Mt. Folly Farm, KY

COVER CROP DEMONSTRATION TRIAL CASE STUDY

2021–2025

TRIAL TREATMENTS

Treatment	Description
Traditional Rate	University of Kentucky (UK) recommended cover crop seeding rate; cover crop terminated with tillage
Increased Rate	Above UK recommended cover crop seeding rate; cover crop terminated with tillage
Increased Rate + Roller Crimper	Above UK recommended cover crop seeding rate; cover crop terminated by roller crimper; no-till cash crop planting

DEMO FARM OVERVIEW

Diverse cover crop mix in the treatment plots, April 2022.

AYSHA TAPP ROSS

County	Clark
Watershed	Upper Lulbegrud Creek
Crops in Trial	Organic corn, soybeans, sunflowers, & rye
Cover Crops in Trial	Cereal rye & cover crop mixes
Farm Size	1,150 acres (14-acre trial)
Soils	Silt loam soils
Annual Precipitation	50 inches

TRIAL GOAL

To evaluate cover crop seeding rate and no-till roller crimping for soil function, farm profitability, and weed control in an organic system. Laura Freeman (owner and operator of Mt. Folly Farm) has been using cover crops for many years. She was interested in exploring the costs and benefits of increased cover crop seeding rates, as well as trialing a roller crimper to terminate cover crops in a no-till system.

KEY TAKEAWAYS

- **Laura's use of a roller crimper and an increased cover crop seeding rate did not work well to suppress weeds**, so a cultivator was used to kill the weeds. As herbicides are not used in organic systems, use of a roller crimper with no-till would require additional adjustments.
- **Soil laboratory results did not indicate differences between the trial treatments.** However, soil organic matter increased (statistically significant) in all treatments over time, likely due to the biomass provided by cover crop use.
- **The trial provided Laura with the opportunity to try other cover crop species**; she previously mainly used wheat or rye. Tillage radish showed Laura that the hard pan issue was more severe than previously thought. In Laura's eyes, crimson clover provided clear nitrogen benefits for the farm, so she plans to use it more often.
- **Traditional Rate had the highest net income when compared to the other treatments.** This was due to better establishment, better weed suppression, and therefore higher yield, combined with lower cover crop seed cost and termination costs.
- Beyond the farm trial, Laura benefited a lot by **networking with other farmers in Kentucky** conducting similar cover crop trials.

Laura Freeman giving a talk to visitors during the Smithsonian traveling exhibit, "Spark! Places of Innovation" tour August 2023.

AYSHA TAPP ROSS

> "I have tremendous weed pressure here. I'm organic and you have to cultivate. You have two choices: chemical no-till or organic. I really think the chemical stuff is bad."
>
> **—LAURA FREEMAN**

American Farmland Trust

Laura Freeman owns and operates Mt. Folly Farm, a 1,150-acre diversified organic farm in Clark County, Kentucky. With portions of the farm certified organic since 2014, the farm produces crops such as corn, soybeans, small grains, hemp, sunflowers, and sweet potatoes on about 300 acres. The remaining acres are pastures where cattle are rotationally grazed in 20-acre paddocks. Laura also integrates her farm products into several businesses she owns—Regeneration Whiskey, a distillery specializing in premium Kentucky whiskey and moonshine, Laura's Mercantile, a CBD hemp business, and Mercantile on Main, specializing in local farm products—demonstrating her commitment to full-circle farming.

Freeman has a long history in agriculture, having founded and later sold Laura's Lean Beef before transitioning Mt. Folly to organic production. Since then, she and her team have steadily refined their soil health practices. Cover crops, terminated with tillage, are central to the farm's management system. They are seeded in combinations of rye, vetch, radish, oats, and clover to build organic matter, protect the soil, and improve fertility. In addition, compost and compost teas are applied to support soil biology, and weeds are controlled with shallow tillage, mechanical cultivation, and flame weeding. Despite these efforts, soil health assessments on her demonstration field identified ongoing challenges with compaction, aggregate stability, and nutrient cycling—constraints Freeman is determined to overcome.

