2020 Corn Cropping Systems to Improve Economic and Environmental Health

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2020 CORN CROPPING SYSTEMS TO IMPROVE ECONOMIC AND ENVIRONMENTAL HEALTH

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In 2020, UVM Extension's Northwest Crops & 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 five different corn rotations: continuous corn, no-till, corn planted in a rotation with perennial forage, corn planted after a cover crop of winter rye, and a perennial forage fescue.

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, in plots that were planted in corn every year since 2014, a mixture of alfalfa/fescue was planted. Plots that had been perennial forage since 2008 were tilled, and the first year of corn was planted after first cut.

Table 1. Corn cropping system specifics for corn yield and soil health, Alburgh, VT, 2020.

Crop	Management method	Treatment abbreviation
Corn silage	Continuous corn, tilled	CC
Corn silage	First year in corn silage in 5 year corn/5 year hay rotation	RotYr1
Corn silage	No-till corn	NT
Corn silage	Winter cover crop, tilled	WCCC
Perennial Forage	First year in perennial forage in 5 year corn/5 year hay rotation	RotYr6

The soil type at the research site was an Amenia silt loam with 0-2% slopes (Table 2). Each cropping system was replicated 4 times in 20' x 50' plots. Soil samples were collected on 29-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. Compaction was measured at 0-6 inch depth and 6-12 inch depth by penetrometer twice at the same five locations the soil samples were collected. The compaction measurements and soil types were used by the Cornell Soil Health Laboratory to calculate surface and sub-surface hardness (psi).

Percent aggregate stability was measured by Cornell Sprinkle Infiltrometer and indicates ability of soil to resist erosion. 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 (2000° F). Total nitrogen is measured with DUMAS combustion methodology. It measured 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 28-Apr, all plots in the trial (corn and forage) received an application of 300 lbs ac^{-1} of 19-19-19. On 5-May, WCCC cover crop was sampled. 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 where they were analyzed for carbon and nitrogen using gas chromatography. The CC and WCCC plots were plowed 6-May. On 26-May, after first perennial forage (RotYr1) cut, an application of Round-up was sprayed to terminate the perennial forage. Corn was seeded in 30" rows with a John Deere 1750 corn planter on 12-May in the CC, WCCC, and NT plots and on 27-May in the RotYr1 plots. At planting, 200 lbs ac^{-1} of an 10-20-20 starter fertilizer was applied to all corn plots. The corn variety was Pioneer 38N85, relative maturity (RM) of 92 days, at 34,000 seeds ac^{-1}. On 6-May, the treatments that were planted in corn since 2014 were tilled, becoming RotYr6, and planted the next day with a perennial forage mix of 60% alfalfa and 40% tall fescue at a rate of 20 lbs ac^{-1}.

Table 2. Agronomic information for corn cropping system, Alburgh, VT, 2020.

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
Replications	4
Management treatments	Tilled continuous corn (CC), tilled rye cover crop (WCCC), perennial foraged rotated into corn (RotYr1), no-till corn (NT), new seeded perennial forage (RotYr6)
Corn variety	Pioneer 38N85 (92 RM)
Seeding rates (seeds ac^{-1})	34,000
Planting equipment	John Deere 1750 corn planter
Plow date	6-May (CC & WCCC)
Planting date	12-May (CC, WCCC, & NT); 27-May (RotYr1)
Row width (in.)	30
Fertilizer (all plots)	300 lbs ac^{-1} 19-19-19, 28-Apr
Chemical weed control for corn	3 qt. ac^{-1} Acuron® (NT, CC, WCCC, and RotYr6), 18-May

Table 2 (cont'd). Agronomic information for corn cropping system, Alburgh, VT, 2020.

