Corn Cropping Systems to Improve Economic and Environmental Health

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THE UNIVERSITY OF VERMONT EXTENSION

2024 CORN CROPPING SYSTEMS TO IMPROVE ECONOMIC AND ENVIRONMENTAL HEALTH

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In 2024, UVM Extension's Northwest Crops and Soils Program continued a multi-year trial at Borderview Research Farm in Alburgh, VT to assess the impact of corn cropping systems on overall health and productivity of the crop and soil. Management choices involving crop rotation, tillage, nutrient management, and cover crops also make differences in the long term. Yields are important and they affect the bottom line immediately and obviously. Growing corn with practices that enhance soil quality and crop yields improves farm resiliency to both economics and the environment. This project evaluated yield and soil health effects of six different corn rotations: continuous corn, no-till, no-till with cover crop, corn planted in a rotation with perennial forage, corn planted after a cover crop of winter rye, and a perennial forage fescue planted after continuous corn.

MATERIALS AND METHODS

The corn cropping system trial was established at Borderview Research Farm in Alburgh, VT in 2014. The experimental design was a randomized complete block with replicated treatments of corn grown in various cropping systems (Table 1). In 2020, plots that had been in corn every year since 2014, were seeded with a mixture of alfalfa/fescue. Also in 2020, plots that had been perennial forage since 2008 were plowed under, and the first year of corn was planted after first cut (Figure 1). In the fall of 2020, winter cover crops were planted in conventional and no-till corn plots.

Table 1. Corn cropping system specifics for corn yield and soil health, Alburgh, VT, 2024.

Crop	Management method	Treatment abbreviation
Corn silage	Continuous corn, tilled	CC
Corn silage	Fifth year in corn silage in 5-year corn/5-year hay rotation	RotYr5
Corn silage	No-till corn	NT
Corn Silage	No-Till with winter cover crop	NTCC
Corn silage	Winter cover crop, tilled	WCCC
Perennial Forage	Fifth year in perennial forage in 5-year corn/5-year hay rotation	RotYr10

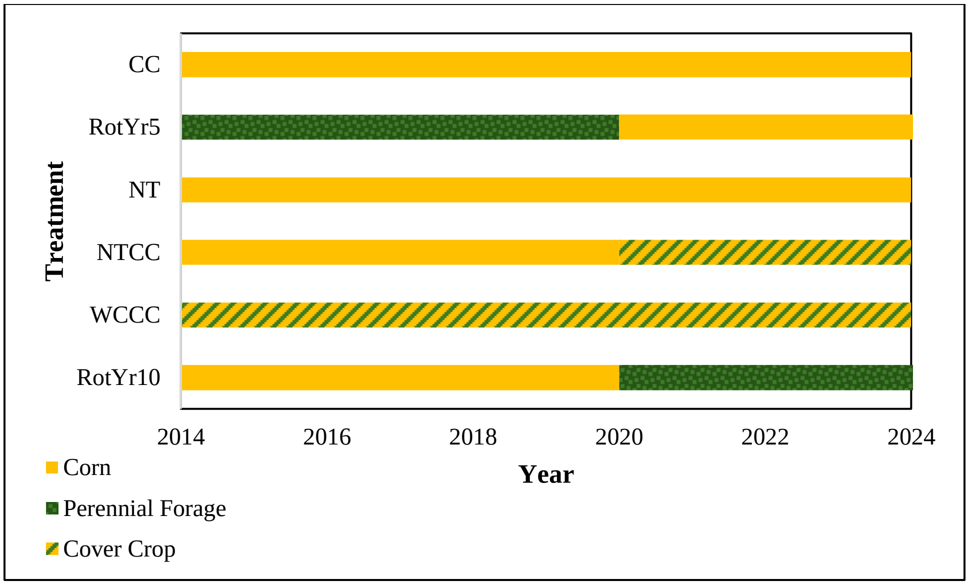

Figure 1. Cropping system timeline, Alburgh, VT, 2024.

