

Tracking Vegetable Yields and Labor in a No-Till Perennial Clover Living Mulch System

2022 Northeast Partnership Grant

ID: PG22-017

Link to share: <https://projects.sare.org/proposals/show/861065/15014>

Grant Type: On Farm Research/Partnership

Region: Northeast

A collaboration between Sawyer Farm, Four Corners Farm, American Farmland Trust, and UMass.



Sawyer Farm has been experimenting with the Clover Living Mulch System (CLMS) since 2020.



This study aimed to expand CLMS to neighboring Four Corners Farm and track labor and yield to assess profitability.



In particular, we asked whether plug size and mowing frequency would have an effect on clover competition and yield.

Why CLMS?

Ecosystem benefits:

Physical: Breaks impact of raindrops, shades soil, increases infiltration, eliminates erosion

Chemical: Fixes N, sequesters C

Biological: Feeds below- and above-ground biodiversity



Why CLMS?

Management benefits:

Establishes and overwinters reliably

Suppresses weeds, reduces labor

No dust, no mud

Minimal residue makes equipment modification simple relative to rye



But, how to manage clover/cash crop competition?

Types of Competition:

Photosynthetic

Nutrient

Water

Other – fungal? Bacterial? Enzymatic?

Some crops seem to ‘play well’ with clover, while others do not.

Managing clover/cash crop competition

Cultural: plug size, irrigation schedule, timing, nutrient applications

Physical/mechanical: mowing, undercutting clover, tarp suppressing clover

Chemical: herbicides

CLMS plantings **don't need to out-yield** 'conventional' plantings, but they **do need to be as or more profitable**.

That profitability, for us, comes primarily from labor savings on weed control in clover.

We studied the effect of plug size and mowing frequency on labor and yield in CLMS vs. bare soil treatments.

Trials at Two Sites

Four Corners Farm (Cabbage, Squash)

Study Mowing Regime



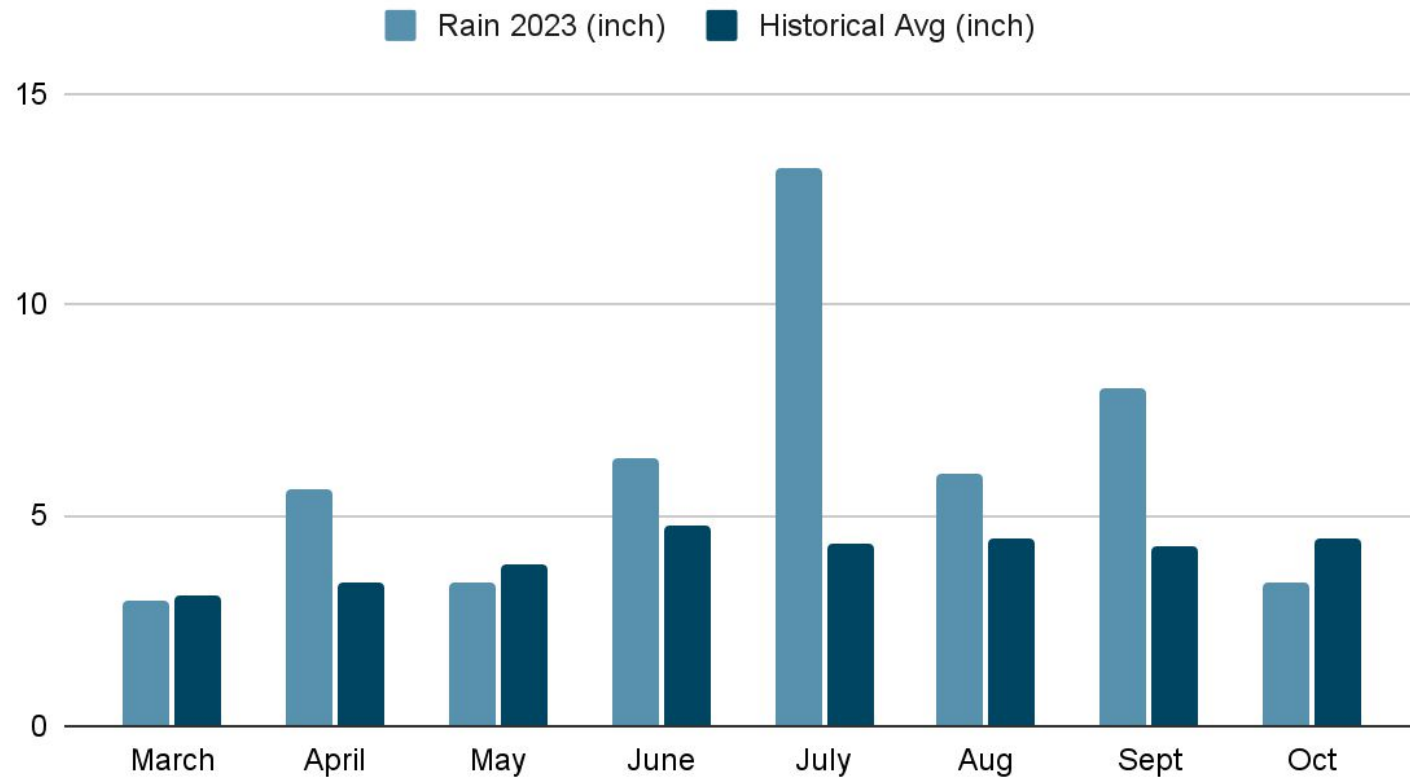
Sawyer (Cabbage, Squash, Tomatoes)