Laura Freeman partnered with American Farmland Trust (AFT) on a 5-year on-farm soil health demonstration trial from 2021 to 2025 to evaluate the impacts of diverse cover crop mixes, adjusted seeding rates, and no-till organic management on soil function and farm profitability. Through the trial, Freeman experimented with higher seeding rates of diverse cover crop mixes, as well as the use of a **roller crimper**, an alternative method of cover crop termination, paired with no-till. Her goals were to suppress weeds with more densely seeded cover crops, reduce tillage, build soil organic matter, and sequester more carbon in her soils. This work is especially pioneering given the rarity of no-till organic row-crop systems in Kentucky.

For Freeman, the purpose of participating in this trial extends beyond Mt. Folly Farm. By testing new approaches, documenting results, and sharing her experiences, she hopes to push the frontier of organic soil health practices in Kentucky and provide a model for other farmers navigating similar challenges. Her work reflects both innovation and stewardship, grounded in the belief that healthy soils are the foundation of resilient farms and communities.

FIGURE 1: TRIAL DESIGN MAP

TRIAL DESIGN

The 14-acre field selected for this trial was purchased by Laura in 1990 and used for grazing cattle until 2014, when it received organic certification. From 2015 to 2021, the field was primarily managed in a corn–soybean rotation with annual cover crops including a rye/vetch mix or an oat/pea/vetch mix, occasionally adding radish or clover to those mixes.

The study was conducted on 5.5 acres divided into three replicated blocks of varying lengths to fit field contours, with a bit under 2 acres in each treatment (Figure 1):

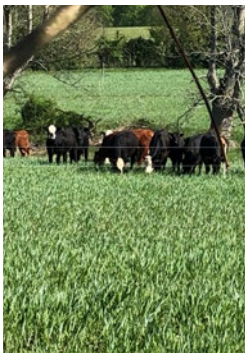
- Traditional cover crop seeding rate (status quo for this farm),
- Increased cover crop seeding rate (a new practice for this farm), and
- Increased cover crop rate with no-till roller crimper (an advanced new practice for this farm).

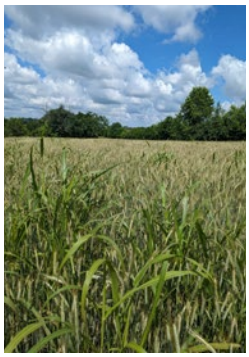
This replicated design helps differentiate effects of the cover crop treatments from natural variation between years and within the field.

During the trial, Laura grew a variety of cash crops and cover crops (Table 1), though not all were successful. Cover crops on the Traditional Rate and Increased Rate plots were terminated in the spring with grazing and tillage, while the Increased Rate

TABLE 1: CASH CROP AND COVER CROP ROTATION. Crop failures are labeled "F," grazing is labeled "G," while adaptations for farm reality impacts on cover cropping are labeled "A," all described in the Farming Reality Impacts section below.

Traditional CC Seeding Rate	Corn	Cereal Rye (A) 70lbs/ac	G	Corn	Cereal Rye 75lbs/ac	G	Soybeans	Serafino Rye (A) 40 lbs	Sun-flowers (F)	Clover-Radish-Timothy (A) 50lbs/ac
Increased CC Seeding Rate	Corn	Rye-Clover-Radish Mix 115-30-5 lbs/ac	G	Corn	Cereal Rye 105 lbs/ac	G	Soybeans	Serafino Rye (A) 50 lbs	Sun-flowers (F)	Clover-Radish-Timothy (A) 50lbs/ac
Increased CC Seeding Rate + Roller Crimper	Corn	Rye-Clover-Radish Mix 115-30-5 lbs/ac		Corn	Cereal Rye 105 lbs/ac		Soybeans	Serafino Rye (A) 50 lbs	Sun-flowers (F)	Clover-Radish-Timothy (A) 50lbs/ac
Year	**2021**	**2022**			**2023**			**2024**		**2025**



BRIAN BRANDT

From left: Cattle grazing on the Traditional Rate and Increased Rate plots with fenced off Increased Rate + Roller Crimping plots in the foreground, April 2023. Increased Rate treatment after cattle grazing showing crushed cover crops and fenced off Increased Rate + Roller Crimper plot in background, May 2022. Cover crop grazing on Traditional Rate and Increased Rate plots, with fenced off Increased Rate + Roller Crimping plots in background, April 2023. Serafino rye cover crop, May 30, 2024, grown out for seed and sold.

