Stabilizing Nutrient-Rich Farm Land with Slurry-Enriched Seeding of Cover Crops After Corn Silage

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Dairy and livestock farmers face considerable economic and environmental challenges as they prepare for the future. Over the last several years many farmers have adopted low-disturbance tillage and soil conservation practices that improve profitability and protect the environment. A modified no-till system with a rolling tine harrow suitable for use on dairy and livestock farms reduced machinery costs 25%; fuel costs, 45%; and labor costs, 50% compared to a conventional tillage and planting system (Harrigan et al., 1996). Cropping systems that reduce tillage intensity and increase the use of cover crops improve soil quality and protect the environment in many ways. Even small amounts of crop residue reduce soil erosion, and no-till systems are associated with the least runoff. However, manure use is a challenge in no-till cropping systems.

There is a need for cropping and manure management options that stabilize soil and prevent overland flow of sediment, nutrients and contaminants. Such options will retain manure in the root zone for nutrient use in the following crop and remediation of pathogens. Cover crops have not been used widely in livestock-based cropping systems because establishment costs, competition for labor and added management needs have discouraged their use. Because cover crops are an effective barrier to overland flow, sedimentation, and manure contamination of waterways, interest in the use of cover crops is increasing.

This article describes on-going work at Michigan State University in combining seeding, manure land application and aeration tillage in one sustainable, efficient, and environmentally sensitive operation (Fig. 1).

Figure 1. Excellent wheat and cereal rye cover crops were obtained by combining low-disturbance aeration tillage, seeding and slurry application in one efficient operation.

Increasing Awareness of Water Quality

Michigan has developed water quality standards (WQS) applicable to all waters of the state to serve the purposes of the federal *Clean Water Act* and the *Great Lakes Water Quality Agreement* between the United States and Canada. The Michigan Department of Environmental Quality (MDEQ) lists pollution from agricultural sources as the third most common cause (1,655 river-miles) of failure to attain water quality standards in Michigan (MDEQ, 2004). Pathogens and sedimentation are the third and fourth most frequent reasons, respectively, for the failure of rivers to support designated uses.

Michigan's water quality monitoring strategy seeks to maximize local community and volunteer involvement in the monitoring process. Several federal and state programs such as the *Clean Michigan Initiative, Conservation Reserve Enhancement Program,* and *Section 319* of the *Clean Water Act* (federal funds) have been enacted to increase public awareness of water quality issues and support education and demonstration projects. The MDEQ has trained more than 30 volunteer organizations to assess water quality in waters of the state (MDEQ, 2004). The information gathered from volunteer organizations is used as a screening tool to identify priority areas for more detailed assessments. The increased interest and awareness of water quality issues have led to an adversarial relationship among some dairy and livestock farmers and their neighbors. The causes of the conflicts are related to sedimentation and manure contamination of surface waters from runoff and tile drains.

Barriers to Water Contamination

Farm land is rich in nutrients. Runoff from farm fields can transport sediment, organic solids, nutrients and pathogens to surface waters. Long-term erosion control is achieved on many livestock farms by including hay crops in the rotation. In the short-term, little protective residue remains to stabilize soil, nutrients and contaminants after harvest of a low residue crop such as corn silage, even though manure is often applied to such fields. Low-disturbance tillage serves as a barrier because it improves infiltration, conserves crop residue and increases surface roughness (Fig. 2). Vegetative filters, buffer strips and grass waterways have long been used to separate cropped or manure-applied land from nearby waterways.

Figure2. Aeration tillage improved infiltration. Seed-laden slurry filled the cracks and fissures created by the aeration tines.

Cover crops are grown specifically to protect the soil from wind and water erosion, recycle nutrients, and improve soil structure and fertility. When manure is applied to a bare soil surface, near-surface filtration and accumulation increase the chance of nutrient and bacterial transport in runoff water. When manure is applied to a vegetative surface, the near-surface zone of high biomass and organic matter enhance adsorption, straining and filtering of bacteria and nutrients. Most nitrate-nitrogen (NO_3-N) leaching occurs during the fall and early spring months when the soil is fallow (Owens et al, 1995). Winter cover crops can temporarily immobilize nutrients, prevent NO_3-N leaching losses and reduce winter soil erosion (Power and Doran, 1988). Lim et al. (1998) showed complete coliform removal of up to $2x10^7$ colony forming units (cfu) 100 ml^{-1} in passing a 6.1 m wide fescue filter strip.

Manure Slurry-Enriched Seeding

Recent work at Michigan State University showed excellent stands of wheat and cereal rye can be achieved in untilled corn silage ground with a new process that combines seeding, manure application and aeration tillage in one sustainable and efficient operation. Goals of this project are to prevent sediment, nutrients, and bacterial contaminants from entering surface waters. The project is funded by a grant from the *Great Lakes Basin Program for Soil Erosion and Sediment Control*. The *Basin Program* is coordinated by the *Great Lakes Commission* in partnership with the *USDA-NRCS*, *US-EPA*, and the *Army Corps of Engineers*. A specific objective is to evaluate a process that combines low-disturbance aeration tillage, seeding, and slurry application in an efficient and cost effective manner with little soil disturbance or loss of protective crop residues.

