fit on your cultivating tractor easily and your tractor must be reliable.
- If needed, consider using a rear-mounted steerable toolbar.
- Overall, the most important aspect of mechanical weed control is to have a complete system of tools to effectively deal with weeds at all stages.

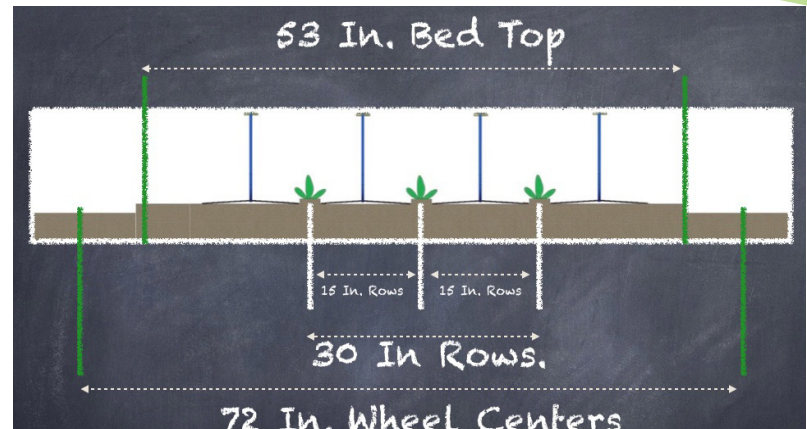
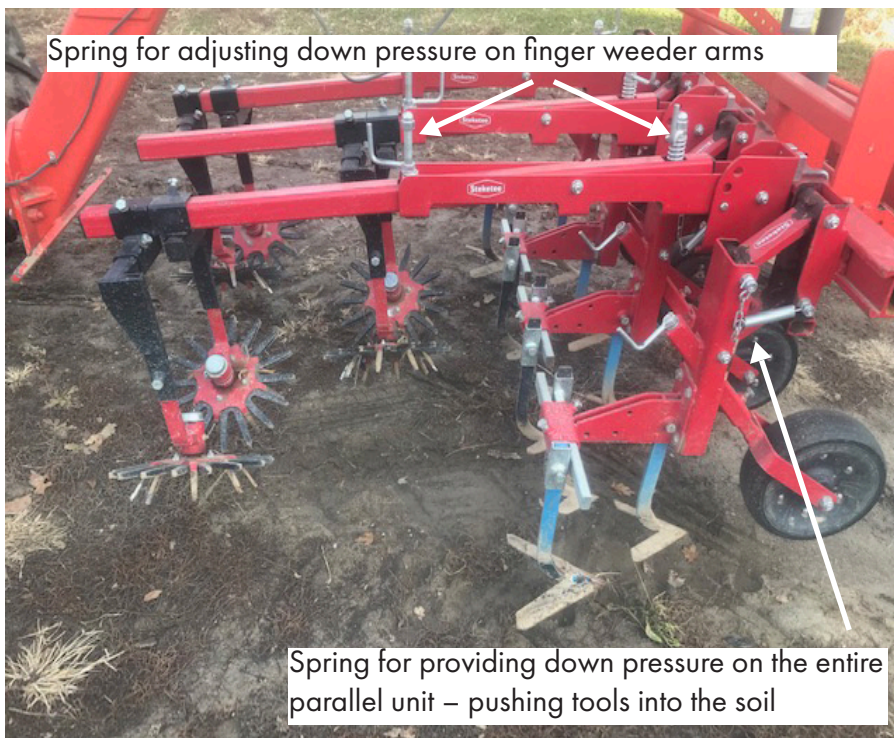


fig. 3: common row spacing for cultivation in vegetables. Many tools don't function well at row spacing less than 15 inches.

SECTION II - **Common Setups and Their Parts**



Your ultimate goal is to have a cultivator that consists of several weeding tools, each achieving a specific action in one system. A combination of sweeps to deal with tire-track and between-row cultivation, as well as finger-weeders to take care of in-row cultivation complete a cultivation system (fig. 4). While much more efficient, having a single system cultivator can be expensive. These weeding tool actions (tire-tracks, between-row, in-row) can also be achieved by using 2 or 3 different units depending on your scale.

fig. 4: an example of a cultivator which combines many tools into a single system.

