Cost-Effective, Performance-Based Environmental Management

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Cost-effective, performance-based environmental management

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Introduction

Iowa has over 19,000 miles of interior rivers and streams, numerous lakes and other natural resources and considerable agricultural production capacity. With such an extensive network of water bodies running through the state it is no surprise that experts have estimated that 90% of Iowa water quality issues are attributed to agricultural land and related activities. This nonpoint source contamination often results from long term actions and will take a long time for measurable outcomes.

Nonpoint source water quality improvements and solutions on the broad landscape need new approaches that lead to a majority of producers in a watershed community working to manage nonpoint source contaminants and jointly developing locally acceptable environmental stewardship goals. Partnerships rich with cooperation and innovation are needed to bring these assets together to enhance Iowa's economic and environmental performance.

In recent years water quality assessments and the science of water quality management have progressed much more rapidly than delivery of this information and implementation of strategies for performance-based water quality improvement. With enhanced monitoring and assessments plus science-based analyses and considerable water quality research findings, Iowa is equipped to implement modern water quality improvement processes. We can no longer rely solely on conservation structures and practices to address non-point, TMDL, and especially nutrient management issues that require a critical mass of conservation (>50% of watershed involvement). Awareness, education, information and involvement of those who will make the needed management alterations are keys to the process of sustainable change.

In agricultural watersheds cost-share for engineered soil conservation structures is an important but costly use of public funds that does not address landscape-based issues which require day-to-day, site specific management such as nonpoint source nutrients from fertilizer and manure. There are usually restrictions and limits to public resources for improving water quality. This watershed implementation model allows watershed leaders to sharpen targeting and implementation of publicly-funded programs to secure the most environmental benefit from limited program resources through innovative ideas and management flexibility.

Watershed residents will change water quality given science-based information. They will work with watershed neighbors, reflecting community pride and the desire to keep the finger of regulators from pointing at their farm or pointed at their neighbors, Wright Morton et al (2006). A performance-based management program can reward improving environmental performance on whole farms, determined by science-based computer modeling with proven links to improving farm income. Environmental indexes like the Iowa Phosphorus Index (P-index), Soil Conditioning Index (SCI), and Cornstalk Nitrate-Nitrogen test are indexes that can be measured.
at the field, farm, and watershed levels. The indexes offer an on-going measurement of progress toward environmental solutions and outcomes at each level.

**Implementation**

Three northeast Iowa watersheds are experimenting with bringing science-based indexes and flexible adaptive management alternatives together through a locally-managed incentive program that rewards cooperators for improved environmental performance. The incentive model goes beyond BMP practice recommendations to locally-managed rewards for improved environmental performance. The focus on performance is crucial as measured outcomes will provide an objective measure of improved environmental management that can be shared and supported by the watershed community.

The Hewitt Creek sub-watershed of the North Fork Maquoketa and the Coldwater-Palmer and Lime Creek sub-watersheds of the Cedar River are the locations of on-going performance-based incentive projects. Within each watershed farmers are cooperating with each other through their own watershed councils to develop incentive programs to reward cooperators based on the results of three environmental indexes. Each watershed has developed slightly different programs based entirely on the results of these indexes in their individual watersheds.

**Performance Index Summaries**

The Phosphorus (P) Index is a computer model used to assess the potential risk of P movement from fields into nearby water bodies. Increasing P concentrations in surface water results in increasing algae growth. The primary components of the P-index are soil loss (erosion), soil test P, rate and method of P application, field distance to water, and tile drainage. Regulations for new confinement feeding operations require (after 8/25/04) manure applications to be planned based on P-index. A one page questionnaire of field-by-field management practices will provide P-index computer modeling input.

The Soil Conditioning Index (SCI) is a computer model to predict the effect of cropping systems and tillage practices on Organic Matter (OM) reported on a scale from -1 to +1. The three main components are organic matter returned or removed from the soil, the effect of tillage and field operations on OM decomposition, and effect of predicted soil erosion associated with soil conservation and other field management. Major contributing practices to increase index scores include: Forage or small grains in rotation, reduced tillage and especially no-till planting, and fall cover crop planting following corn silage or soybean harvest. Also Soil Conservation practices and structures including: waterways, contouring, contour buffers, terraces, headland planting, sediment control structures, etc. A negative SCI value predicts declining OM, while a positive value predicts increasing OM. NRCS requires a SCI value of 0 or above to be eligible for the Conservation Security Program.

