2015

Pasture Productivity Trial

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NORTHWEST CROPS & SOILS PROGRAM

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CULTIVATING HEALTHY COMMUNITIES

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INTRODUCTION

Pasture is an essential component of feed for dairy cattle on organic farms. Productivity of pastures is essential to ensure the cattle have a plentiful source of high quality feed during the entire grazing season. Optimal management of pastures should include animal, plant, and soil factors. This project aims to identify weak links in the pasture system and evaluate the impact of adopting new strategies to overcome barriers to productivity. In this case, soil fertility and species diversity were identified as the weak links to productivity.

The pasture where this research took place was seeded to grass about 30 years ago and prior to that had been used for corn silage. For the last 10 years, the pasture has been minimally fertilized with a spring or fall manure application at a rate of 3000-4000 gal ac^{-1}. Based on soil test information, the pasture was low in potassium (K). The pasture consisted primarily of grass with low diversity and a very low percentage of legumes. This species scenario substantially increases the pasture demand for nitrogen (N). The long-term strategy to improve yield and quality included over-seeding the pasture to improve species diversity and ultimately providing higher yields and quality. A goal was to increase legume percentage to minimize the need for N in the pasture system. Base fertility consisting of manure/compost was added in the fall. Low levels of supplemental fertility sources were also added throughout the season to try and boost production at a low cost. Data was collected throughout the growing season to determine the impact on pasture productivity and costs associated with implementation of practices.

MATERIALS AND METHODS

The trial was conducted at Holyoke Farm located in St. Albans, VT. The experimental area included 18 acres of pasture that were grazed by 60 cows using management intensive grazing techniques. General plot management is shared in Table 1. Cows were given approximately 1 acre of pasture, representing 1 paddock, for every 24 hours that they grazed. There were two treatments that included fertility/seeding and a control where no additional fertility or seed was applied. The fertility/seeding treatment was seeded with a grass/legume mix, fertilized with 52 lbs ac^{-1} of K and 6.6 lbs ac^{-1} N.

To boost species diversity, the following forage mix was overseeded into the established pasture: 5 lbs ac^{-1} each of HDR meadow fescue, Kentucky bluegrass, Preval meadow fescue, and Liherold meadow fescue, and 2 lbs ac^{-1} each of TFL chicory, Freedom red clover, Dynamite red clover, Kopu white clover, and Ladino white clover, totaling to 30 lbs ac^{-1}. We strived to apply the seed prior to back-grazing, so the cows would work the seed into the soil. Seed was broadcast using a nylon bag Earthway seed spreader. Seeding occurred during the first round of grazing from 7-Jul to 2-Aug.

Based on soil test information, the soil was deficient in K and 140 lbs ac^{-1} was recommended to meet the needs of the pasture. To begin to rectify nutrient deficiencies, 52 lbs ac^{-1} of K (100 lbs ac^{-1} of potassium sulfate product) was applied to the soil. The K was applied after the first grazing with a broadcast spreader. N fertilizer was applied to help meet fertility requirements of the pure grass stand. The paddocks were fertilized with N at 2.2 lbs ac^{-1} in the form of sodium nitrate (14 lbs ac^{-1} of 16-0-0), 1-3 days after each grazing. The N was applied after each of three grazing cycles, totaling to 6.6 lbs N ac^{-1} (42 lbs ac^{-1} of 16-0-0) over the course of the season. The sodium nitrate was dissolved in water, at a ratio of one-pound fertilizer to one gallon of water, using a paint stirrer to agitate and dissolve the fertilizer. A four wheeler with a spray tank trailer and 20 foot wide boom was used to apply the fertilizer. GPS tracking was used to record where fertilizer had already been sprayed and to maintain accuracy.

Table 1. General plot management, St. Albans, 2015.

Trial Information	Holyoke Farm St. Albans, VT
Soil type	Massena stony loam 0-3% slope
Previous crop	Permanent pasture
Grazing cycles	Jul, Aug, Sep
Fertilizer rate	6.6 lbs nitrogen ac^{-1}, applied as 42 lbs ac^{-1} sodium nitrate 16-0-0, split over the three grazing cycles 52 lbs potassium ac^{-1}, applied as 100 lbs ac^{-1} potassium sulfate 0-0-52, after the first grazing cycle
Seeding rate	30 lbs ac^{-1}
Application method	Four wheeler drawn spray tank with 20' boom

After fertilizing, pasture was allowed to regrow and paddocks were sampled just prior to the following grazing cycle to determine biomass and quality. Samples were dried until they reached a stable weight and then sent to Dairy One Forage Laboratory for wet chemistry analysis of crude protein (CP), net energy lactation (NE_L), relative feed value (RFV), and neutral detergent fiber (NDF). Yield was calculated from biomass samples.

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). This fraction includes cellulose, hemicellulose, and lignin. Because these components are associated with the bulkiness of feeds, NDF is closely related to feed intake and rumen fill in cows.

Net energy of lactation (NE_L) is calculated based on concentrations of NDF and acid detergent fiber. NE_L can be used as a tool to determine the quality of a ration. However, it 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.

Variations in yield and quality can occur because of variations in genetics, soil, weather and other growing conditions. Results were analyzed with an analysis of variance in SAS (Cary, NC). Statistical analysis makes it possible to determine whether a difference among varieties is real, or whether it might have occurred due to other variations in the field. At the bottom of each table, a p-value is presented for each variable (i.e. yield). The p-value represents the probability that there was an effect from the treatment. The lower the p-value, the greater the probability that the treatment had an effect on the variable (i.e. yield).