The soil type at the research site was an Amenia silt loam with 0-2% slopes (Table 2). Each cropping system was replicated four times in 20' x 50' plots, except the NT plots which were split in half (10' x 50') to study effects of cover crops in a long-term no-till corn system. Soil samples were collected on 26-Apr and were submitted to the Cornell Soil Health Laboratory for the Comprehensive Assessment of Soil Health analysis (Ithaca, NY). Ten soil samples from five locations within each plot were collected six inches in depth with a trowel, thoroughly mixed, put in a labeled gallon bag, and mailed.

Percent aggregate stability was measured by Cornell Sprinkle Infiltrometer and indicates ability of soil to resist erosion. Predicted percent available water capacity and predicted soil protein (N mg/soil g) was calculated with a Random Forest model from a suite of measured parameters and soil texture (Cornell Soil Health Manual Series, Fact Sheet Number 19-05b). Predicted soil protein is used to quantify organically bound nitrogen (N) that microbial activity can mineralize from soil organic matter and make plant-available. Percent organic matter was measured by loss on ignition when soils are dried at 105℃ to remove water then ashed for two hours at 500℃. Total carbon (organic and inorganic forms) is measured using complete oxidation of carbon at high temperature combustion (2,000° F). Total nitrogen is measured with DUMAS combustion methodology. It measures organic (living and non-living) and inorganic (mineral) forms of nitrogen. Active carbon (active C mg/soil kg) was measured with potassium permanganate and is used as an indicator of available carbon (i.e. food source) for the microbial community. Soil respiration (CO_2 mg/soil g) is measured by amount of CO_2 released over a four-day incubation period and is used to quantify metabolic activity of the soil microbial community. The Overall Quality Score is an average of all soil health indicator ratings. It includes the aforementioned quality indicators as well as pH, phosphorus, and potassium levels. It should be considered as a general summary for soil quality. The scores range between 0-100%. Less than 20% is regarded as very low, 20-40% is low, 40-60% is medium, 60-80% is high, and greater than 80% is very high.

On 3-May, cover crops were sampled in all WCCC plots. Dried and coarsely-ground plot samples were reground using a cyclone sample mill (1mm screen) from the UDY Corporation and brought to UVM's

Agricultural and Environmental Testing Laboratory (AETL) where they were analyzed for carbon and nitrogen using gas chromatography. The CC, WCCC, and RotYr5 plots were tilled with a Pottinger TerraDisc on 5-May (Table 2). The cover crop in the NTCC plots was terminated on 7-May with 1 qt ac^{-1} Cornerstone® 5 Plus. Corn was seeded in 30" rows with a John Deere 1750 corn planter on 7-May in the CC, WCCC, NT, NTCC, and RotYr5 plots. At planting, 200 lbs ac^{-1} of 19-19-19 starter fertilizer was applied to all corn plots. The corn variety was Pioneer P8602AM, relative maturity (RM) of 86 days, at 32,097 seeds ac^{-1}.

Table 2. Agronomic information for corn cropping system, Alburgh, VT, 2024.

Location	Borderview Research Farm – Alburgh, VT
Soil type	Amenia silt loam, 0-2% slope
Previous crop	Corn or Alfalfa/Fescue
Plot size (ft)	20 x 50, except 10 x 50 for NT and NTCC
Replications	4
Management treatments	Tilled continuous corn (CC), tilled rye cover crop (WCCC), 5th year corn (RotYr4), no-till corn (NT), no-till with cover crop (NTCC), 5th year perennial forage (RotYr9)
Corn variety	Pioneer P8602AM (86 RM)
Seeding rates (seeds ac^{-1})	32,097
Planting equipment	John Deere 1750 corn planter
Cover crop (2023)	150 lbs ac^{-1} organic Hazlet winter rye, 22-Sept-2023
Tillage date	5-May (CC, WCCC, RotYr5)
Planting date	7-May (CC, WCCC, NT, NTCC, RotYr5)
Row width (in.)	30
Corn Starter fertilizer (at planting)	200 lbs ac^{-1} 19-19-19, 7-May
RotYr10 (forage) 1st harvest date	23-May
Forage fertilizer	300 lbs ac^{-1} 10-20-20, 23-May
Corn nitrogen sidedress and forage fertilizer	350 lbs ac^{-1} 30-0-20 with ContaiN Max™, 17-Jun
RotYr10 (forage) 2nd harvest date	28-Jun
RotYr10 (forage) 3rd harvest date	31-Jul
RotYr10 (forage) 4th harvest date	30-Aug
Corn silage harvest date	3-Sep

The presidedress nitrate test (PSNT) soil samples were collected on 12-Jun from corn plots with a 1-inch diameter Oakfield core to six inches in depth at five locations per plot. The samples were combined by plot and analyzed by UVM's AETL using KCl extract and ion chromatograph. Corn was top-dressed on 17-Jun with 350 lbs ac^{-1} 30-0-20 with ContaiN Max™, a nitrogen urease inhibitor, by broadcast.