The Cornstalk Nitrate-Nitrogen Test is a direct performance evaluation of nitrogen and/or manure N management measured by the Nitrate-N concentration in the lower cornstalk. The sample consisting of 15 random 8” cornstalk sections will indicate nitrogen available during grain filling. Inadequate nitrogen is associated with reduced yields. More nitrogen than needed for maximum yields is indicated by nitrate accumulation in the lower cornstalks at the end of the season. Multiple year testing to account for seasonal variability will increase confidence in
refining nitrogen management. Figure 1 shows how to collect samples for analysis.

Figure 1. Cornstalk Nitrate-Nitrogen Test sampling.

**Change**

A significant component to performance-based management is effecting change based on the results of the indexes. To see how change in practices will impact the index values several performance scenarios are developed for each watershed. The following baseline and seven scenarios demonstrate the potential impact of connecting agricultural production and environmental performance using modeling and performance rewards for improving performance.

Scenario 1 is the baseline of current practices the first year of working with a producer or the first year of a multi-farm or watershed project. The continuous corn is grown using relatively aggressive tillage and manure application practices. The weighted average P-Index used for performance of the farm is attained by the P Index for each field being multiplied by the acres in the respective fields divided by the total acreage. The P Index of 3.62 is within the medium (2 to 5) range for Iowa P Index but above the 3.0 required for a performance reward payment established by the producer-led watershed councils.

The Soil Conditioning Index (SCI) is 0.43, well above the 0.00 required by the Conservation Security Program. The range of SCI is -1.0 to 1.0 and is an indication of trend; loss or gain in organic matter, related to productivity and sustainability, due to production practices including rotations, tillage practices, crop residue management or removal and conservation practices in the field. The performance reward (lower right corner) is earned for annual review of data from all fields on the farm. This scenario may apply to a swine operation that needs corn and uses the land for manure application or increased corn production for ethanol production.
Scenario 2 is a typical corn/soybean rotation with typical tillage practices using the identical fields in scenario 1. The soybean in rotation versus continuous corn is reducing the crop residue and organic matter trend versus scenario 1 thus the less favorable P Index at 4.03 and a lower SCI at 0.20. In the lower right box, the producer is rewarded for providing a performance update, however, due to lower performance there is a reduced payment compared to scenario 1 with a decline in environmental performance.

Scenario 3 is a rotation that is receiving increasing attention for several agronomic and economic reasons, a blend of scenarios 1 and 2. The P Index and SCI modeling results, as expected, are near the mid-point between scenarios 1 and 2 and the performance reward likewise is between 1 and 2.

Scenario 4 is somewhat extreme for Iowa as oat and alfalfa production is declining, however, this scenario demonstrates the impact of forages and small grains in rotation on the environmental performance measured by the P Index and SCI. The reward for improved performance, at the lower right, is significant compared to the continuous corn baseline with the same fields (scenario 1).

Scenario 5 is an alternative to scenarios 1 and 4 that includes a small percentage of the land in forage or small grains. The environmental performance measured by the modeling indexes is also rewarded as shown to the lower right.

Scenario 6 increases the number and length of waterways on scenario 1 to 75% of the waterways needed on each of the five fields. Waterways function as a buffer in critical locations and significantly reduce erosion, soil and nutrient loss from the field. The SCI value at 0.43 remains the same as the tillage practices remain the same as scenario 1. The improved P Index results in more than triple the reward payment for lowering the risk of P loss to the nearest open water.

Scenario 7 adds no-till soybean planting to scenario 2 versus conventional tillage practices resulting in considerably more residue on the soil surface during the rotation. The SCI increases from 0.20 to 0.40 and the P Index improves due to the residue reducing soil erosion. The performance and resulting performance rewards are nearly identical to the continuous corn scenario 1.

Scenario 8 adds no-till corn to scenario 7 making a huge improvement in the environmental performance of a common rotation used in Iowa. Due to labor and fuel costs, improved machinery and hybrids the use of no-till is expanding rapidly. The performance rewards associated with scenario 8 are a substantial incentive that also provides a perpetual reward to sustain the improved performances as shown in the reward table. There are equipment, herbicide and insecticide costs and risks that require a high level of management, thus justifications for increased performance rewards.

The scenarios demonstrate an opportunity to connect production agriculture and environmental performance that has the potential to improve water and soil quality and long term profitability of Iowa agriculture.
**Summary**

There is much yet to learn about the implementation of performance-based incentives in successful watershed projects but the use of current environmental and agricultural performance measures will provide producers and watershed residents with the valuable information they need to make positive changes in their watersheds.

**References**