+ Roller Crimper terminated the cover crop in the spring using a roller crimper.

Farming Reality Impacts Trial Plans

This trial was an example of how many challenges can compound to challenge adoption and successful implementation of cover cropping and reduced tillage, especially in organic systems. It was originally a non-replicated design comparing two fields, which were seeded with a cereal rye-clover-radish cover crop mix in August 2021. However, due to extreme cocklebur weed pressure, the original Traditional Rate field was transitioned to pasture for weed control. Upon additional discussion about goals and interests, the Increased Rate + Roller Crimper field was turned into a replicated randomized block design in November 2021. To do this, the identified Traditional Rate plots (see Figure 1) were tilled and re-seeded at the traditional rate with only cereal rye, as it was too late in the year to plant the clover and radish portion of the cover crop mix at a lower seeding rate.

Unfortunately, the August 2021 cover crop mix failed to establish uniformly; only two of the three blocks showed good establishment. This was the first time Laura had planted this cover crop mix, and it quickly presented a challenge. Gradually, while seeding, all of the smaller clover and rye seeds shifted to the bottom of the hopper, so by the end there was only radish left to plant. In an attempt to recuperate, Laura seeded rye at 40 lbs/ac in October 2021 on the increased rate plots. Due to this uneven seeding ratio and timing, the third block did not have enough rye or any clover to compete with the weeds in the spring, as radish frost-kills. The lack of weed suppression on the treatment plots resulted in heavier weed pressure throughout the summer 2022, thus lower cash crop yields. Laura grazed the cover crop in the Traditional and Increased Rate plots May 2022 to decrease biomass prior to tillage. However, Laura was only able to roller crimp one-third of the intended plots, resulting in all plots being tilled to terminate what grew of the cover crop and to suppress weeds in Spring 2022.

In Spring 2023, Laura once again grazed the cover crop in the Traditional and Increased Rate plots. However, she was unable to successfully terminate the cereal rye cover crop with the roller crimper due to the rye being too immature to terminate through crimping, so she ended up tilling after crimping.

In Fall 2023, Serafino rye was planted at 40 lbs/ac and 50 lbs/ac according to the trial design, but the rye was harvested in Spring 2024 instead of treated as a cover crop, so the roller crimper was not used. This was because Laura got big news that her rye seed was approved for the organic market. The sunflowers planted after the Serafino rye harvest experienced a crop failure due to heavy weed pressure.

With ongoing weed issues, especially from cocklebur and Johnson grass, a cover crop mix was planted across all treatment plots in August 2024 with a plan to transition the plots to pasture to reduce weed pressure, which significantly impaired treatment comparisons throughout the project. In the end, Laura was only able to experiment with roller crimper termination in spring 2022 and spring 2023, and neither instance was successful at suppressing weeds.

> "If you plant a very high seeding rate, it is hard to get the timing right with the anthesis [pollen shed stage], the cover crop will not be ready for termination early enough. People don't like cover crops because they like to get their crops in late April, and the rye is not ready to terminate until early May. The window is too small." **—LAURA FREEMAN**

Data Collection

Soil health indicators were analyzed annually in the field using the qualitative observation-based NRCS In-Field Soil Health Assessment (IFSHA) and soil samples collected in the spring of 2021 through 2025. Data from 2021 reflect baseline conditions prior to treatments. Cornell Soil Health Lab provided the quantitative Comprehensive Assessment of Soil Health (CASH) and bulk density data. Annual field operations data, including machinery, inputs, input costs, and yield, were provided by the farmer in the cover crop years (2021–2025)

and used alongside published machinery costs and crop prices to estimate average annual per-acre net income by treatment. See Technical Note[1] for methodology details.