Study Plug Size and Mowing regime



2023 Was an Extremely Wet Year (Worthington, MA)

Monthly Precipitation



Four Corners Farm

Yield, Labor, and Soil Analysis

Experimental Layout at Trip's



Squash No Mow

Squash High Mow

Squash Competitive Mow

Cabbage Competitive Mow

Cabbage No Mow

Potatoes

Hemp

Corn

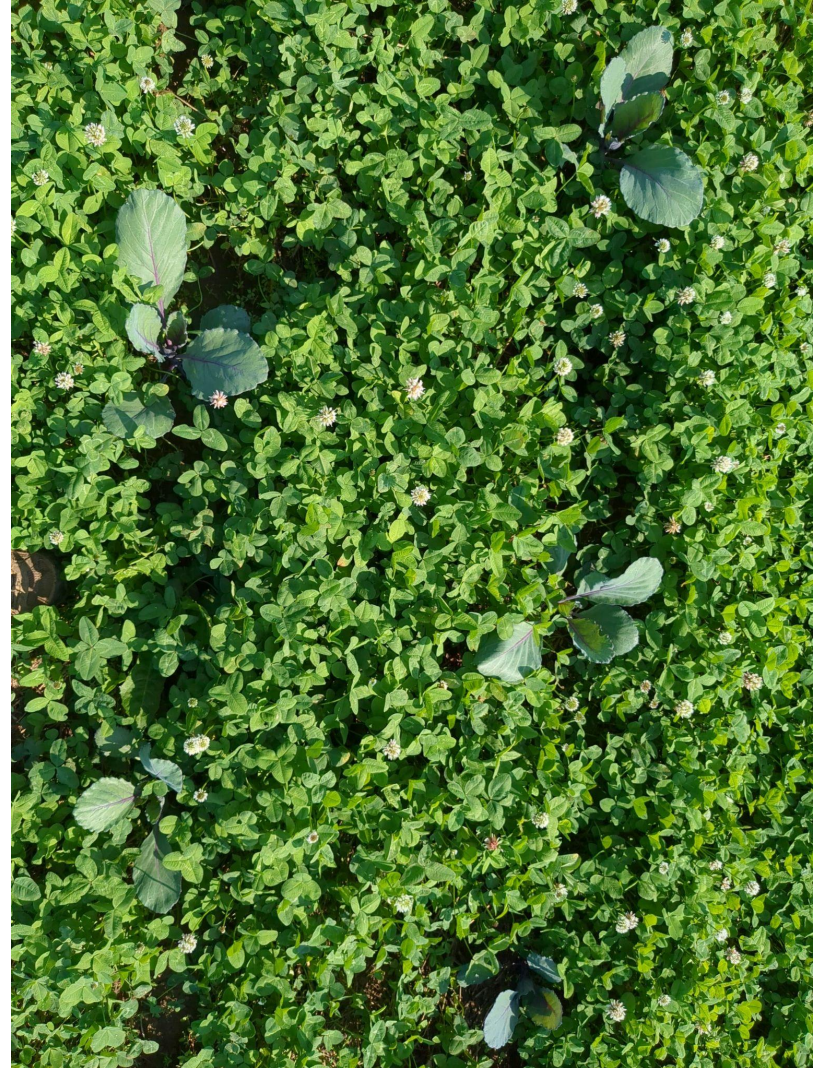
Squash Control

Cabbage Control

Crop Progression: Cabbage

Red Cabbage “Ruby Perfection” seeded in
72 trays on May 9th

Transplanted: June 14th and 15th (during very
dry spell.)



A note about transplanting:

This year, we used a modified Checci & Magli Dual Gold transplanter. It took us a while to get it dialed in. We think it wasn't adequately firming in the transplants in clover, which delayed growth and caused some loss in the clover vs. in the bare soil, where the transplanter packed the plants in as usual. We added weight later in the season and it worked much better.



Transplanter was not properly firming plugs, which led to some initial slow growth and loss of some transplants.

These photos are from 3 weeks after transplanting.



Mowing regimens

We had two different mowing regimens for cabbage.

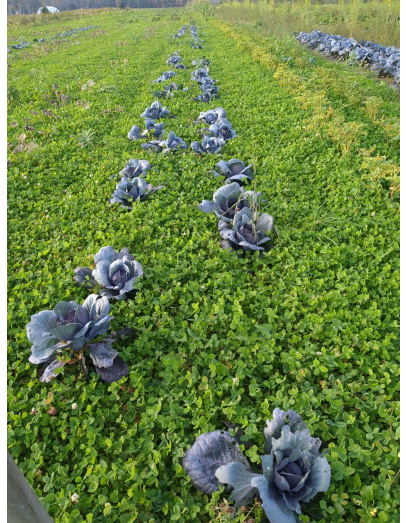
“No mow,” which actually got mowed one time a few days after transplanting.

“Competitive mowing,” which was mowed four times – every other week for eight weeks.

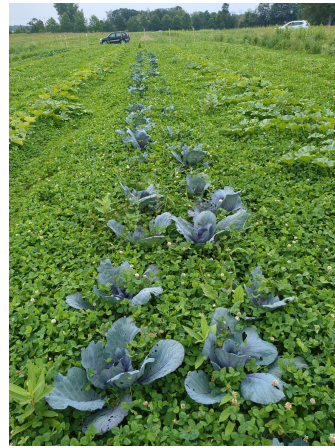
Cabbage Competitive Mowing (mowed four times)



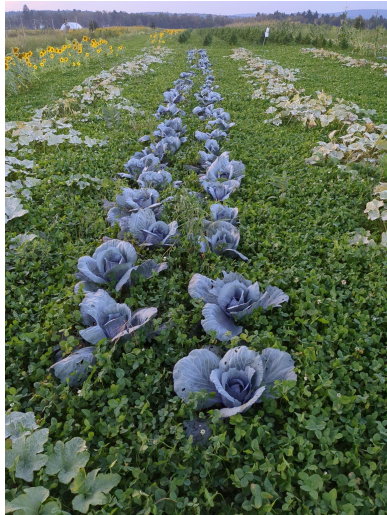
These photos were taken two weeks apart throughout the season.



Cabbage No Mow (mowed once)



These photos were taken two weeks apart throughout the season.



Cabbage Comparison Sept 2023

High Suppression



No Mow



Bare Soil



Cabbage Comparison Sept 2023

High Suppression



No Mow



Bare Soil



Cabbage Yields Trips

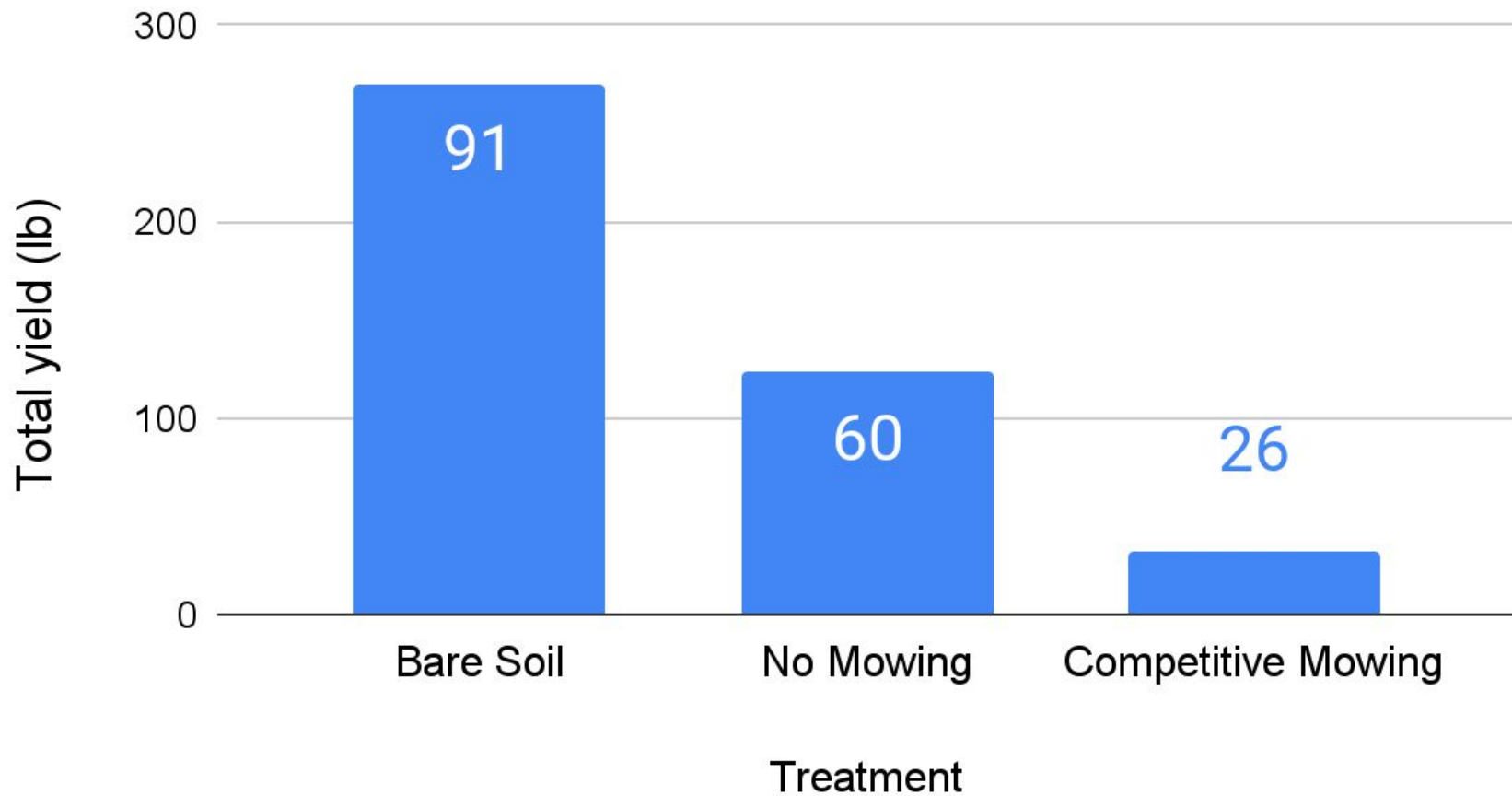
Treatment	No. of Cabbage	Total yield (lb)	Size (lb per head)	Labor (min)	Total Labor (min)	Yield per min
Bare Soil	91	270.36	2.97	2p + 9p + 45w + 45w + 40w	141	1.92
No Mowing	60	123	2.05	4p + 3m + 15w	22	5.59
Competitive Mowing	26	31.9	1.22	4p + 12m + 15w	31	1.03

