
Integrating Steel and Ecology
for Better Weed Management
Joel Gruver
WIU Agriculture

What is your context?

Climate

Weather

Soil types

SOIL HEALTH

Soil seed bank

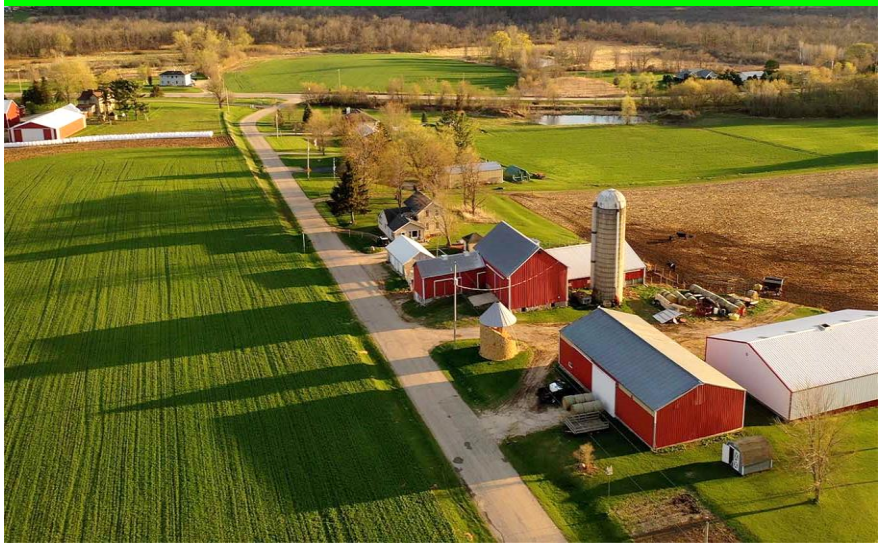
Topography

Field shapes & sizes

Geographic spread of fields

Built Infrastructure
(buildings, bins fencing, tile…)

Every farm has a UNIQUE CONTEXT



Human resources

Available Inputs

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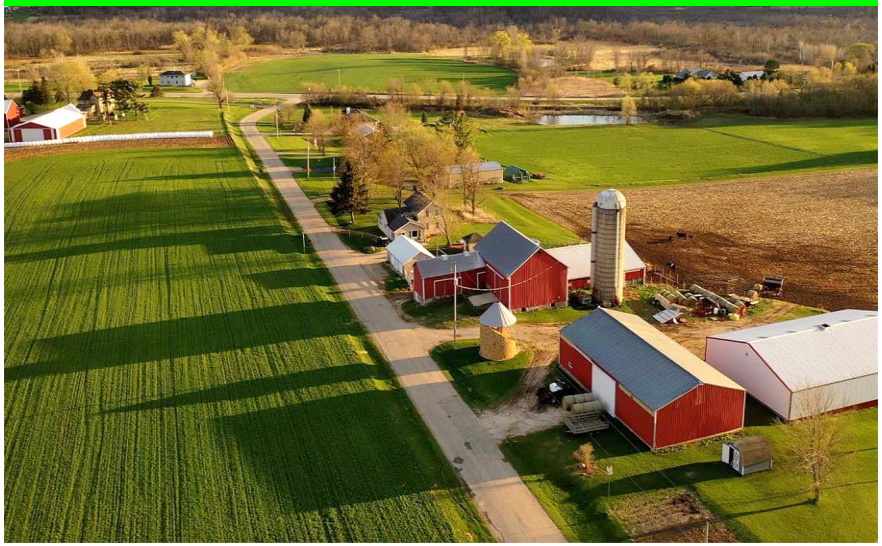

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CORN & SOYBEANS

Small grains Oilseeds Forages

LIVESTOCK

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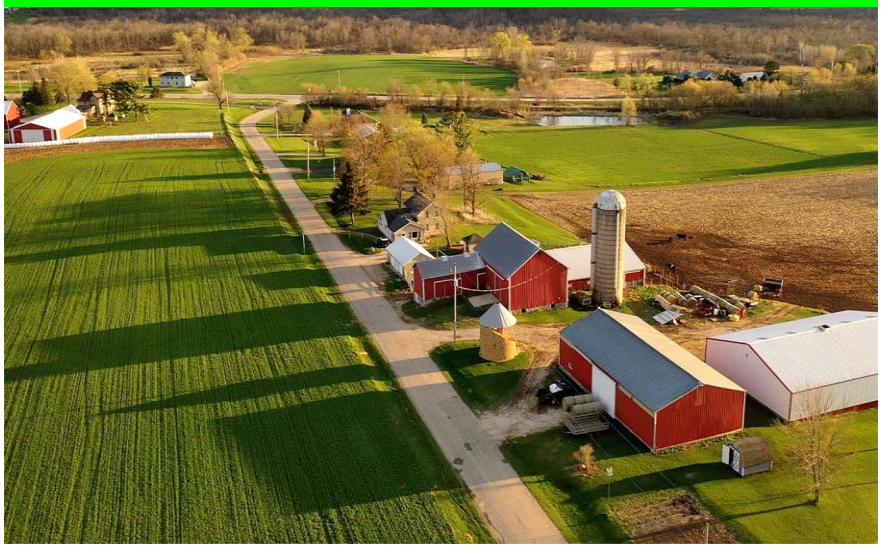

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Types & scales of enterprise$

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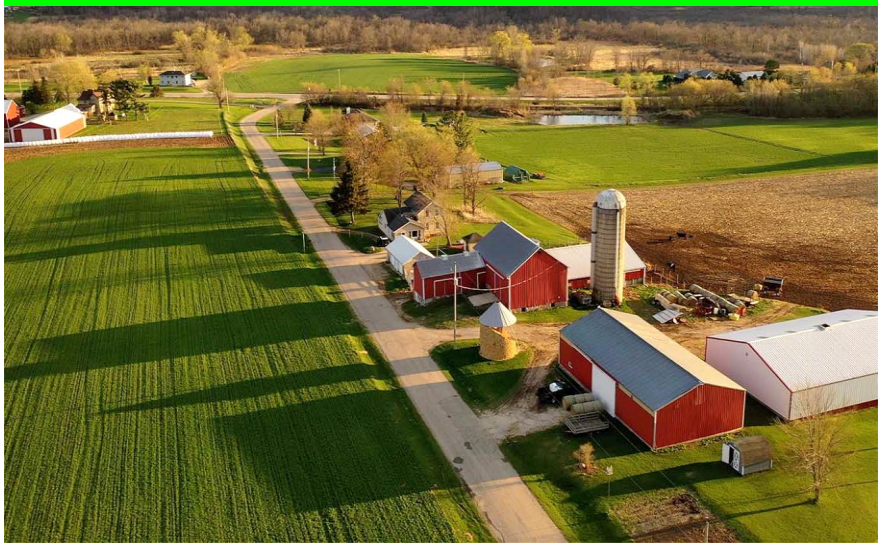

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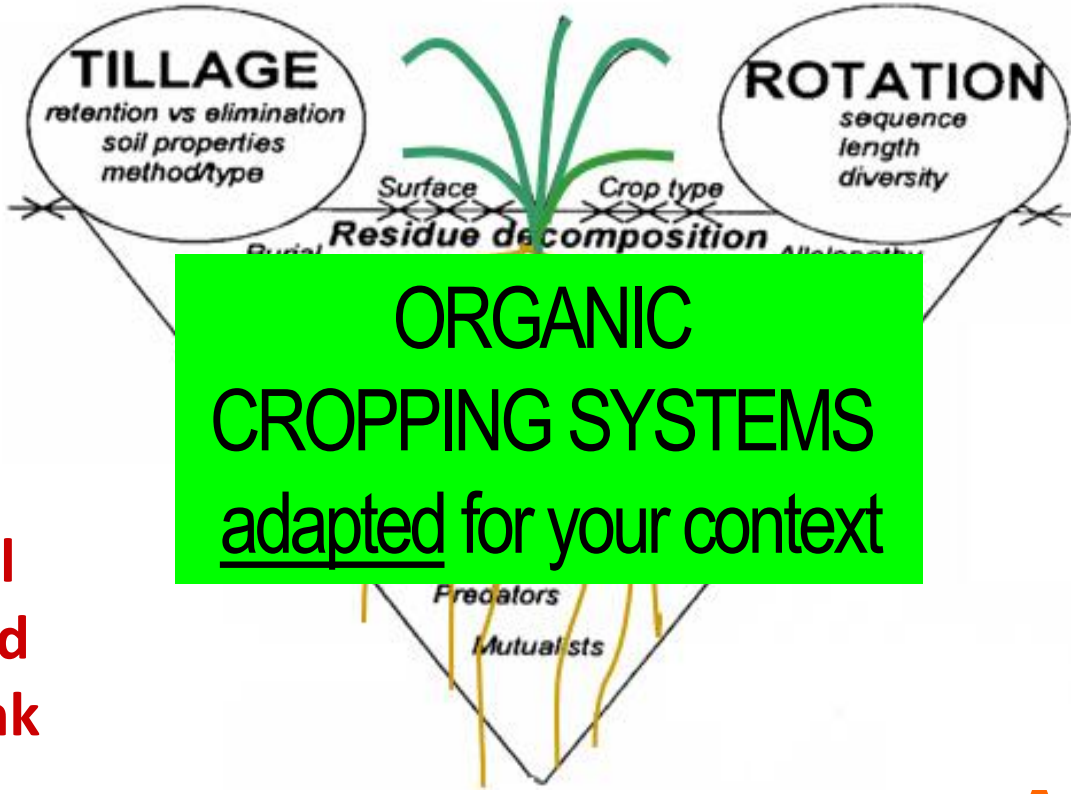

ORGANIC CROPPING SYSTEMS adapted for your context

Types & scales of enterprise$

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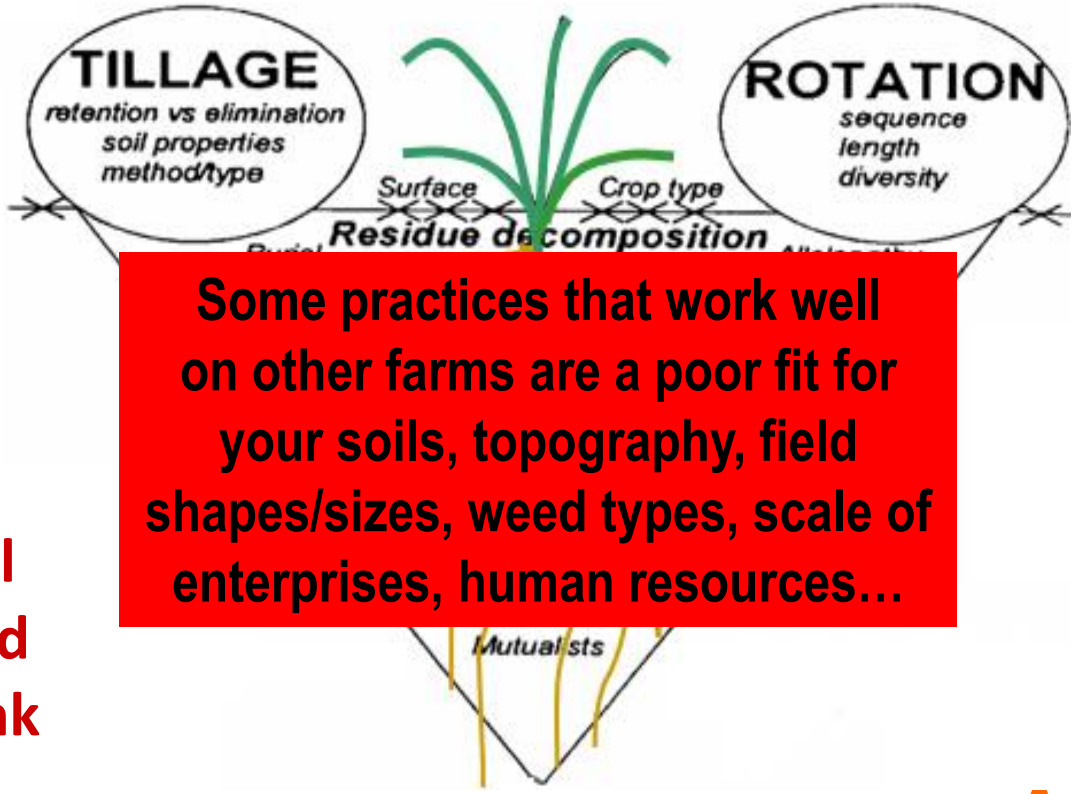

Some practices that work well on other farms are a poor fit for your soils, topography, field shapes/sizes, weed types, scale of enterprises, human resources…

Human resources

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Available equipment

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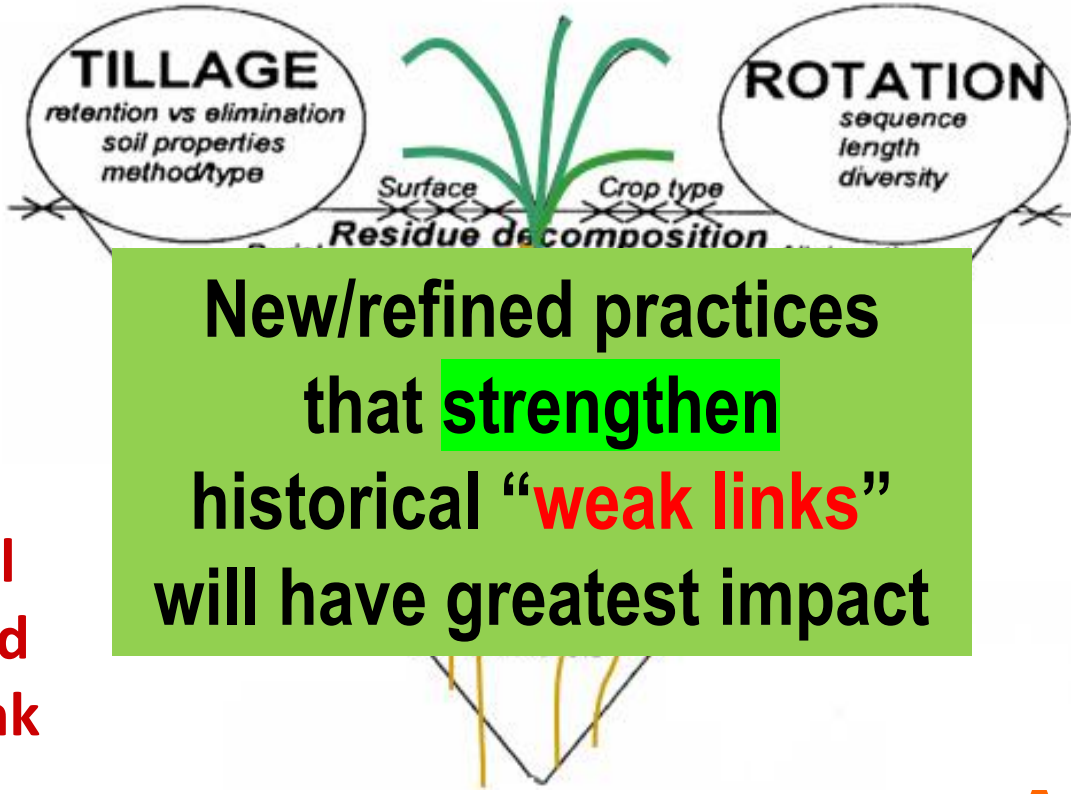

New/refined practices that strengthen historical "weak links" will have greatest impact

Human resources

Available Inputs

Available equipment

#livestockontheland #regenerativeagriculture

Livestock on the Land - Full-Length Film

760 views • Premiered 23 hours ago

55 0 SHARE SAVE ...