Location	Borderview Research Farm – Alburgh, VT
Corn Starter fertilizer (at planting)	200 lbs ac^{-1} 10-20-20
Additional fertilizer (corn topdress)	200 lbs ac^{-1} 46-0-0 with ContaiN Max, 23-Jun
RotYr1 1st harvest date	26-May (RotYr1)
Chemical termination in RotYr1	1 qt. ac^{-1} PowerMax®, 27-May
RotYr6 1st cut date	22-Jun
Forage fertilizer	300 lbs ac^{-1} 10-20-20, 24-Jun
RotYr6 2nd harvest date	28-Aug
Forage fertilizer	100 lbs ac^{-1} 0-0-52, 5-Sep
Corn harvest date	3-Sep (NT, CC, & WCCC); 29-Sep (RotYr1)

On 18-May, 3 qt. ac^{-1} Acuron® was applied for weed control on NT, CC, WCCC, and previous RotYr6 plots. RotYr1 plots were terminated with 1 qt. ac^{-1} PowerMax® on 27-May. Corn was topdressed with nitrogen fertilizer by broadcast according to the highest Pre-Sidedress Nitrate Test (PSNT) recommendation on 23-Jun (Table 7). The PSNT soil samples were collected 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 Agricultural and Environmental Testing Laboratory using KCl extract and ion chromatograph.

Corn was harvested for silage from NT, WCCC, and CC plots on 3-Sep and RotYr1 plots on 29-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 in a 17.5 feet section 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 UVM's Cereal Grain Testing Laboratory 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. The forage in the RotYr1 plots were harvested on 26-May. On 22-Jun, the newly seeded RotYr6 plots were cut, but not harvested due to potato leaf damage and high prevalence of weeds. RotYr6 was harvested on 28-Aug. RotYr6 plots received 300 lbs ac^{-1} 10-20-20 after first cut and 100 lbs ac^{-1} 0-0-52 on 5-Sep after the August harvest. 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 University of Vermont's Cereal Grain Testing Laboratory, Burlington, VT, for quality analysis with the methods outlined above. CP, ADF, NDF and 48-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 48-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.

Yield data and stand characteristics were analyzed using mixed model analysis using the mixed procedure of SAS (SAS Institute, 1999). 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

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

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.

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 2020 growing season (Tables 3 and 4). Historical weather data are from 1981-2010 at cooperative observation stations in Burlington, VT, approximately 45 miles from Alburgh, VT.

In 2020, the growing season began cooler and drier than the 30-year average. Growing conditions worsened throughout the season. The summer months of Jun-Aug were warmer than the 30-year average. There were a total of 2484 Growing Degree Days (GDDs) for corn from May through September—139 GDDs more than the historical average (Table 3). There were a total of 3862 GDDs for forages from April through September—39 GDDs more than the historical average (Table 4). Although there was the warmth the crops needed, there was not the rainfall to support growth at the time the crop needed it. Most of the rainfall came in August in two major storms. Regardless, the season ended with a 1.86 inch rainfall deficit.

Table 3. Consolidated weather data and GDDs for corn, Alburgh, VT, 2020.

Alburgh, VT	May	June	July	August	September
Average temperature (°F)	56.1	66.9	74.8	68.8	59.2
Departure from normal	-0.44	1.08	4.17	0.01	-1.33
Precipitation (inches)	2.35	1.86	3.94	6.77	2.75
Departure from normal	-1.04	-1.77	-0.28	2.86	-0.91
Corn GDDs (base 50°F)	298	516	751	584	336
Departure from normal	6	35	121	2	-24

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Table 4. Consolidated weather data and GDDs for perennial forage, Alburgh, VT, 2020.

Alburgh, VT	April	May	June	July	August	September
Average temperature (°F)	41.6	56.1	66.9	74.8	68.8	59.2
Departure from normal	-3.19	-0.44	1.08	4.17	0.01	-1.33
Precipitation (inches)	2.09	2.35	1.86	3.94	6.77	2.75
Departure from normal	-0.72	-1.04	-1.77	-0.28	2.86	-0.91
Perennial forage GDDs (base 41°F)	144	497	766	1030	860	564
Departure from normal	-88	-4	29	123	5	-27

Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.