Trial expectations

We anticipated that higher seeding rates and more diverse mixes would suppress weeds more effectively and build soil health more quickly than standard rates, and that roller-crimping would reduce tillage costs and retain soil cover. However, previous research indicates that soil health benefits tend to take longer than five years to accrue, even for first time adopters of cover crops who start with degraded soil and are making a significant change in management. With the trial field's previous management including long-time use of cover crops, rotational grazing, and other soil health practices, and all treatments including a cover crop, it was anticipated that any measurable soil health changes or treatment differences in this demonstration would be small, if even detectable.

Laura Freeman and her team hoped the trial would demonstrate the viability of using cover crops and roller crimping in a no-till organic system in Kentucky, where few organic row-crop farmers have attempted this approach.

SOIL HEALTH CHANGES

In-Field Soil Health Assessment (IFSHA)

While there was not a consistent trend in the resource concerns identified by the IFSHA, the **Increased Rate treatment had the fewest overall resource concerns identified compared to the other two treatments.** Across all three treatments, we observed at least 50% fewer resources concerns by Year 4 and Year 5. The variation in resource concerns identified year-to-year may be due to treatment effects (increased rate of cover crops reducing resource concerns), or due to variability of the qualitative assessment.

TABLE 2: RESOURCE CONCERNS IDENTIFIED BY THE IN-FIELD SOIL HEALTH ASSESSMENT. Numbers one through five indicate the year of the trial (1=2021, 2=2022, etc.). Red indicates the resource concern was present in the given year; blue indicates the resource concern was **not** present in the given year.

Resource Concerns	Traditional Rate					Increased Rate					Increased Rate + Roller Crimping				
Year	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*	*5*
Compaction															
Soil Organism Habitat Loss															
Soil Organic Matter Depletion															
Aggregate Instability															

Comprehensive Assessment of Soil Health (CASH) Report

The CASH report analyzes 12 indicators (four physical, four biological, and four chemical indicators, listed below) and provides indicator-specific and overall soil health scores (0–100, 100 being best).

Crimson clover in the diverse cover crop mix in the treatment plots, April 2022.

AYSHA TAPP ROSS

"The trial helped me become a big fan of crimson clover, enough to change my tactics. I took cattle out of a paddock and planted crimson clover in September [2025] so that I get a good stand, it was definitively providing nitrogen." — **LAURA FREEMAN**

Over the course of the project, there was no significant difference between treatments for any of the indicators. This is most likely due to Laura's consistent, historical use of cover crops and the small difference in management between treatments as implemented. However, there were some significant differences over time.

Overall Soil Health Score

The overall score remained in the **high or very high** ranges for all 5 years. High overall scores indicate the soil is functioning relatively well compared to farms with soils of similar texture, but there are still constraints that could be improved with management, while very high scores indicate that management is effective at maintaining soil health.

Physical Soil Indicators

The average scores for the physical indicators (predicted water holding capacity, aggregate stability, surface hardness, and subsurface hardness) consistently scored in the **high** range, except in Year 3 when the average scored in the medium range (Figure 2) indicating potential improvement with a decreased risk of soil constraints, in particular for compaction. However, surface hardness consistently scored very low indicating potential compaction issues. **The four physical indicators and bulk density were not statistically different between treatments in any year.**