Practical Farmers of Iowa
3.66K subscribers

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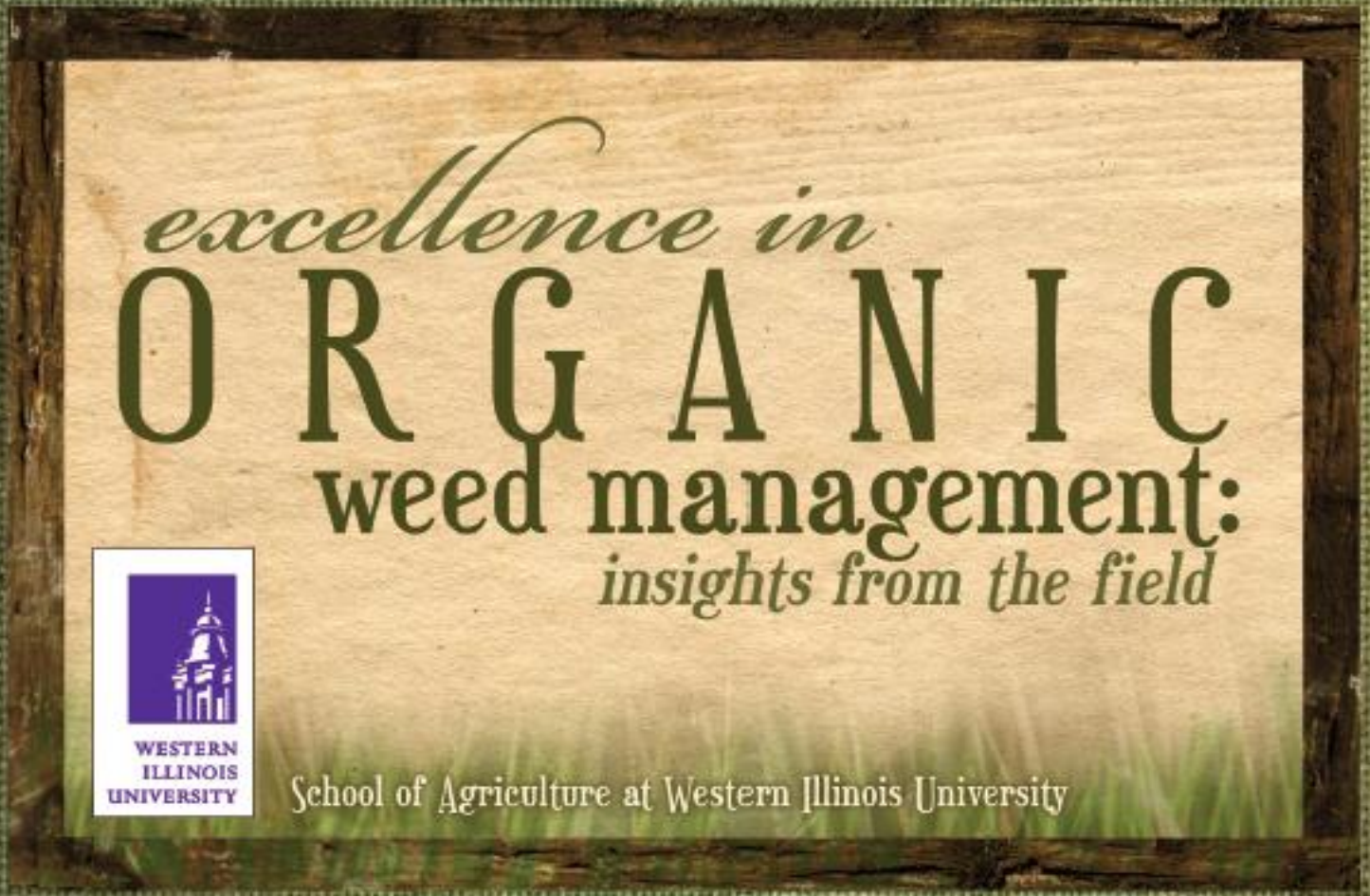
Livestock on the Land is a story by *Practical Farmers of Iowa* about the ways that farmers are building a regenerative agriculture by centering their operations around the animals they care for. Whether it's through rotational grazing or cover crops or fertility for crop fields, livestock hold the key to protecting our soil, cleaning up our water and even providing habitat for wildlife. But most importantly, livestock give farmers a chance to get started, grow businesses, provide for their families, work together, and ultimately, bring back the next generation to start it all over again.

This compilation of farmer profiles illustrates different contexts for



successful organic weed management

https://offer.osu.edu/eco-weed-mngt/case-studies

OFFER

Organic Food & Farming Education and Research

THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

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Organic Weed Control Case Studies

Below are various case studies that show how individual farms approached ecological weed management techniques.

CASE STUDIES

Organic Vegetable Farms in New England: Three Case Studies

From the Connecticut Agricultural Experiment Station, a detailed overview of the operations of three highly diversified organic vegetable farms. Weed management strategies and weed control successes and challenges are clearly presented. Additional information about soil fertility management and economics of several crops is also included.

https://portal.ct.gov/-/media/CAES/DOCUMENTS/Publications/Bulletins/b1021pdf.pdf?la=en

Excellence in Organic Weed Management: Insights From the Field

Created by Western Illinois University's Organic Research Program, this booklets documents examples of successful organic weed management. Presents interviews from 9 different Midwest farmers compiled by Dr. Joel Gruver and Andy Clayton.

View here as a pdf.

Search

Related Content

Organic Weed Decision Making Tool

Organic Weed Management Resources

To each their own: case studies of four successful, small-scale organic vegetable farmers with distinct weed management strategies

FREE download

The Art and Science of Cultivation

9 videos • 1,692 views • Updated 5 days ago

You may not have or want to use the specific equipment that Gary recommends but we should all strive to achieve his level of artistry

OGRAIN - Organic Grain Resources and Information Network

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5. Fine Tuning your Cultivator

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6 

6. In Field Adjustments

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I think we need a little more soil flow into this row
He drove 5 hrs to walk behind a cultivator!
Find opportunities to visit successful organic farms
WHEN they are cultivating and performing other key operations

Welcome to the Organic *INTEGRITY* Database!

Find a specific certified organic farm or business, or search for an operation with specific characteristics. Listings come from USDA-Accredited C
Operations and monthly snapshots of the full data set are available for download on the Data History page. Only certified operations can sell, la
excluded from certification.

Reset Search Filters

I recommend that you identify every organic farm in your county and adjacent counties

Operation	Certifier	Info	Status	City	State/Province
	Select Certifier		Certified	Enter City	OH-Ohic
Aaron and Terri Rook	[OEFFA] Ohio Ecological Food and Farm Association		Certified	Fredericktown	Ohio
Aaron E. Mast	[QCS] Quality Certification Services		Certified	Fredericksburg	Ohio
Aaron Hostetler	[PCO] Pennsylvania Certified Organic		Certified	Apple Creek	Ohio
Aaron Miller	[OEFFA] Ohio Ecological Food and Farm Association		Certified	Holmesville	Ohio
Aaron Yoder	[OEFFA] Ohio Ecological Food and Farm Association		Certified	Apple Creek	Ohio

Spray Farms

Howard Spray
5061 Martinsburg Rd.
Mt. Vernon, OH 43050
Knox

Wholesale | Farm Sales

Certified Organic by: OEFFA

Listing updated 05 06, 2019

Products
feed grade soybeans, clover seed, wheat, food or feed grade corn

Description
We were the first certified organic farm in the state of Ohio. We grow feed grade soybeans and wheat on around 700 acres. Visitors are welcome. We are located 8 miles SE of Mount Vernon on State Rte. 586

Contact:
Howard Spray (740) 507-2767

< Back to Search Results

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Find people to mentor you on your organic journey

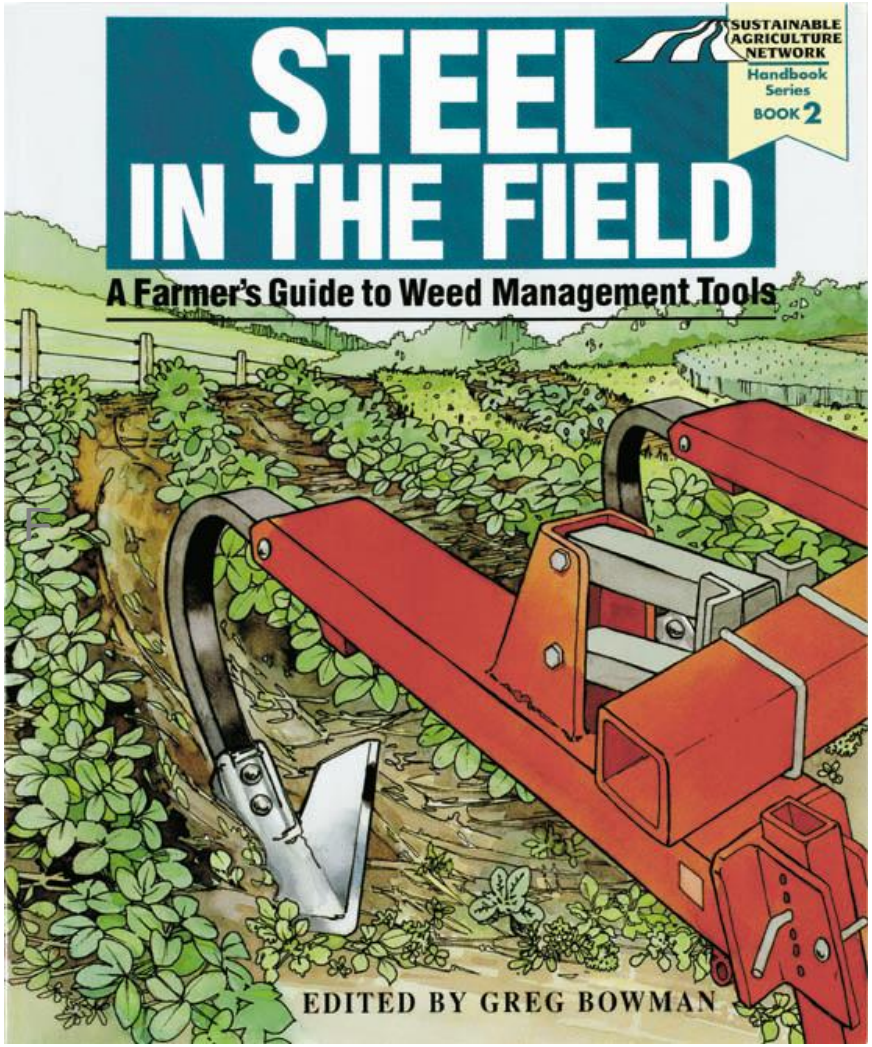
ALWAYS RESPECT THEIR TIME

but dig below the surface to identify why they are successful

Key factors leading to improved weed management at the WIU Organic research farm

- Improvements in soil tilth
- More effective management of cover crops and crop residues
- Better seed bed preparation
- Establishment of better crop stands using neighbor's JD 1760 12-row air planter w/ RTK guidance
- More intensive blind cultivation (tine weeder and rotary hoe)
- Precision row cultivation equipment for 1st cultivation
- Earlier row cultivation when conditions permit/warrant
- More complete hand roguing of weeds
- Periodic inclusion of summer fallow (mostly << 1 month)
- Improved understanding of organic NT opportunities
- Solar corridor systems

STEEL



FREE download

Published 2 decades ago!

Lots of diagrams of tools & farmer profiles!

Focus is on equipment for direct control of weeds

http://www.sare.org/Learning-Center/Books/Steel-in-the-Field

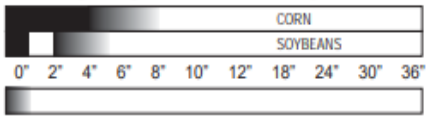
Great discussion of a wide variety of tools

I. AGRONOMIC ROW CROPS

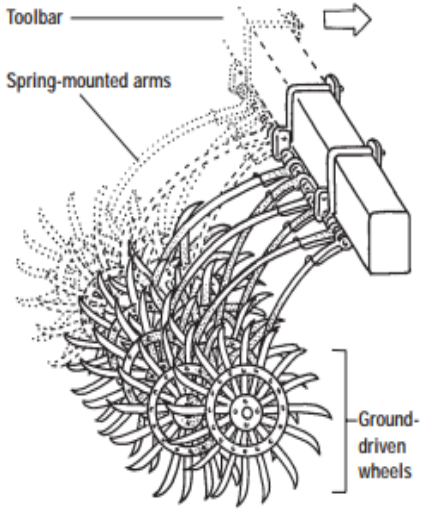
The Tools

Great discussion of a wide variety of tools

Standard Rotary Hoe



Match tillage timing, depth and location to crop root growth. Weed control varies with soil conditions and weed density.



Overview: In clean-tilled or low-residue fields, the sharp-edged, rounded teeth on rotary hoe spokes aggressively uproot weeds in the pre-emergent, white-root stage. Hoes work before or after crops are up, as long as crop seed is more deeply rooted than weeds and crop tissue damage is not too severe. Rotary hoes are used for "broadcast" cultivation, i.e. lightly tilling their full width at 1" to 2" deep without regard to crop rows. Faster speed enhances surface aggressiveness but decreases penetration. Rotary hoes have a vertical entrance and surface shattering action ideal for aerating crusted soils. Increase corn seeding rate about 2 percent per intended mechanical pass to compensate for possible plant population reductions.