Bare soil outyielded clover plantings because all transplants survived and heads were larger.

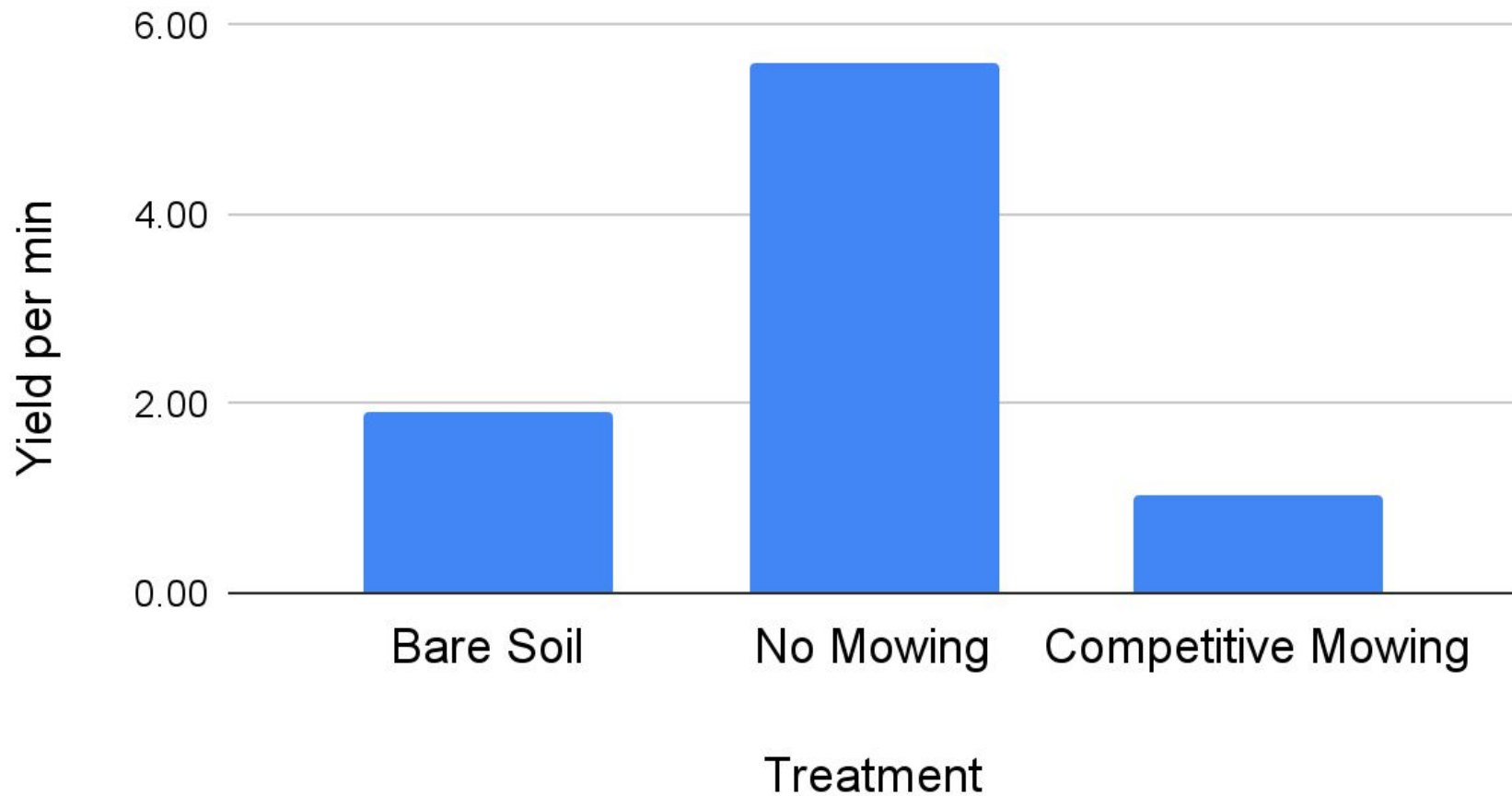
BUT, labor per pound was way lower in clover.



Cabbage Total yield (lb) @ Trips



Cabbage Yield per min @ Trips



1 acre profit extrapolation for cabbage at Four Corners Farm

Bare soil cabbage would have yielded 36,000 pounds per acre and required about 300 hours of labor – not including harvest. Wholesaled at \$0.80/lb. (\$28,800) and weeded at \$17/hour (\$5,100), that's \$23,700 profit (before fertilizer, seed, etc.)

No mow clover would have yielded 16,400 pounds per acre and required about 50 hours of labor. Wholesaled at \$0.80/lb. (\$13,120) and weeded at \$17/hr. (\$850), that's \$12,270 profit.

To compete with the bare soil, the clover planting could have yielded 5,300 pounds (15%) less than bare soil and been equally profitable.