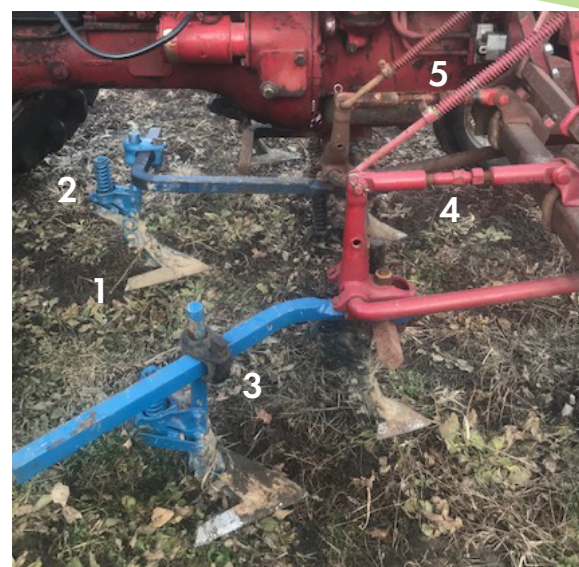
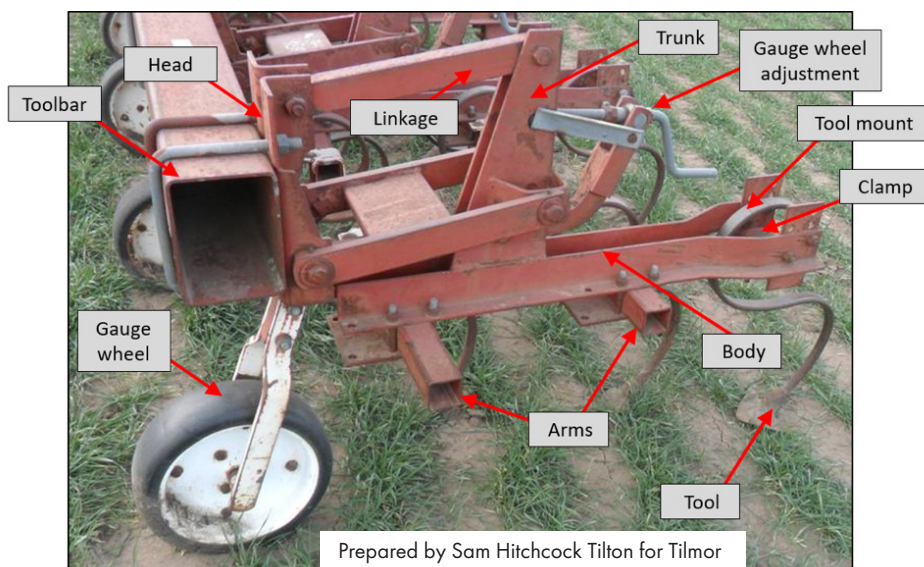


fig. 5: S-Tine cultivator with parallel linkages.

fig. 6: Farmall Super C setup.

There are many types of weeding tools, and it is easy to be penny-wise but pound foolish when buying tools. Tools with the following features are necessary for consistent success:

1. Parallel units – individual row-units are preferred to toolbars with rigidly-mounted tools. Each row-unit should have its own gauge wheel and parallel system so that it can flex with the terrain and keep the tools at a consistent depth in the soil.
2. A gauge wheel that is easily adjustable, with either a screw-crank or a single bolt.
3. Clamps that can be easily moved on the arms towards the row or away from the row by a single bolt.
4. Moving parts that move freely and accurately, no rust or excessive play.
5. Make sure that all parts are square and not bent, such as the toolbar, linkages, trunk, body, and arms. Anything that is out of square must be straightened so that tools run exactly where they should.

NOTE: With proper seedbed preparation you can accurately and consistently cultivate with rigidly mounted (non-parallel) units, like those on a Super C, or those designed for many other older cultivating tractors.

In fig. 6 above, you can see the configuration for a Farmall Super C for 2 rows 30" apart. In the blue you see high-crown sweeps (1) with spring-mounted trip-shanks (2) that allow the shank to bend back when the sweep hits a rock. The shanks are rigidly clamped (3) to the blue arms. In red you see the lift mechanism – there is a turnbuckle (4) to adjust the pitch of the sweep into the soil by adjusting the pitch of the arm. Above the turnbuckle is an adjustable spring-loaded rod (5) that applies consistent but flexible down pressure to the sweeps.



SECTION III - *In the Shop*

CHOOSING A CULTIVATION STRATEGY

First, visit your field. You can decide which cultivation approach is needed by determining the most effective way of attacking the weeds. Common strategies are:

- shallow cutting for white-thread stage weeds (3/8" deep),
- a little deeper for cutting with an uprooting action (3/8" - 1" deep),
- or aggressive burying for large weeds or crops that want hilling (>1" deep).

Also notice planting and field inconsistencies that may affect how closely weeding tools can be placed to the row. The goal is to place weeding tools as close to the row as possible, while keeping crop death low. A good practice is to run more aggressively on your first pass, when weeds are most susceptible, and reduce aggressivity on later cultivations. With such calibration, crop death on first cultivation should be below 10%.

Your seeds and plants should be placed accurately enough so that you can do a preliminary set-up of your weeding tools in the shop. To properly set up your system in your shop, find a flat piece of concrete on which to place your weeding tool for shop adjustments (this assures that your machine is square and all adjustments are even). Below are some key considerations, tips, and best practices to follow when setting up between-row and in-row tools.