Soil Test Results

On 29-Apr, before field operations, soil samples were collected on all plots. Overall, treatments that were in RotYr1 had superior soil quality when compared to any of the corn cropping systems. The RotYr1 treatment had significantly higher organic matter, active carbon, total carbon, total nitrogen, soil protein, and aggregate stability. For the last six years, RotYr1 consistently had statistically significantly higher soil respiration than the corn treatments (Tables 5 and 6). The RotYr1 had significantly higher surface hardness than the corn treatments. Among the corn treatments, the NT had significantly higher aggregate stability. Differences among the treatments for total nitrogen and soil proteins were similar. RotYr1 had significantly higher total N and soil proteins than the other treatments. Among the corn treatments, the NT treatment had significantly higher total nitrogen and soil proteins. The amount of total carbon was significantly different in each treatment. Following similar trends to organic matter and active carbon, RotYr1 has significantly more carbon, followed by NT, RotYr6, WCCC, and lastly CC. There is a significant difference in the soil health scores of NT and CC, but there were no significant differences in soil health scores among RotYr6, WCCC, and CC.

Table 5. Organic matter, active carbon, soil proteins and soil respiration for five cropping systems, Alburgh, VT, 2020.

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	3.31d†	739bc	2.15e	0.299c	7.74c	0.537c
RotYr1	4.53a	888a	3.02a	0.303a	11.0a	1.16a
NT	3.72b	806b	2.49b	0.265b	9.27b	0.666bc
WCCC	3.38cd	724c	2.23d	0.227c	7.88c	0.634bc
RotYr6	3.55bc	733bc	2.30c	0.237c	7.93c	0.671b
LSD (0.10)‡	0.187	75.1	0.069	0.015	0.782	0.133
Trial Mean	3.70	778	2.44	0.252	8.76	0.734

† Within a column, treatments with that 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 five cropping systems, Alburgh, VT, 2020.

Cropping system	Aggregate stability %	Available water capacity m/m	Surface hardness psi	Sub-surface hardness psi	Soil health score
CC	33.3d†	0.226c	122ab	262	74.8c
RotYr1	74.6a	0.251a	158c	293	86.1a
NT	61.5b	0.246ab	113ab	260	81.4b
WCCC	36.8cd	0.229bc	129b	274	77.1c
RotYr6	42.7c	0.224c	98.8a	264	77.3bc
LSD (0.10)‡	6.16	0.019	26.5	NS§	4.19
Trial Mean	49.8	0.235	124	270	79.3

† Within a column, treatments with that 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 16-Jun, soil samples were collected for PSNT analysis (Table 7). The mean soil nitrate-N (NO^{-}_{3}-N) among the treatments was 14.3 ppm with a mean N recommendation of 88.4 N lbs ac^{-1}. PSNT results were significantly higher in the NT and WCCC treatments than the CC and RotYr1 treatments. Hence, the nitrogen recommendations were significantly lower for NT and WCCC plots. Nitrogen, in the form of urea (46-0-0) with ContaiN Max was applied to the corn treatments at a rate of 200 lbs ac^{-1} (92 N lbs ac^{-1}) on 23-Jun.

Table 7. Soil nitrate-N and N recommendations for medium and high yield potential, Alburgh, VT, 2020.

Corn cropping system	NO_3^--N ppm	N recommendation for 25 ton ac^{-1} corn
CC	13.0[b†]	95.0[a]
RotYr1	12.3[b]	98.8[a]
NT	15.8[a]	81.3[b]
WCCC	16.3[a]	78.8[b]
LSD (0.10)‡	2.31	11.5
Trial Mean	14.3	88.4

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

Cover Crop Results

On 5-May, cover crop samples were taken in the WCCC plots. The winter rye cover plots yielded an average of 820 dry matter (DM) lbs ac^{-1}. On average, cover crop biomass was 43% carbon and 3.75% nitrogen for an average C:N ratio of 14:1. This equivalates to 353 lbs ac^{-1} of carbon and 31 lbs ac^{-1} of nitrogen. This coincides with the PSNT test indicating more available nitrogen in the cover crop plots.