Corn was harvested for silage from NT, NTCC, WCCC, CC, and RotYr5 plots on 3-Sep with a John Deere 2-row chopper and weighed in a wagon fitted with scales. Corn populations were determined by counting number of corn plants the entire length of the plot (50 feet) in the middle two rows of each plot. Dry matter yields were calculated and adjusted to 35% dry matter. Silage quality was analyzed using the FOSS NIRS (near infrared reflectance spectroscopy) DS2500 Feed and Forage analyzer. Dried and coarsely-ground plot samples were brought to the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT) where they were reground using a cyclone sample mill (1mm screen) from the UDY Corporation. The samples were then analyzed using the FOSS NIRS DS2500 for crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients (TDN), and Net Energy-Lactation (NE_L).

Perennial forage was harvested and weighed with a Carter Forage Harvester fitted with scales in one 3' x 50' strips. RotYr10 was harvested on 23-May, 28-Jun, 31-Jul, and 30-Aug. The day of 1st cut, RotYr10 plots received 300 lbs ac^{-1} 10-20-20 on 23-May. Before 2nd cut, RotYr10 received 350 lbs ac^{-1} 30-0-20 on 17-Jun. Fertility was not applied after 3rd or 4th cuts. Perennial forage moisture and dry matter yield were calculated with an approximate two-pound subsample of the harvested material from each strip was collected, dried, ground, and then analyzed at the E. E. Cummings Crop Testing Laboratory at the University of Vermont (Burlington, VT) for quality analysis with the methods outlined above. CP, ADF, NDF and 30-hour digestible NDF (NDFD) were determined.

Mixtures of true proteins, composed of amino acids and non-protein nitrogen, make up the CP content of forages. The CP content of forages is determined by measuring the amount of nitrogen and multiplying by 6.25. The bulky characteristics of forage come from fiber. Forage feeding values are negatively associated with fiber since the less digestible portions of plants are contained in the fiber fraction. The detergent fiber analysis system separates forages into two parts: cell contents, which include sugars, starches, proteins, non-protein nitrogen, fats and other highly digestible compounds; and the less digestible components found in the fiber fraction. The total fiber content of forage is contained in the neutral detergent fiber (NDF). Chemically, this fraction includes cellulose, hemicellulose, and lignin. Because of these chemical components and their association with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows. In recent years, the need to determine rates of digestion in the rumen of the cow has led to the development of NDFD. This in vitro digestibility calculation is very important when looking at how fast feed is being digested and passed through the cow's rumen. Higher rates of digestion lead to higher dry matter intakes and higher milk production levels. Similar types of feeds can have varying NDFD values based on growing conditions and a variety of other factors. In this research, the NDFD calculations are based on 30-hour in vitro testing.

Net energy for lactation (NE_L) is calculated based on concentrations of NDF and ADF. NE_L can be used as a tool to determine the quality of a ration, but should not be considered the sole indicator of the quality of a feed, as NE_L is affected by the quantity of a cow's dry matter intake, the speed at which her ration is consumed, the contents of the ration, feeding practices, the level of her production, and many other factors. Most labs calculate NE_L at an intake of three times maintenance. Starch can also have an effect on NE_L, where the greater the starch content, the higher the NE_L (measured in Mcal per pound of silage), up to a certain point. High grain corn silage can have average starch values exceeding 40%, although levels greater than 30% are not considered to affect energy content and might in fact have a negative impact on digestion. Starch levels vary from field to field, depending on growing conditions and variety.

Milk per acre and milk per ton of harvested feed are two measurements used to combine yield with quality and arrive at a benchmark number indicating how much revenue in milk can be produced from an acre or a ton of corn silage. This calculation relies heavily on the NE_L calculation and can be used to make generalizations about data, but other considerations should be analyzed when including milk per ton or milk per acre in the decision-making process.