Design Features: Curved steel spokes radiating as a flat wheel from a hub are rotated forward by ground contact. The curvature accelerates the exit of a tooth tip from the soil, sharply kicking up soil and weeds. Rigid or folding toolbar; 18" to 21" wheels; 16 teeth per wheel; wheels on 3.5" centers. One or two wheels per arm, with most models using down-pressure springs for consistent penetration on uneven surfaces. **Cautions:** worn tips greatly decrease effectiveness. Replace worn hub bearings as needed for smooth operation. Bolt attachments, rather than rivets, makes bearing replacement easier. Residue, corn rootballs, stones, sticks and plastic can plug wheels. Adding knives to cut residue or increasing spacing between wheels can improve performance in these conditions. (See next page.)

Options: Gauge wheels (recommended); extra down-pressure springs for crusted soil. (Other options for extending hoe use are described on the next page.)

▶ **Model for comparison:** 21', rigid-frame
Rec. PTO HP: 75 to 90 **Speed:** 5 to 15 mph **List price:** $4,700 to $6,100

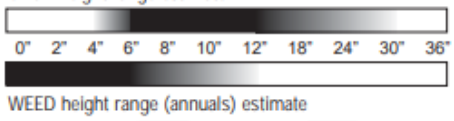
Width range (all makers/all models): 10' to 42'

Sources: 14, 18, 21, 68, 86

Farmers: Berning, Cavin, de Wilde, Fernholz, Kenagy, McKaskle, Spray

High-Residue Cultivator

Intended for no-till or ridge-till fields, tilled fields with up to 60 percent residue or untilled residue equivalent to a corn crop of up to 160 bushels/acre, moderate soils, stones up to 10 pounds.



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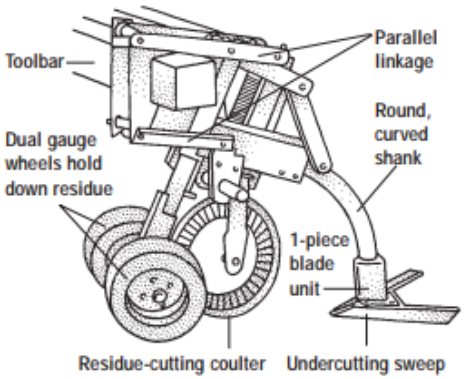


Overview: Single-sweep cultivators were created in the '70s to work in substantial amounts of crop residue. Compared with S-tine units with multiple-shanks per gang, these tools can move more soil (including building ridges at last cultivation), work in tighter soils, and cope with more severe obstructions. Wide, flat sweeps of several designs undercut weeds and leave residue on the surface. Adjusting for more aggressive cultivation (tilting the sweep point downward) can push the sweep deep enough to disrupt incorporated herbicide layers in row middles, often releasing a new flush of weeds.

Design Features: Box-beam type main toolbars, fabricated steel-plate gang members and heavy-duty curved or straight shanks are common. Virtually all have parallel linkage, stabilizing coulters and residue-cutting coulters. Ground clearance ranges from 19" to 32", so match with your anticipated field conditions.

Front-to-back clearance varies greatly in this class. "Close-coupled" units set a single sweep immediately behind a residue-cutting coulter. This lightens the strain on hydraulics but sacrifices some residue-handling capacity. Longer gang frames facilitate residue movement, but these units usually require more hydraulic power to lift because sweeps are mounted farther behind the tractor's center of gravity. Optional **disk hillers** may work with close-coupled units in lighter residue conditions but won't have the clearance to handle higher amounts. They can be set to cut weeds and soil away from the row or to throw soil from between the rows back into the row. Operating depth is 1" to 2".

▶ **Model for comparison:** 15', rigid frame model for 6 rows on 30" centers (6R30)
Includes toolbar; C-shank, box-beam or curved standards; wide one-piece sweeps; residue-cutting coulters; gauge wheels/gang; disk hillers.
Rec. PTO HP: 75 to 120 **Speed:** 4 to 8 mph **List price:** $8,000 to $12,300

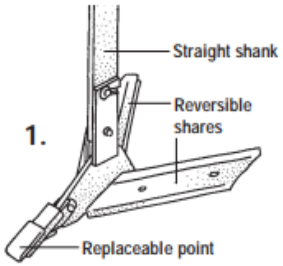
Width range (all makers/all models): 5' to 40'

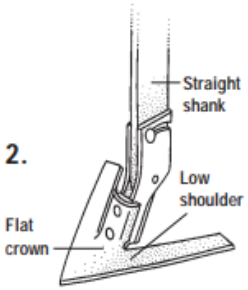
Sources: 2, 5, 12, 18, 21, 37, 40, 46, 47, 62, 73, 78

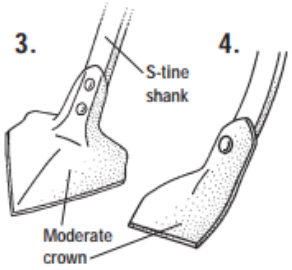
Farmers: Artho, Bennett, Berning, Cavin, Chambers, Erisman, Thacker

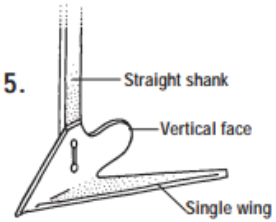
Great discussion of tool components

Cultivator Sweeps, Knives and Wings









1. Point-and-share (three-piece) sweeps (14" to 27" wide, for straight shanks) use a pair of replaceable, two-edged shares that usually lay flat to slice weeds. Replaceable point fractures soil, increasing penetration.
See: Erisman, Kenagy, Thompson

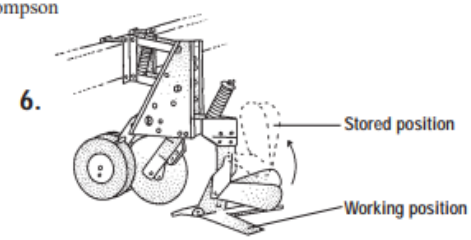
2. One-Piece, No-Till Sweeps (6" to 28" wide, for straight shanks) have a flat-crown, low wing (shoulder) angle. These sweeps leave row middles flat; slice through tall weeds and uproot shallow ones.
See: Bennett, Erisman, Hattaway, Kenagy, Thompson, Thacker

3. Pointed Row-Crop Sweep (4" to 7" wide, for S-tines). Better penetration than wider sweeps, more coverage than narrower shovels. Low-profile sweeps give similar soil mixing and weed impact as one-piece sweeps; moderate profile (higher center zone) causes greater mixing.
See: McKaskle

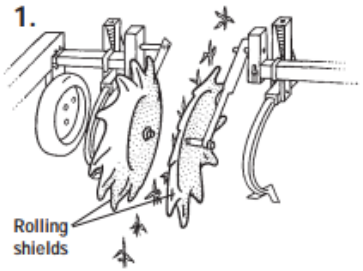
4. Duckfoot sweep (2" to 7" wide, for S-tines) provides good penetration of hard soil, significant soil mixing and weed uprooting (not slicing).
See: Chambers, Foster

5. Vegetable (Beet or Delta) Knife (8" to 30" wide, for straight shanks). For close cultivation in clean-tillage fields. A long, flat vertical face runs parallel to the row to protect the crop while a thin, flat sweep extends into the row middle. Mounted on straight or offset (dog-leg) standards.
See: deWilde, Foster, Haines, Kenagy, McKaskle, Muller, Thacker

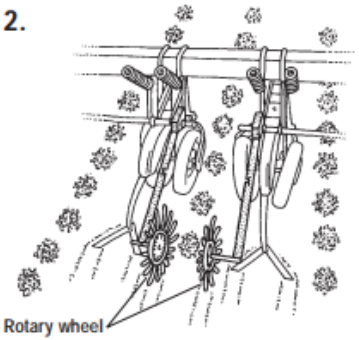
6. Ridging Wings (on no-till sweeps) divert soil into row area to bury weeds and create an elevated ridge of soil for next year's planting at the same row position as the current year. Often width-adjustable and hinged to swing upward on the standard into a storage position during non-use. Usually used at last cultivation.
See: Thompson



Cultivator Shields

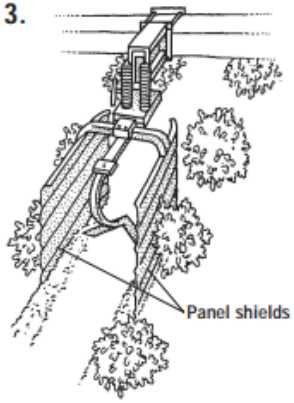


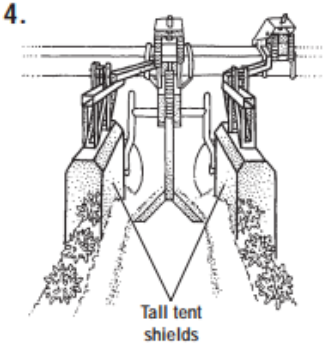
1. Rolling Shield
Round disks made of heavy-gauge sheet metal, plastic or of actual notched disk-harrow blades rotate vertically on a hub next to the crop. Mounted as a pair over the row or split on the cultivator gang between the rows. They are often notched or pegged along the edge to assure positive rotation to help them roll over residue. Use of some over-the-row mounts may be limited by crop height.
See: Hattaway, Spray



2. Rotary (Hoe) Wheel Shield
Spinning wheel on walking arm protects crop from flowing soil and residue. The wheels aggressively uproot small weeds next to row or in the row—depending on setting—without penetrating deeply enough to damage crop roots.
Source: 105

3. Panel Shield
Flat metal pieces 10" to 24" tall and 2' to 3' long can handle high-volume residue and soil flow. Various mounts either over the row or between rows, usually on parallel linkage to follow soil contour.
Source: Widely available **See:** Thompson





4. Tent Shield
Smaller sizes of these U- or V-shaped cover-the-row shields allow soil to flow up and over their tops. Taller models are basically heavy-duty panel shields joined at the top for strength and durability. Up to 3' long, 3" to 8" wide and 6" to 30" tall.
Source: Widely available
See: Thompson, Muller, Spray

Agronomic row crop farmers profiled in **Steel in the Field**

Brothers perfect disking, cultivating that beats no-till on sloping land

Glenn and Rex Spray
Mount Vernon, Ohio

- ***500 acres*** • ***corn, soybeans, small grains, hay*** • ***disk tillage (30 percent residue)***
- ***red clover cover crop***

Weed management highlights

Strategies: delayed planting into warm soil... crop rotation... high-tilth soil with increasing organic matter... mechanical controls

Tools: spike-tooth harrow... standard rotary hoe... four-row low-residue cultivators... rolling shields... tent shields

Two Ohio brothers understand the adverse impact of tillage on soil but demonstrate how a four-crop rotation helps them actually *build* soil on their rolling crop acres. Data from a nearby USDA researc from a county corn y system even beats ma duction and soil prote clover secures sloping

Mechanical weed for more than two Glenn and Rex Spray farming pioneers. Th more than a dozen so land, many hills and percent. They plant t sion-prone soybeans only in years when soil conditions are suitable.

Their soil-building cornerstone is a cover crop of KENLAND red clover, which they grow the season before they plant a corn crop. They value KENLAND (a certified variety of medium red clover) for its vigorous germination and growth. The legume is "frost seeded" by broadcasting into wheat or spelt from late February to April at about 8 pounds per acre. The first clover growth after grain harvest becomes hay for beef cattle, with the regrowth left for seed harvest of 1 to 4 bushels per acre in late August.

Two fall passes with a 12-foot offset disk with notched blades kills the clover and incorporates some of the residue to start decomposi- n the second pass for winter applica- pack beef manure. may be necessary with two or three with flat, 8-inch hes of weeds.

canopy (when crop een rows) is when ve the least protec- orn ground readily , loose and spongy, the direct result of the previous year's red clover.

The brothers say that this soil condition is

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sion-prone soybeans only in years when soil conditions are suitable.

> The first cultivation is critical to a crop's success in relation to weeds, Rex explains. "If you don't get weeds on this round, you won't get them the next time, either."

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Thank you Glenn and Rex!

Building Soils for Better Crops

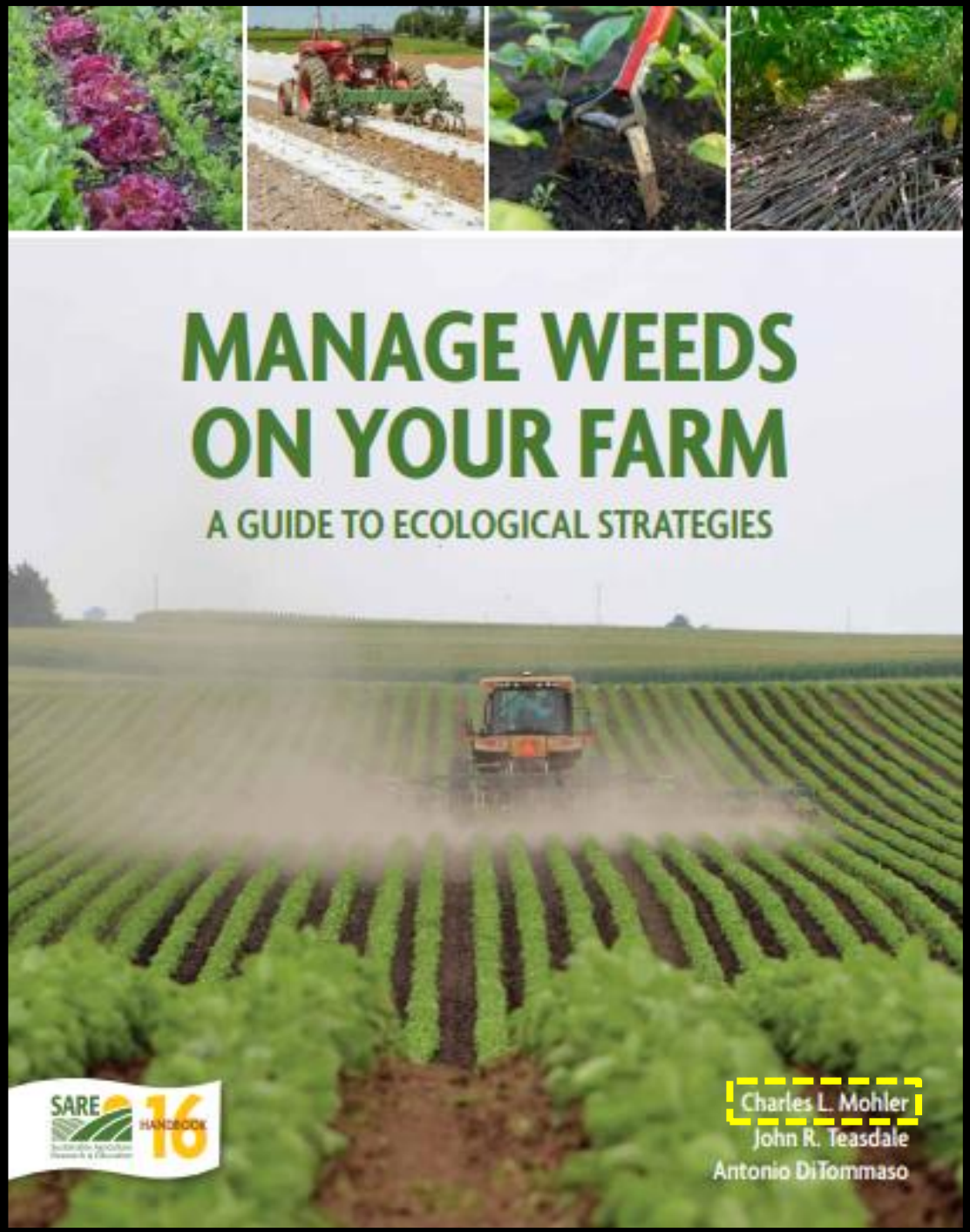
Ecological Management for Healthy Soils

SARE Outreach

Fred Magdoff, Harold van Es | 2021 | 394 pages

PDF (13.7 MB)

