2022 Soil Health Education and Demonstration Annual Review

Plots:

1. Interseeding Diverse Mix
2. Interseeding Mix to Corn
3. Interseeding Jungle Mix
4. Interseeding Proven Mix
5. Interseeding Mix to Soybeans
6. No-Till – No Cover Crop
7. Conventional Till/No Cover Crop
8. 45 inch corn + Interseeding
9. Legume Max
10. Regenerative Year
11. Interseed Proven Mix
12. A. Living Mulch - Mammoth Red Clover
    B. Living Mulch - New Zealand White Clover
    C. Living Mulch - Medium Red Clover
13. Interseeding Proven Mix
14. Alfalfa Terminated to Corn
15. Alfalfa
16. Lowland Grass/Clover

Results:

Our historical silage buyer was not interested in buying feed from us again so we changed buyers this year. The new buyer only has larger equipment so they were unable to use our smaller scales onsite and they were not interested in weighing each plot area. With that we were only able to get a weight of plots 1-5(interseeded plots) to represent the plots that have been using soil health principles over the past 3 years. We did a simple kernel count in our living mulch plot for an estimated yield.

Plot 1-5 Yield = 24wT/ac or 8.4dT/ac

Living Mulch: 154 bushels/acre

1st set = 163.8bu/ac -- 6 ears averaged -- 504kernels/ear*26,000 ears/ac/80,000 kernels/bu

2nd Set = 144.8bu/ac – 5 ears averaged -- 445.6kernels/cob *26,000 ears/ac/80,000 kernels/bu

Workflow and Observations:

General Crop Plan:

Planting Date: May 16th
Corn Variety: Renk 600VT2P @ 34,000sds/ac
Fertility: 5gal 6-24-6 in furrow
150# Urea + 150# AMS Broadcast pre-plant
20gal 32% Y-drop June 30th
Pre-emerge Herbicide - May 17th: (Plots 1-7, 11, 13)
1Qt Glyphosate + 10oz Verdict
Strip Spray At Planting: (Plots 9, 12 A,B,C, 14)
1Qt Glyphosate + 1pt 2,4-D
Legume Max Termination - June 10th: (Plots 9 + 14)
1Qt Glyphosate + 1pt 2,4-D
Post-emerge Herbicide - June 21st:
1Qt Glyphosate (Plots 1-5, 8, 13)
1Qt Glyphosate + 1.5Qt Warrant (Plots 6, 7, 11)
1Qt Glyphosate + 3oz Sharpen (Plot 10)
Living Mulch Suppression - June 23rd: (Plots 12 ABC)
1Qt Glyphosphate or crimper
Interseeding: June 29
Harvest: September 27th

Corn Interseeding:

Goal: To promote living roots and diversity in our soil health driven plots and analyze different cover crop species in an interseeding system.

Background: Interseeding cover crops into corn at the V2-4 growth stage allows for earlier establishment and cover crop diversity than after crop harvest, especially corn grain. However not ever specie is able to survive under the corn canopy for much of the summer until the corn is chopped or begins to dry down to allow sunlight to reach the interseeded crops.

Workflow:

- Corn planted on May 16th.
- Interseeded with a 6 row drill on June 29th.
- Specie trials.
  - Plot 1 Mix: 15#Oats, 3#Annual Ryegrass, 2#Red Clover, 3#Crimson Clover, 4#Buckwheat, 4#Flax, 5#Lentils, 5#Hairy Vetch, ¼# Turnips, 1#Gourds
  - Plot 2 Mix: 4#Hairy Vetch, 5#Red Clover, 5#Lentils, 3#Crimson Clover
  - Plot 3 Mix: 4#Mung Beans, 3#Crimson Clover, 4#Lentils, 3#Hairy Vetch, 6#Cowpeas, 4#Forage Soybeans, 6#Cereal Rye, 1.5#Flax, 1#Safflower, ½#Beets, ¼#Kale
  - Plot 4 Mix: 5#Annual Ryegrass, 5#Red Clover, 5#Hairy Vetch, ½# Turnips

Observations + Notes:

A. Our interseeding was drilled a little later than we anticipated because of a major break down and helping other farms get their fields interseeded.
B. The interseeding germinated well even with delayed planting and persisted throughout the growing season and after harvest.
C. All of the species used in the plots have some shade tolerance and potential to be used. Even with most of the species surviving after harvest, we would recommend using species that can tolerate cool weather or overwinter because the fall season is when the interseeded species can begin to thrive again with increased sunlight from harvest or dry down. Other warm season species like cowpeas or frost intolerant species like oats have very little time before a frost to express themselves once sunlight reaches the understory of the corn. Species we would recommend include annual ryegrass, clovers, hairy vetch and possibly winter rye.