Replicated plots (12 ft x 100 ft) were established in a Capac fine sandy loam at the University Farms at Michigan State University in East Lansing. A commercial variety of winter wheat (Vinson) and a common variety of cereal rye were established in late September 2004 in corn silage stubble. Specific treatments were:

1) surface manure, no tillage, no seed
2) wheat, 2 bu/ac, no-till drill, 50 lb/ac N
3) wheat, 2 bu/ac, slurry seed, 5° gang angle
4) wheat, 2 bu/ac, slurry seed, 10° gang angle
5) wheat, 4 bu/ac, slurry seed, 5° gang angle
6) wheat, 4 bu/ac, slurry seed, 10° gang angle
7) cereal rye, 2 bu/ac, 5° gang angle
8) cereal rye, 2 bu/ac, 10° gang angle

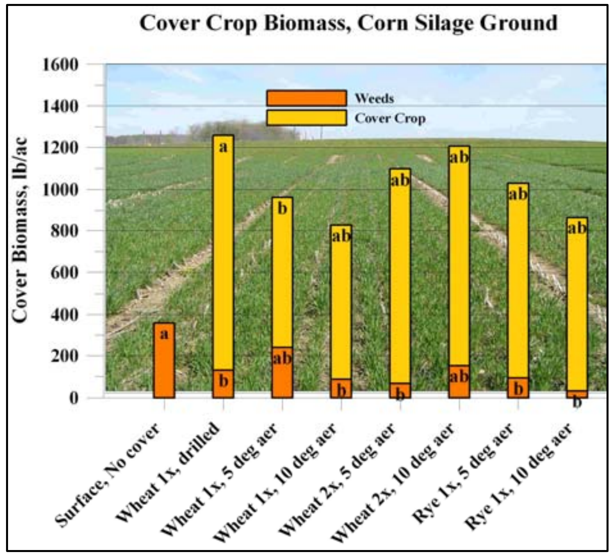

Figure 3. Wheat and cereal rye cover crop biomass measured on April 29, 2005. Slurry-seeded wheat is shown in the background.

The wheat was sown with a Great Plains no-till drill (September 24) and both wheat and cereal rye were sown with a new manure slurry-enriched seeding process (September 29). The slurry seeding was done with a slurry tanker (3000 gal) equipped with a rear-mounted rolling-tine aerator (12 ft; Aer-Way)[1] and SSD (sub-surface deposition) slurry distribution system. The seed was placed in the spreader tank where bypass flow provided tank agitation and seed mixing. The seed-laden dairy slurry was applied at 5000 gal/ac. The slurry (9.5% solids, sawdust bedding) provided 125 lb/ac total N (65 lb/ac as NH_4-N; 60 lb/ac as organic N), 43 lb/ac P as P_2O_5, and 140 lb/ac K as K_2O. Drop tubes placed the seed-laden slurry in the fractured and loosened soil behind each set of rolling tines. No additional tillage or soil firming was used.

Biomass Yield

Above-ground plant mass for the eight treatments are shown in figure 3. Each of the slurry-seeded treatments provided a uniform cover that suppressed weed growth. Although our primary interest was in cover crop establishment, we will maintain the plots and measure grain yield in July. Additional work is in progress with MSU researchers Dale Mutch and Sieglinde Snapp to evaluate nutrient uptake and release, impacts on soil quality and crop protection, and the environmental benefits of slurry seeding in diverse cropping systems.

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[1] Mention of trade names, proprietary products, or specific equipment is intended for reader information only and constitutes neither a guarantee nor warranty by Michigan State University, nor does it imply approval of the product named to the exclusion of other products.

Seed Placement and Emergence

A favorable seeding site must provide a suitable environment for seed germination (temperature, water, light exposure), leaf expansion (temperature, light exposure), and root penetration (soil particle size, pore size distribution, aeration, pH, and nutrient and moisture availability (Pearson and Ison, 1997)). Surface placement is generally less reliable than a tilled seed bed because soil temperature and moisture fluctuations are more extreme at the surface. In this project the aeration tillage tines created cracks and fissures in the soil that were filled with seed-laden slurry. Seed germination and emergence occurred at variable depths ranging from near the surface to 2 to 3 inches below the surface. Seed placement was influenced largely by the soil response to the tillage tines--consolidated, blocky soil encouraged deeper placement in cracks and fissures; loose and flowable soil that backfilled the tillage tine opening encouraged near-surface seed placement.

Seed Contact with Manure

Manure can cause problems in the following crop if excessive application rates and poor distribution create anaerobic soil conditions, but manure does not generally create a harmful environment for the seed. A common method of seed dispersal in the natural environment is through ingestion and deposition of the seed in feces of grazing animals. In New York, Mt. Pleasant and Schlather (1994) recovered viable seeds from 13 grasses and 35 broadleaf plants in dairy manure samples collected from 20 farms. Cudney et al. (1992) recovered more than 21,000 viable weed seeds per ton of sediment from dairy manure handling facilities and reported that anaerobic storage did not have a significant impact on seed viability. In our slurry-seeding work, shallow placement of the seed-laden slurry did not appear to create an anaerobic environment for the germinating seed or emerging plant.

Conclusions

The integration of soil conservation, nutrient cycling, soil quality improvement and manure use provided by the manure slurry-enriched seeding process will provide important operational efficiencies that will encourage environmentally sensitive manure use. This process will expand the land base and windows of opportunity for manure spreading, reduce cover crop establishment costs and protect water quality. Based on our recent work:

- Manure slurry-enriched seeding of wheat and cereal rye cover crops in untilled corn silage stubble was an efficient and effective establishment method.
- The cereal grain cover crops suppressed weed growth, and manure application did not increase weed competition in the subsequent cover crop.

Find Out More at the Ag Expo Farm Show

Visitors to the Ag Expo farm show (July 19-21) at Michigan State University can see the wheat and rye crops established with the slurry seeding process and learn about the equipment that was used. There will be information and demonstrations on the practical use of barriers to prevent overland flow and capture manure nutrients in the root zone, the use of global positioning systems (GPS) for mapping manure rate and timing verification, and other topics in environmentally sensitive manure management.

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