Soil health metrics, yield data, and stand characteristics were analyzed using mixed model analysis in *R* (Rstudio, 2024) using the *dplyr* (Wickham, et al., 2023), *lmerTest* (Kuznetsova, et al., 2017), and *agricolae* (de Mendiburu, 2023) packages. Replications within trials were treated as random effects, and corn cropping systems were treated as fixed. Treatment mean comparisons were made using the Least Significant Difference (LSD) procedure when the F-test was considered significant ($p<0.10$).

Variations in yield and quality can occur because of variations in genetics, soil, weather, and other growing conditions. Statistical analysis makes it possible to determine whether a difference among hybrids is real or whether it might have occurred due to other variations in the field. At the bottom of each table a LSD value is presented for each variable (i.e. yield). Least Significant Differences (LSDs) at the 0.10 level of significance are shown. Where the difference between two treatments within a column is equal to or greater than the LSD value at the bottom of the column, you can be sure that for 9 out of 10 times, there is a real difference between the two hybrids. Treatments that did not perform significantly different from each other share the same letter. In this example, treatment C is significantly different from treatment A, but not from treatment B. The difference between C and B is equal to 1.5, which is less than the LSD value of 2.0. This means that these treatments did not differ in yield. The difference between C and A is equal to 3.0 which is greater than the LSD value of 2.0. This means that the yields with these treatments were significantly different from one another. The shared letter indicates that treatment B was not significantly lower than the top yielding treatment C, indicated in bold.

Treatment	Yield
A	6.0[b]
B	7.5[a]
C	**9.0[a]**
LSD	**2.0**

RESULTS

Weather Data

Weather data were collected with an onsite Davis Instruments Vantage Pro2 weather station equipped with a WeatherLink data logger. Temperature, precipitation, and accumulation of Growing Degree Days (GDDs) are consolidated for the 2023 growing season (Tables 3 and 4). Historical weather data are from 1991-2020 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT.

On average, the 2024 growing season started warmer and ended cooler than the 30-year average. Although there was rainfall deficit early in the season (May), from April through August, there was 7.15 more inches than the 30-year average. All months except August had higher than average Growing Degree Days (GDDs). The corn growing season had a total of 2,263 GDDs from May through August—102 GDDs more than the historical average (Table 3). The forage growing season had a total of 3,572 GDDs for forages from April through August—130 GDDs more than the historical average (Table 4).

Table 3. Consolidated weather data and GDDs for corn, Alburgh, VT, 2024.

Alburgh, VT	May	June	July	August
Average temperature (°F)	61.9	68.5	73.7	69.2
Departure from normal	3.47	0.950	1.33	-1.45
Precipitation (inches)	2.27	6.65	6.67	5.78
Departure from normal	-1.49	2.39	2.61	2.24
Corn GDDs (base 50°F)	388	548	732	595
Departure from normal	87.2	24.8	37.3	-46.8

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger.
Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Table 4. Consolidated weather data and GDDs for perennial forage, Alburgh, VT, 2024.

Alburgh, VT	April	May	June	July	August
Average temperature (°F)	45.7	61.9	68.5	73.7	69.2
Departure from normal	0.132	3.47	0.950	1.33	-1.45
Precipitation (inches)	4.47	2.27	6.65	6.67	5.78
Departure from normal	1.40	-1.49	2.39	2.61	2.24
Perennial forage GDDs (base 41°F)	226	647	815	1011	873
Departure from normal	10.9	108	21.3	37.3	-47.2

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1991-2020) from Burlington, VT.

Soil Test Results

On 26-Apr, before field operations, soil samples were collected from all plots. Average soil health scores were in the high functioning range for all cropping systems. However, there were statistical differences in soil health indicators and soil health scores among the cropping systems (Tables 5 and 6). The soil health score for RotYr5 was similar to NTCC and significantly higher than all other cropping systems CC, NT, WCCC, and RotYr10. This suggests that either the cover crop/no-till synergy is having an effect or the positive soil health legacy effects of perennial forage are waning. Since the crop rotation, 2024 is the first year that RotYr10 had a significantly higher soil health score than cropping systems with annual tillage (WCCC and CC). This indicates that it may take about five years for soil health to recover after transition from continuous corn with tillage to perennial forage. WCCC consistently had the lowest soil health metric measurements among any of the treatments which may be because the positive benefits from cover crops may be hard to capture. For example, soil health samples taken too early in the season before the impact of living roots could impact soil health results, soil health samples taken before cover termination may not capture impacts of nutrient release from the cover crops, or cover crop benefits may not persist long enough to carry over from the previous year.