Interseeding plots on June 29st.

Interseeding on July 20th.

Legume Max:

Goal: To utilize a legume cover crop to its full potential and reduce nitrogen use.

Background: Legumes fix a significant amount of their total nitrogen production as the plant gets larger and around the flowering stage. The flowering stage occurs 2-3 weeks after the generally planting period when the clover is killed. Killing the legume cover crop shortly after planting a row crop limits its' nitrogen fixing potential.

Economic Benefits (LegMx)	
66% Burn Chem Red.($30 full)	20.00
Eliminate burndown app	9.00
N Credit ($0.50/N) 60#N gain	30.00
Yield Bump	5.00
Weed Supression - Chem Red.	0.00
Cover Crop Seed+Drill Savings	0.00
Other - Beneficials, Soil Health Imprv, Trafficability, Ect.	0.00
Benefit Total	**64.00**

Workflow:

- Plant a heavy legume cover crop the previous fall. We used red clover interseeded in corn silage.
- A 30" planter retrofitted with band sprayers to kill a 8-10" band over the row was used to plant and spray on May 17th.
  - Replaces broadcast burn down pass, reducing chemical cost/ac and eliminating an application cost.
  - Sprayed bands will eliminate any early competition as the corn emerges.
- Allow cover crop between rows to continue to grow.
  - Untreated cover crop between rows act as a weed suppressor while providing living roots (exudates) for soil biology and nitrogen fixation.
- Broadcast sprayed on June 10th to kill the remaining cover crop. Clover was in full bloom.
  - Possibly reduce chemical needs on 2nd pass since untreated crop is suppressing all weeds.
- Consider interseeding with legume to repeat.

Observations + Notes:

A. The sprayed band died slowly, possibly hindering corn emergence. We believe this was due to the use of a garden 2,4-D that we later found out was a reduced concentration than agricultural 2,4-D causing a reduce rate to be applied. In the future we plan to use appropriate rates and possibly try a product with a quicker burn down like Sharpen or Verdict.

B. Even with bands suppress/killed the surrounding clover began to shade corn until it was sprayed off. We may possible need to look at an early suppression or kill 7-10 days earlier so the corn does not become shaded.

C. The newly emerged corn also began to show drought stress. With the corn underdeveloped root system, lack of rain, and developed clover roots utilizing soil moisture led to a lack of soil moisture for new plant growth. In the future, the operator

will need to be aware of soil moisture and have a plan to kill the clover sooner than expected to avoid drought conditions.

D. We took an above ground forage analysis at planting when a clover cover crop would be killed on May 17th and just prior to killing the clover on June 10th. With the additional 26 days of growth there was an additional 80# of nitrogen in the above ground growth. The rule of thumb is that whatever is above ground is also below ground.

Next Steps: Now that we know this practice shows merit we will use what we learned and improve our workflow as well as assess nitrogen savings more closely with soil tests and nitrogen reduction study.

Sprayed strips. Photo taken: June 1st.

Emerging corn in sprayed strip on June 1st.