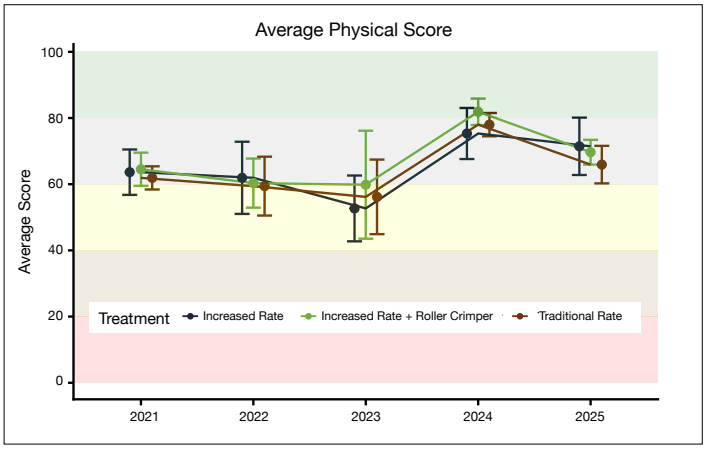
Biological Soil Indicators

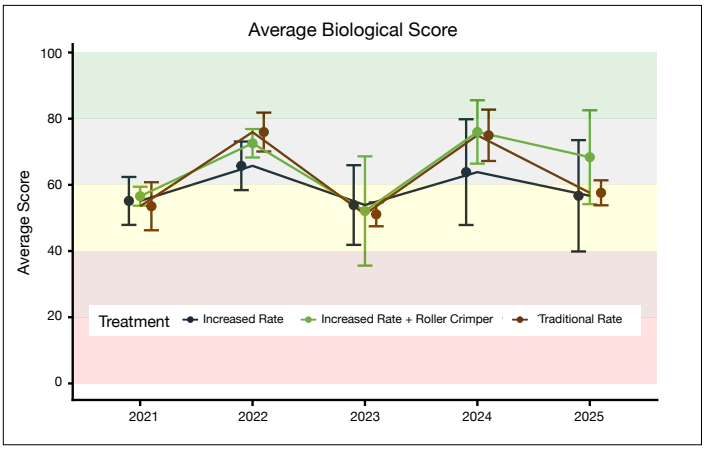
The average scores for the biological indicators (organic matter, ACE soil protein index, soil respiration, and organic carbon) fluctuated between **medium and high** ranges (Figure 2). Medium scores indicate that yields and sustainability of farming may currently be constrained and could further decline over time if soil health is not addressed through management practices. **The four biological indicators were not statistically different between treatments in any year.**

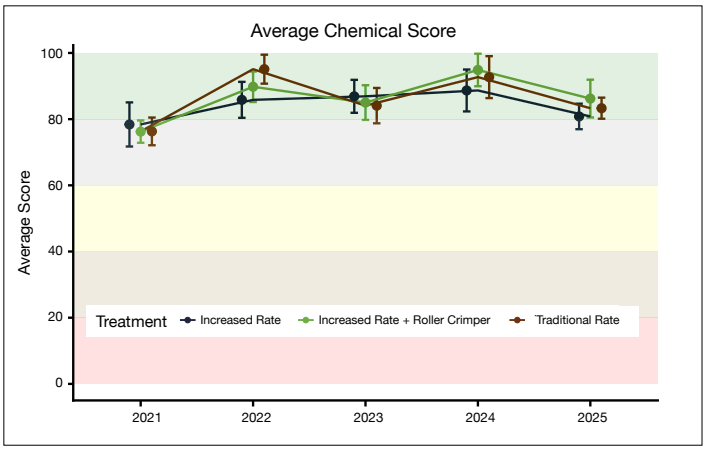
Organic matter scores increased from the high to very high range across all treatments. The increase was significant over time for each treatment; however, there was no significant

"Some of the soil testing was particularly interesting. We knew we had a compaction problem at the farm, so we used a tillage radish and they were getting by this far, and then they would not go any further, they would turn, and I realized the hard pan problem was really bad." **—LAURA FREEMAN**

FIGURE 2: AVERAGE OVERALL, PHYSICAL, BIOLOGICAL, AND CHEMICAL SOIL HEALTH SCORES BASED ON CASH REPORT. To represent sample variation within each treatment error bars are present to indicate one standard deviation. Red = very low, Orange = low, Yellow = medium, Light green = high, Dark green = very high.







difference between treatments in any particular year. We expected that the continual use of cover crops in all fields would improve organic matter over time due to the addition of biomass and carbon to the soil.

