

Status of organic dairy pasture forage composition, productivity, soil fertility and grazing management practices in Wisconsin

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Wisconsin has the largest number of organic dairies in the United States with over 450 dairy farms that represent more than 25% of the nation's certified organic dairy farms (USDA NASS, 2014). Despite the large amount of organic dairy operations in Wisconsin, interest in expansion of existing and new operations exists due to the high consumer demand for organic milk products (Greene and McBride 2015).

One of the major challenges for dairies is production and management of feed, as costs for these two factors can be 50% of total costs of milk production (Hardie et al. 2014). While feed can be obtained from several sources, at least 30% of animal feed must be from pastures during the growing season (at least 120 days) for certified organic dairies. As this can be challenging, producers typically utilize grazing management methods that involve moving animals on and off of pastures to maximize forage utilization and quality required for dairy cows using a practice called managed intensive rotational grazing (MIRG). While MIRG is an effective approach, a wide range of practices within this system can influence milk production, including forage composition (Brink et al. 2008; Sleugh et al. 2000), soil fertility (McCartney et al. 1998), and grazing management (e.g. rest period) (Dale et al. 2008). Given that limited land is available for expansion of existing operations (Jackson-Smith 2002), increases in on-farm efficiencies are needed, and pastures have been identified as a primary means of improving milk production.

While it is believed that improvements to pastures can result in significant increases in milk production, the current status of pastures on organic dairies and how they are managed are not known. Therefore, we undertook a two-year study to assess the status of organic dairy pastures. While many factors can influence milk production, we focused on forage composition, soil fertility, and grazing management. Our goal is to inform producers of the current status of pastures and suggest where to focus efforts to improve pasture performance that contributes to greater milk production.

Organic Dairy Farm Survey Methods

Eighteen farms were visited between 2013 and 2014 in two distinct regions in Wisconsin (Figure 1). At each farm, two pastures were surveyed, resulting in 36 pastures visited. Pastures were visited just prior to a grazing event in June to measure forage species present and forage available. As composition differed significantly from farm to farm, species were grouped into planted (improved) and unplanted (non-improved) grasses and legumes. Examples of common species observed are summarized in Table 1. Since pastures often have mixtures of many species in different parts of the canopy, cover measurements exceed 100% when summed. Available forage was determined using a pasture plate meter (Sanderson et al. 2001) and soil samples were taken from each pasture to a depth of six inches in October to assess soil fertility. Management practices were collected by asking producers about their average pasture management over the last five years. This allowed for integration of what had happened over time as past practices often impact current pasture composition and performance.



Figure 1. Map of the 18 farms studied in 2013-14.

Results

Results from the 36 pastures are presented in figures 2-5 for variables assessed. Histograms show the percentage of pastures that fall into one of 10 (forage and grazing management variables) or 20 (soil fertility variables) intervals. When available, the recommended range or recommended minimum level are shown by the red dotted lines. Optimal or recommended levels of soil nutrients are defined using economical and environmental considerations, where primary nutrient additions should match the amount harvested.^{1,2}

Table 1. The most common legume and grass species found in pastures in June.

Legumes	
Improved	Non-Improved
Alfalfa	‘Dutch’ white clover
<i>Medicago sativa</i> L.	<i>Trifolium repens</i> L.
Red clover	Sweet clover
<i>Trifolium pratensis</i> L.	<i>Melilotus officinalis</i> L.
Improved white clover	Black medic
<i>Trifolium repens</i> L.	<i>Medicago lupulina</i> L.
Grasses	
Improved	Non-Improved
Orchardgrass	Kentucky bluegrass
<i>Dactylis glomerata</i> L.	<i>Poa pratensis</i> L.
Smooth bromegrass	Quackgrass
<i>Bromus inermis</i> L.	<i>Elytrigia repens</i> L.
Tall fescue	
<i>Festuca arundinacea</i> L.	
Timothy	
<i>Phleum pratense</i> L.	



