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Can We Find a 21st Century Approach to Agriculture and Water Resources Policy?

Warren Formo

Agriculture has undergone major changes since the first crop and livestock domestications some 10,000 years ago. Productivity increases due to invention and advancing technology have reduced the labor required for farm production to the point that fewer than 2% of us find it necessary to produce food. Increasing productivity also enabled population growth, economic growth and economic consumption to occur without increasing land use. In fact, agricultural land use in Minnesota has actually declined during the past half century due to competing land uses. Still, farmland constitutes the single largest land use category in the state.

By definition, those who manage a resource are the stewards of that resource. Minnesota farmers manage nearly 27 million acres, or about one half of the land area of the state; thus farm practices are of great interest when soil and water resource sustainability are considered. This is a familiar concept to farmers, who have long recognized the need to maintain soil fertility and tilth while protecting water resources. Their practical problem solving approach is largely responsible for the development of the diversity of management systems in place on Minnesota farms today. Farmers have discovered multiple approaches to farming, which contributes to sustainability.

Recently however, agricultural practices have come under increased external scrutiny from newcomers to the conversation with limited understanding of farming and related soil-water interactions. Many of these newcomers are simply unaware, having lost their agrarian connections as society becomes increasingly urbanized. They are genuinely seeking assurance that farming practices are sustainable. They want to know that farmers are caring for their land and livestock appropriately; they want to know that our food production system is sustainable.

Background

The modern era of agriculture in Minnesota began with European settlement in the early 19th century. Early settlers found a familiar climate, fertile soils and abundant water in much of southern and western Minnesota. They brought with them the crop and livestock production practices with which they were experienced, which naturally coincided with the types of food demanded in the market since most non-farming Minnesotans shared the same cultural background (logical, but this still does not explain the existence of lutefisk).

Productivity was the primary measure of good stewardship in this era. Production data based on output that could be weighed or counted are readily available. Measures of resource protection or depletion were not yet available.

In the 1930s, dust storms and other visible signs of soil erosion prompted farmers to begin searching for new practices to prevent their land from becoming less productive. In 1933 the federal government formed the Soil Erosion Service as part of the Department of the Interior to provide technical assistance to resource managers — primarily farmers — to help them identify practices that would reduce or prevent erosion. In 1935 the Soil Erosion Service was moved to the Department of Agriculture and renamed the Soil Conservation Service. Since 1994 the agency has been known as the Natural Resources Conservation Service.

A significant amount of agricultural research throughout the remainder of the 20th century was dedicated to increasing production per acre while reducing visible soil loss. In addition to the environmental benefits of soil conservation, farmers were also motivated to protect the future productive capacity of their land by enhancing soil quality. Through the efforts of farmers, researchers, resource advisors and inventors, some of whom were also farmers, a whole series of agronomic tools were developed, including new tillage and planting equipment, herbicides, fertilizers, improved crop genetics and farmland drainage. Used in varying combinations depending on the specific crop, soil type and location, these tools changed farming in Minnesota dramatically. Soil organic matter content, which had been declining, began to stabilize and today is actually increasing on many Minnesota farmlands.

Prior to World War II, the moldboard plow was the centerpiece of virtually every farm tillage system. Today, a wide array of tillage systems is in use on Minnesota farms, ranging from continuous no-till (directly seeding crops into the soil without tillage) to moldboard plowing (perfectly acceptable in many programs on suitable soils).

Visible erosion has been eliminated under all but the most extreme weather conditions, but accurate measures of soil loss are still not available.

Efforts to control soil erosion have likely had a positive impact on water quality as well. Reduced tillage intensity and increased plant material (crop residue) on or near the soil surface holds soil in place on most croplands. Some formerly cropped areas with high erosion potential, usually due to steepness of slope or proximity to water, have been retired from crop production and planted to grass, shrubs or trees. These changes resulted in visible improvements, but accurate measurements attributing observed water quality improvements to changes in farming practices under a wide range of conditions are still not available.

Water conservation practices today

During the past 50 years, practices adopted by Minnesota farmers have likely reduced soil loss significantly, but a precise measurement of the reduction in soil loss due to their adoption is not possible — the numbers generated by models are merely estimates. Through decades of adaptive management, Minnesota farmers have perfected long lists of practices expected to protect soil and water while optimizing productivity. In fact, almost every practice identified as a BMP (best management practice) for soil or water quality was first tried by a farmer. No-till, minimum till, strip till, ridge till, terraces, contour farming, grass waterways, buffer strips, filter strips, precision nutrient management, herbicide incorporation, manure testing, manure incorporation, manure storage, integrated pest management, irrigation management, managed grazing, water management, and field windbreaks to name a few, all of these BMP concepts were conceived, born and raised on farms.