Chemical Soil Indicators

The average scores of the chemical indicators (phosphorus, pH, potassium, and minor elements) fluctuated between **high and very high** ranges (Figure 2). This finding is common for CASH analyses, since the assessment and management of soil chemical constraints is well-researched, standard practice on farms, and relatively easier to manage compared to other soil health indicators. **The four chemical indicators were not statistically different between treatments in any year.**

ECONOMIC CHANGES

We calculated per-acre **cover crop costs, value of production** (crop yield times crop price), and **net income** (value of production minus all machinery and input costs) by crop year to analyze the effect of the treatments, as actually implemented, on annual economic outcomes (costs versus benefits). No statistical comparisons were made for economic calculations based on differences in yield, due to only one yield value collected per treatment per year. See Technical Note[1] for methodology details.

Cover Crop Costs

For the **first crop year of the trial**, we compared the cover crop cost of Traditional Rate with cereal rye (70lbs/ac) to Increased Rate and Increased Rate + Roller Crimper with cereal rye-crimson clover-radish mix (115lbs-30lbs-5lbs, respectively, per acre) with the unintended additional pass of rye (40lbs/ac) mentioned above. Laura that the seeding method led to uneven application of the cover crop mix, leaving sections bare after the radish winter killed. This left a large section of the field unable to use roller crimping termination, so the cover crop was terminated with one disc pass and one mower pass ($28.50/ac) instead. As a result, Increased Rate + Roller Crimper had the highest cover crop costs at $351.70/ac (Figure 3), while Traditional Rate had the lowest cover crop costs at $148.50/ac, primarily due to the lower rate single species seeding.

In the **second crop year of the trial**, cereal rye was planted at 70 lbs/ac on the Traditional Rate plots and at 115 lbs/ac on the Increased Rate and Increased Rate + Roller Crimper plots following the trial design. This year Laura had her cover crop planted differently, using a no-till drill (10 ft; $35.90/ac) instead of broadcast seeding (20 ft; $9.10/ac). **Cover crop planting costs were higher for both Increased Rate treatments due to the extra seed and drill pass needed.** In terms of cover crop termination, both Traditional Rate and Increased Rate plots were terminated with one disc pass ($13.70/ac). On Increased Rate + Roller Crimper, **roller crimping ($6/ac) was attempted but it didn't work, so they had to disc terminate, resulting in a total cover crop termination cost of $19.70/ac.**

In the third year of the trial, the Serafino rye cover crop was harvested for grain upon organic market approval, so the treatments were not implemented as planned, and yield was measured as a cash crop, completing the economic analysis for this year. Double cropping is recognized as a valuable way to improve biodiversity, soil cover, and living root presence, while gaining economic benefits from diverse cover crop species.

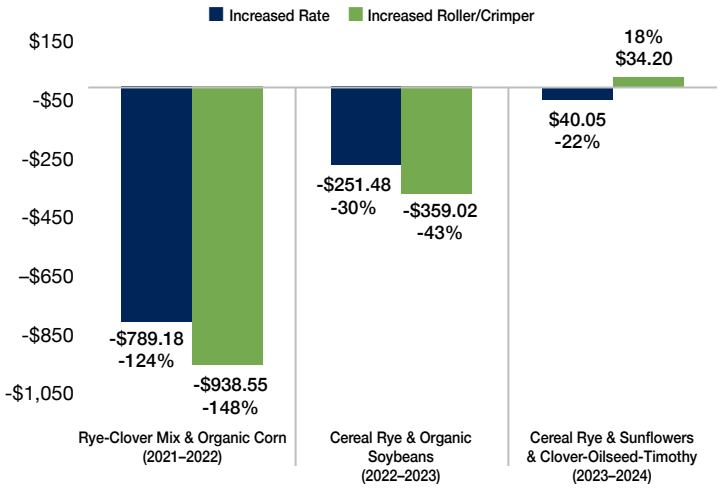
In the final year of the trial, treatments were not implemented (see farming reality section). Across all treatments, Laura planted a clover (25%)-radish (25%)-timothy (50%) cover crop mix (50 lbs/ac) in August 2024 that was grazed that November through December. This final cover crop saw no variation in cover crop-related costs between treatments.

Net Income

Net income (value of production minus costs) differed between years and treatments due to differences in cover crop costs and cash crop yields.