RESULTS AND DISCUSSION

Seasonal precipitation and temperature were recorded with a Davis Instrument Vantage Pro2 weather station, equipped with a WeatherLink data logger at Borderview Research Farm in Alburgh, VT. June was a wet month with 2.73 more inches of precipitation than normal (Table 2). The remainder of summer was relatively dry with 9.92 fewer inches of precipitation than normal over July, August, and September. Temperature varied with May and September being much warmer than the 30 year average. Overall, there were an accumulated 5693 Growing Degree Days (GDDs) this season, approximately 226 more than the historical average.

Table 2. Seasonal weather data[1] collected in Alburgh, VT, 2015.

Alburgh, VT	May	June	July	August	September	October
Average temperature (°F)	61.9	63.1	70.0	69.7	65.2	46.5
Departure from normal	5.5	-2.7	-0.6	0.9	4.6	-1.7
Precipitation (inches)	1.94	6.42	1.45	0.00	0.34	2.51
Departure from normal	-1.51	2.73	-2.70	-3.91	-3.30	-1.09
Growing Degree Days (base 32°F)	930	938	1188	1184	1010	443
Departure from normal	174	-76	-10	45	152	-59

[1]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.

The yield and quality of the pasture treatments are presented by grazing cycle and also averaged across grazing cycles (Tables 3 and 4). The CP concentration did not show significant difference between treatments when evaluating each grazing cycle and also when data was analyzed across the cycles. The NDF concentrations, NE_L, and RFV showed increasing significant difference as the season continued. Also, when comparing NDF, NE_L, and RFV across grazing cycles, the fertility/seeding treatment was significantly better than the control. This may imply that a couple of months are needed before the quality of pasture changes significantly, compared to not treating the pasture at all. Yield showed inconsistent results throughout the season and showed no significant difference when comparing treatments across all grazing cycles. It is important to note that the rate of N applied was extremely low, at 2.2 lbs ac^{-1}, which may not have been enough N to have impact on pasture productivity. The N requirements for the field were projected to be 150 lbs ac[1]. The 52 lbs ac^{-1} K applied may have had a greater impact on the pasture productivity.

Table 3. Pasture yield and quality of the fertilizer and control treatments, shown by each grazing cycle, 2015.

	CP	NDF	NE_L	RFV	Yield
	% of DM	% of DM	Mcal lb^{-1}		tons/acre
Cycle 1: 7-Jul – 2-Aug					
Control	13.7	54.5	0.59	109	3388
Fertilizer	16.8	52.1	0.60	122	2859
p-value	0.46	0.78	0.83	0.61	0.55
Cycle 2: 6-Aug – 3-Sep					
Control	18.3	47.3	0.65	132	3074
Fertilizer	17.2	47.6	0.64	130	2344
p-value	0.54	0.90	0.70	0.89	0.06
Cycle 3: 9-Sep – 2-Oct					
Control	19.8	52.0	0.59	115	1610
Fertilizer	20.9	43.3	0.67	152	1611
p-value	0.48	0.01	0.01	0.03	0.99

Table 4. Pasture yield and quality of the fertilizer and control treatments, shown across grazing cycles, 2015.

	CP	NDF	NE_L	RFV	Yield
	% of DM	% of DM	Mcal lb^{-1}		tons/acre
Control	18.4	50.9	0.61	119	2334
Fertilizer	18.7	46.2	0.65	138	2087
p-value	0.83	0.03	0.04	0.04	0.33

The total cost in time and materials to fertilize the pasture was \$118 ac^{-1} (Table 5). The total cost in time and materials to over-seed the pasture was \$174 ac^{-1} (Table 6). The total cost of seeding and fertilizing one acre was \$292. However, it is key to note that seeding would not happen regularly, certain equipment was a one-time purchase, and when activities are performed for more than one acre at a time, costs generally go down.

Table 5. Costs associated with fertilizing pasture.

Activity/Material needed per acre	Time required (minutes)	Cost ($)
Sodium nitrate fertilizer (14 lbs), $0.53/lb		7.42
*Preparing nitrogen fertilizer solution, $12/hr	20	4.00
Spraying nitrogen fertilizer, $12/hr	20	4.00
Potassium sulfate fertilizer (100 lbs),		55.00
Spreading potassium fertilizer	15	3.00
Electric drill		40.00
Paint stirrer drill bit		5.00
Total cost to fertilize 1 acre		118.42

*Note that this cost will decrease when solution is prepared for more than one acre at a time.

Table 6. Costs associated with seeding pasture.

Activity/Material needed per acre	Time required (minutes)	Cost ($)
Seeding, $12/hr	25	5.00
Grass/legume seed (30 lbs)		133.84
Earthway seed spreader		35.00
Total cost to seed 1 acre		173.84

The results here only represent one year of data at one location. The first year of the experiment was used to primarily solidify methodology including application and sampling techniques. The pasture was fertilized for remaining nutrient needs in the fall of 2015. Manure was applied at 4000 gal ac^{-1}, with nutrient analysis of 4.8% total N, 1.7% P_2O_5, and 5.3% K_2O on a dry weight basis. Lime was applied at 1200 lbs ac^{-1} to further improve pasture quality. The study will continue in 2016 to evaluate impact of over-seeding on the species diversity and improved fertility management on yield and quality over the entire grazing season. We will investigate how productivity will change with a higher rate of sodium nitrate application (20% of crop removal) applied as a granular fertilizer. A return on investment will be calculated to evaluate the strategies implemented as part of this project.

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