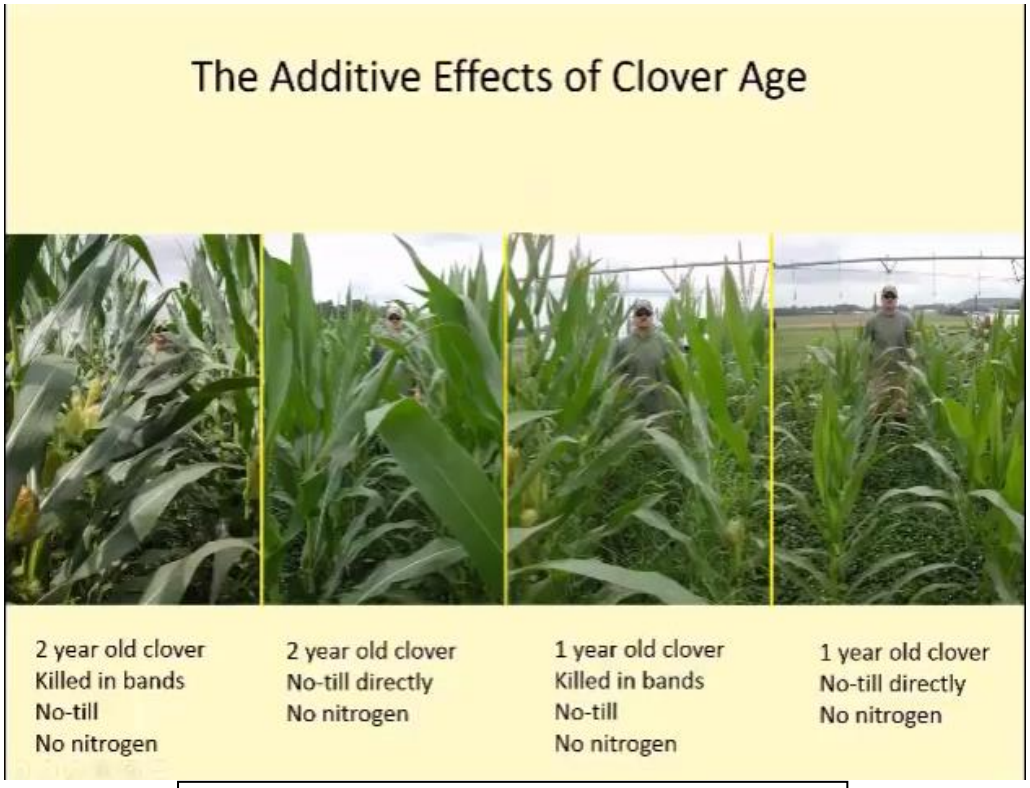
Drought stressed corn after plot was sprayed. Taken June27th.

Living Mulch:

Goal: Reduce costs by using a living mulch system to produce nitrogen and eliminate need to re-establish cover crops each season.

Economic Benefits (LivMulch)	
66% Burn Chem Red.($30 full)	20.00
Eliminate burndown app	9.00
N Credit ($0.50/N) 60#N gain	30.00
Yield Bump	0.00
Weed Supression - Chem Red.	0.00
Cover Crop Seed+Drill Savings	52.00
Other - Beneficials, Soil Health Imprv, Trafficability, Ect.	0.00
Benefit Total	**111.00**

Background: This trial mimics the legume max in many ways with one exception. Rather than killing the legume cover crop our goal is to simply suppress it with herbicide. This suppression will force the living mulch, clover in this scenario, to release nitrogen and eliminate any competition with the corn. The clover will begin to rebound, but the corn canopy will keep the clover suppressed (like interseeding) until it is harvested or the plant begins to dry down when sunlight can reach the clover again. At this time the clover can rejuvenate eliminating the need to plant a new cover crop and the process can start over again the following year. This system provides direct economical savings, soil health benefits, continuous living roots, and a water quality impact. Some research on living mulch was completed in the 2000's and more recently at the University of Georgia along with other universities, but there had yet to be any wide spread adoption.



Visual results from the University of Georgia.

Workflow:

- Plant living mulch in early fall previous cropping season.
  - We used white clover, medium red clover and mammoth red clover.
  - White clover would be the most ideal because of its ability to spread or "creep" through root rhizomes and above ground stolon.
- A 30" planter retrofitted with band sprayers to kill a 8-10" band over the row was used to plant and spray on May 17th.
  - Replaces broadcast burn down pass, reducing chemical cost/ac and eliminating an application cost.
  - Sprayed bands will eliminate any early competition as the corn emerges.
- Allow living mulch between rows to continue to grow.
  - Untreated cover crop between rows act as a weed suppressor while providing living roots (exudates) for soil biology and fixing nitrogen.
- Broadcast spray to suppress living mulch on June 23rd, when the clover was in full bloom.
  - Possibly reduce chemical needs on 2nd pass since untreated crop is suppressing.
  - Consider using herbicide that will kill other weeds if present.
- Consider interseeding with annuals to improve diversity, but not hinder clover regrowth.