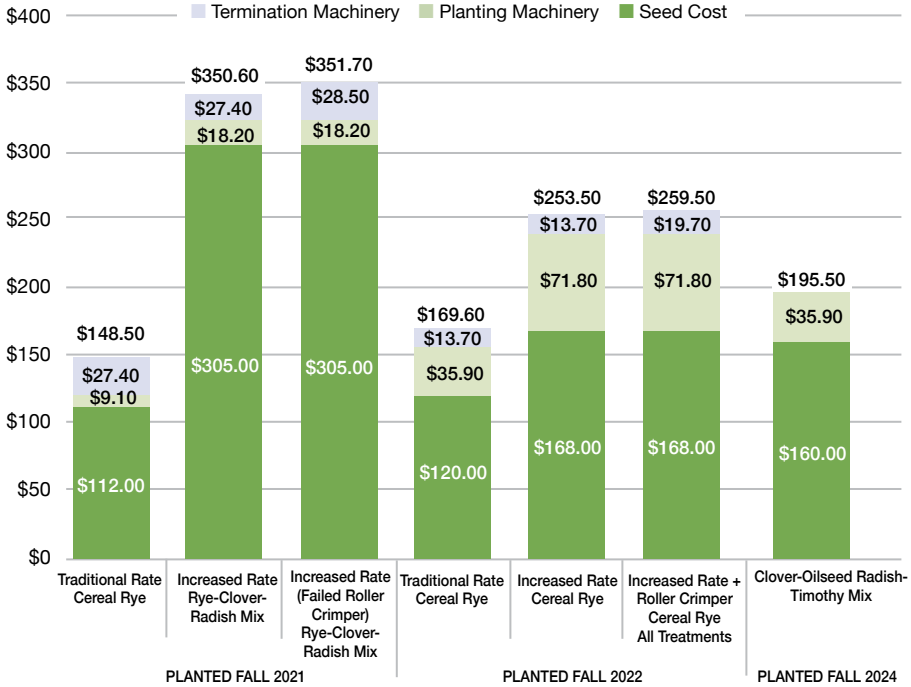
Year 1 of the trial included a cereal rye cover crop on the Traditional Seeding Rate treatment and a cereal rye and clover mix on both Increased Seeding Rate treatments, all of which were followed by organic corn. As shown in Figure 4, Traditional Rate held the highest net income at $634.62/acre, followed by Increased Rate then Increased Rate + Roller Crimper, which both had negative net incomes (Figure 4). For the Increased Rate treatments, this net income difference was due to much lower yields resulting from extreme weed pressure from uneven/failed mixed cover crop implementation, plus 2.7 times higher cover crop seed cost. The organic corn yields were 104 bu/ac, 52 bu/ac and 21 bu/ac for Traditional Rate, Increased Rate, and Increased Rate + Roller Crimper, respectively, showing that good cover crop establishment, as achieved for Traditional Rate, can suppress weeds and improve yields.

FIGURE 4: DIFFERENCE IN NET INCOME ($/AC) OF INCREASED RATE AND INCREASED RATE + ROLLER CRIMPER COMPARED TO TRADITIONAL RATE. Average net income of Traditional Rate for each crop year was $634.62/ac; $836.21/ac; & -$186.25/ac, respectively. Negative values indicate a lower net income than Traditional Rate, while positive values indicate a higher net income than Traditional Rate.



Year 2 of the trial, Laura planted cereal rye across all treatments followed by organic soybeans as the cash crop. The net income results followed the same pattern as the previous year with Traditional Rate having the highest net income at $836.21/ac (Figure 4) with lower net income for Increased Rate (by 30%) and Increased Rate + Roller Crimper (by 43%). Neither Increased Rate treatment had a major crop failure, but yields were lower by 11 bu/ac ($167.58/ac, Increased Rate) and 16 bu/ac ($297.92/ac Increased Rate + Roller Crimper). In addition to yield differences, both Increased Rate treatments cost more due to the higher seeding rate (Figure 3). Traditional Rate and Increased Rate both had higher tillage operations costs due to extra tandem disk ($13.70/ac) and row cultivation ($15.10/ac) operations compared to the one tandem disk pass on the Increased Rate + Roller Crimper (These are in addition to any cover crop termination operations).