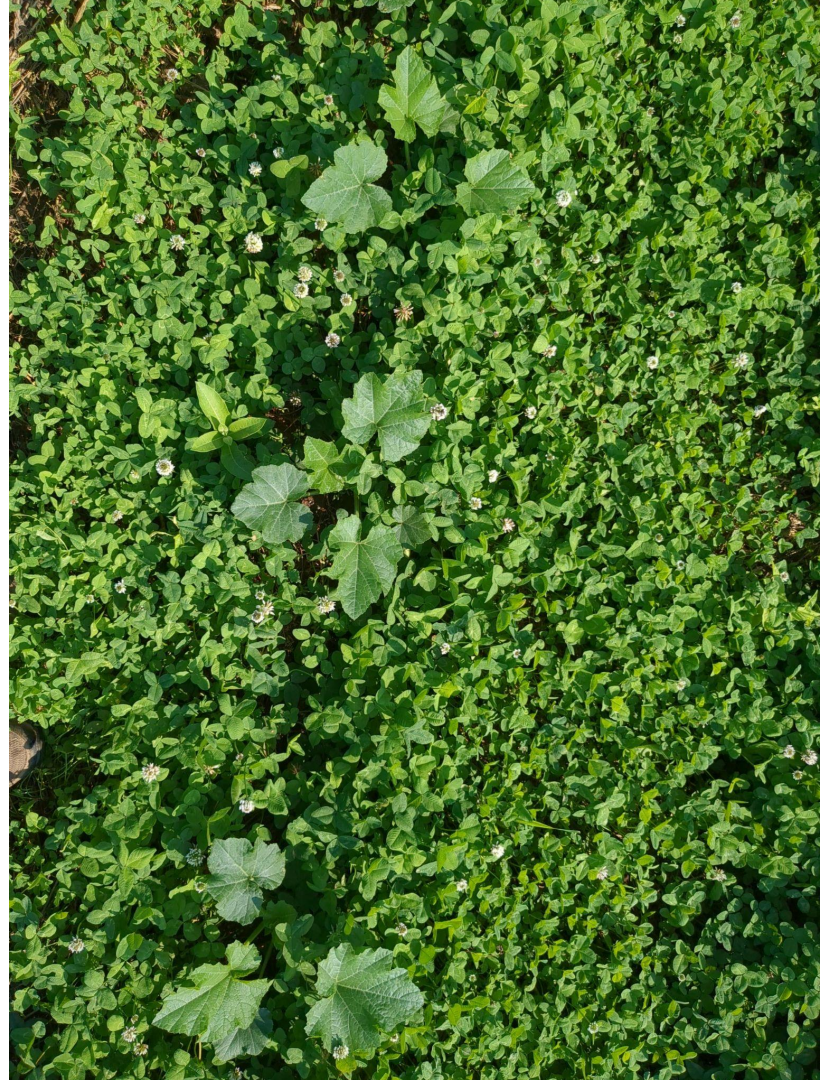
However, either because of wet weather, transplanter issues, or nutrient competition with clover, cabbage yield was reduced by nearly half in clover plantings.

Crop Progression: Squash

Delicata Squash Started in 128 trays

Transplanted on June 14th and 15th

*Normally, we would transplant squash on June 1, but this field is unirrigated and we had a drought in early June, so we had to wait for rain in the forecast.

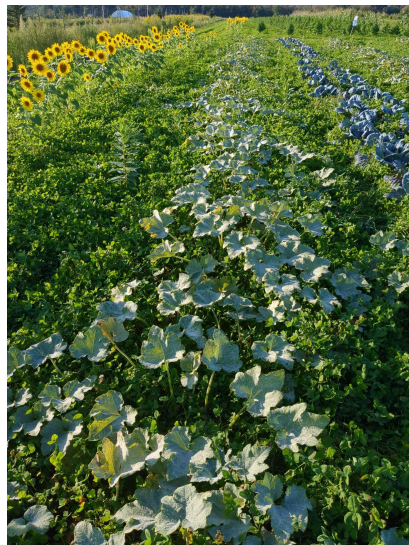


Squash No Mow

(mowed once)



Photos
taken two
weeks apart
throughout
season.

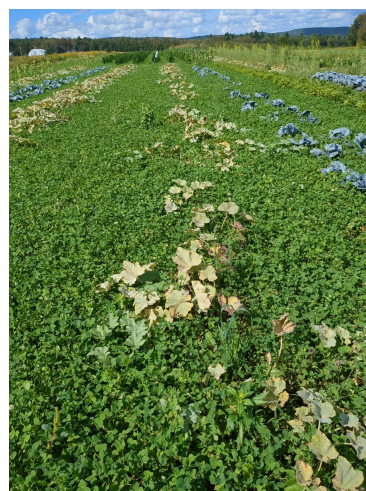


Squash No Mow

(mowed twice)



Photos
taken two
weeks apart
throughout
season.



Squash
High
Suppression
(mowed four
times)



Photos
taken two
weeks apart
throughout
season.

