RECYCLING AND MANAGEMENT OF MANURE IN FORAGE CROPS

[1]Eric Young and [2]Jessica Sherman

ABSTRACT

Modern dairy production relies on capturing nutrient and production efficiencies for the animal and cropping sides of the business to optimize profitability. Manure management is an increasingly important economic and environmental aspect of dairy production. While manure nutrient content/speciation and total solids content can vary widely among farms and over time for individual farms, manure is a critical source of crop nutrients and soil organic carbon (SOC), underpinning long-term soil quality/health. Managing a range of semi-solid and liquid manures is common on larger dairy farms. Technology for handling, transporting, and incorporating manure has quickly evolved and encompasses a large range of field application equipment and tillage combinations. While broadcast/surface application of manure is still common in hay crop and annual cropping systems, incorporating manure with some type of tillage captures more nitrogen and often reduces nutrient runoff risk. However, tillage itself can also be counterproductive in some situations, particularly in coarser-textured soils with low organic matter content, where greater water holding capacity and SOC are required for improved crop growth. Low disturbance manure application (LDMI) can incorporate manure (via injection or enhancing manure infiltration) while reducing soil disturbance compared to tillage incorporation (chisel, disk/harrow). Shallow disk injection and -banding are two LDMI methods that use liquid manure and can be used during both corn and hay crop production. Research at the USDA-ARS indicates that shallow disk injection conserved more N for fall-applied manure in a corn-silage winter rye cover crop system and maintained more surface residue compared to tillage. Additional experiments also indicated a relatively low risk of yield reduction for shallow disk injection and aeration-banding application methods in hay crop and corn silage fields. LDMI methods therefore show promise for improving nutrient use efficiency and utilizing more on-farm nutrients, however longer-term research at multiple locations is needed to better evaluate possible impacts of LDMI on forage yield and quality.

Key words: Dairy manure, soil fertility, nitrogen, phosphorus, tillage, soil health

INTRODUCTION

Manure management is an important aspect of modern dairy production, influencing agronomic, economic, and environmental facets of the business. Liquid manure (<15% solids content) storages are common on larger dairies, however proper handling of semi-solid manures (>15%

[1] Eric Young (eric.young@usda.gov). Research Soil Scientist, United States Department of Agriculture, Institute of Environmentally Integrated Dairy Management, 2615 East 29th St., Marshfield, WI 054449.
[2] Jessica Sherman (Jessica.sherman@usda.gov). Biological Science Technician, United States Department of Agriculture, Institute of Environmentally Integrated Dairy Management, 2615 East 29th St., Marshfield, WI 054449.
In: Proceedings, 2021 Western Alfalfa & Forage Symposium, Reno, NV 16-18 November 2021. (http://alfalfa.ucdavis.edu).

solids) from dry cows, heifers, and manure separation systems is also important. Several considerations should be evaluated in trying to optimize manure application benefits on forage crops including crop species, stage of development, nutrient content/forms in the manure, application rates, soil test nutrient levels, environmental risks, soil moisture status, weather conditions, and critically, the method and timing of applications.

Nutrient content of manures varies widely mainly due to variation in forages and feedstuffs used in dairy rations. Manure nutrient testing and spreader rate calibration are essential for determining accurate estimates of nutrient inputs from manure and determining field-by-field inorganic fertilizer needs, which has important farm economic impacts.

Broadcast/Surface Applied Manure

Broadcast application/surface application of manure in annual and perennial forage crop systems is commonly done on farms. While this is not ideal with respect to nutrient use efficiency and runoff potential, some farms may not have the necessary equipment to incorporate manure or have other reasons for not wanting to incorporate using primary or secondary tillage (no-till systems). Incorporating manure with tillage tools is an effective way to conserve nitrogen (N) and other nutrients while reducing loss potential associated with runoff and leaching, however tillage increases erosion potential and can increase nutrient and sediment loss in runoff.

Low Disturbance Manure Application

Low disturbance manure incorporation (LDMI) methods attempt to strike a balance between soil disturbance from tillage and increasing the extent of manure-soil interaction to reduce nutrient loss potential. Field research at the USDA-ARS indicates that both shallow disk injection and aeration-banding tools can substantially decrease ammonia-N loss, in addition to reducing dissolved and particulate phosphorus (P) and N loss in surface runoff compared to broadcast or banding alone (Sherman et al., 2020ab; Sherman et al., 2021ab).

LDMI can be used in both hay crop and corn production systems without necessarily compromising crop yield. A three-year ARS trial conducted in at the Marshfield Agricultural Research Station in central Wisconsin showed that shallow disk injection conserved more N when fall-applied in a corn silage system compared to other LDMI methods and spring applied fertilizer N. Moreover, there were few significant differences in soil N among manure application methods at the end of the season (Sherman et al., 2020b). Research conducted at other ARS laboratories and university trials also indicate greater overall soil N and P retention when manure is incorporated with tillage or LDMI methods.

In other LDMI experiments conducted in alfalfa-grass plots at the same location, results showed that shallow disk injection significantly reduced dissolved P losses in runoff (after simulated rainfall events). Compared to other treatments, LDMI plots also tended to maintain greater surface residue coverage, indicating lower overall soil disturbance and potential plant damage. While our results have indicated few differences in alfalfa dry matter yields among broadcast and LDMI methods, more research is needed to more accurately account for the cost-effectiveness of

LDMI in hay and annual cropping systems and their potential impacts on forage quality compared to more traditional approaches.

CONCLUSIONS

Manure management will continue to be a critically important aspect of sustainable dairy production in the US. Research conducted at multiple USDA-ARS locations and that done by other institutions indicate that LDMI can offer benefits of lower soil disturbance and decreased N and P loss potential, but in general requires more time and specialized equipment.

As with any new field practice, site-specific field limitations and environmental risk considerations in relation to manure application equipment availability and goals should be evaluated to help determine if LDMI is a fit for a given farm. In summary, LDMI methods show promise for conserving more nutrients in dairy systems, but more research is needed to better assess forage yield and quality effects compared to broadcast and more traditional tillage incorporation methods, in addition to drag hose and other viable techniques.

REFERENCES

Sherman, J.F., E.O. Young, W.E. Jokela, and J. Cavadini. 2020a. Influence of low-disturbance fall liquid dairy manure application on corn silage yield, soil nitrate, and rye cover crop growth. J. Environ. Qual. 49:1298–1309.

Sherman, J.F., E.O. Young, W.K. Coblentz, and J. Cavadini. 2020b. Runoff water quality after low-disturbance manure application in an alfalfa–grass hay crop forage system. J. Environ. Qual. 49:663–674.

Sherman J., Young E., Jokela W, Cavadini J. 2021a. Impacts of low disturbance liquid dairy manure incorporation on alfalfa yield and fluxes of ammonia, nitrous oxide, and methane. Agriculture. 2021; 11(8):750.

Sherman, J.F., E.O., Young, W.E. Jokela, and J. Cavadini. 2021b. Impacts of low-disturbance dairy manure incorporation on ammonia and greenhouse gas fluxes in a corn silage–winter rye cover crop system. J. Environ. Qual. 1–11.