¹ UW-Extension soil fertility recommendations (A2809 and A4034) were used to determine optimum values and legume content. Recommendations for loamy soils were used, since all pastures were classified as loams in this study. Nutrients analyzed included, soil pH, Bray phosphorus, and exchangeable potassium, magnesium, calcium, sulfur, boron, manganese, zinc, iron, and copper.

² Recommended remaining forage height after a grazing event (residual sward height) was determined from the scientific literature including work by Brink et al. (2013).

Forage Status

of Organic Dairy Pastures

Available forage in June varied almost ten-fold among pastures. Pasture cover was also highly variable, with results for each category ranging from near 0-100% cover. In addition to yield, forage species can improve milk production due to increased palatability, intake, and forage quality. Improved grasses and legumes that are adapted to Wisconsin are recommended due to superior agronomic and animal-related traits compared to non-improved species. Although farms on average were within recommended ranges for improved legume cover, the range of values suggest many pastures are below optimum and could be enhanced through pasture renovation and management.

KEY FINDINGS

- **46% of pastures** had under 1,000 lbs/acre of available forage from one grazing event in June.
- **59% of pastures** had less than the recommended 30% improved legume cover in June. Additional nitrogen is suggested for pastures with less than 30% legume cover. Although high legume cover can impact animal health, if managed correctly, it improves milk production.
- While non-improved legumes were common in many pastures, their benefits are reduced compared to improved varieties and often are a symptom of overgrazing.
- **52% of pastures** had greater than 70% non-improved grass cover. Non-improved grasses can form a thick sod that inhibits renovation, and these species typically have reduced palatability and productivity.

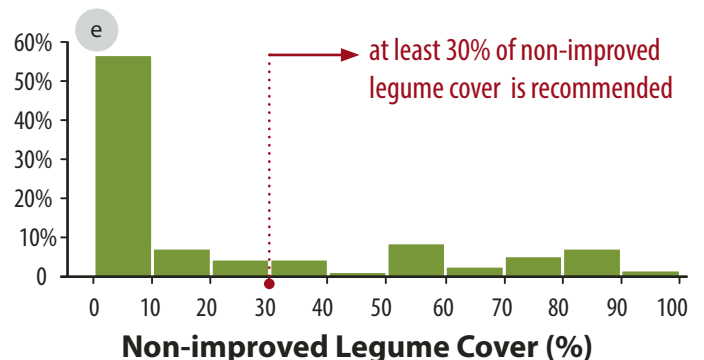
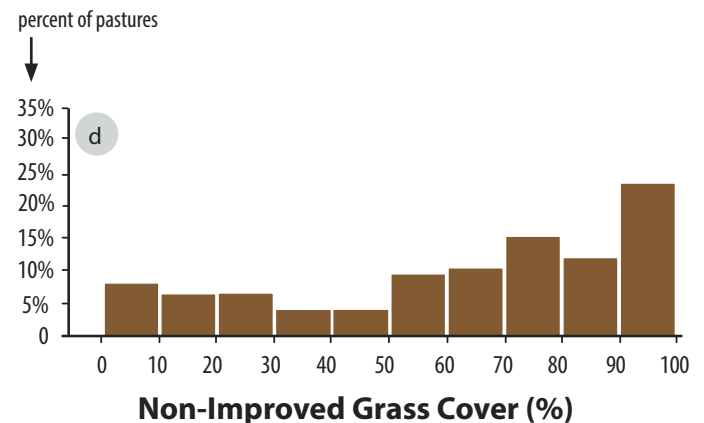
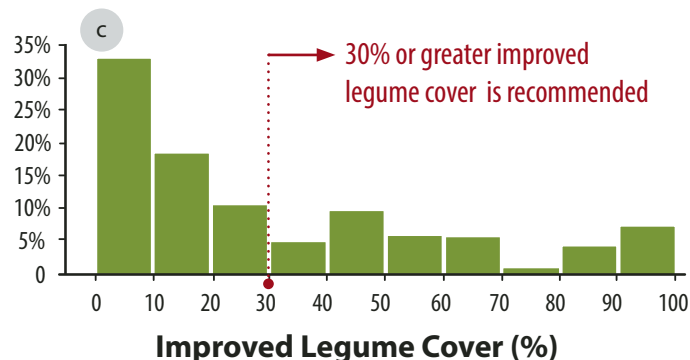
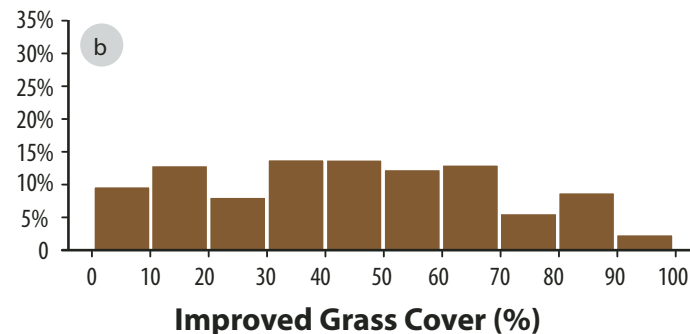
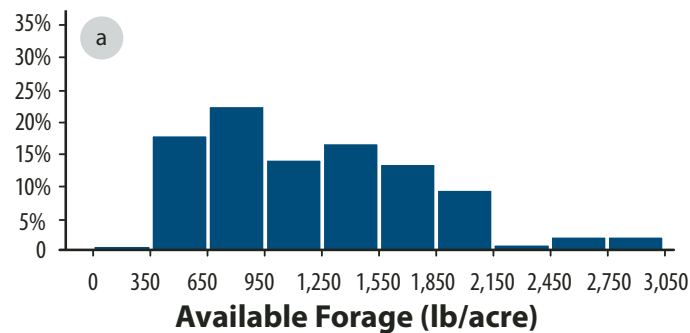