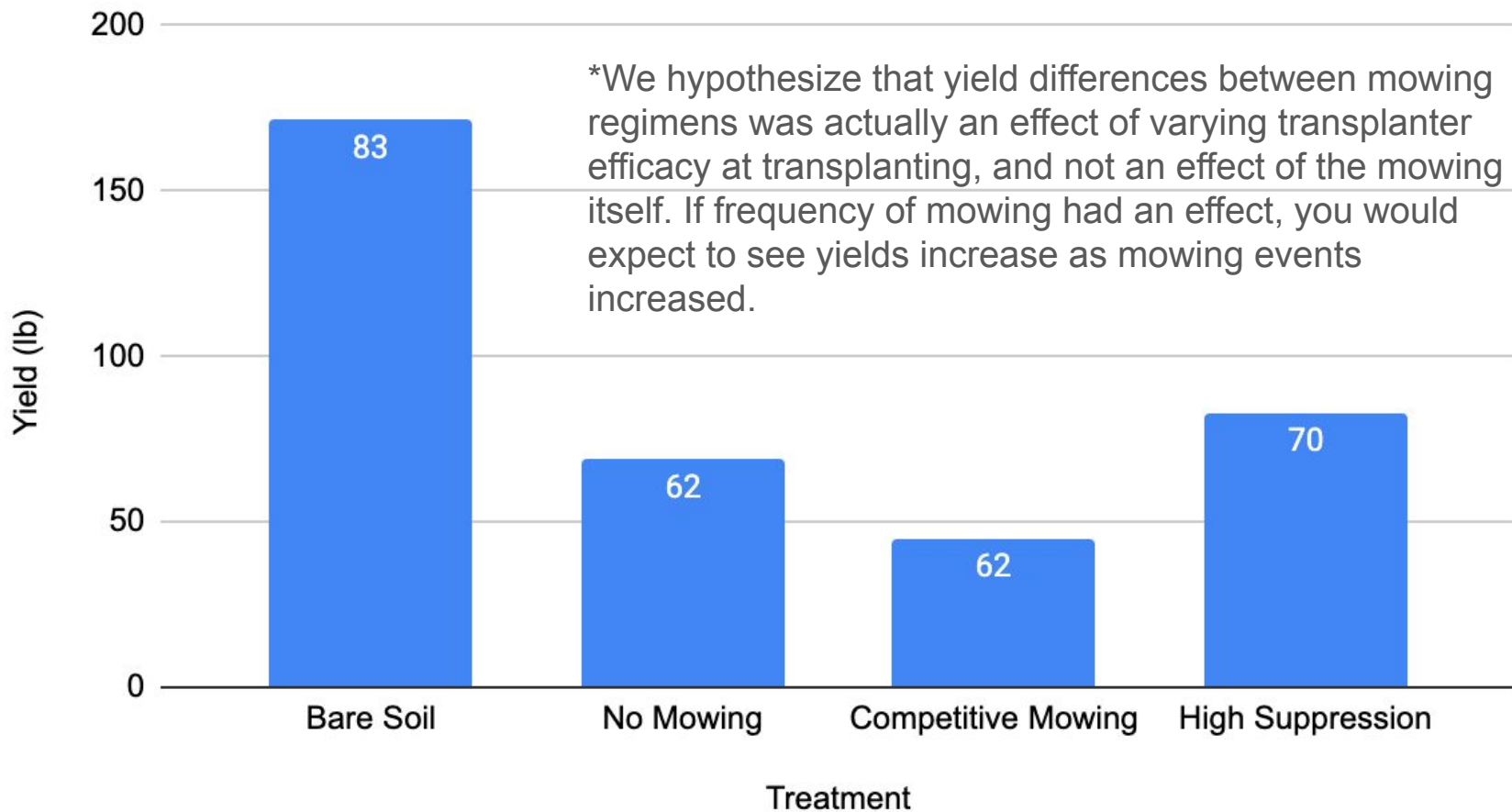


Squash Yield at Four Corners Farm

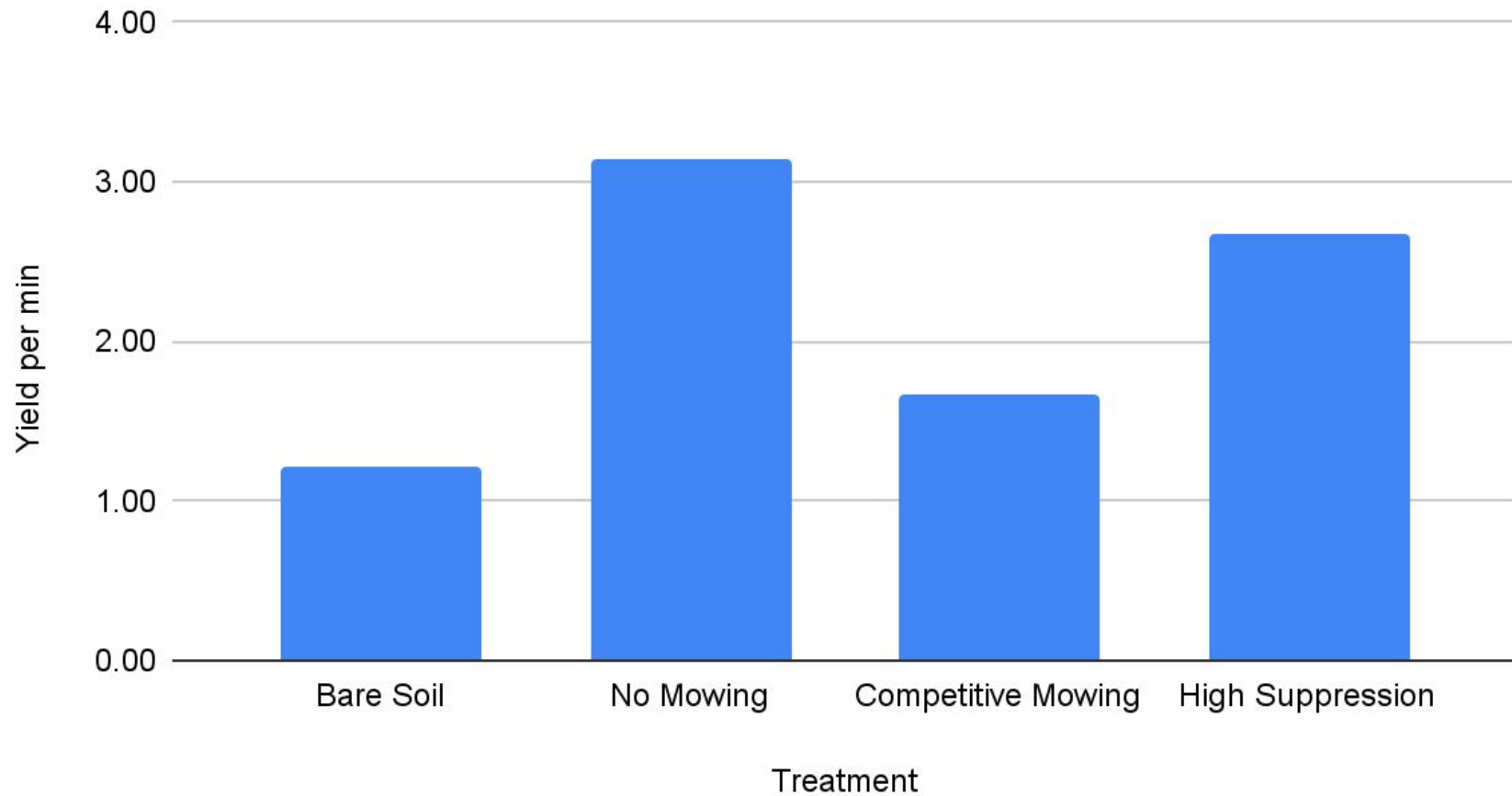
Treatment	Plants (weak ones)	Yield (lb)	Yield per plant (lb/plant)	Labor (min)	Total Labor (min)	Yield per min (lb / min)
Bare Soil	83(5)	171.7	2	45w + 45w +40w	141	1.22
No Mowing	62(6)	69	1.11	3m + 15w	22	3.14
Competitive Mowing	62(14)	45.1	0.72	8m +15w	27	1.67
High Suppression	70(4)	82.9	1.18	12m+15w	31	2.67

*We hypothesize that yield differences between mowing regimens was actually an effect of varying transplanter efficacy at transplanting, and not an effect of the mowing itself.

Squash Yield (lb) @ Trips



Squash Yield per min (lb / min) @ Trips



1 acre profit extrapolation for squash at Four Corners Farm

Bare soil squash would have yielded 11,660 pounds per acre and required about 150 hours of labor – not including harvest. Wholesaled at \$0.80/lb. (\$9,328) and weeded at \$17/hour (\$2,550), that's \$6,778 profit (before fertilizer, seed, etc.)

No mow clover would have yielded 5,660 pounds per acre and required about 35 hours of labor. Wholesaled at \$0.80/lb. (\$4,528) and weeded at \$17/hr. (\$595), that's \$3,933 profit.

To compete with the bare soil, the clover planting could have yielded 9,200 pounds (20%) less than bare soil and been equally profitable.