Observations + Notes:

A. There were many similar observations and challenges as the "Legume Max" trial. These include proper rate of 2,4-D (A), suppressing the living mulch sooner to avoid shading/competition with the corn (B) and watching the soil moisture level closely to avoid drought stress in the young corn plants (C).
B. The season before we allowed the clover to get tall and lush to promote the stand. For the white clover, this lush stand turned into a dense mat of dead residue keeping the sun and wind off the soil surface which hindered soil warming and drying. The cool spring soils slowed the clovers spring growth and possibly smothered some area out. Even at planting there was a lack of clover growth in comparison of other clover stands. In the future we do not expect so much residue because the clover will never get that tall again. Also we may look into a harrow or rotary hoe to break up the spring mat.
C. We noticed early on a poor to moderate stand emerging. A population count showed we had 26,000plants/acre, 8,000 less than we had planted. Much of this was likely related to planting conditions described in A & B.
D. Areas that had a weaker stand did have waterhemp break through. Areas with solid stand kept almost all other weeds under control. We will look at a herbicide program to help control breakthrough weeds when a week stand is present.
E. After the suppression pass we were disappointed with the corn growth for much of the season, however right before harvest we performed an ear count check and where surprised to find that even with a moderate stand we estimated the yields to be around 150 bushels/acre.
F. The red clover died from the roundup suppression pass. We had thought we killed the white clover however about 6 weeks later we began to see the white clover recovering under the corn canopy.
G. A roller crimper was also used to try and suppress the clover in place of herbicide. This did lay the clover down, however a few days later the clover was standing again.

Next Steps: We met many challenges with this trial, but we still saw enough merit to have plan to expand the living mulch area. Next cropping season we'll try other types of perennial legumes along with white clover. There will be one farm planting white clover next spring that will be using 40" corn to try and get this system to work. By mitigating the challenges described above and implementing other improvement we think we can begin to see a successful living mulch system that would be a great benefit to farms and the environment.

Dense residue mat preventing sun and wind to warm and dry soil on May 5th.

A weak white clover stands due to cool soils 2 weeks after planting corn. Note the much taller red clover on the left of the photo. Taken: May 31st.

Corn emerging in white clover plot. Notice areas lacking white clover plants. Taken: June 23rd.

White clover beginning to rebound after herbicide suppression. Taken: August 2nd.

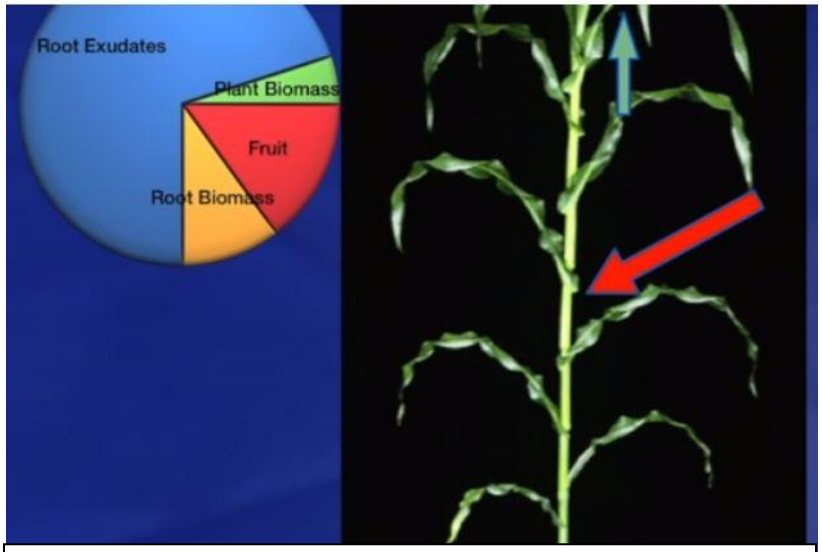
Rebounded white clover providing ground cover and living roots eliminating the need to reestablish a cover crop after harvest. Taken: September 20th.