Figure 2. Histograms of pasture biomass(a), improved grass cover (b), improved legume cover (c), non-improved grass cover(d), and non-improved legume cover (e). Y-axis in all histograms is % of pastures.

Macronutrient and pH Status

in Soils of Organic Dairy Pastures

Macronutrients are required in greater amounts than micronutrients in plants and, therefore, are common factors that limit yield. Generally, 70-95% of nitrogen, phosphorus, and potassium consumed from pasture are deposited back by urine and manure in grazing systems (Wood et al. 2012). Organic pastures sampled were rarely low in macronutrients, but more frequently had high/excessive levels. This suggests that fertility practices are not causing a deficiency in macronutrients, and additional applications are not necessary for the majority of pastures. While the high or excessively high values for macronutrients rarely result in reduced productivity, they have environmental consequences for water quality.

KEY FINDINGS

- **60% of pasture soil tests** were high in phosphorus, only 20% were below the recommended range.
- **57% of pasture soil tests** were high in potassium, only 23% were below the recommended range.
- **No pastures** were low in calcium or magnesium.
- University of Wisconsin-Extension does not have a recommendation for soil sulfur levels. Sulfur is vital for nitrogen fixation in legumes, but deficiencies are uncommon in fields with manure applications. Plant tissue testing can verify sulfur deficiencies.
- **The majority of pastures (91%)** had a soil pH of 6.3 or greater. A soil pH of 6.3 or greater is needed to maintain red clover stands. Alfalfa is even more sensitive to soil pH and requires a value of 6.8 or greater.