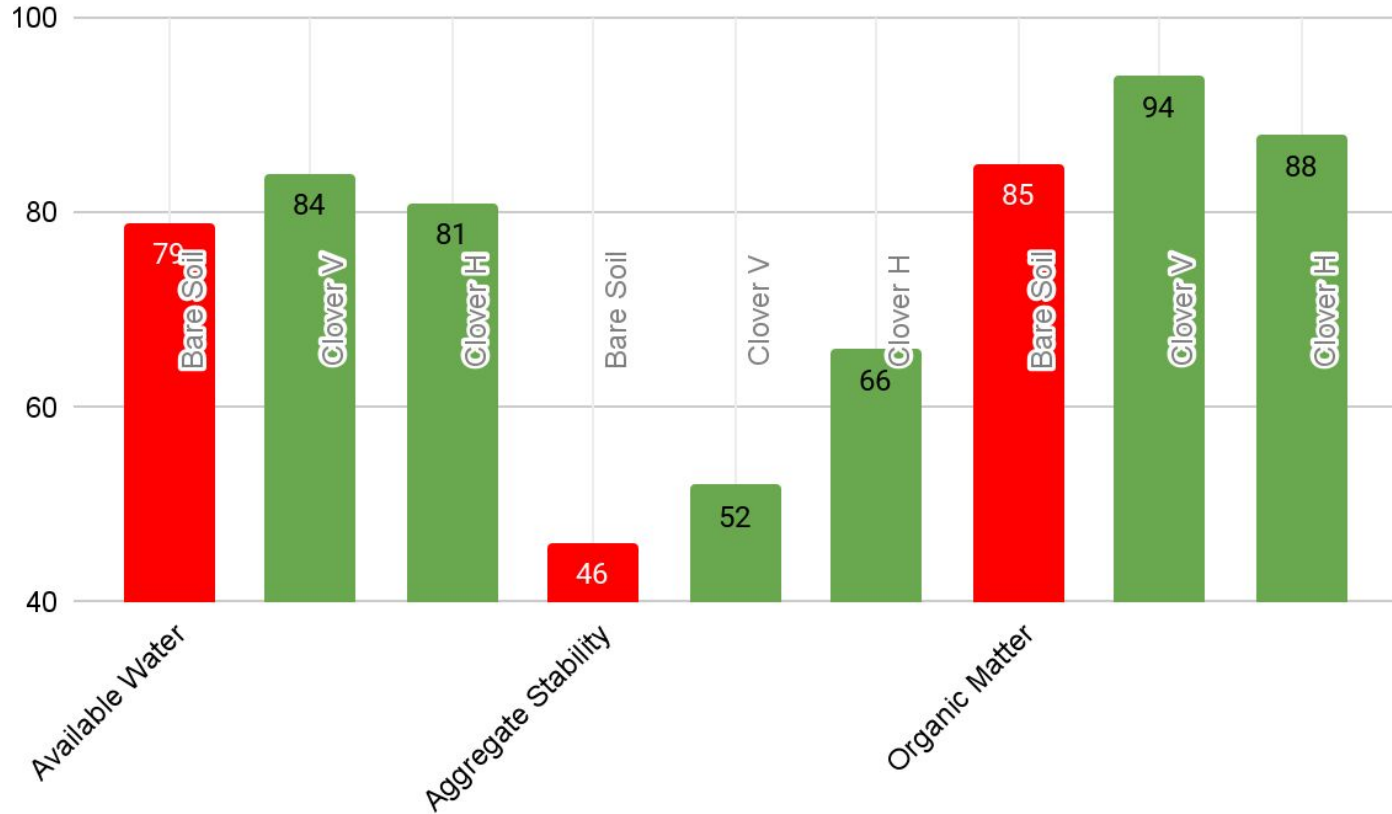
Either because of wet weather, transplanter issues, or clover competition, squash yield was reduced by nearly half in clover plantings.

Soil Health Indicators

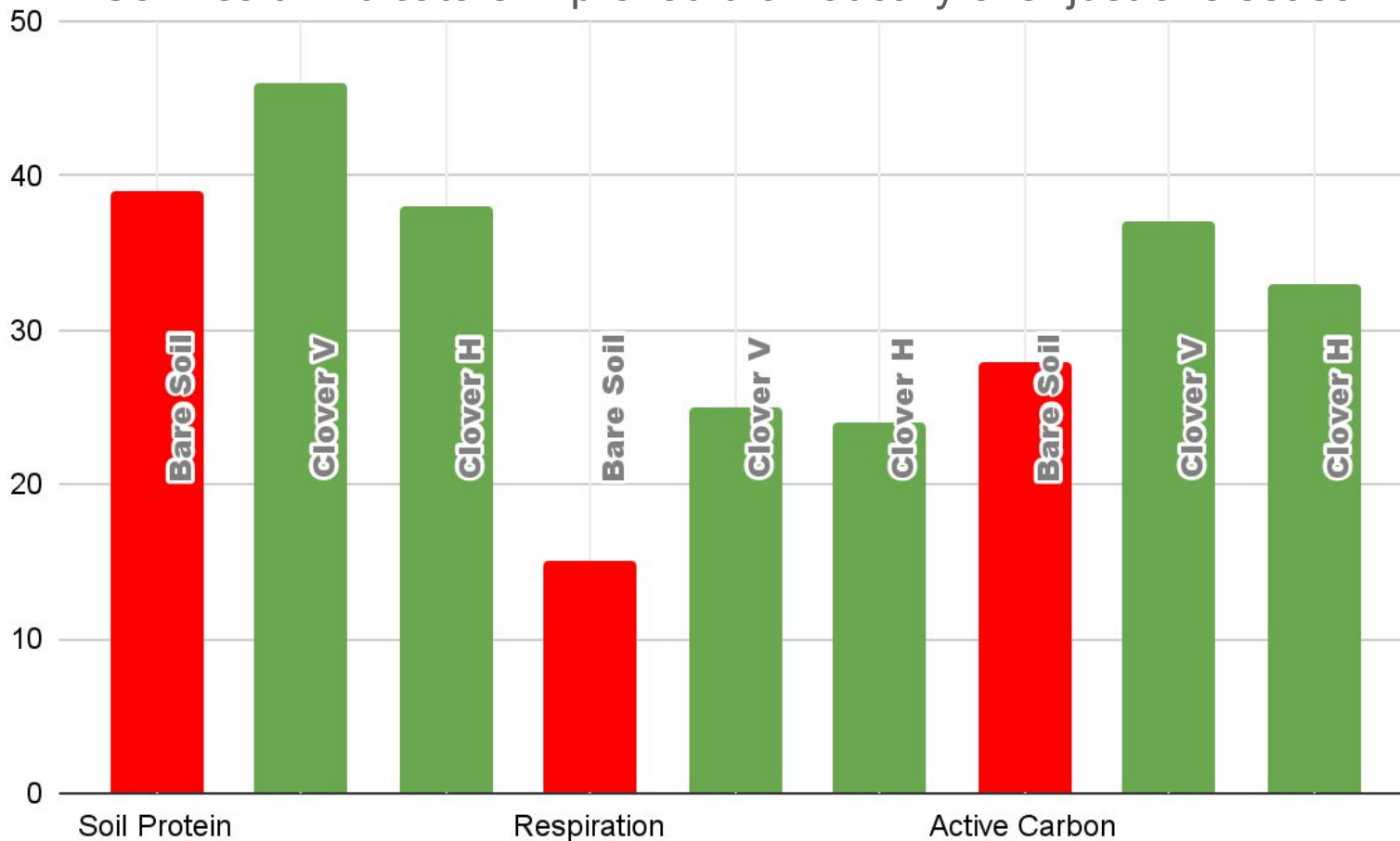
* We used both the Cornell Assessment of Soil Health and Ward Lab's Soil Health Assessment to cross-check results.

**We grew an acre of hemp in clover adjacent to the SARE plots, and we included those soil test results in the following graphs as an additional data point.