There were other individual soil health indicator differences among treatments. The RotYr5 treatment had significantly higher organic matter, active carbon, total carbon, total nitrogen, and soil protein than any other treatments. NT and NTCC had statistically similar levels of all soil health indicators except total nitrogen was lower in NTCC and soil respiration was higher in NTCC than NT. These differences between NTCC and NT are most likely due to nitrogen tie up of cover crops and the cover crops as a food contribution to microbes thus stimulating population growth, captured as respiration. WCCC performed similarly to CC in all metrics except total nitrogen, soil protein, and available water capacity in which it was significantly lower than CC. The differences among systems with cover crop and those without may be that the soil samples were taken too early in the easy to capture the additional nitrogen that would be released from the soil micro-organisms feeding on the living roots and decomposing the dying cover crop vegetation.

Table 5. Organic matter, active carbon, total carbon, total nitrogen, soil proteins, and soil respiration for six cropping systems, Alburgh, VT, 2024.

Cropping system	Organic matter %	Active carbon ppm	Total carbon %	Total nitrogen %	Soil proteins N mg/soil g	Soil respiration CO_2 mg/soil g
CC	3.26[b†]	518[b]	1.96[bc]	0.223[bc]	6.16[bc]	0.373[d]
RotYr5	4.02[a]	602[a]	2.54[a]	0.270[a]	7.52[a]	0.576[a]
NT	3.45[b]	481[b]	2.02[b]	0.235[b]	6.34[b]	0.444[c]
NTCC	3.45[b]	524[b]	1.93[bc]	0.217[cd]	6.24[bc]	0.508[b]
WCCC	3.20[b]	495[b]	1.84[c]	0.205[d]	5.68[d]	0.409[cd]
RotYr10	3.52[b]	502[b]	2.11[b]	0.233[b]	5.87[cd]	0.549[ab]
LSD (0.10)[‡]	0.401	55.8	0.179	0.015	0.428	0.048
Trial Mean	3.48	520	20.7	0.230	6.30	0.477

† Within a column, treatments with the same letter did not perform significantly different from each other.
‡ LSD – Least Significant Difference at p=0.10.

Table 6. Aggregate stability, available water capacity, surface hardness, sub-surface hardness, and overall soil health score for six cropping systems, Alburgh, VT, 2024.

Cropping system	Aggregate stability %	Available water capacity m/m	Surface hardness psi	Sub-surface hardness psi	Soil health score %
CC	25.4[b†]	0.224[b]	198	295	61.2[c]
RotYr5	42.7[a]	0.231[a]	172	291	71.3[a]
NT	41.4[a]	0.224[ab]	179	289	65.1[bc]
NTCC	38.5[a]	0.227[ab]	154	289	68.1[ab]
WCCC	24.5[b]	0.217[c]	181	280	61.2[c]
RotYr10	27.0[b]	0.230[ab]	139	284	66.3[b]
LSD (0.10)[‡]	7.88	0.007	NS[§]	NS	4.02
Trial Mean	33.3	0.225	171	288	65.5

† Within a column, treatments with the same letter did not perform significantly different from each other.
‡ LSD – Least Significant Difference at p=0.10.
§ NS – No significant difference was determined among the treatments.

On 12-Jun, soil samples were collected for PSNT analysis (Table 7). There was no significant difference in corn cropping systems for soil nitrate concentrations or nitrogen recommendations for 25 ton ac^{-1} yields. Mean soil nitrate-N (NO_3^--N) among the treatments was 13.1 ppm with a mean N recommendation of 94.3 N lbs ac^{-1}. Nitrogen was applied as 30-0-20 with Contain Max™ to all corn plots on 17-Jun at a rate of 350 lbs ac^{-1} (105 N lbs ac^{-1}).