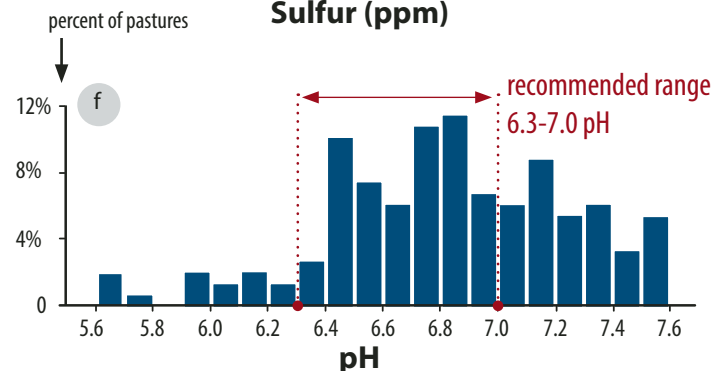
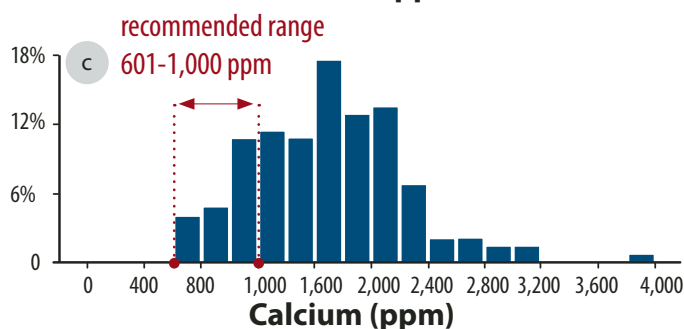
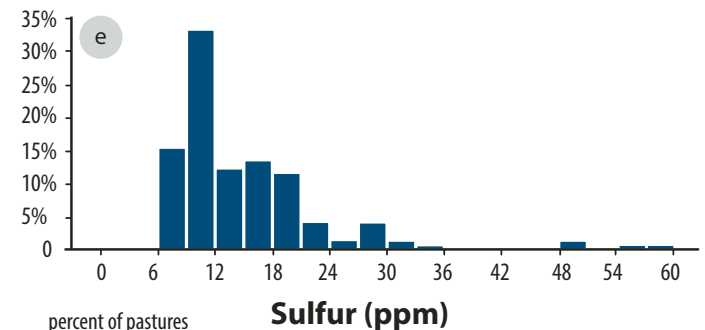
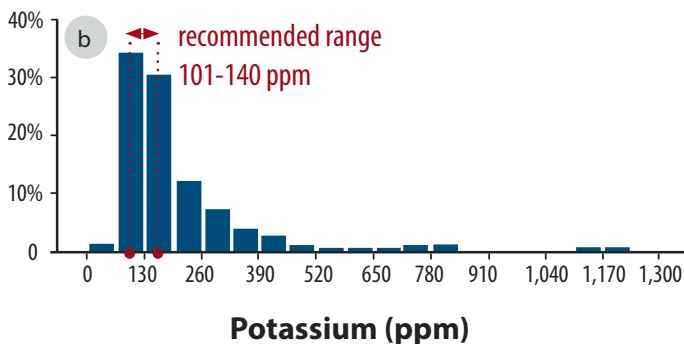
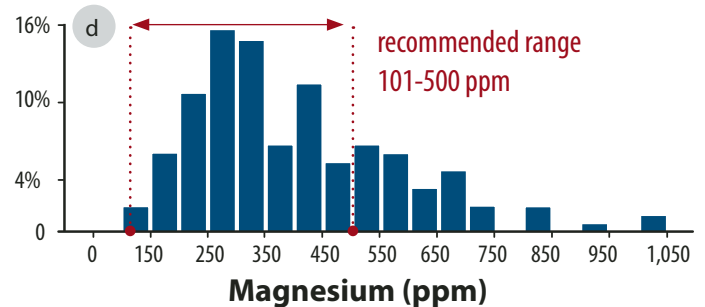
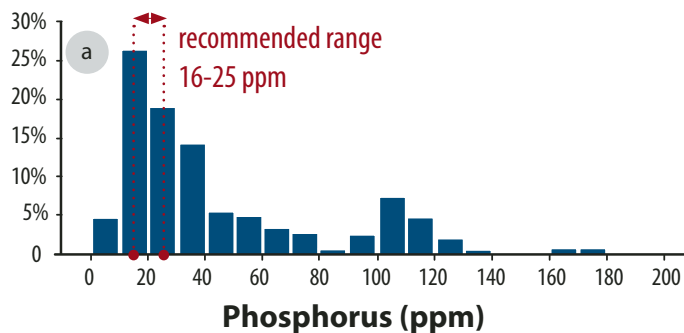


Figure 3. Histograms of pasture soil macronutrient levels, phosphorus (a), potassium(b), calcium(c), magnesium (d), sulfur (e), and pH (f). Y-axis in all figures is percent of pastures. Y-axis in all histograms is % of pastures.