Order in Print $23.00



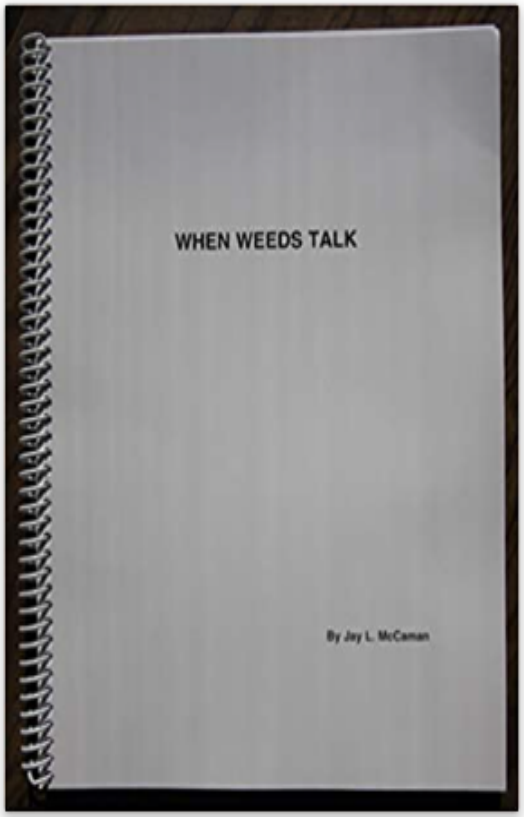
In Memoriam – Charles L. Mohler

We dedicate this book to our dear friend, colleague, and coauthor, Charles “Chuck” Mohler. Unfortunately, Chuck passed away in April 2021 and was not able to witness his 15-year-long book project to its deserved culmination. Chuck was a unique individual in that he was not only a brilliant scientist able to produce some of the most innovative weed science research, but he could translate this often highly technical research into practical and useful information and advice for growers

Dr. Mohler obtained a PhD in Ecology and Evolutionary Biology from Cornell University in 1979.

His dissertation research involved plant community ecology – specifically, the predictability of species at field sites, as driven by interactions w/ other species and environmental conditions which he tested through careful field work in natural plant communities

Are you familiar with this book?



When Weeds Talk Spiral-bound – January 1, 2013

by Jay L. McCaman (Author)

15 ratings

See all formats and editions

Spiral-bound
$39.99

2 New from $32.99

"When Weeds Talk" is the title of the new edition of "Weeds and Why They Grow". Weeds volunteer to solve mineral imbalances in the soil and species of weeds change as soils degenerate and they change again when the soil environment improves. This book allows the reader to identify soil conditions based upon weed populations. Weed inventory is a very, very accurate method of identifying mineral requirements for all soil types and "When Weeds Talk" identifies 21 soil variables for over 800 weed species. Unique, informative and full of valuable information for farmers, gardeners, landscapers and turf managers.

Weed:nutrient relationships discussed in When Weeds Talk:

- Redroot weeds, such as redoot pigweed (*Amaranthus retroflexus*), are signs that the iron-manganese ratio is out of balance. It may indicate there is too much iron or too little manganese. It also indicates a soil that is very high in potassium and manganese and
- Quackgrass (*El*
- Bitterweed (*He*
- Wild buckwhea
- Burdock (*Artiu*
- Curly dock (*Ru*
- Lambsquarters (*Chenopodium album*) grows in low phosphorus, high potassium

A smorgasbord of anecdotal information, ripe for testing by the next generation of Chuck Mohlers and innovative farmers

Weed:nutrient relationships discussed in When Weeds Talk:

- Redroot weeds, such as redoot pigweed (*Amaranthus retroflexus*), are signs that the iron-manganese ratio is out of balance. It may indicate there is too much iron or too little manganese. It also indicates a soil that is very high in potassium and manganese and
- Quackgrass (*Ely* … nganese ratio.
- Bitterweed (*Hel* … *radicans*), broom sedge (*Andropogon vi* … setail (*Equisetum arvense*) and wi … y all indicate a calcium deficiency in the
- Wild buckwheat … phosphorus and an excess of potass
- Burdock (*Artiu* … um soils.
- Curly dock (*Rumex crispus*) loves compacted soil, low calcium and extremely high magnesium, phosphorus and pot.
- Lambsquarters (*Chenopodium album*) grows in low phosphorus, high potassium

Have you TRANSLATED this type of info into practical weed management strategies?

agsolutionsnetwork.com/agemergepodcast

For insight into how McCaman collected the info in his book

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051 AgEmerge 2021 Podcast - Jay McCaman "When Weeds Talk"

15:44 44:38

1x 15 15

Weed Science

www.cambridge.org/wsc

2021

Review

Cite this article: Little NG, DiTommaso A, Westbrook AS, Ketterings QM, Mohler CL (2021) Effects of fertility amendments on weed growth and weed–crop competition: a review. Weed Sci. **69**: 132–146. doi: 10.1017/wsc.2021.1

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Email: ad97@cornell.edu

Effects of fertility amendments on weed growth and weed–crop competition: a review

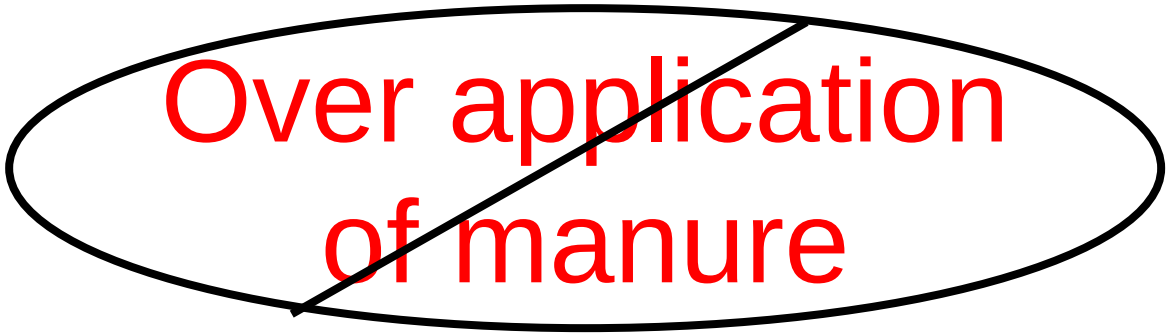
Neith G. Little[1], Antonio DiTommaso[2], Anna S. Westbrook[1], Quirine M. Ketterings[3] and Charles L. Mohler[4]

[1]Graduate Student, Section of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY, USA; [2]Professor, Section of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY, USA; [3]Professor, Department of Animal Science, Cornell University, Ithaca, NY, USA and [4]Senior Research Associate, Section of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY, USA

Abstract

Macronutrient inputs to annual cropping systems can benefit weeds as well as crops, sometimes decreasing or eliminating the benefits of fertilization. This interaction between fertility management and integrated weed management is becoming increasingly important as these fields increase their f… weed competition reflects… o nitrogen, phosphorus, an… dies of species such as …bsquarters (*Chenopodium*… …nd by ecological theory. …utrients on weed–crop con… …allenges in interpreting, comparing, and extrapolating from these diverse reports, we propose a conceptual framework that summarizes the mechanisms underlying observed variation within and between studies. This framework highlights functional traits and trends that help predict yield outcomes in binary weed–crop interactions. Important factors include timing of emergence, maximum heights of the weed and crop, and relative responsiveness to the added nutrient. We also survey recent work on the effects of nutrient source (e.g., the composition of organic

Research shows that <u>some</u> weeds are highly responsive to the availability of <u>some</u> nutrients



- Many weed species are highly responsive to soil fertility.
- Weeds often have 1.5 to 3 X higher N, P, K, & Ca concentrations than the crops they are growing with.
- Excess fertility increases weed growth rates and may enhance weed germination.

Adapted from Moehler


I see some variation in weed abundance and size but this spray program should kill EVERYTHING

IN ORGANIC CROPPING SYSTEMS

Practices >>> Products

Effective organic weed management = **Integration of many little hammers**

No one **PRACTICE** or product will **consistently** provide acceptable organic weed control

Effectiveness of **PRACTICES** & products
on organic farms
is strongly influenced
by farmer
SKILL and WILL
(*timeliness, prioritization,*
INTEGRATION of MLH
and commitment!)

CROPPING SYSTEM STRATEGIES

for weed management have 2 main priorities:

Opportunities to INCREASE crop competitive advantage !!!

Plant later

- soil must be warm enough for rapid crop emergence

Prepare a good seed bed

- weed-free and favorable for uniform crop emergence

Optimize planter performance

- depth, down pressure, closure of slot…

Accelerate crop canopy closure

- Plant well adapted tall leafy crops/genetics

- Increase crop populations
and/or adjust row spacing

- Apply seed treatments
and/or banded fertilizer

Opportunities to REDUCE weed pressure

Optimize performance of cultivation equipment

- right timing, setting, ground speed & soil conditions

Right timing = target weak links in weed life-cycles

- use blind cultivation and 1st cultivation effectively!!!

Prevent weed seed production

- Crop rotation, weed zapping, walking of crops, termination of excessively weedy crops (e.g., harvest as forage, graze, use as CC…)

Promote weed seed predation, decay & dormancy

- Crop rotation, cover crops, targeted tillage and LATE planting

WEED SEED DORMANCY AND GERMINATION

Micheal D.K. Owen
Professor and Weed Science Extension
Iowa State University

Innate?

Environmentally Induced? Enforced?

Introduction

persistent

Weeds are consistent problems in agriculture because of seed dormancy. Without dormancy, weed seeds would not survive in the soil for any period of time. Also critical are the factors that influence dormancy. These factors which describe seed dormancy also serve to "determine" when the seed has the greatest potential to germinate successfully, and thus survive to replace the seed bank. Understanding the concepts of seed dormancy and factors that influence the continuation or termination of dormancy thus allowing germination are critical for the development of an effective weed-management program.

Become a student of weed seed dormancy!

Seed dormancy has been described in a number of ways using many different, often synonymous terms. Dormancy has also been categorized into to specific types of dormancy, presumably based on different physical and environment (physiological) conditions that cause the *different categories of dormancy. Dormancy has been classically described as the failure for seeds* to germinate when environmental conditions are favorable to potentially support development. This failure to germinate is "blocked" by some condition or factor within the seed which, in itself, is not a requirement for germination. Thus, a dormant seed is one that can be prompted to germinate by removing or overcoming a particular condition(s) or factor(s).

Manage the Weed Seed Bank—Minimize "Deposits" and Maximize "Withdrawals"

Organic Agriculture August 20, 2013 Print

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eOrganic authors: Fabian Menalled, Montana State University
Mark Schonbeck, Virginia Association for Biological Farming

One of the most important—yet often neglected—weed management strategies is to reduce the number of weed seeds present in the field, and thereby limit potential weed populations during crop production. This is accomplished by managing the weed seed bank.

What is the Weed Seed Bank, and Why is it Important to Organic Farmers?

The weed seed bank is the reserve of viable weed seeds present on the soil surface and scattered throughout the soil profile. It consists of both new weed seeds recently shed, and older seeds that have persisted in the soil from previous years. In practice, the soil's weed seed bank also includes the tubers, bulbs, rhizomes, and other vegetative structures through which some of our most serious perennial weeds propagate themselves. In the following discussion, the term **weed seed bank** is defined as the sum of viable weed seeds and vegetative propagules that are present in the soil and thus contribute to weed pressure in future crops. Agricultural soils can contain thousands of weed seeds and a dozen or more vegetative weed propagules per square foot.

Weed Science, 1995. Volume 43:498–503

Exploiting Weed Seed Dormancy and Germination Requirements through Agronomic Practices[1]

WILLIAM E. DYER[2]

Abstract. **Many common agronomic practices affect weed seed dormancy and germination by influencing the microenvironmental and edaphic conditions surrounding seeds in soil. Factors such as light penetration, soil water content, soil fertility, and temperature are modified by tillage, planting, harvesting, and other production practices, resulting in enhanced or depressed weed seed germination. Changes in these environmental factors may also indirectly lead to alterations in phytohormone concentrations during seed development, which can subsequently affect dormancy status of the mature seed. on depleting wee mancy or germi to enhance weed tems. Nomenclat Heynh), barley (ters (*Chenopodiu* giant foxtail (*Seta* Roth), rough stal weed (*Polygonun* L.), red rice (*Or* L.), redroot pigw *cereale* L.), silver *tilla recta* L.), wi *asiatica* (L.) Kur *Additional index* physiology.**

This interesting article discusses a wide variety of factors that effect weed seed dormancy & germination (e.g., *nutrient levels, light, temperature, O_2 & CO_2, crop residues, depth of burial, tillage implement*…) and opportunities to exploit these effects

INTRODUCTION

Weed seed dormancy and germination are regulated by a complex interaction of environmental, edaphic, physiological, and genetic factors. Almost all agronomic practices can affect these factors, primarily by altering the physical environment of

literature. Most classifications are based on the proposed physiological mechanisms of dormancy. However, since the underlying regulatory processes controlling dormancy induction, maintenance, and relief are essentially unknown, it may be premature to assign terms to different types of dormancy. In this paper, the term dormancy is used in its broadest sense, in which seeds do not germinate under environmental conditions that would normally support germination of that species in the field. Because it has been difficult to develop broad generalizations about seed dormancy, the reader should be cautious about ex- ment to another.