Regenerative Year:

Goal: To excel the soil rebuilding process by giving cropland a year off and maximizing cover crop growth throughout the year.

Background: Many species direct 40-60% of the carbohydrates (sugars) they produce through photosynthesis to their roots as exudates to feed soil biology in return of plant growth benefits, whether nutrients, water or pathogen protection. This symbiotic exchange excels and is maximized as the plant root structure develops and photosynthesis is maximized in later vegetative growth stages when much more foliage is available to absorb sunlight. Once the plant moves to the reproductive stage it drastically shifts it's energy from scavenging nutrients and releasing root exudates to mobilizing nutrients to its grain to make viable seed. During this time the abundance of soil biology can become suppressed because the plant shifted its energy to grain fill. With the fallow or "Regen" year we want to keep pushing root exudates into the throughout the growing season in comparison to a typical crop that needs to first grow to a point of maximum photosynthesis and then shifts energy flow to grain fill. This leaves many

month of year with a lack of energy moving below ground. In a natural setting there is a wide diversity of plants growing with different life cycles that is able to fill those months. To fill in the lacking months and soil biology function maximized, we will use a diverse selection of cover crops that include over wintering cool season species and warm season annuals. We believe by maximizing an influx of energy (sugar exudates) we will maximize soil biology potential and excel our soil health building process.



Graph showing the distribution of photosynthetic derived carbohydrate distribution in the late vegetative stage of a growing crop.

Workflow:

- Plant an overwintering cool season cover crop
  - In this case we had interseeded red clover the summer before and drilled winter rye after silage harvest.
- Allow the over wintering cover crop to grow until late vegetative growth stages or just before heading/flowering.
- Kill this over wintering cover crop mid-late May
  - We sprayed on June 10th
- As soon as possible plant a diverse warm season cover crop mix around mid June.
  - Planted on July 18th
- Clip once to promote root growth and add residue to soil surface in late July.
- Leave warm season cover crop grow until late August - September.
- Consider applying compost or manure.
- Spray or just plant a cool season mix if temperatures are declining, suppressing the warm season mix.
- Allow the cool season to grow into next spring, but plant crop as you would in a typical year.

Observations + Notes:

A. We believe the first spray pass was later than ideal. We sprayed June 10th when the clover was in full bloom. At the time we thought this was a good time, but looking back we should have sprayed when the clover was budding or earlier.
B. To spray out the clover we used 2,4-D which has a 2 week planting restriction for many of the species we were using in our warm season mix. At the time we didn't think this would hinder us much, but with continuous rains and a thick mat of residue. The soil was tough to get dried out enough for planting. It wasn't until July 18th when we were able to get the warm season cover crop mix seeded. Even at this timing the soil was still a bit wet, but the planting was pushed because of the delay and a forecasted rain. To mitigate this issue, we will try to use a herbicide that doesn't have planting restrictions. We would be able to allow the over wintering mix dry out the soil and plant the warm season mix right after the spray pass. Alternatively, we could also use over wintering cover crop that would kill mechanically by mowing or roller crimper to avoid the planting restrictions.
C. When seeding the warm season cover crop mix we ended up with poor seed to soil contract because the heavy residue made it difficult for the planter's disks to penetrate the soil and place the seed. Rather much of the seed was placed on top or tucked into the soil with residue leading to poor germination. To address this issue we can either plant directly after terminating the over wintering cover crop when the foliage is still green and can easily be sliced through with the planter's disk or use a drill capable of cutting through dense residue.
D. With the delayed and poor stand of warm season cover crop it was decided to abandon this trial.
E. Overall, this trial turned into a failure because of delayed plantings of summer annual, less than ideal planting conditions and using a drill that was unable to plant through thick residue.

Next Steps: We will likely take a look at this trial again in 2023. With the challenges we met we will look for other herbicides without planting restrictions, be more aggressive on kill the spring cover crop and use a drill with high residue capabilities.