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Organic Lawn Clipping Silage as a Potential Livestock Feed

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Abstract

Lawns are recognized as being an amenity for quality of life, but they are generally viewed as having little agricultural value. The ability of ruminants to digest grass clippings harvested from lawns has the potential to convert these otherwise nonproductive landscapes into feed. This study of organic lawn care compared organic fertilizer-amended plots to unamended plots, to demonstrate the feasibility of fermenting fresh lawn clippings into a grass silage to be used as winter livestock feed, and to evaluate the silage palatability and quality. Silage fermentation was performed in plastic bags by air removal through a vacuum and analyzed 200 days after harvest. Except for increasing yield with fertilizer, there were no differences in silage quality between treatments. Silage average dry matter (DM) content was 41%, Protein Crude Soluble 19%, Acid Detergent Fiber 66%, Ash 9.6%, Total Volatile Fatty Acid 7.7%, Lactic Acid 7.8, Acetic Acid 1%, Propionic and Butyric Acids <1%, pH 4.2, and Net Energy Lactation 3152 calories lb-1. The fermented clipping pH was sufficiently acidic, and the other measured indicators were comparable to common types of silage. Because organic lawns often supply more phosphorous (P) than is needed for lawn maintenance, and many New Jersey turf soils already have soil test P levels above the optimum range, adding more P from organic fertilizers is not desirable. This study found that a single harvest of clippings for silage may remove about 10 kg ha-1 of P from the lawn soil.

Keywords: food, nutrient management, phosphorus, plant nutrition, soil fertility, turf management

1. Introduction

Grass lawns cover about 16 million hectares or 2% of the land area in the United States (Jenkins, 1994; Marshall, Orr. Bradley & Moorman, 2015; Milesi et al., 2005). Turfgrass is among the most intensively managed and irrigated crops in the country. Although valued for beauty, recreation, and protection against soil erosion, lawns are often vilified as mere “status symbols” with “no agricultural value” (Botti, 2019; Chatham 2020; Henderson, Perkins & Nelischer, 1998; Hardt, 2024). However, if lawns can contribute to the food system, they may be viewed more favorably.

Home lawns are often managed as high-input systems requiring fertilizer, chemical, water, petroleum, and labor inputs to maintain a high aesthetic property value (Cheng et al., 2008; Morris and Bagby, 2008; Robbins, 2007). Concerns over runoff, water pollution, and animal contact with chemical inputs on intensively managed lawns has spurred a trend toward adopting a more ecologically based organic land care system (Heckman, 2017; Marshall et al., 2015; Raver, 2009; Rowe & Bakacs, 2017).

Livestock serve a valuable ecological role in organic farming systems. Organic farming pioneer Albert Howard argued that natural farming systems must include livestock (Heckman, 2015). Harvesting feed from turfgrass may be one approach to taking organic land care a step further towards livestock inclusion and even food production.

The traditional home landscape originally had much in common with pasture grazing. The same plant species are often grown for both pasture and turf (D'Costa, 2017). Before mechanical lawnmowers were invented, grazing animals were employed to manicure grass-covered landscapes. Meat, milk, or fiber were byproducts of such pastoral food systems, that also created the managed landscape that evolved into the modern turf lawn. With the harvest of clippings as feed, lawns can once more contribute to the production of animal products.

With the advent of the lawnmower, grass clippings were no longer harvested by livestock. In modern lawn care, clippings are either removed or left shredded in place to recycle organic matter and mineral nutrients. In the case of grazing of pastures, a substantial amount of the minerals once consumed by animals are similarly recycled in place as manure. Although animals would not normally graze on modern lawns, animal manures and animal byproducts are commonly used fertilizers for organic lawn care.

Leaving clippings on a lawn reduces the need for N fertilization by about half or more (Heckman et al., 2000; Guillard, 2002). However, there are some disadvantages to this otherwise sustainable practice. Clipping residue, especially the larger amounts associated with the surge of spring growth, can distract from the attractiveness of a lawn. Also, walking over recently mowed turf can lead to tracking of clipping residue offsite. On the other hand, harvest of clippings withdraws essential nutrients from the soil, requiring extra time and labor, and creating a disposal problem. But harvested clippings may also find beneficial use as compost or garden mulch (Krogmann et al., 2001), or possibly as livestock feed.