Y

behavior in bur- l weedy species en documented seeds of summer ring, and winter pring, while re- r. Although the cycling are not the result of two ncy (7). For the ears to be inde- a certain critical with increasing temperature. Field data of dormancy cycling have been successfully modelled using soil temperature (heat and cold sum) as the primary controlling factor (8), although other authors have suggested that light conditions also may be involved (2). In addition to dormancy cycling under field conditions, some evidence indicates that an endogenous rhythm is established that may persist in seeds removed from the field and stored under control-

Weed Technology. 1999. Volume 13:421–424

Effects of Soil Calcium and pH on Seed Germination and Subsequent Growth of Large Crabgrass (*Digitaria sanguinalis*)[1]

GARY L. PIERCE, STUART L. WARREN, ROBERT L. MIKKELSEN, and H. MICHAEL LINKER[2]

Abstract: Large crabgrass is a problem weed in horticultural crops, particularly in turfgrass in the southeastern United States. If growth of large crabgrass could be suppressed via soil pH or calcium levels, control of this weed in turfgrass might be improved while minimizing herbicide usage. To determine the eff rge crabgrass, seeds were sown in a l agnesium carbonate ($MgCO_3$) that establish lso sown in soil amended similarly with calcium stablished a range of exchangeable Ca levels corresp H 4.8 to 7.8. Seed germination of large crabgrass was unaf with $CaCO_3$, whereas seed germination decreased with increasing d with $MgCO_3$. Crabgrass germination was not affected by Ca ($CaSO_4$) in Increasing soil pH reduced shoot and root dry weights of seedlings regardless of material used to raise pH. Maximum shoot dry weights occurred at pH 4.8 in the unamended soil, whereas maximum root dry weights occurred at ranges from pH ights were not affected b growth of large crabgrass and its exchangeable Ca does not appear to be an effective p this weed species.

Nomenclature: Large crabgras p. #[3] DIGSA.

Additional index words: Calcitrge, integrated pest management, integrated weed management.

More research is needed on how CALCIUM impacts weed germination and growth

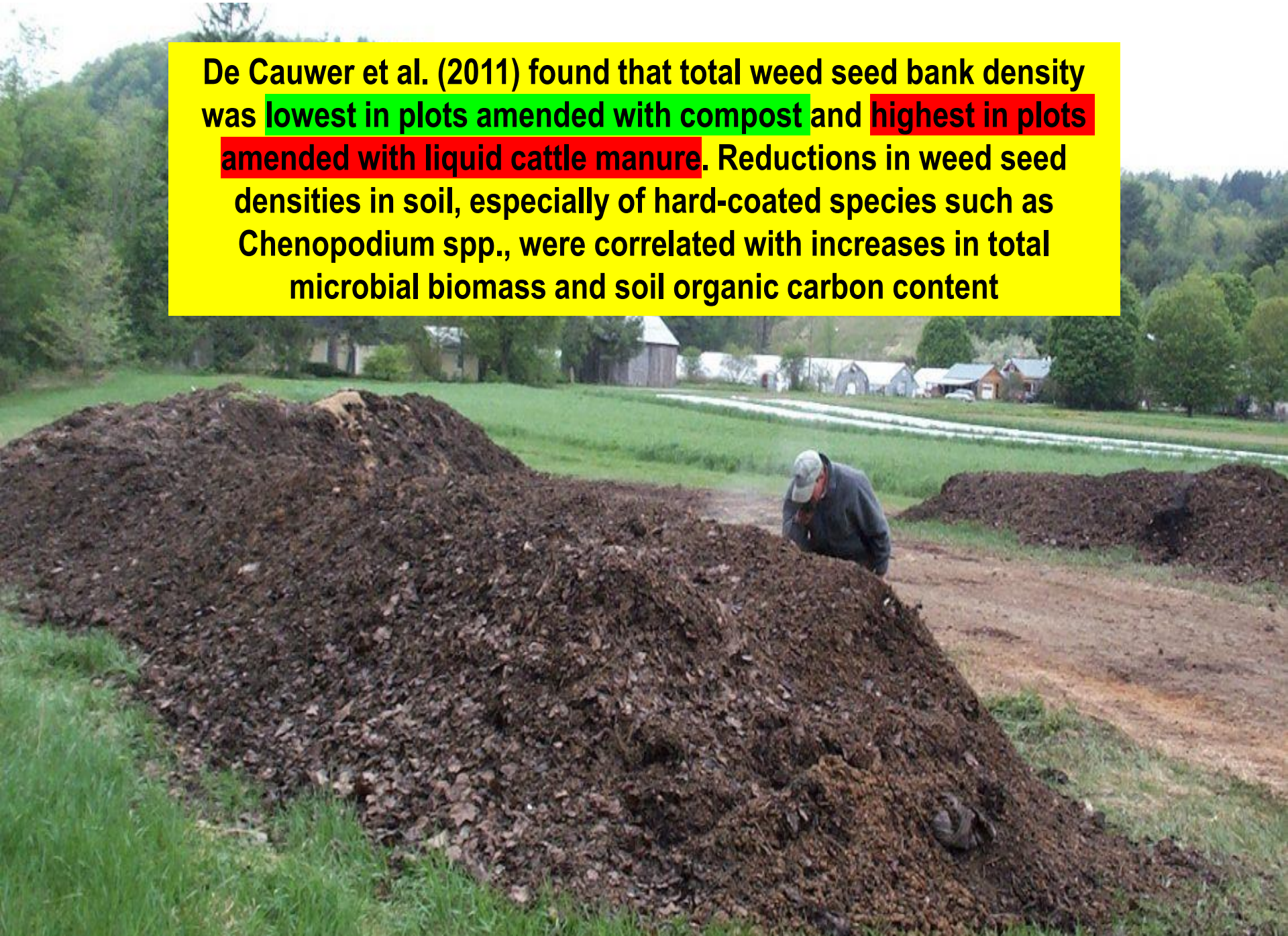
This research indicates that higher Ca availability does NOT suppress Large Crabgrass

Regulation of seed dormancy and germination by **NITRATE**

Published online by Cambridge University Press: 06 June 2018
Lisza Duermeyer et al.

Abstract

Nitrate promotes seed germination at low concentrations in many plant species, and functions as both a nutrient and a signal. As a nutrient, it is assimilated via nitrite to ammonium, which is then incorporated into amino acids. Nitrate reductase (NR) catalyses the reduction of nitrate to nitrite, the committed step in the assimilation. Seed sensitivity to nitrate is affected by other environmental factors, such as light and after-ripening, and by genotypes. Mode of nitrate action in seed germination has been well documented in Arabidopsis thaliana and the hedge mustard Sisymbrium officinale. In these species nitrate promotes seed germination independent of its assimilation by NR, suggesting that it acts as a signal to stimulate germination. In Arabidopsis, maternally applied nitrate affects the degree of primary dormancy in both wild-type and mutants defective in NR. This indicates that nitrate acts not only during germination, but also during seed development to negatively regulate primary dormancy.



De Cauwer et al. (2011) found that total weed seed bank density was lowest in plots amended with compost and highest in plots amended with liquid cattle manure. Reductions in weed seed densities in soil, especially of hard-coated species such as Chenopodium spp., were correlated with increases in total microbial biomass and soil organic carbon content

“Swatting the hornet’s nest”

Tillage

triggers the germination of weed seeds by increasing exposure to light, oxygen, temperature fluctuations…

Some tillage practices trigger more weed germination than others!

Reducing weed seed pressure with the false seedbed technique

Problem

Annual crops are especially sensitive to weed pressure during early growth. Intensive weed pressure limits crop growth through competition for light, nutrients and water.

Solution

Grow the weeds, and then grow the crop! The false seedbed technique consists of preparing a regular seedbed (early) and then – instead of sowing the crop directly – you allow the weeds to germinate and then control them repeatedly before planting or sowing the actual crop.

Outcome

The false seedbed technique reduces the weed seed bank in the topsoil and, as a result, significantly reduces competition of annual weeds in the succeeding crop.

Practical recommendation

- Prepare a regular seedbed 2 to 4 weeks before the planned seeding date of the next crop.
- Let the weeds germinate and grow to the 2- to 4-leaf stage, the most effective stage for weed control.
- Uproot the weeds to a depth of 3 to 5 cm using a harrow comb or a flexible or chain harrow.

Applicability box

Theme
Weed management

Geographical coverage
Global, limited to specific soils, climates

Application time
2-4 weeks before sowing or planting

Required time
Harrowing 1 to 2 times

Period of impact
Succeeding crop

Equipment
Harrow-comb or flexible harrow, chain harrow

Best in
Crops with slow emergence and/or slow establishment; crops with low competitiveness such as soya, beans, peas, sugar beet, carrots or onions.

https://orgprints.org/id/eprint/31022/25/PA_007_False-seedbed_final_QR.pdf

Stale seedbed (SSB) technique

(modified from a rice production guide)

SSB is a seedbed prepared weeks or even months prior to sowing or planting a crop with a goal of flushing out germinable weed seeds prior to the planting of the crop, thus depleting the seed bank in the surface layer of soil and reducing subsequent weed seedling emergence.

The three ‘golden rules’ of SSB:

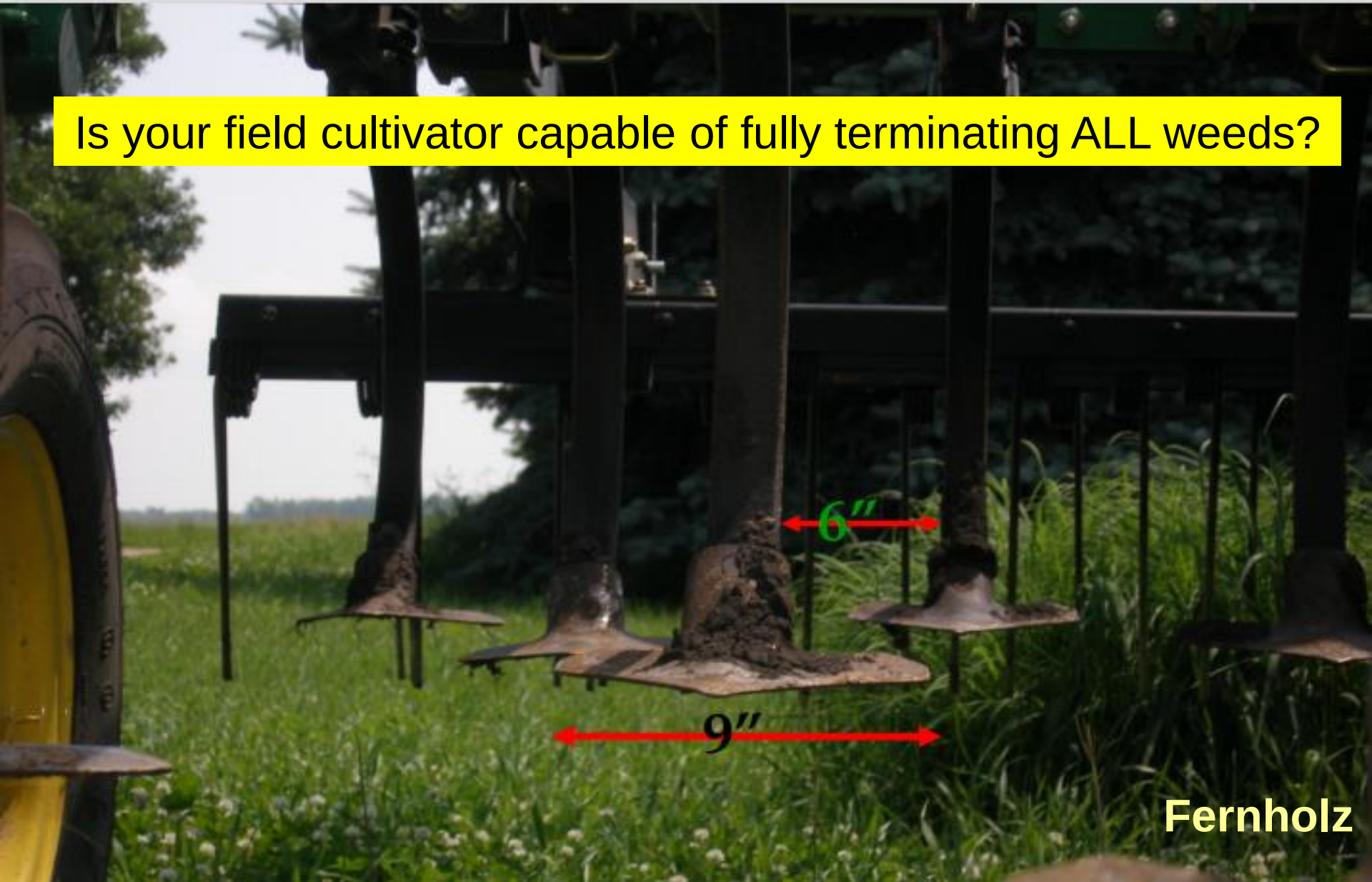
1) 85-95% of the seed in a seed bank have innate dormancy at any given time and most of the other 5-15% will germinate quickly with the right environmental conditions.

2) Tillage is the most effective means of getting weed seeds to germinate.

3) Most weeds emerge from top 2” of soil.


Will these weeds be fully terminated
by the last tillage pass before planting?

Seed Bed Tillage




~ 5 days after planting
Corn emerging rapidly and uniformly
WHY DOES THE SOIL SURFACE LOOK LIKE THIS?

Early season weed control – Part 2

By Klaas and Mary-Howell Martens, Lakeview Organic Grain
Originally posted on February 10, 2005

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 germinate shallower in the soil.

Annual weeds are most sensitive to disturbance *between germination and emergence*.

Weed seedlings are killed by the least amount of mechanical disturbance during this time frame.

What blind cultivation tools are you currently using?