Micronutrient Status

in Soils of Organic Dairy Pastures

Here we provide the distribution of soil test values for boron, manganese, zinc, copper, and iron. Unfortunately, there has been little research conducted on micronutrient needs in pastures. And while there are soil test interpretation categories for boron, manganese, and zinc, these are most likely developed for row crops and their application for pastures is dubious. In general it is not likely that an application of micronutrients will produce a response, as most pastures species have low demand for micronutrients. Of the micronutrients, boron may be of interest to producers who have paddocks with a high legume content, as boron is an important element for nitrogen fixation. If producers are struggling to maintain or establish a high legume content, boron application could be considered, especially if tests are low. While soil testing for these nutrients can be

valuable to know if they are increasing or decreasing in your field, the decision to apply micronutrients should also be based on tissue sampling and trends in soil test results.

KEY FINDINGS

- Limited research on pastures' response to micronutrients prevents interpretation and application of soil test categories to pastures.
- Boron is important for legumes as it is vital for nitrogen fixation. Pastures with over 30% cover of legumes may have a higher demand for boron than grass-only pastures. Boron levels should be weighed against other grazing management factors affecting legume performance in pastures.
- Grass and legume species have a low demand for both manganese and zinc. A yield or quality response to additional manganese and zinc is unlikely. Low levels indicate the need for continued monitoring of soil levels over time. Plant tissue testing can verify deficiencies.
- No recommendations currently exist for optimum soil levels for copper and iron in Wisconsin. Deficiencies are rare; if concerned, plant tissue testing is recommended.

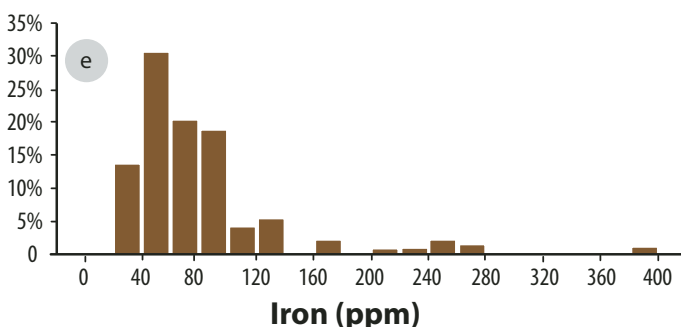
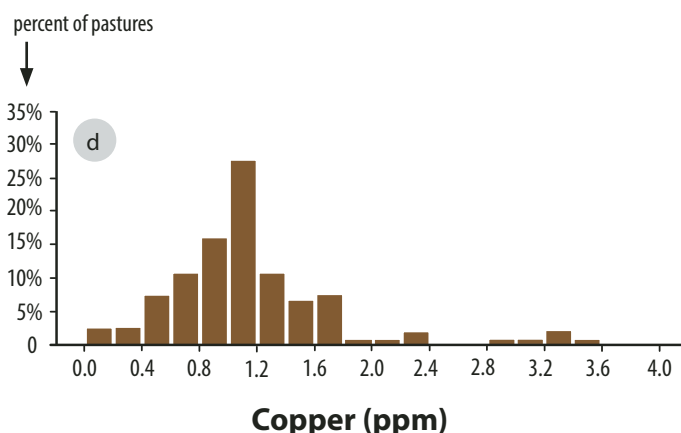
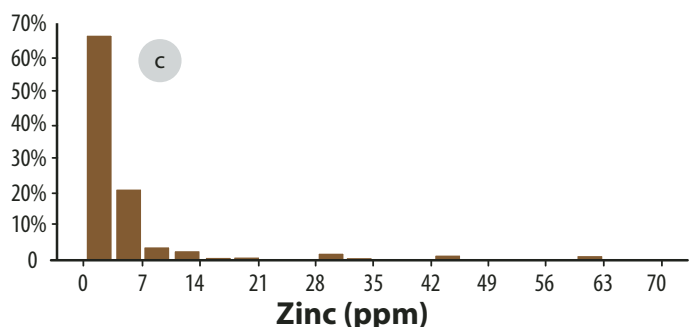
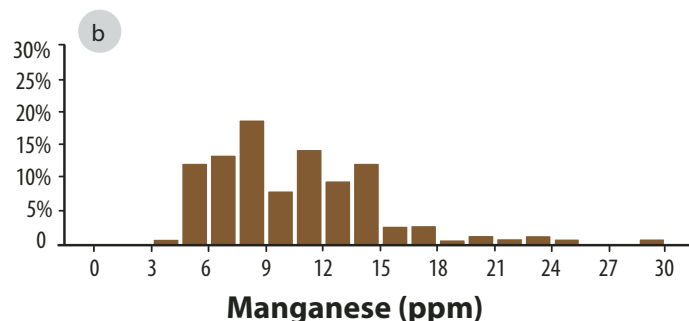
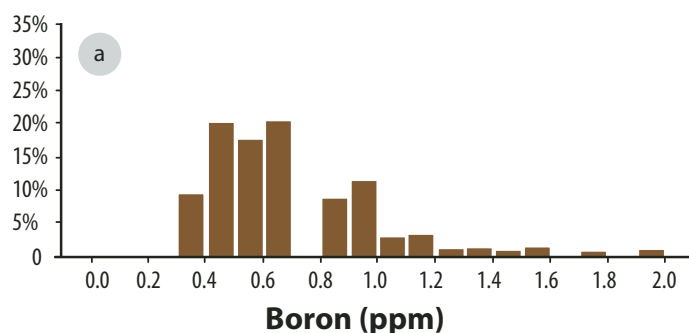