In the case of organic lawn care, there may be some advantage to occasional clipping harvest and removal. Because organic lawns typically rely on natural organic fertilizer materials, such as compost or manure-based fertilizers, they often supply more phosphorous (P) than is needed for lawn maintenance. Many New Jersey soils, including those used for turf, already have soil test P levels above the optimum range (Heckman et al., 2006; Hamel & Heckman, 2006). Thus, adding more P from organic fertilizers is sometimes not desirable unless a nutrient management plan can be designed to balance P fertilizer inputs with P harvest by clipping removal.

The objectives of this case study in organic lawn care were to evaluate a proof of concept for spring harvest of an organically managed lawn, fermentation of the fresh clippings, their storage for winter livestock feed, the consumption by goats or cattle, and the theoretical potential to contribute to food production. An additional objective was to measure removal of mineral nutrients from the lawn soil system with the harvest of clippings within the context of sustainable nutrient management.

2. Method

At a farm in Ringoes, NJ a new lawn was established late summer 2014 and was managed using principles of organic land care (Heckman, 2017; Rowe and Bakacs, 2017). The silt loam soil was amended with compost and limestone based on Rutgers Cooperative Extension soil tests recommendations. The site was seeded with a 1:1 blend of the following species and cultivars: Midnight#1 Kentucky bluegrass (Poa pratensis), and Falcon#5 Tall Fescue (Lolium arundinaceum). Organic approved fertilizers were applied to all plots in spring 2015 as previously described (Heckman, 2016). In years 2016 to 2018 no fertilizers were applied to this organic lawn, but it was mowed weekly during the growing season and clippings were always left on the turf to allow nutrients to recycle.

In the spring 2019 the organic lawn was split into six plots with each square plot sized at 5.5m x 5.5m. The experimental treatments were replicated three times in a completely randomized design. Three of the plots were unfertilized controls and the other three plots were amended with an organic approved fertilizer. On 2 April 2019 organic nitrogen: phosphorous: potassium (N: P: K) fertilizer (4% N, 1.32% P, 1.66% K made from poultry litter Perdue Microstart) was applied at 7 kg ha-1 N, 2.3 kg ha-1 P, and 2.8 kg ha-1 K. On 15 Sept. 2020 organic fertilizer made from soybean meal, dried blood, and compost (8% N, 0.44% P, 0.83% K from McGearly Organics) was applied at 48 kg ha-1 N, 2.5 kg ha-1 P, 5 kg ha-1 K. Lastly on 7 April 2021 organic fertilizer (4% N, 1.32% P, 1.66% K, made from poultry litter Perdue Microstart) was applied at 30 kg ha-1 N, 7.5 kg ha-1 P, and 12.6 kg ha-1 K.

The turf plots were mowed regularly, once per week from April to November, to maintain and attractive organic lawn. Mowing height was 7.5 cm. Occasionally there were longer periods between mowing due to weather conditions or a desire to collect and harvest a larger quantity of clippings. Clippings were left on the mowed lawn except on 27 May 2020 and 21 June 2021 when they were harvested to make grass silage for livestock feed.

Visual color quality was evaluated just before mowing during the spring season of rapid growth. A 1 to 10 scale was used with 1 representing brown turf and 10 representing dark green. The lawn relied on natural rainfall and was never irrigated.

Clippings were harvested from each plot on 27 May 2020 and the clippings were collected by mowing at a 10 cm height when turf was about 20 cm tall. And on 21 June 2021 the clippings were collected by mowing at a 10 cm height when turf was about 20 cm tall and at the time when some grass seed heads were present. After clippings were discharged from the side of the mower deck, they were allowed to lay on the surface of the turf to partially dry in the afternoon sun for a period of about an hour before they were gathered in place by hand rake. This allowed some moisture reduction before the clippings were tightly packed into the plastic zip lock vacuum bags. Each bag was weighed fresh to determine the moisture content of the biomass from each plot (Fig. 1).