We use an M&W high residue rotary hoe and an Einbock tine weeder @ the WIU Organic Research Farm.


Tine weeding has worked very well for soybeans (pre- and post emergence). We have limited experience with corn.


Blind cultivation tools provide the most “action”
when they are shattering a crust

Blind cultivation tools move more soil (& terminate more weeds) when the initial soil condition is rough and residue rich.

Blind cultivation terminates white root seedlings

& creates a loose, dry soil surface environment

(sometimes called a dust mulch)

unfavorable for weed germination

until the next rain

2019 data

Soybean Variety	Blind cultivation (pre and post)	average # per row foot	st dev	#/a
34A7	Rotary hoe	4.7	3.47	82,009
34A7	Tine weeder	4.3	3.83	75,039
35DC2	Rotary hoe	3.9	2.84	68,302
35DC2	Tine weeder	3.4	4.38	59,706

All final stands were much lower than planted, but stands varied with variety & tool.

A high level of weed control was achieved & the loss of stand had little effect on yield.

Row cultivation tools

When properly set, inter-row weeds are dessicated and in-row weeds are buried


Extended spacing between sweeps improved residue flow


New Additions
Improved lateral stability and residue sizing

It is possible to achieve a high level of in-row weed control using a row crop cultivator (even when in-row weed pressure is high)…

…but this can only be accomplished during the

1st cultivation

WIU = testing ground for prototype Accuraflow cultivator

Much easier adjustment allows more accurate control of soil flow into the crop row

Mechanical, GPS and sensor-based guidance systems can significantly IMPROVE blind and row-cultivation

Reduced operator fatigue and easier monitoring of cultivator

Do you have experience with guidance systems?

FARM SHOW
For everyone in agriculture interested in latest new products and ideas

1990 - Volume #14, Issue #1, Page #15

Tractor mounted guide system runs 7-9 inches deep

"This is the guidance system everyone's been looking for," says Emeric Bernard, Tintah, Minn., about his "under-tractor" guidance system that uses the weight of the tractor to form guide furrows 7 to 9 in. deep and 5 in. wide.

Bernard designed and now manufactures the new system, which uses sharp-ed use we weren't h ms use the weight of em uses the weigh t'll stand up to heavy rain and irrigation. Guidance systems that use wand-type sensors require lots of electronics and can be thrown off the row if they hit a corn stalk or a dirt clod. This system makes a trench that's hard and distinct. It's the only guidance system that works well in heavy trash. The furrow is easy to follow with single rib tires on the tractor and the guidance wheels on the cultivator. Once you're in the fur-row, you can take your hands off the wheel and forget about steering."

Old school guidance is making a come-back

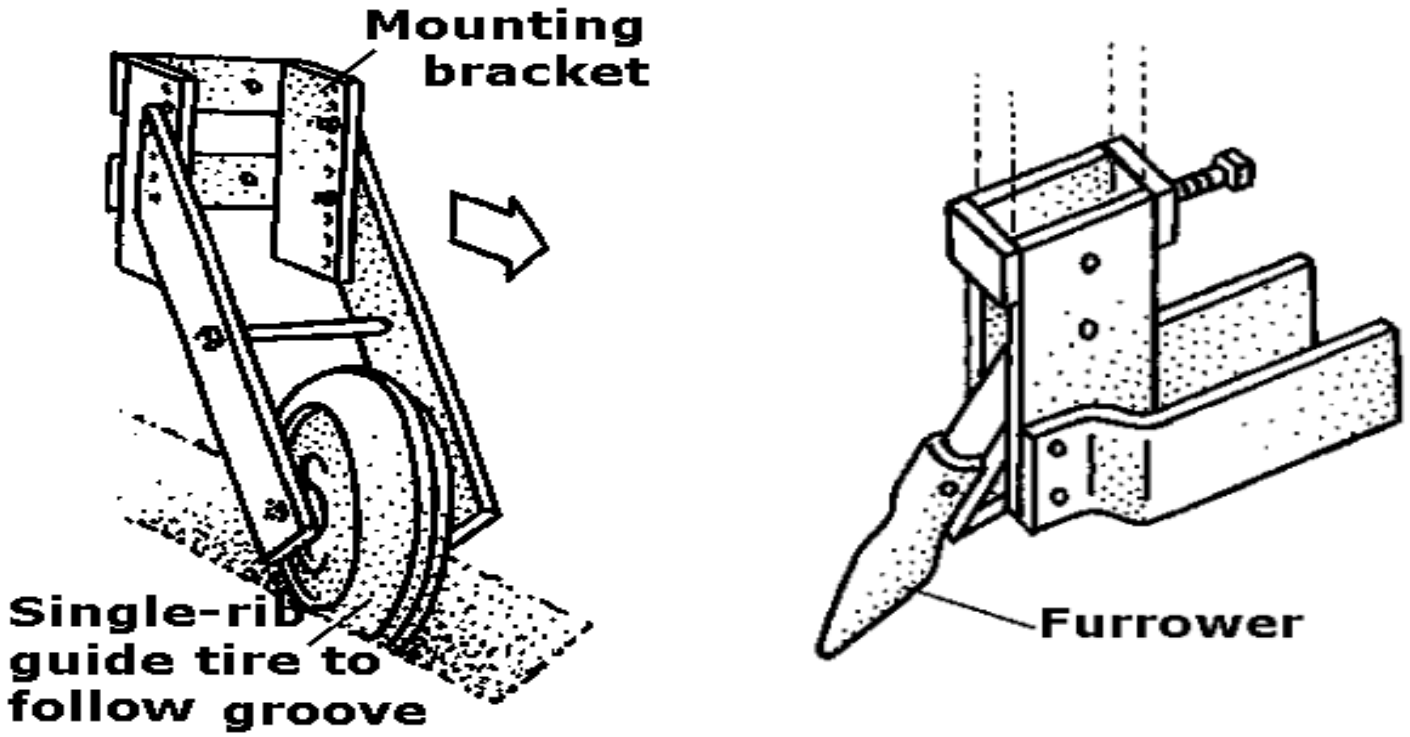
Sharp-edged wheel makes a furrow that's 7 to 9 in. deep and 5 in. wide. Furrow is easy to follow with single rib tires on tractor and guidance wheels on cultivator.

Guidance, furower/wheel

from **Steel in the Field**

Agronomic Row Crops
Furrower/Wheel Guidance

Overview: Furrow-following guidance systems perform well in fields that are fairly flat and relatively residue- and rock-free. At planting or final tillage pass, a furrowing ripper forms a distinct trench shaped to securely guide a sharp-edged steel wheel or thin, ribbed rubber tire attached to the cultivator toolbar. Positioning the guide wheel at the end of the toolbar, creating firm furrow sides and running the guide wheel deeply are steps to maximize control. Use with sway blocks up or removed so that hitch arms swing freely.



Design Features: Guide-shoes or custom sweeps create a V-shaped furrow; steel wheels or flared boots smooth and firm furrow walls; single-rib or highway tires—depending on design—ride in the furrow to guide the tool.

List price: $1,720 to $2,090
Sources: 2, 11, 68, 73

2 keys to successful cultivation

START RIGHT

FINISH STRONG

= rapid crop growth after cultivation

STARTING RIGHT

Manage soil for good tilth

WITHOUT good soil tilth, crumbling of soil from weed roots and flow into the row will be inadequate!

Prepare a weed-free seed bed suitable for your planter to establish a good stand

Set planter carefully and check seed depth and spacing multiple times

Plant the straightest rows possible

Take blind cultivation VERY seriously!!!

Take 1st row cultivation VERY seriously!!!

In 2018, we evaluated the impact of
standard vs **aggressive** residue management

2018 Field 4-2/4-3: soybean yields

Why do you think planting into a furrow had a significant positive effect on yield?

Rep	Treatment ID #	Weigh Wagon Wet W	% Moisture	Plot Length (ft.)	Area (acre)	Yield (Bu/A)
1	1	2398	11.7	1183	0.68	59.7
2	1	2596	11.5	1183	0.68	64.8
3	1				0.68	67.9
4	1	2760	11.5	1183	0.68	68.9
5	1	2540	11.5	1183	0.68	63.4
1	2	2370	11.7	1183	0.68	59.0
2	2	2468	11.6	1183	0.68	61.6
3	2				0.68	59.2
4	2	1932	12.2	1183	0.68	47.9
5	2	2108	11.9	1183	0.68	52.4

aggressive residue management

standard residue management

ID 1 ="Aggressive/Deep" setting for residue managers

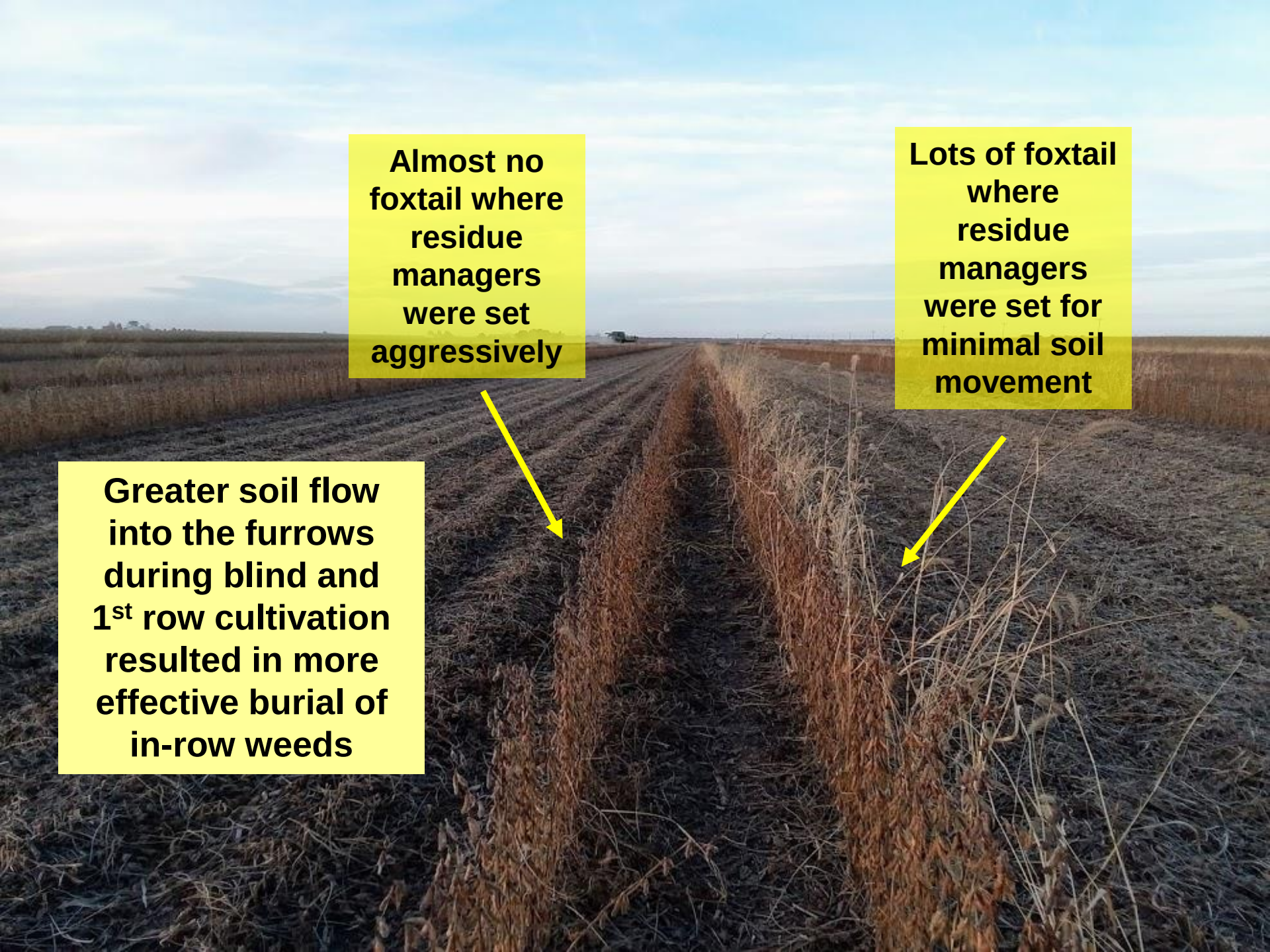
ID 2 = "Standard" setting for residue managers

Avg Yields (Bu/A)

65.0

56.0

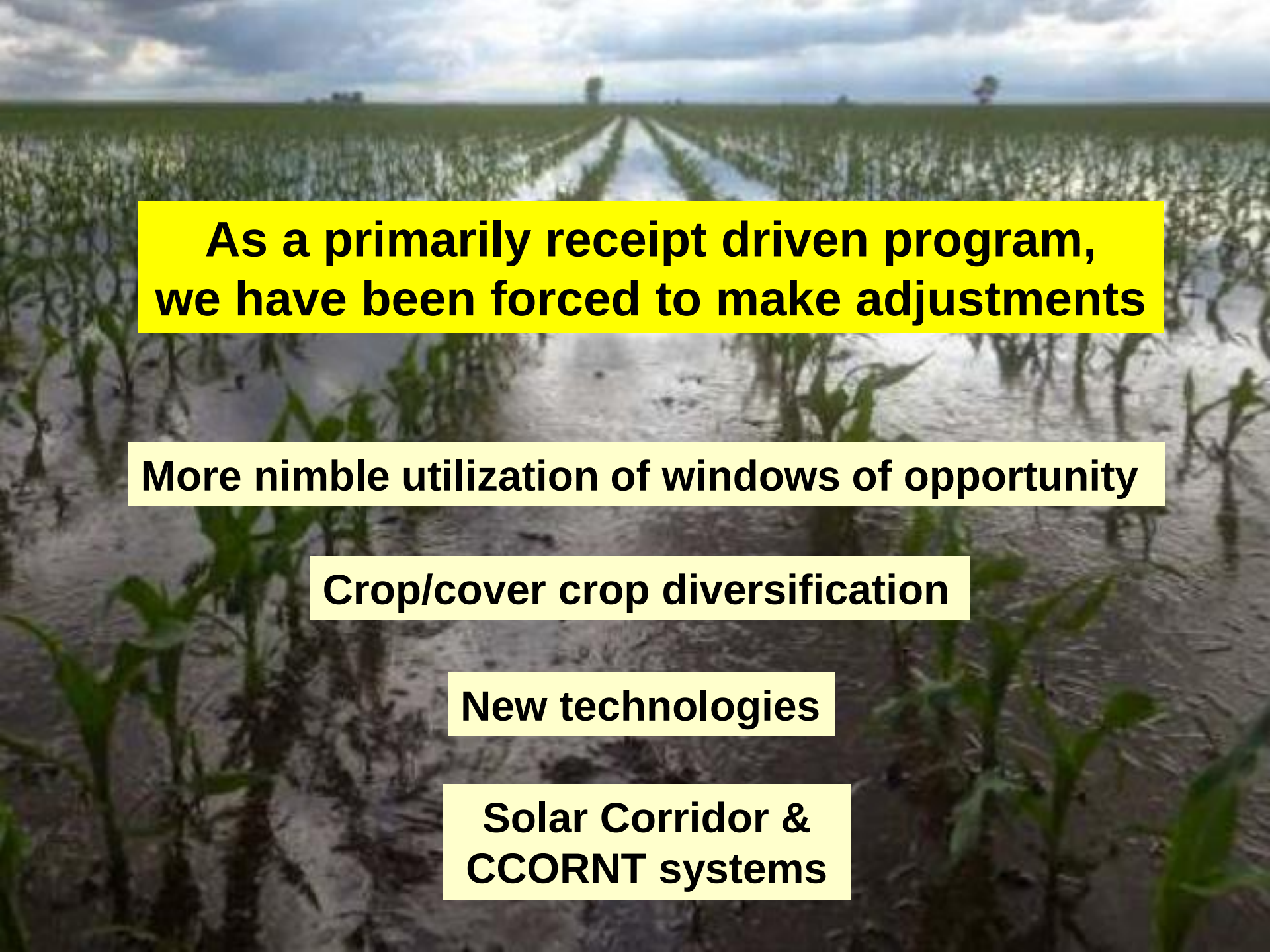
GH 389N was planted on 5/31/18 at ~ 170,000 seeds/ac.