Table 7. Soil nitrate-N and N recommendations for high yield potential, Alburgh, VT, 2024.

Corn cropping system	NO_3^--N ppm	N recommendation for 25 ton ac^{-1} corn
CC	13.5	92.5
RotYr5	17.8	63.8
NT	9.00	119
NTCC	12.0	101
WCCC	13.3	95.0
LSD (0.10)†	NS§	NS§
Trial Mean	13.1	94.3

† LSD – Least Significant Difference at p=0.10.
§ NS – No significant difference was determined among the treatments.

Cover Crop Results

On 5-May, cover crop samples were taken in the NTCC and WCCC plots. The winter rye cover plots yielded an average of 1,084 dry matter (DM) lbs ac^{-1}. On average, cover crop biomass was 41.5% carbon and 2.57% nitrogen for an average C:N ratio of 16.4:1. This equivalates to cover crop soil contributions of 450 lbs ac^{-1} of carbon and 27.0 lbs ac^{-1} of nitrogen.

Corn and Perennial Forage Crop Results

On 3-Sep, data was collected on corn silage populations and corn plots were harvested to determine moisture and yield (Table 8). Forage plots were harvested on 23-May, 28-Jun, 31-Jul, and 30-Aug to determine moisture and yield (Table 8). Corn silage yields at 35% DM were higher than perennial forage (RotYr10). However, on a DM basis, there were no yield differences among the cropping systems indicating the potential of perennial forage to rival corn silage yields (Table 8 and Figure 2).

Table 8. Corn silage population, harvest dry matter, and yield by treatment, Alburgh, VT, 2024.

Cropping system	Harvest population plants ac^{-1}	Yield at DM ton ac^{-1}	Yield at 35% DM ton ac^{-1}
CC	33,000	6.55	18.7[a†]
RotYr5	33,750	7.16	20.5[a]
NT	34,000	6.56	18.7[a]
NTCC	32,000	6.93	19.8[a]
WCCC	34,125	6.88	19.7[a]
RotYr10	NA[ϒ]	6.01	14.7[b]
LSD (0.10)‡	NS§	NS§	3.13
Trial mean	33,375	6.68	18.7

† Within a column, treatments with the same letter did not perform significantly different from each other.
ϒ NA– Not applicable for this treatment.
‡ LSD – Least Significant Difference at p=0.10.
§ NS – No significant difference was determined among the treatments.

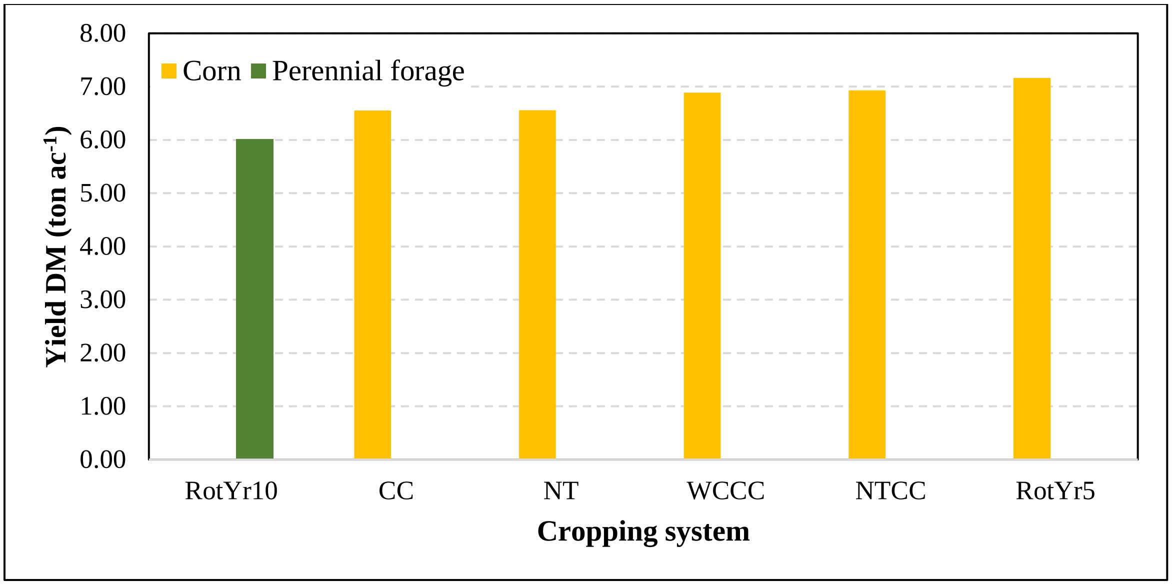

Figure 2. Cropping system total yield, Alburgh, VT, 2024.