Soil health indicators improved dramatically over just one season.



Soil health indicators improved dramatically over just one season.



What caused reduced yields in clover plots?

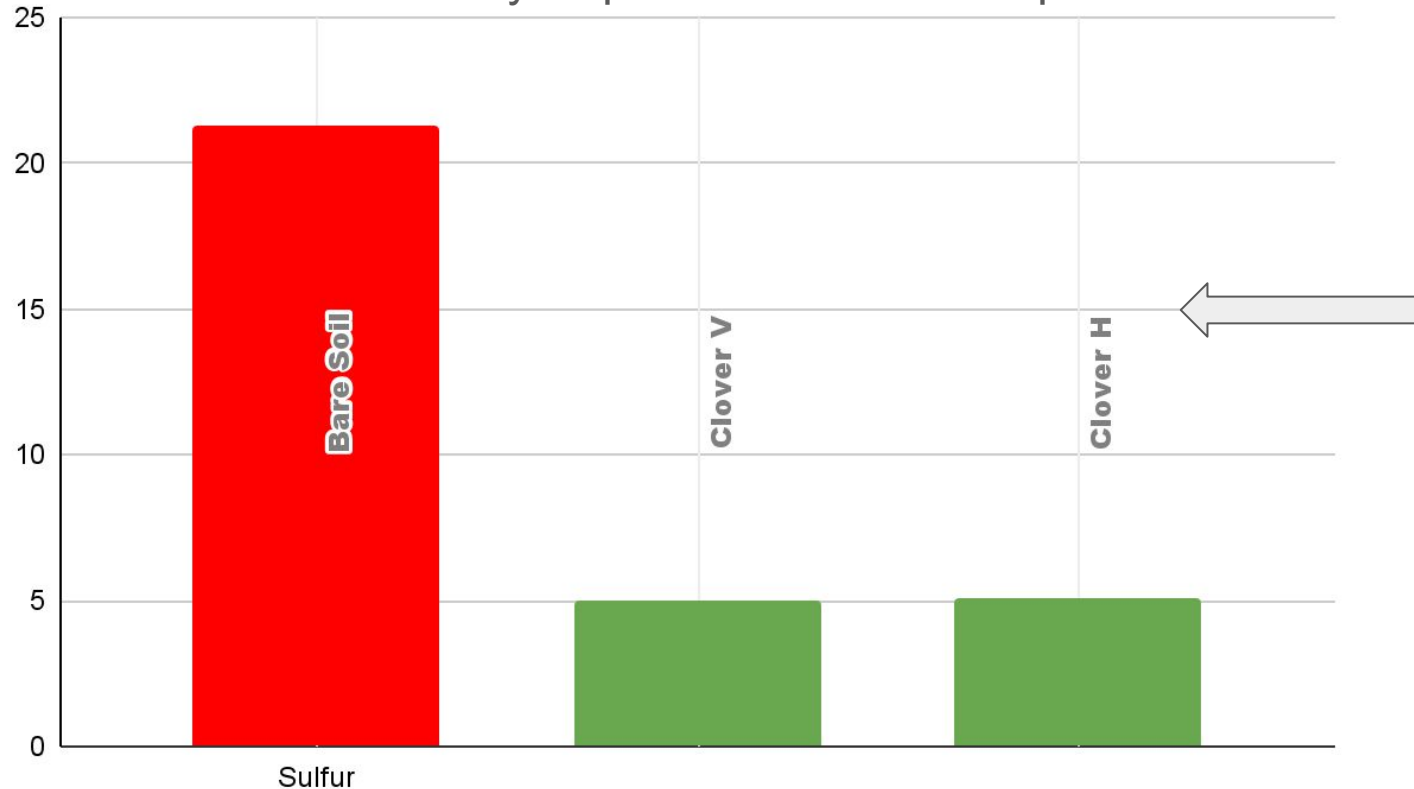
- Transplanter issues? Easy to fix if so...
- Wet season? Clover tends to shade soil and retain moisture better in hot months. That's usually good, but this season it may have slowed drying of waterlogged soil relative to bare soil. See next slide.
- Nutrient competition. We initially suspected competition for N and P, and this may be true. But we are also curious about S and B. See upcoming slides.

Bare Soil
Dries Out
Faster Than
Clover -

usually a bad
thing, but in a
season like
this one, it
was a benefit.

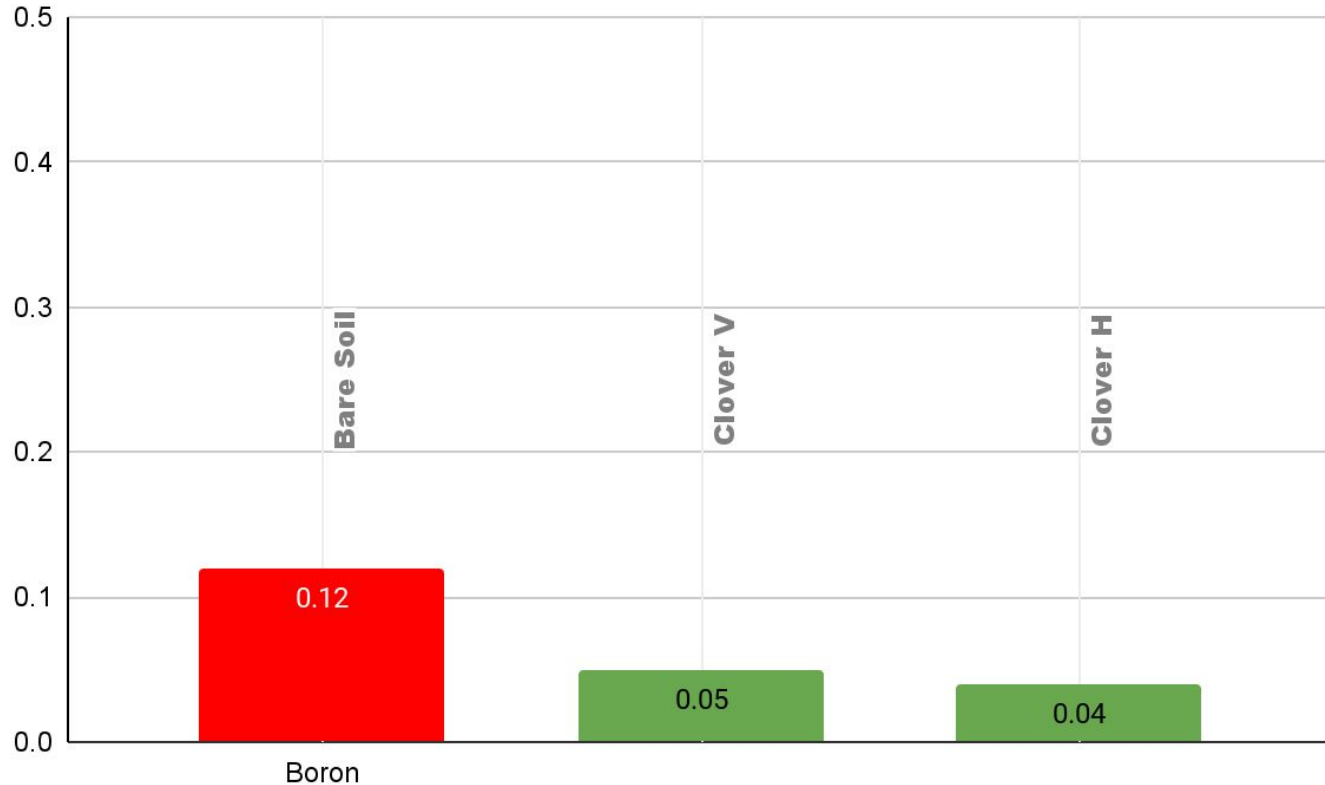


The “missing” sulfur in the clover plots must be...in the living clover itself. This may be an indication that clover competes aggressively for sulfur and success in CLMS may require more-than-adequate levels of S.