Figure 4. Histograms of pasture soils' micronutrient levels, boron (a), manganese (b), zinc (c), copper (d), and iron (e). Y-axis in all figures is percent of pastures. Y-axis in all histograms is % of pastures.

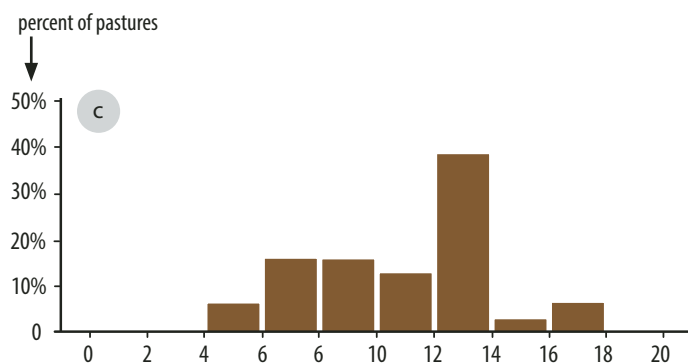
Grazing Management Practices Status

on Organic Dairy Pastures

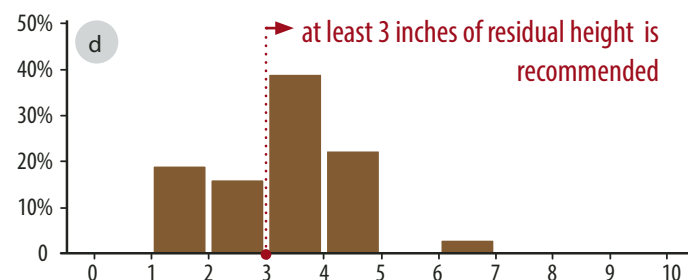
Management of pastures is complex, and often practices are applied differently depending on the specific factors of the pasture and weather during the growing season. We focused on key pasture management methods that have been shown to impact milk production from MIRC pastures. Differences in grazing strategies were observed. Many are likely due to different forage species and/or weather with no clear recommendation or range that is considered ideal. One clear exception was the height of forage remaining after a grazing event (residual sward height). Experts recommend at least 3 inches for not only maximum forage production, but also to ensure species survival. Despite this recommendation, nearly 25% of producers left less than 3 inches during the season and more than 50% at the end of the grazing year. While other factors likely play a role in producers not meeting this recommendation, residual height management is a key area in which pasture management can be improved.