Almost no foxtail where residue managers were set aggressively
Lots of foxtail where residue managers were set for minimal soil movement
Greater soil flow into the furrows during blind and 1st row cultivation resulted in more effective burial of in-row weeds

Timeliness strongly impacts the effectiveness of cultivation


This is possible!
but is much more difficult when
weather does not cooperate :(


Has your area
experienced
increasing frequency of
extreme weather events?


As a primarily receipt driven program, we have been forced to make adjustments
More nimble utilization of windows of opportunity
Crop/cover crop diversification
New technologies
Solar Corridor & CCORNT systems


We now start cultivating
when the crop
is still very small
IF there is weed
pressure and soil
conditions are fit


Sunflowers can be planted very late (mid-July!)
making it easier to achieve good weed control

Some organic weed control tools are less sensitive to soil moisture

Row-Crop Flamer

(standard U.S. LP-gas, liquid feed)

CROP height range estimate

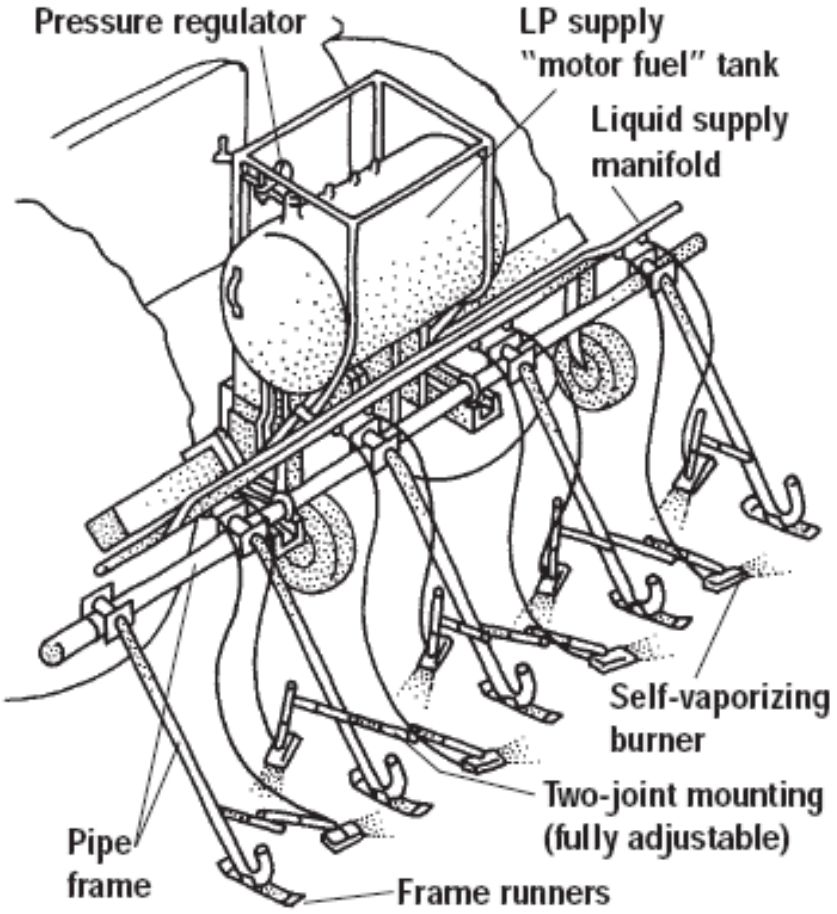
0" 2" 4" 6" 8" 10" 12" 18" 24" 30" 36"

WEED height range (annuals) estimate

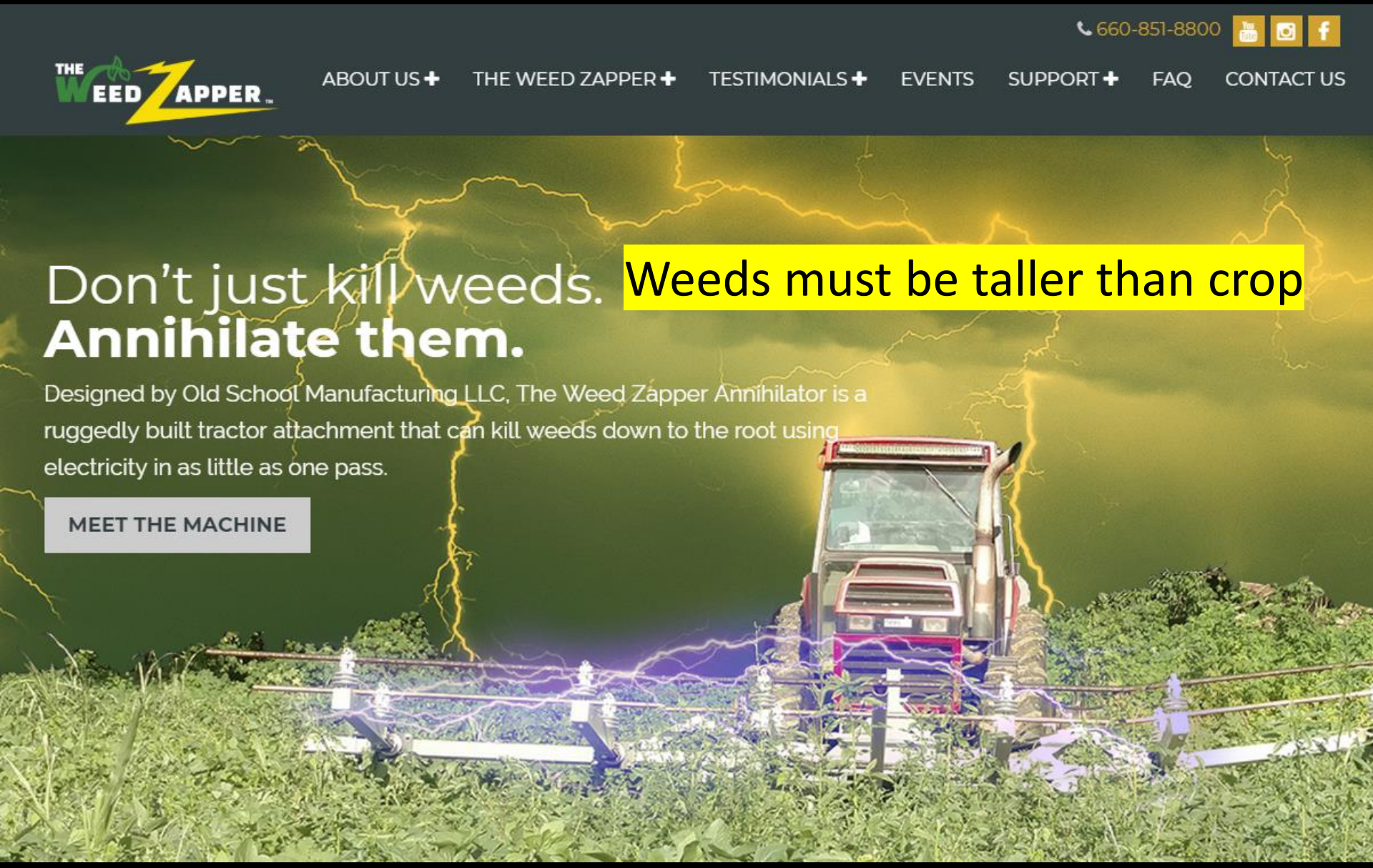
suitable less suitable unsuitable

Match tillage timing, depth and location to crop root growth. Weed control varies with soil conditions and weed density.

*Postemergent heights for crops with a heat-resistant stalk, such as corn or cotton, that allow cross-flaming in row. Flame contacts stalks. Optimum stages for in-row flaming corn are up to 2", 8" to 12", then 18" to 24."



Overview: Flames from LP-gas burners kill plants by rupturing cell walls, not burning plant tissue. Flaming is most effective on broadleaf weeds as small seedlings. It is less effective against grasses, and least effective on sedges and weeds that branch at ground level. **Broadcast flaming** can cover an entire bed or toolbar width prior to crop emergence. **Directed flaming** targets a specific zone between crop rows or in-row beneath plants after they develop a heat-resistant stem.


660-851-8800
THE WEED ZAPPER
ABOUT US
THE WEED ZAPPER
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Don't just kill weeds.
Annihilate them.
Designed by Old School Manufacturing LLC, The Weed Zapper Annihilator is a ruggedly built tractor attachment that can kill weeds down to the root using electricity in as little as one pass.
MEET THE MACHINE
Weeds must be taller than crop

rootwave

Home About Technology Solutions

Targeted control of small weeds between rows

High frequency electricity gives better weed control with lower energy use

CROP.ZONE
integrated weed management

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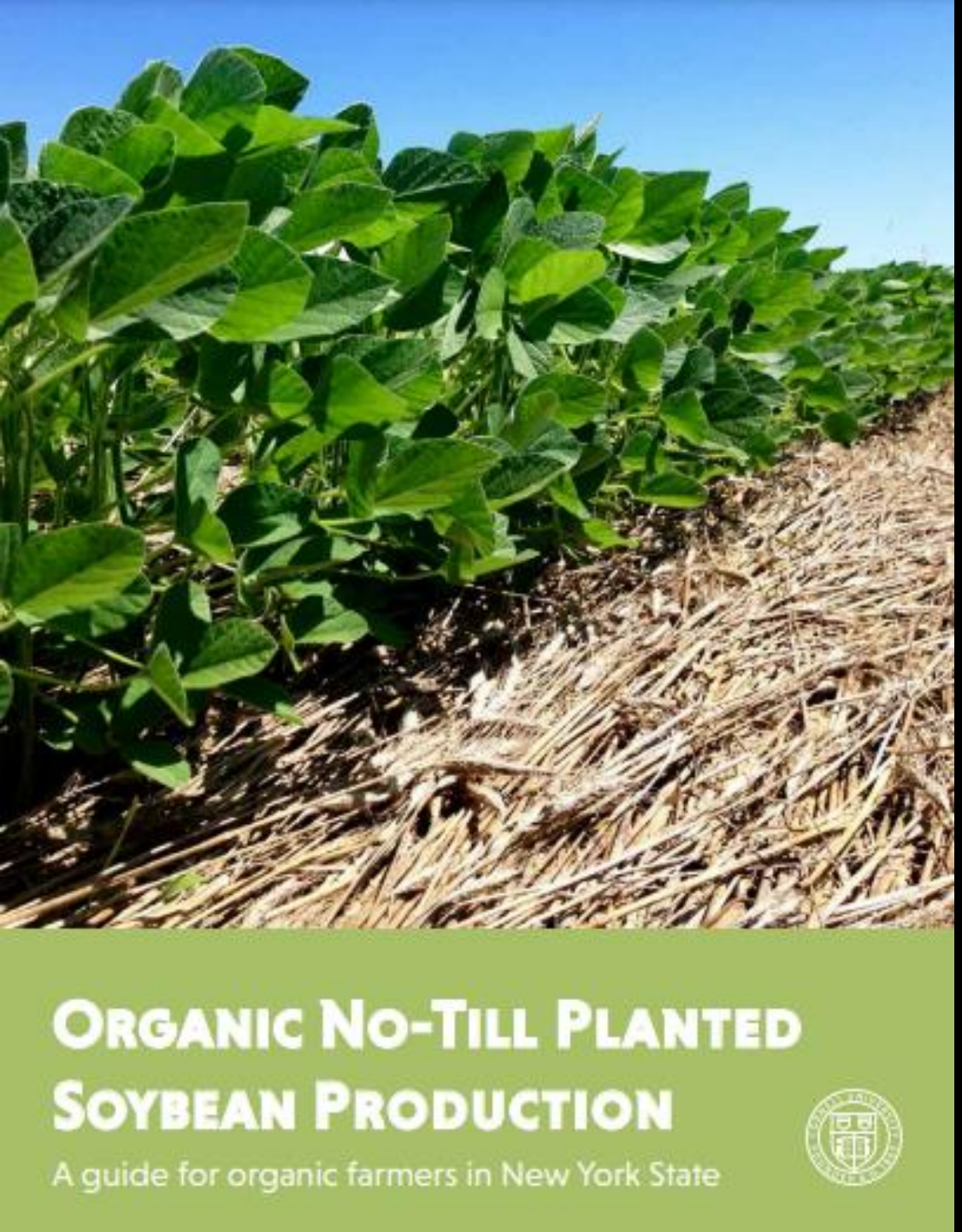
The crop.zone process combines chemical and physical plant protection to create an effective way to kill weeds.
By pre-treating the plants with substances that are highly acceptable for agriculture plants are treated with a much high degree of efficiency and lower energy use.