After clipping harvest, a vacuum cleaner was used to extract air from a one-way valve in each plastic zip lock bag. Following the initial seal of the bags, residual air was removed on day 2 and 3 to ensure a permanent vacuum seal.

The sealed bags of grass silage were stored during the summer and autumn in an outdoor shed. They were opened and sampled for forage nutritive value analysis and the bulk of the silage was fed to livestock in early winter. Three goats and eight cattle were offered the silage free choice and observed during feeding with regards to palatability and feed preference. The silage samples were packed in plastic bags and sent to Cumberland Valley Analytical Services, Waynesboro, PA for forage analysis and concentrations of minerals: P, K, sulfur (S), calcium (Ca), and magnesium (Mg).

At the conclusion of the study in 2021 a soil probe was used to collect eight cores per plot from the 0 to 6 in depth. The composite soil sample from each plot was sent to the Rutgers University Soil Test Laboratory for analysis for organic matter content, pH, and Mehlich-3 extractable P, K, Ca, and Mg (Mehlich, 1984). Organic matter content was measured by the Walkley-Black method (Walkley & Black, 1934). Soil pH was measured on a 1:1 ratio of soil volume to water.

Analysis of Variance (ANOVA) was performed using the SAS GLM procedure (SAS Institute Inc. Cary, NC). A least square means test ($P < 0.05$) was used for the comparison of treatment means.

3. Results

Turf color response to the applied organic fertilizer versus unamended plots during May tended to have better color (Table 1) but the difference was not significant ($P = 0.10$ in 2020 and $P = 0.29$ in 2021). Harvested clipping dry matter yield (Fig. 1) also tended to be greater with fertilizer compared to unamended plots but the yield increase was not significant (727 vs 581 lb acre-1 in year 2020 and 1590 vs 1342 lb acre-1 in year 2021 for fertilizer vs unamended treatment, respectively). The fertilizer application rates were relatively modest in comparison to typical lawn nutrient management practices which may explain the limited turf color and yield responses to fertilizer.

Table 1. Lawn turf average color index

sampling	May 27, 2020	May 26, 2021	June 21, 2021	July 9, 2021
Control	6.7	5.0	5.0	5.0
Fertilizer	7.7	6.0	7.0	6.3
p-value	0.1	0.29	0.07	0.13

tatreatment plots were observed for color indexed from 1-10, where 10 is most vibrant green.

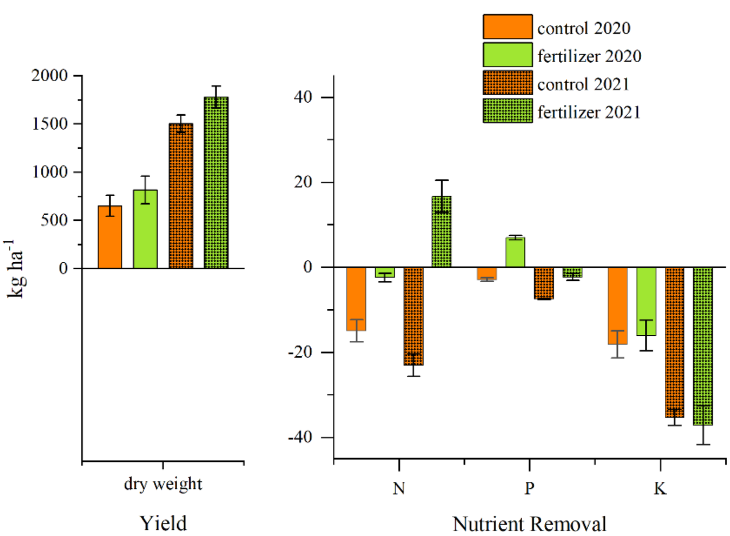

Figure 1. Dry matter yield and nutrient removal.

Dry matter and nutrient in kg ha-1 for control (tan) and fertilizer treatment, following first (1st, clear) and second (2nd shaded) clipping. Error bars represent standard errors.