BETWEEN-ROW TOOLS

Things to consider when setting up:

- Make sure the entire toolbar is square with your tractor. Check the 3pt. links or how the toolbar is positioned on the tractor bellymount.
- Make sure the toolbar is square to the ground.
- Mark your rows on the toolbar. Depending on your tool, each parallel unit must be centered exactly over the row or exactly between the rows. And we mean exactly. Mark each unit placement on your toolbar with a bright permanent paint so you can place tools in the exact spot and notice if they shift during operation. (fig. 7)
- Mark your rows on the shop floor or on a sheet of plywood. From these marks you can easily set the tool distance from the crop-row.



fig. 7: marking the rows on the toolbar.



- Set tool distance from the row (fig. 8). The distance between the tool and the crop-row is crucial and changes with many factors. You can tweak this adjustment in your field calibration, but in the shop set all tool-row distances equal. As a rule of thumb we recommend starting with the following distances between the tip of the nearest sweep/knife and the crop-row (from your row mark on the floor, measure this distance out on either side towards the sweep):
 - tender direct-seeded = 1"
 - vigorous direct-seeded = 1.5"
 - transplanted = 2"
- Adjust each gauge wheel so that they are at an equal place in their adjustment mechanism. This will make it easy to make uniform depth adjustments to all units in the field.
- To set the depth of your row-units equally and shallowly, take a sheet or strips of 3/8" plywood and place it under the gauge wheels. Now lower your tools onto the concrete floor. At this point all tools should be set exactly 3/8" below your gauge wheels, and set to run 3/8" deep in the soil.

In fig. 9 below you can see an older American cultivator. Sweep wings have been cut away near the row. Closest sweeps are set 2" from the row to throw soil onto transplanted crops. These older tools and sweeps are designed to uproot weeds between rows and bury weeds in the crop-row. They cannot be run close to direct-seeded crops at early stages because of the soil they throw into the row.



fig. 8: measuring the distance between sweeps.



fig. 9: sweeps on an older American cultivator.



IN-ROW TOOLS

Things to consider when setting up:

- Finger weeders work best when they are mounted on independent spring-loaded arms, although they also work when mounted rigidly to a toolbar or trailing on a parallel linkage.
- Finger weeders need consistent down-pressure into the soil.
- Adjust the nuts on all arm-springs so that they are at the same place.
- For spring-loaded arms, raise each arm and place a tool (such as a box-wrench or combination wrench) between the bottom bracket and the arm, so that the arm is held approximately $\frac{1}{2}$ " above the bottom bracket. When arm is so raised, lower the finger weeders down onto the concrete 'ground level' and fix them in place. When you remove the wrench, the fingers should now have equal pressure into the soil from the arm-spring.

- Distance between fingers is measured as the gap between finger tips or their overlap. (fig. 11)

We recommend the following initial settings:

- o tender direct-seeded: 2-3" gap, so that when fingers are running in the soil they are not contacting the crop-row. Fingers are often run 14-21 days after seeding (often 4-6 true-leaves).
- o vigorous direct-seeded: 1-2" gap, so that when fingers are running they do contact the crop-row. These crops (e.g. corn beans) can tolerate fingers soon after emergence.
- o transplanted: 1" or <1" gap, so that when fingers are running they overlap the crop-row. Transplants can be finger weeded once they have begun rooting, commonly 7-14 days after transplanting.