- Yield protection for farmers
- Competitive pricing (less costly than chemical model)
- Protects the soil, promotes CO2sequestration in soil (no ploughing -no-till)
- Complies with organic farming guidelines
- Broad mode of action
- Efficiency for application as good / fast as a sprayer
- Very low CO2-footprint
- About 3x faster than ploughing

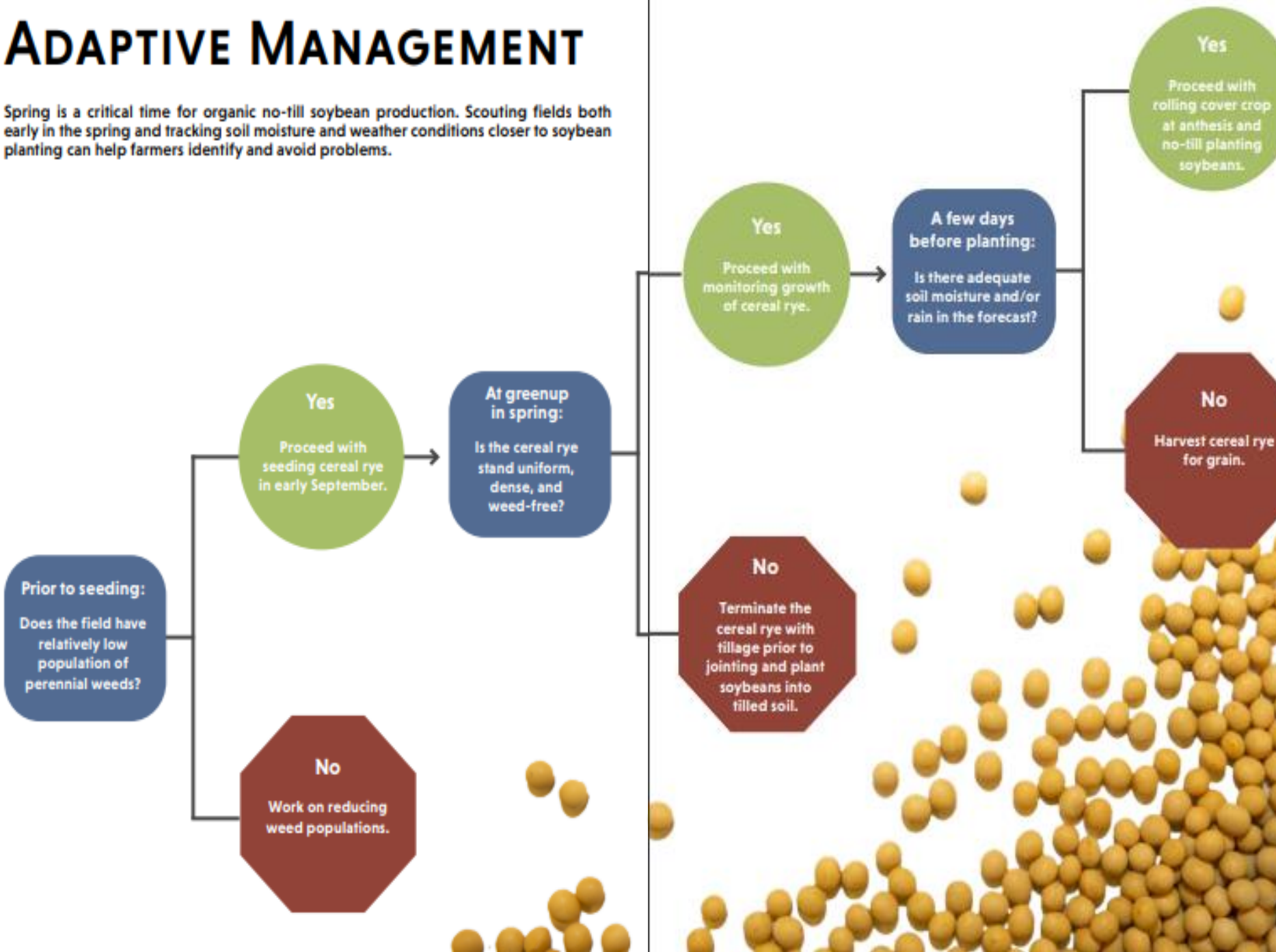
Application of electrolyte solution allows control of high biomass weeds (or CCs) with much lower power requirement

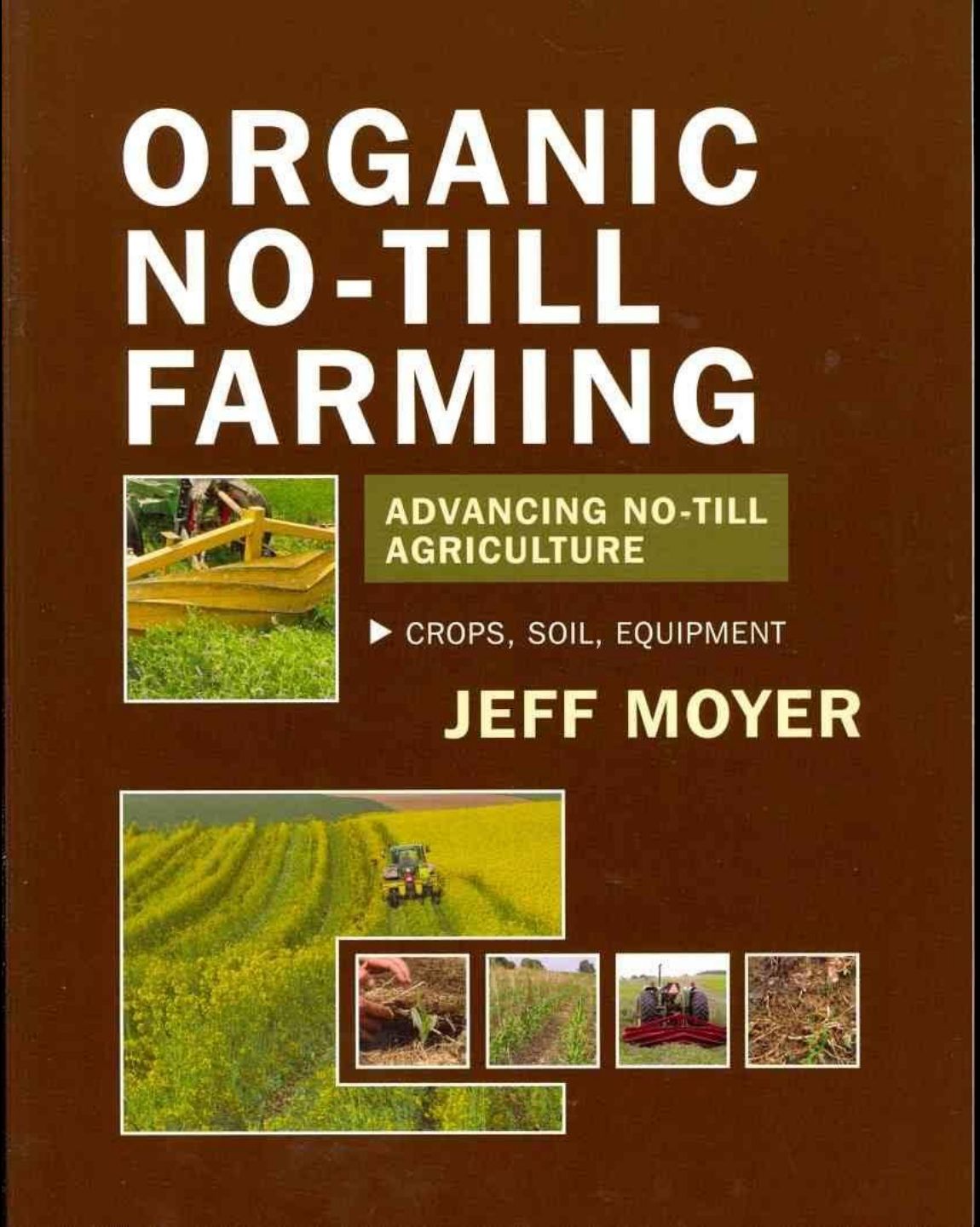


Great compilation of practical recommendations for organic no-till soybean production

Adaptive Management

Spring is a critical time for organic no-till soybean production. Scouting fields both early in the spring and tracking soil moisture and weather conditions closer to soybean planting can help farmers identify and avoid problems.





"Too much about the roller crimper and not enough about no-till organic farming.

A crimper is not the all-to answer for organic no-till farming...not by any means.

In the right environmental condition, it is a useful tool to terminate some cover crops, but the book makes it seem as though it solves the termination issue mechanically."

Amazon review
by organic farmer in IA

NT organic soybeans following corn is HIGH RISK

It is often difficult to establish
an adequate stand of cereal rye after corn harvest

We now normally follow small grains or peas:

T T

Year 1: **Corn**

T = tillage

T T

Year 2: **Field pea** → **rye** (volunteer peas)

Year 3: **rye** → NT soybean

Early planted rye w/ adequate N is very likely to produce a strong stand

Weed control and **adequate N supply**
are often identified as the
2 greatest challenges faced by
producers of organic corn

Solar Corridor Cropping Systems (SCCS)
have the potential to address both issues
through strategic adjustment of plant spacing
(both in-row and between row)
and **complementary practices**

Key SCCS concepts

Solar corridors

(i.e., gaps between corn rows
wider than traditional row spacing)

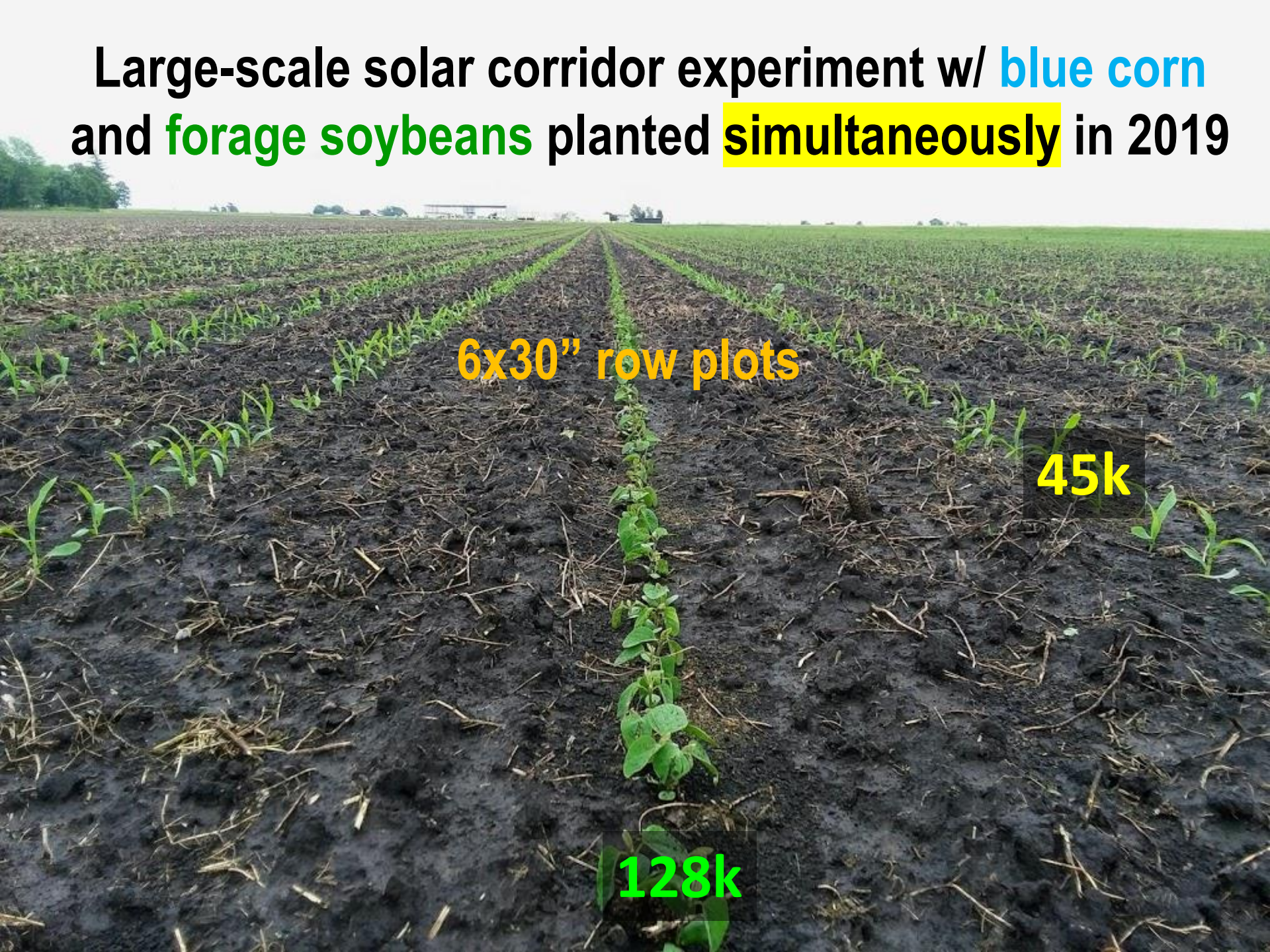
occur at regular intervals across SCCS fields

(e.g., every other row **or** 3rd row w/ 30” row spacing)

& standard or near standard
corn populations are maintained

(e.g., 2 rows packed into 1 **or** 3 rows packed in 2)

Large-scale solar corridor experiment w/ blue corn and forage soybeans planted simultaneously in 2019



Uniform management across the field after planting


Fast in-row canopy development in double rows of corn planted @ 45k
Looks good so far…
I wonder how the corn
is going to yield

Over 5yrs we have tested many variations on **SCCS**

- row configurations
- row orientations
- corn genetics
- N products and placements
- cover crops

consistent high biomass CCs ☺

consistent yield drag compared to 30” corn

(10 to >25%) ☹

Effective physical weed control (PWC) requires a systems approach to weed problems. In practice, this means that PWC relies on prior application of agronomic practices aimed to:

(1) reduce weed emergence through the use of preventive methods (crop sequence choice, primary tillage, false seedbed technique, blind cultivation, use of cover and⁄or smother crops)

(2) reduce weed competition through cultural methods that improve crop competitive ability (use of appropriate crop genotypes, transplants, sowing⁄planting pattern, fertilization strategy).

The aim of weed management strategies in organic farming is to maintain weed populations at a manageable level through a range of husbandry approaches throughout the rotation, so that that direct control actions within individual crops have a greater surety of success.