Table 2. Analysis of lawn silage quality for 2020 and 2021 harvest dates

Results	**Harvest1: May 27, 2020**			**Harvest2: June 21, 2021**		
Treatment	control	Fertilizer	p-value	Control	fertilizer	p-value
Protein Crude SP %	19.7	19.4	0.46	17.7	18.4	0.36
Protein Soluble %CP	68.1	64.6	0.42	48.2	48.8	0.87
Protein Soluble %MD	13.4	12.5	0.37	8.5	9	0.58
Fiber ADF %NDF	65.9	66.3	0.64	66	67.1	0.66
Fiber ADF %DM	31.5	32.4	0.00	34.7	34.9	0.84
Ash (%DM)	9.6	8.9	0.53	9.8	10	0.73
Calcium (%DM)	0.5	0.5	0.28	0.6	0.6	0.78
Phosphorus (%DM)	0.4	0.4	0.50	0.5	0.5	0.57
Magnesium (%DM)	0.2	0.2	0.68	0.3	0.2	0.42
Potassium (%DM)	2.8	2.8	0.41	2.4	2.4	0.65
Sulfur (%DM)	0.3	0.3	1.00	0.3	0.3	0.14
Net Energy Lactation (Mcal/lb)	0.7	0.7	0.10	0.6	0.6	0.84
Net Energy Maintenance (Mcal/lb)	0.7	0.7	0.06	0.6	0.6	0.89
Net Energy Gain (Mcal/lb)	0.4	0.4	0.00	0.4	0.4	0.88
Non Fiber Carbohydrates (%DM)	18.7	18.7	1.00	NA	NA	NA
Moisture	69.2	69.6	0.76	48.2	57.8	0.27
Dry	30.8	30.4	0.76	51.8	42.2	0.27
Ammonia %DM	2.8	2.5	0.49	2.2	2.2	0.98
Total VFA %DM	9.6	10.2	0.55	6.5	6.8	0.85
LacticAcid %Total VFA	80.9	78.6	0.46	79.3	80.8	0.84
LacticAcid %DM	7.8	8	0.81	5.2	5.5	0.82
AceticAcid %DM	1.1	1.3	0.49	1	0.8	0.59
PropionicAcid %DM	0	0.1	0.20	NA	NA	NA
ButyricAcid %DM	0.7	0.8	0.81	0.4	0.4	0.82

Soil test results at the conclusion of the experiment found no significant differences between fertilizer application treatments. Across all plots soil organic carbon content averaged 3.0 % and soil pH 6.1. Mehlich-3 soil test P, K, Ca, and Mg were 259, 380, 385, and 3610 kg ha-1 repectively.

The ash content of the grass clipping silage averaged 9.5% on a dry matter basis (Table 2). Essential minerals Ca, Mg, P, K, and S contributed about 3.9% to the ash content. Additional minerals, not directly measured in the silage analysis, would include essential micronutrients and other elements such as Na, Si and Al commonly taken up by plants. Also, traces of soil may have been collected with the lawn clippings while raking.

The P content of lawn clipping silage, averaged 0.45% on a dry matter basis, is of special interest in terms of nutrient management because many soils have above optimum soil test P levels. At this study site the soil test level for P was over 259 kg ha-1 which is well above the optimum fertility level of 163 kg ha-1 for established turfgrass (Hamel and Heckman, 2006). On very high P testing soils it is desirable to draw down the nutrient level by plant uptake and removal. But this does not happen when lawn clippings are always recycled in place. The harvest of clippings for silage as found in this study removed an agronomically measurable amount of P (Fig. 1). These single harvests each year were calculated to remove from soil 29 to 36 kg ha-1 of P in 2020 and 68 to 80 kg ha-1 in 2021. The fact that significant amounts of P are being removed by clipping harvest may be taken into consideration with respect to sustainable nutrient management and future fertilizer or compost applications to organically managed lawns. This is of special concern with regards to P for its connection to eutrophication of water bodies and New Jersey fertilizer application regulations (NJ Fertilizer Law, 2013). On high P testing soils, it can take many years of crop harvest to draw down above optimum fertility levels into a responsive range to fertilizer addition (Kamparth, 1999). Similar nutrient management calculations may be performed based on clipping harvest for K and other essential element flows from the lawn ecosystem. Fertilizer amended plots produced on average 21% more silage dry matter but no significant yield increase. The silage quality analysis (Table 1) also exhibited no differences between feed made from clippings harvested from unamended or fertilizer treated plots. Silage moisture levels were 69% in 2020 and 53% in 2021. Lawn silage pH levels were in the range of pH 3.7 to 4.4.

