Manure Application Guided by Grid Soil Sampling: Minnesota Case Studies

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Introduction

Livestock operations that have been in place for several decades often have a history of **non-uniform manure applications**, with more frequent applications closer to the manure source (barn or feedlot). This can lead to excessive build-up of **Soil Test Phosphorus (STP)** in those areas. The risk of soluble and particulate P loss to surface waters in runoff is directly related to STP.

Case studies evaluating the economic and environmental effects of using grid soil sampling compared to field-average sampling to guide manure application were prepared for eight farms in southern Minnesota.

Methods

Case Farm Selection: Soil test maps (including GIS shapefiles when available) , crop rotations, and livestock information were provided by crop consultants, primarily Progressive Ag Center, from new client farms in southeast Minnesota. Eight farms , including dairy, swine, beef, and poultry operations were selected, based primarily on STP maps. Alternative manure application strategies were compared as described in the following sections.

Outreach: The case studies were presented in 12 workshops for livestock producers and agricultural consultants. Videos presenting highlights of the case studies were produced and posted with the case studies on-line. (See "Resources " at center below.)

Environmental Analysis

Combinations of crop rotations, manure application strategies, and tillage type were compared for risk of loss of P and soil erosion as measured by the Minnesota Phosphorus Index and its embedded RUSLE2 calculator. The MN P Index is available at **http://www.mnpi.umn.edu**

On-line maps of soil types (Web Soil Survey), topography (LiDAR), hydrography (USGS Topo maps), and air photos (FSA-NAIP), also assisted in analysis.

The case studies are from southeast Minnesota, most on fields with significant slopes and nearby streams. The dominant risk for P loss on these soils is from eroded sediment-bound P, so the emphasis is on crop rotations and tillage types that minimize soil disturbance and leave protective crop residue when possible.

The exception is when manure is applied and not incorporated, leading to a P-Index risk rating that is high due to losses of soluble P in runoff. Manure injection or incorporation is recommended for all of these case studies.

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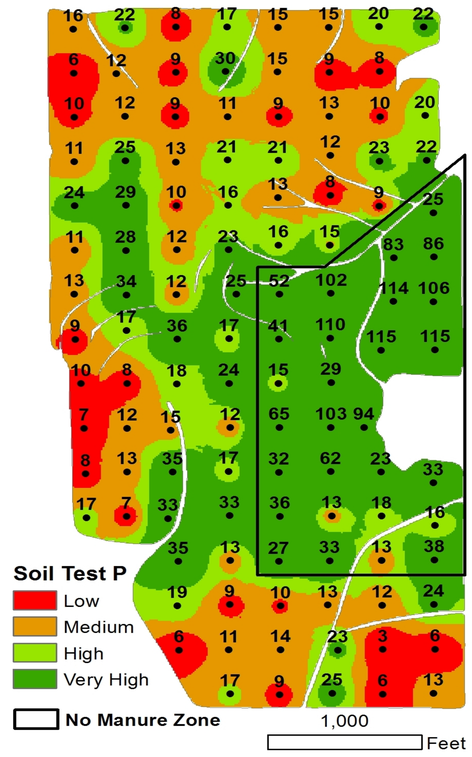
Funding was provided by a grant from the McKnight Foundation



2' Contour Lines and Aerial Image

Resources

UM Extension Manure Management and Air Quality Web Page
http://manure.umn.edu

- Grid soil sampling case studies with background and introduction
- Videos presenting highlights of the grid soil sampling case studies
- Additional links and resources

Economic Analysis (Case Study 3)

Manure Application Strategy	N-Based, Whole-Field	N-Based, Zonal	P-Based, Zonal
Manure Application (Acres)	276	209	209
Crop Nutrient Need N - P_2O_5 - K_2O (lbs/acre)	120-0-0	120-45-0	120-45-0
Manure Application Required/Acre (gal/acre)	2700	2700	1600
Manure to be Applied (gal/acre)	3000	3000	2000
Manure-Available Nutrients Applied (lbs/acre)	137-84-84	137-84-84	91-56-56
Net Value of Manure ($/acre)	72	108	82
Net Value of Manure ($/1000 gal)	24	36	41
Manure Remaining After Spreading (gal)	172,000	373,000	582,000

The STP map (Bray-1), aerial image, and table are from Case Study 3, a farm with liquid swine manure. Note the high STP values near the farmstead.

The three **manure application strategies** compared above are:

1. Apply to the whole field based on nitrogen (N) requirements of the crop.
2. Apply only to the zone where P is needed, but at a rate based on N requirements of the crop. Apply N fertilizer in the no-manure zone.
3. Apply only to the zone where P is needed, and at a rate based on the average STP for that zone, and supplement with N fertilizer as needed.

Economic comparisons were made using the spreadsheet "What's Manure Worth?" MANURWKST.XLS, available at **http://z.umn.edu/manureworth/**. Data on the farm's manure type, amount, analysis, spreading method and spreading costs, application rates, and nutrient availability, as well as fertilizer costs, crop nutrient needs, acres for spreading, expected yield boost from use of manure instead of fertilizer, and second year nutrient credits are entered to determine the value of manure (total, per acre, and per gallon) under the a specific application rate and method.

Conclusions

- Grid soil sampling allows the livestock producer to identify and treat zones of excess and deficiencies for P, which may have developed with a history of non-uniform manure applications.
- Targeting manure applications to low STP areas of the field, if present, will likely result in higher average yields compared to uniform rate applications based on the average soil test value for the field. Variable rate applicators are not required if contiguous zones of low STP are available.
- Excluding zones of excess STP from manure application will allow more efficient use of the conserved manure on other fields and field areas, increasing the total value of the manure supply as a fertilizer substitute. These savings far exceeded the cost of grid soil sampling.
- Excluding zones of excess STP from manure application will reduce P pollution in runoff, since P in runoff is proportional to soil test P.
- The choice of crop rotation, manure application method, and tillage practices have a strong influence on loss of P to water.