Corn Silage Results

On 1-Sep, data was collected on corn silage populations. CC, NT, and WCCC plots were harvested on 3-Sep and RotYr1 on 29-Sep to determine moisture and yield (Table 8). Although the NT system had statistically significantly higher plant populations at harvest and the RotYr1 corn was planted much later, there was no corn yield or total yield (corn plus perennial forage) differences among the treatments (Figure 1). The RotYr1 had significantly higher percent dry matter likely associated with the fact that the plots were hit by a killing frost prior to harvest.

Table 8. Corn silage population, harvest dry matter and yield by treatment, Alburgh, VT, 2020.

Corn cropping system	Harvest population plants ac^{-1}	Harvest dry matter %	Yield at 35% DM ton ac^{-1}
CC	29,063[a]	38.2[b]	19.0
RotYr1	29,375[a]	46.3[a]	17.7
NT	24,453[b]	37.9[b]	17.4
WCCC	30,742[a]	37.3[b]	19.1
LSD (0.10)[‡]	3,340	2.29	NS[§]
Trial mean	28,408	39.9	18.3

† Within a column, treatments with that 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.

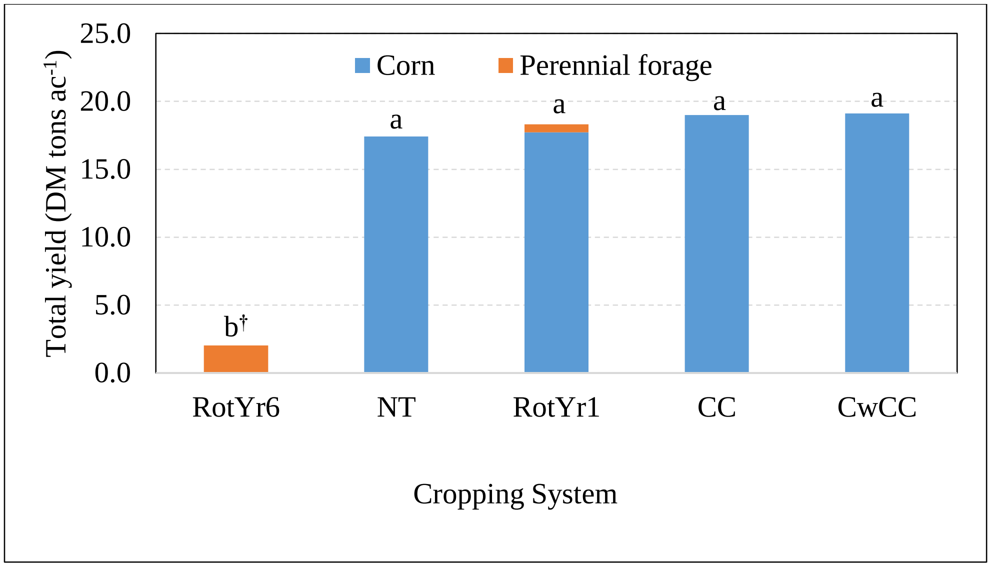

Figure 1. Cropping system total yield, Alburgh, VT, 2020.

† Cropping systems with that same letter did not perform significantly different from each other at p=0.10.

Standard components of corn silage quality were analyzed (Table 9). There was no difference in CP among the corn cropping systems, indicating that the crop was adequately fertilized. There was no difference in NDF among corn cropping systems. In general, the RotYr1 treatment has lower quality when compared to the other corn treatments. This difference was likely related to a later planting date and early frost prior to reaching the proper maturity.

Table 9. Impact of cropping systems on corn silage quality, 2020.