fig. 10: measuring the distance between finger-weeders



fig.11: measuring the distance between fingers

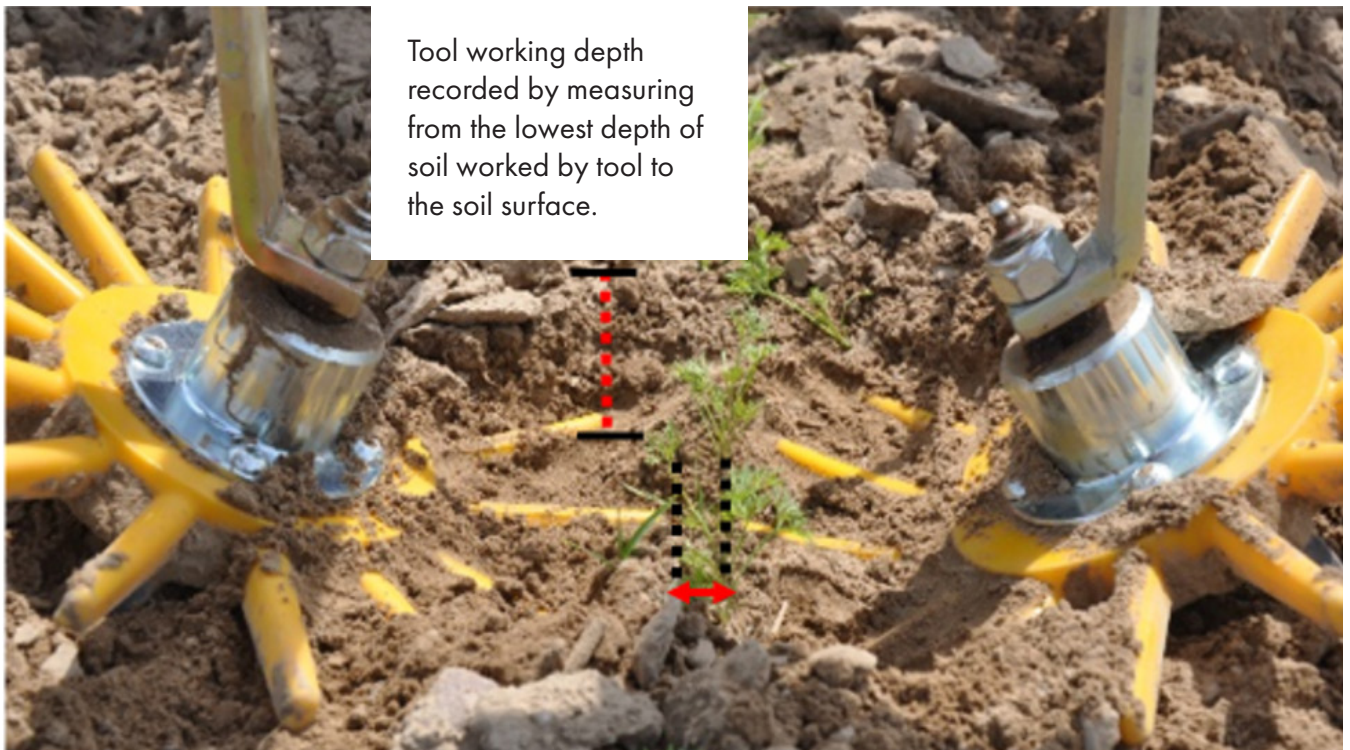


SECTION IV - *Field Calibration and Adjustment*

Assess field conditions:

- How established is the crop — can you run tools through it? How tender is this crop?
- If you can run tools through it, what factors in the field will determine the strategy that you use?
 - a. **Soil crusting** — is there a hard crust that may impede tool penetration?
 - b. **Soil moisture** — will soil moisture cause build-up on the sweeps?
 - c. **How thick are the weeds?** Weed density will influence whether residue will plug your cultivator. You may need to be more aggressive (tolerate greater crop death) to save your crop. If conditions are bad enough, it may be more profitable to replant.
 - d. **Tug test** — pull on several crop plants and weeds to compare how well each is rooted. You need a difference in rooting force to effectively use finger weeders. If there is little difference in rooting force but there is a size difference in top-growth, consider burying weeds.
- Run your cultivator with the shop settings until working speed and working depth are achieved. Stop to inspect:
 - a. Check crop mortality by counting plants and calculating a mortality percentage. If crop death is too high, aggressiveness must be reduced. If there is not crop death, aggressiveness can be increased.
 - b. If burying weeds, check burying of crop. It is generally okay to bury part of your crop, as long as one leaf remains unburied.

fig. 12:
Determining
tool working
depth. D.
Brainard and
S. Hitchcock
Tilton





- c. Check tool working depth — is it what you planned? If not, assess gauge-wheels sinking into soil, etc. Are you running too deep in wet soil and creating clods? If so, reduce working depth so that tools are running in the drier, upper layer of soil.
 - d. Adjust working pitch of tools. If soil is hard, increase pitch of tool(s) into ground so that they pull into the soil and stay at a consistent working depth. On 3pt.-mounted tools this is often done by adjusting the 3pt. top-link.
- When making adjustments, start with the easiest adjustments first:
 - a. First change the operating speed - faster is more aggressive.
 - b. Second change the working depth - deeper is more aggressive.
 - c. Third change the down-pressure - more is more aggressive.
 - d. Fourth change the tool distance from the row - closer is more aggressive.

If you are thinking about cultivating, you should probably be out cultivating. Our recommendation is to cultivate every 10 days until canopy closure and before every big rain (as you don't know the next time you will be able to run tools in the field). When soil is 'too wet to run' tools can often be used if they are set as shallowly as possible.

As crops develop, expect to make adjustments to account for the crop growth. Be careful not to damage the foliage of crops as that may impact their vigor and productivity later and also invite disease — watch for broken leaves. Also, be cognizant of root pruning from running tools too deep and close to crops — watch for wilting plants and exposed roots.

RESOURCES

For more resources on weed control and farming techniques, visit thelandconnection.org/resources

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