KEY FINDINGS

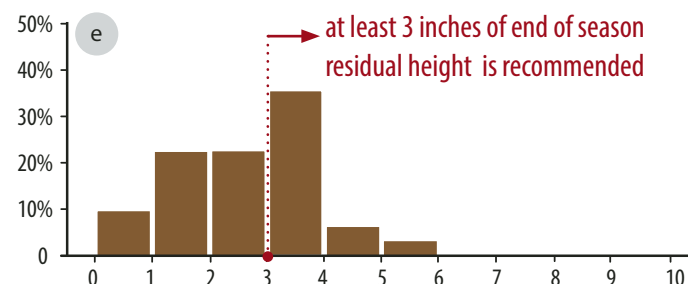
- **54% of producers** had between 5-7 grazing events in each pasture per year.
- **51% of pastures** had a rest period between 25 -30 days.
- **57% of producers** put animals into pastures with a forage sward height of 12 inches or more (turn in height).
- **22% of producers** graze below the 3 inch minimum recommended forage residual sward height. This not only reduces pasture regrowth but can also reduce survival of key forage species.
- **54% graze pastures** to less than 3 inches at the end of the grazing season. This practice is detrimental to pasture regrowth in spring.



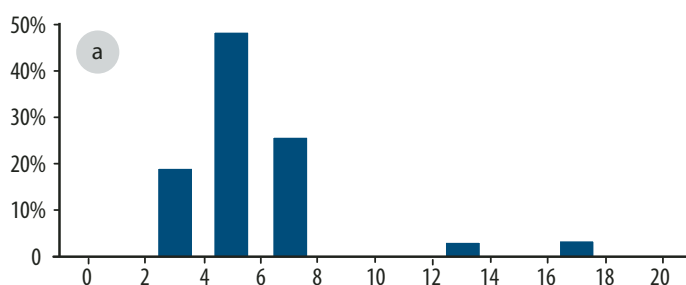
Turn in Height (inches)



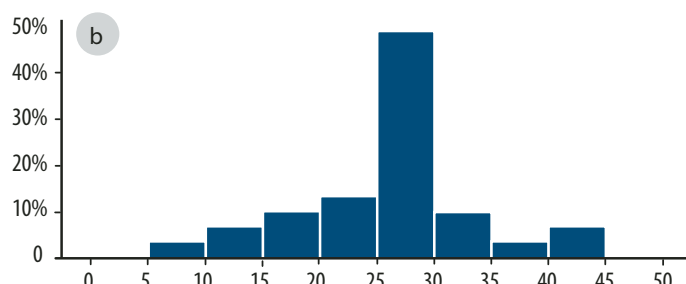
Residual Sward Height (inches)



End of Season Residual Height (inches)



Number of annual grazing events



Rest Period (days)

Figure 5. Histograms of pasture mgmt. variables, number of annual grazing events (a), rest period (b), turn in height (c), residual sward height (d), and end of the season residual height (e). Y-axis in all histograms is % of pastures.



Conclusion

Pasture forage composition, soil fertility, and management varied across organic dairy farms throughout Wisconsin. Low macronutrient levels were uncommon, but over 50% of pastures had high levels of phosphorus and potassium. Managed intensive grazing systems with good manure distribution often have adequate phosphorus and potassium levels.

More research needs to be done on the response of pasture yield and forage quality to micronutrient additions, as current recommendations are based on other row crops. Pasture grasses and legumes have a low requirement of most micronutrients and, therefore, in general an economical yield or forage quality response to additions is unlikely.

Improvements in pasture composition would benefit many producers, as over one half of producers had improved legume cover below recommended levels and non-improved grass cover above recommended levels. The residual sward height after each grazing event and at the end of the grazing season was also found to be below the minimum threshold in many of the pastures. While minimum grazing heights differ among species, it is recognized that repeated defoliations of forage to under three inches will reduce long-term productivity. Increasing this residual height can improve productivity and even survival of improved species.

The results demonstrate that while a variety of practices are employed throughout the state, improvements can be made on many farms that will lead to improved milk production from pastures. While some factors may prove difficult or cost prohibitive to improve, many are relatively inexpensive changes that could be implemented immediately.

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