Corn cropping system	CP % of DM	ADF % of DM	NDF % of DM	TDN % of DM	NE_L Mcal lb^{-1}	Milk lbs ton^{-1}	Milk lbs ac^{-1}
CC	9.51	18.0[a†]	35.4	61.3[a]	0.636[a]	2,663[a]	19,949[a]
RotYr1	8.91	22.9[b]	42.6	51.5[b]	0.524[b]	1,944[b]	14,363[b]
NT	9.51	20.3[ab]	38.7	59.1[b]	0.614[a]	2,520[a]	17,598[ab]
WCCC	9.22	19.1[a]	37.2	60.7[b]	0.631[a]	2,630[a]	18,481[a]
LSD (0.10)‡	NS§	3.12	NS	2.45	0.023	148	3,370
Trial mean	9.29	20.1	38.5	58.1	0.601	2,439	17,598

† Within a column, treatments with that 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.

Perennial Forage Results

The first and only harvest of RotYr1 and the second cut of RotYr6 plots were analyzed for basic quality parameters (Table 10). The first cut of RotYr6 was not harvested due to high weed pressure and potato leaf hopper damage. The RotYr6 harvest was significantly higher in yield, but lower in quality. The higher yield may be due to the long growing period and lower quality related to hot and dry conditions.

Table 10. Impact of harvest date on perennial forage quality, 2020.

Rotation	Cut date	Cut no.	Yield % DM lb ac^{-1}	CP % of DM	ADF % of DM	NDF % of DM	NDFD48 % of NDF	TDN % of DM	NE_L Mcal lb^{-1}	Milk lbs ton^{-1}
RotYr1	26-May	1	0.58[b†]	25.2[a]	27.9[a]	47.1[a]	82.3[a]	61.8	1.37	4,487[a]
RotYr6	22-Jun	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RotYr6	28-Aug	2	2.02[a]	19.6[b]	35.5[b]	59.6[b]	69.8[b]	56.0	1.12	3,924[b]
LSD (0.10)[‡]			0.303	5.60	4.17	11.3	7.35	NS[§]	NS	465
Trial mean			1.30	22.4	31.7	53.4	76.0	58.9	1.25	4,206

† Within a column, treatments with that 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 health 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 most recently out of sod, RotYr1, performed best overall, with the exception of surface hardness, where it was the lowest performing treatment. This makes sense to some extent as the soil has not been aerated in these plots compared to other treatments. It also indicates that perennial forage crops may benefit from soil aeration to help alleviate soil compaction and improve nutrient cycling, water infiltration, and yields. We would expect fields with tillage to have less compact surface layers.

There were some soil quality benefits observed from not tilling the soil. Of the corn cropping systems, the NT had the best soil structure as indicated by aggregate stability and would be less prone to erosion and runoff. The NT treatments were transitioned from perennial forage to corn six years ago and the lack of soil disturbance is reflected in many of the soil quality measurements. This treatment clearly reflects the potential for NT corn to maintain soil quality during the corn years of a rotation. However, we continue to observe suppressed yields in the NT corn treatment compared to other corn treatments with tillage. The NT treatment had consistently better soil health than the CC treatments. The CC system has the least potential to reduce erosion and nutrient runoff. There is a significant difference in the soil health scores of NT and CC, but there were no significant differences in soil health scores among RotYr6, WCCC, and CC.

Although the NT treatment had statistically significantly higher populations, there were no differences among corn systems for corn yield and total yield. This was a transition year of rotating long-term sod (12 years) into corn. Delaying planting to get a first cut from the perennial forage did not have a significant effect on corn yields in the RotYr1 system. This could be because the dry growing season stunted corn growth in all systems. In 2020, another transition took place where continuous corn (6 years) was rotated into perennial forage (RotYr6). The perennial harvest from this year was significantly lower than expected. An establishment year typically has lower yields than maintenance years and the dry growing conditions may have had a compounding effect. In 2021, we will be better able to capture the soil health and yield effects of rotations into and out of sod.

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