For comparison, a pH range of 3.2 to 4.5 is generally regarded as acceptable and typical for a corn or sorghum silage (Ratnaningtyas, Abdullah & Kumalasari, 2023) or a range of 4.3 to 4.7 for a grass silage (Kung, Shaver, Grant, & Schmidt, 2017).

Lactic acid averaged 6.6% of dry matter over the two harvest years and is like values typical for corn silage (6.3%) or for sorghum (5.6%) and is in the normal range of 6 to 10% for a grass silage (Kung et al., 2017). Acetic acid and propionic acid levels in the silage made from lawn clippings averaged about 1% of dry matter which is in the normal range for a grass silage (Kung et al., 2017). Higher levels of lactic acid or acetic acid are regarded as good for silage quality since ruminates can derive nutrition from these molecules. Propionic and butyric acid levels were generally very low and sometimes below laboratory detection. The reported findings here are consistent with good quality silages. Quality silages are expected to have a low soil pH, low levels of butyric acid, and relatively high levels of lactic acid (Collins & Owens, 2003).

Ammonia content averaged 2.4% of dry matter for lawn clipping silage which is lower than values typical for corn or grass silages. Lower values for ammonia content are regarded as better for silage quality (Kung 2018).

Values for Fiber ADF% and NDF% (Table 2) are all lower than those found in the Dairy One (Dairy One, 2024) database for cool-season grass silage in both years. These values are also lower than in the most recent Dairy Cattle Nutrient Requirements Report (NAS, 2021). Non-fiber carbohydrates (NFC) were higher in Year 1, these values are not available for Year 2. Both NDF and Non-fiber Carbohydrate values are used in the calculations of NEL, NEM, and NEG. The values observed in this study indicate that the grass clipping silage had lower fiber levels and improved energy values compared to values for cool-season grass silages seen elsewhere in published literature. The more frequent clippings of lawns as compared to more mature grasses grown commercially for forage may account for this difference in fiber content. Based on these findings, lawn clipping silage should be acceptable livestock feed.

The urban agriculture and homesteading movements (Salatin, 2024) are starting to go beyond the organic gardening lifestyle to inclusion of livestock as part of a traditional food system. The popularity of small urban poultry flocks (Salatin, 2024) may create another demand for lawn silage. According to Feeds and Feeding (Morrison, 1956) small amounts of grass silage (3.0 kg per 100 hens) can be fed to chickens as a nutritional supplement.

This study found that when the lawn clipping silage was offered to goats and cattle, both species readily consumed all research produced feed. If greater amounts of lawn clipping silage were produced, presumably goats and cattle would likely consume more of this stored feed in winter months.

The global demand for food is projected to increase significantly by year 2050 (Godfray et al., 2010). Lawns harvested for silage production, as demonstrated in this study, have the potential to contribute to global food security. Lawns cover a large land mass. The feeding of lawn silage to livestock can be a previously untapped resource to produce food for people.

4. Discussion

In summary, this research project demonstrates proof of concept that it is possible to harvest and store lawn clippings as fermented feed for winter livestock. It also suggests that lawns, sometimes vilified as non-food crops, can in fact be of agricultural value when harvested for livestock feed. Furthermore, organic home lawn care can potentially contribute to feeding humanity with the help of livestock to transform lawn clippings into nutrient rich meat and milk. Also, from the organic lawn care perspective, the occasional clipping harvest from the spring growth flush, can serve to improve the nutrient management balance from organic fertilizer inputs which otherwise tend to oversupply P (Rosen and Allan, 2007). Nutrient management planning may use the analysis of clippings in ppt (N 30.0, P 4.5, K 26.0, S 3.0, Ca 5.5, and Mg 2.5 on a dry matter basis) to calculate mineral uptake and nutrient removal by harvested clippings.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of the Canadian Center of Science and Education.

The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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