Standard components of corn silage and the average RotYr10 perennial forage quality across cuts were analyzed for basic quality parameters (Table 9). Corn quality did not differ among cropping systems in corn, except that WCCC and NT had higher NDFD30 than CC. Overall corn quality was higher than perennial forage. However, average crude protein (CP) was 11% higher, NDFD30 was 12.1% higher, and milk lbs tons^{-1} was 446 tons higher in perennial forage than corn. However, there were no milk lbs ac^{-1} differences among cropping systems.

Table 9. Impact of cropping systems on crop quality, 2024.

Cropping system	CP % of DM	ADF % of DM	NDF % of DM	NDFD 30 % of NDF	TDN % of DM	NE_L Mcal lb^{-1}	Milk lbs ton^{-1}	Milk lbs ac^{-1}
CC	7.50^{b†}	21.4^{a}	36.9^{a}	51.9^{c}	64.3^{a}	1.49^{a}	3,362^{b}	21,991
RotYr5	8.11^{b}	22.7^{a}	38.2^{a}	53.3^{bc}	63.5^{a}	1.47^{a}	3,329^{b}	23,887
NT	8.05^{b}	22.8^{a}	39.2^{a}	54.6^{b}	63.8^{a}	1.47^{a}	3,364^{b}	22,057
NTCC	7.75^{b}	21.8^{a}	37.4^{a}	54.1^{bc}	64.0^{a}	1.48^{a}	3,336^{b}	23,150
WCCC	8.00^{b}	22.4^{a}	38.6^{a}	55.5^{b}	63.5^{a}	1.47^{a}	3,351^{b}	23,072
RotYr10	19.0^{a}	32.6^{b}	48.6^{b}	65.9^{a}	59.8^{b}	1.29^{b}	3,794^{a}	22,736
LSD (0.10)‡	0.632	3.73	4.83	2.66	1.32	0.059	137	NS§
Trial mean	9.73	24.0	39.8	55.9	63.1	1.45	3,423	22,815

† Within a column, treatments with the same letter did not perform significantly different from each other.
‡ LSD – Least Significant Difference at p=0.10.
§ NS – No significant difference was determined among the treatments.

DISCUSSION

The goal of this project is to monitor long-term soil and crop productivity in these cropping systems. Based on the analysis of the data, some conclusions can be made about the results of this year's trial. In terms of soil quality, the system with the most recent rotation from sod, RotYr5, performed best overall. Corn systems with long-term history of tillage (CC and WCCC) had the statistically lowest soil health scores. This is the first year since rotating to sod that RotYr10 had a higher soil health score than the continuous corn tillage systems. This indicates that it may take five years of perennial forage to build soil health levels different from continuous corn production or similar to NT production.

RotYr10 and no-till plots (NT and NTCC) had the second highest soil health scores. This indicates that there are some benefits from not tilling the soil. The NT and NTCC treatments were transitioned from perennial forage to corn over ten years ago and the lack of soil disturbance is reflected in many of the soil quality measurements. These treatments clearly show the potential for no-till corn to maintain soil quality during the corn years of a rotation. The similar scores of NT and NTCC indicate that perhaps it takes more than four years for the synergistic effects of no-till and cover cropping to make an effective difference on soil health.

Despite the differences in soil health among the cropping systems, there is no clear connection between soil metrics and crop yield or quality. Rather, differences in crop yield and quality were impacted by crop type (corn or perennial forage). For example, there were no cropping system DM yield differences among any of the treatments. However, overall perennial forage quality was lower than the corn forage quality of any of the other production systems, but lbs ton^{-1} milk production of the perennial forage was higher. The data presented here only represents one year and data analysis over multiple years provides an opportunity to make observations about long-term trends. In 2025, we will collect more data to inform long-term trend analysis.

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