FIGURE 3: COVER CROP COSTS BY TREATMENT AND CROP YEAR



Year 3 of the trial, Serafino rye was planted and harvested for seed instead of a true cover crop, incurring harvest costs instead of termination costs. This was followed by a failed second cash crop of sunflower, and was then reverted back to grazing land by planting a Clover, Oilseed Radish, and Timothy mix. The highest net income for this crop year was held by the Increased Seeding Rate in the previously Roller Crimped plots at -$152.05/ac (18% higher than Traditional Rate); Traditional Rate was $34.20/ac lower (at -$186.25/ac), followed by Increased Seeding Rate at $40.05/ac (-22%) lower than the Traditional Rate (-$226.12/ac). Serafino Rye yield was the main reason, with the highest yield found on Increased Seeding Rate + Roller Crimper: 8 bu/ac ($54/ac) higher than the Traditional Rate and 11 bu/ac ($74.25/ac) higher than Increased Seeding Rate. In this final year the only cost difference was found in the crop seed cost where both Increased Seeding Rate treatments held a $19.80/ac higher seed cost due to the increased seeding rates used.

Based on the limited economic data gathered in this trial, we observed the struggles of an organic operation increasing cover crop seeding rates and attempting no-till cover crop termination via roller crimping. These practices are very difficult to successfully implement without supplemental herbicide for weed control. However, Laura was able to sell grain from the cover crop in one year, while maintaining benefits of growing a cover crop, and was able to apply lessons learned year-to-year, adjusting her treatment operations accordingly, which resulted in a smaller gap in net income between treatments.

CONCLUSION

Laura's trial evaluated roller crimping and increased cover crop seeding rates to suppress weeds and minimize soil disturbance. While under ideal conditions the roller crimper could have been successful at suppressing weeds with a rolled matt of terminated cover crops, unfortunately, in this trial, persistent weeds were not outcompeted and required cultivation.

Although the main management factors tested in this trial did not show promise, the use of new cover crop species provided very positive effects. The shallow and crooked roots of tillage radish helped Laura realize how severe soil compaction is at the farm. Also, Laura was able to sell Serafino rye grain one year, and observed that crimson clover provided clear and immediate nitrogen benefits. She is now integrating crimson clover into her cover crop program.

> "I had never done no-till successfully. I always had to go after the roller crimper with a cultivator. The cover crops did not come back; they were terminated successfully. After you roller crimped, you got a nice matt, but then, about end of June, all of a sudden, Johnson grass took over the field." **—LAURA FREEMAN**

> "In the future, I will definitively put more complex cover crops. My next interest is to incorporate biochar. I have been making biochar at my farm for years. I'm also very interested in the long-term effects of applying compost and I also want to address compaction."**—LAURA FREEMAN**

Laboratory results showed that soil health did not vary significantly among the very similar trial treatments, as implemented. There was, however, a statistically significant increase in soil organic matter in all treatments over time; however, more data is needed to understand the cause of this difference.

Economic analysis of the trial showed that the Traditional Rate had the highest net income when compared to the Increased Rate treatments, but the gap decreased in over time. Higher net income for the Traditional Rate was mostly due to higher yield (which may be imprecise, per Laura), and lower cover crop seed cost and termination costs.

Finally, the networking element of this cover crop trial, where all four participating farmers from Kentucky came together to share their experiences, was of great benefit to Laura. Laura stated, "I particularly enjoyed the meetings that we had with the farmers in our group. That's where I learned a lot. I've kept in touch with all of them and see them here and there—it was really useful." Research shows that farmers learn a lot from each other when they share what has worked and what has not worked on their farms. Laura's and other farmers' experience confirm the value of farmer networking in the context of farm trials.

NOTES

1 For more information about the methods used for these analyses, see the Technical Note at https://farmlandinfo.org/publications/cover-crop-demonstration-trial-case-studies.

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