Penn State has [documented](#) reliable yield reductions below 15 ppm.

The “missing” boron in the clover plots must be...in the living clover itself.
Less dramatic than sulfur, but worth paying attention to.



Other notes: Four Corners Farm has bindweed, which was the only annual that emerged through clover. Mowing was generally effective, though vines that originated near the crop stem had to be controlled by hand.

Hemp



Squash



Sunflower



Sawyer Farm

Sawyer Farm June 2023



Squash



Tomatoes



Sawyer Farm

Aim to Study
Effect of Plug
Size and Mowing
regime on Yield
and Labor:
Randomized
Split Plot Design



We eventually abandoned bare soil plots because crops drowned out.

Too wet for mechanical cultivation, and not enough crop to justify hand weeding.





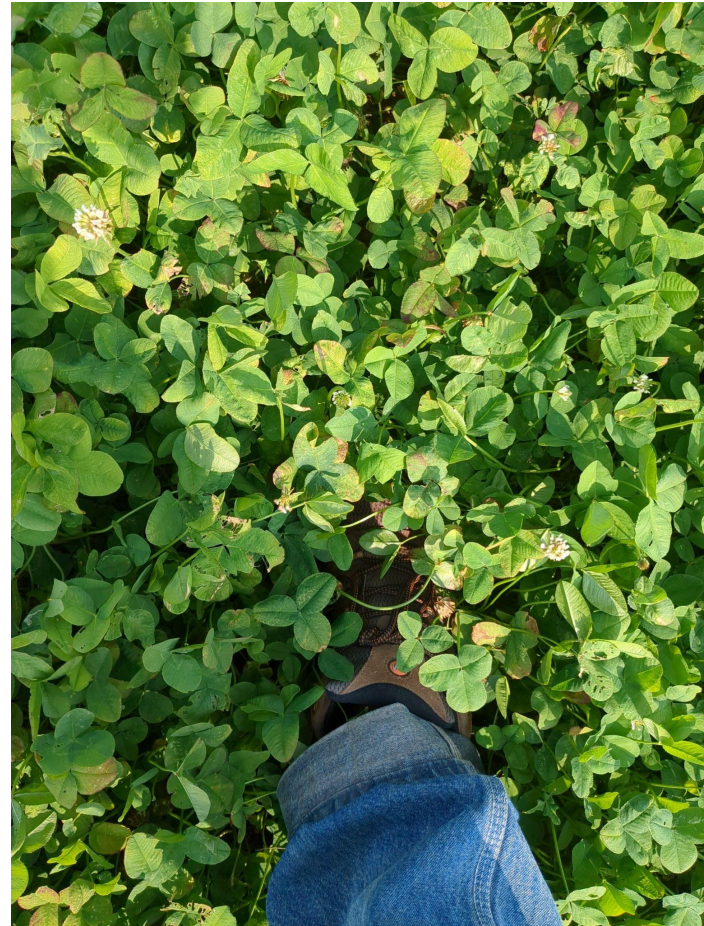
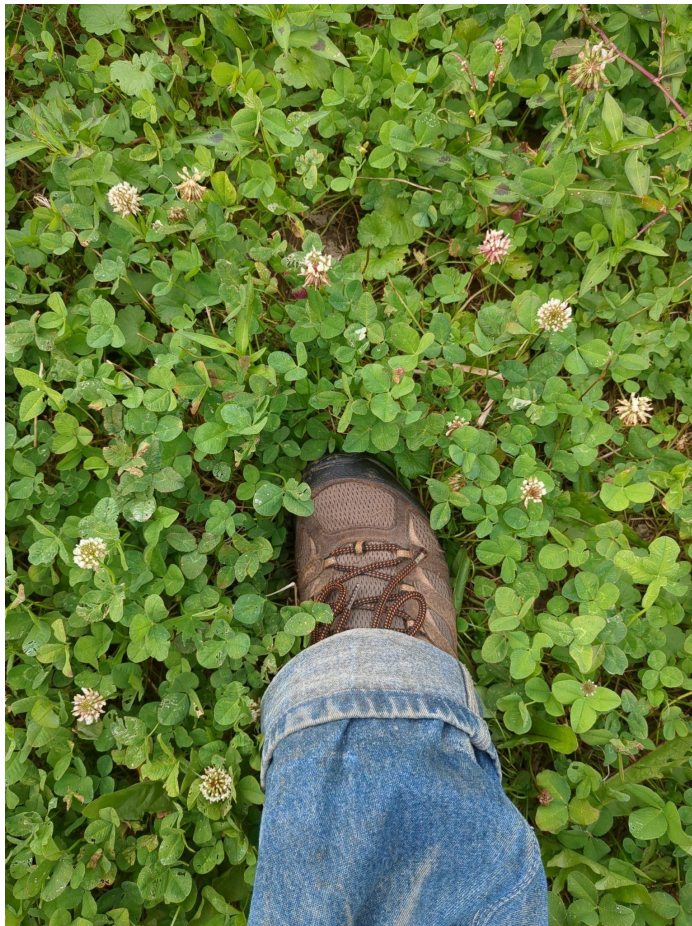
Even clover couldn't keep
weeds down at Sawyer

Fully saturated soil
seemed to weaken clover
relative to grasses and
sedges.



Clover at Four Corners More Lush Than Sawyer

- Older stand at Sawyer than Four Corners
- Poorly drained soil and high water table at Sawyer (USDA Soil Survey)



Labor in bare soil vs. clover – all labor was lost

Total labor (min)	Cabbage	Squash	Tomatoes
Bare soil	156.5	227	316
No mow	11.5	23	6
Competitive mow	NA	50	NA
High suppression	31.5	50	NA

Earthworms
Dead After
Heavy Rain
Only in Bare
Soil, not in
Clover.



Soil Displacement in Bare Soil



In a disastrous year like 2023, we harvested very little at all from bare soil or clover at Sawyer Farm. However, in the bare soil plots we lost topsoil, biodiversity and nutrients, whereas we maintained or increased soil health in clover.

In a world with more frequent extreme weather events, we are more committed than ever to finding resilient systems.

Which is crazier: continuing to farm the 'normal' way (right), or innovating new, resilient systems that hold out hope for continued food production in a changing climate (left)?



CLMS is now being trialed on 20 farms in the Northeast and Midwest.

For more information about CLMS, or to join our trials, visit momentumag.org/farm-enrollment.

Many thanks to SARE for funding this trial.