Farmers made many of these changes, often investing tens of thousands of dollars, pursuing short-term economic gains due to increased productivity, reduced operating cost, or both. Farmers also recognized the potential for long-term economic gain as soil quality improved over time. The evolution of farm practices continues yet today as part of an ongoing exercise in finding the appropriate crop and/or livestock production system for any given place and time. Experiment and experience combine to identify what, where and how something will be produced, depending on soils, climate and other factors. There are very basic reasons that Minnesota farmers do not grow pineapples or mangos.

But Minnesota farmers do grow a lot of other things. According to the United States Department of Agriculture, Minnesota farms produced crops and livestock valued at $13 billion in 2007. Measured by value of sales, primary crop and livestock production categories are corn, soybeans, hogs, milk and dairy products, beef, poultry and eggs, wheat, hay, sugarbeets, potatoes, sweet corn, peas and edible beans.

Variation in production systems adds another dimension to the diversity of Minnesota agriculture. Some production systems have achieved their own market status, such as organic, but the vast majority are slight variations in management protocol involving crop rotation, tillage, fertility application, pest management or drainage in crop systems. Livestock system combinations are even more complex due to species differences, along with variations in housing, nutrition, genetics and other factors.

In addition to adopting production practices that protect water quality, Minnesota farmers also participate in voluntary land retirement programs. Currently 1.7 million acres of farmland are enrolled in the Conservation Reserve Program to protect wetlands, enhance water quality and provide wildlife habitat. Many of these areas are in buffer strips or grass waterways; some are under 10- to 15-year contracts while others are under permanent easement. Periodic spikes in crop prices typically elicit concerns that some of these acres might return to production, but in recent years the actual change in acreage enrolled has been negligible, further evidence of the stewardship ethic demonstrated by Minnesota farmers. Another element of the Conservation Reserve Program worth noting is that it was established in 1985 with goals of reducing erosion, providing wildlife habitat *and* reducing grain inventories. These acres are available during times when grain inventories are low, and with the increased adoption of reduced tillage farming systems, water quality concerns can still be adequately addressed in many cases.

The Conservation Reserve Program is estimated to reduce soil erosion by about 670,000 tons of soil annually. This figure is an estimate, derived from a model — not measured. The inability to accurately measure soil savings from improved farming practices and the installation of buffer strips or other structures is a major hindrance to addressing water quality concerns in agricultural settings.

"Data rich, information poor"

Advances in technology allow the detection of invisible substances in water at levels unimagined only a few years ago. Satellites provide geographic information and imagery from miles above the Earth at resolutions down to less than one meter.

Agronomy and soil scientists have collected huge volumes of data on crop inputs and production. Researchers have gathered mountains of water quality data; little information has been gathered, however, connecting specific farming practices with water quality under a broad range of conditions.

Ward, Loftis and McBride first referred to the "data-rich, information-poor" (DRIP) syndrome in 1986, calling for a new approach to collecting and using water quality data. Twenty years later, we have a lot more water monitoring data, but little progress in making the information more useful. Large volumes of water condition monitoring data are collected, with little ability to associate activities on the land with changes in water quality. In other words, it is relatively easy to determine that a water body is polluted; it is much harder to understand the processes by which it became polluted.

The Clean Water Act, passed in 1972, provides the foundation and framework for states to manage water quality. The Clean Water Act requires states to determine designated uses for all water bodies, set water quality standards protecting the designated uses, then monitor the water bodies relative to the standards. Those waters that do not meet one or more standards are designated as "impaired." Generally, once a lake, river or stream is placed on the list of impaired water bodies, the state is required to conduct a TMDL (Total Maximum Daily Load) study to identify the sources contributing to the impairment and allocate the pollutant reductions needed to bring the water body in line with standards, a problem solving process much easier described than implemented.

During the first decades after passage of the Clean Water Act, implementation was targeted toward "point" source pollution. Primarily consisting of wastewater treatment plant and industrial discharges, point source dischargers operate under a permit system, which generally limits both the mass and concentration of certain pollutants. As a result, discharges have been reduced but not completely eliminated. Discharge permits generally hold point source dischargers to a performance standard, in which they are allowed to discharge at a level equal to the discharge resulting from the best available, economically achievable technology. This regulatory approach has produced significant water quality improvement.

A March 2009 Minnesota Pollution Control Agency report states that, "Minnesota has been successful in controlling end-of-pipe discharges from wastewater treatment plants and industries to our state's waters." According to the report, Minnesota wastewater treatment plants discharged about 1.5 million pounds of phosphorus and 1 million pounds of ammonia into Minnesota waters in 2007. These numbers sound staggering, but they represent dramatic improvements in wastewater treatment technology. Throughout the 1990s and up until about 2003, phosphorus discharges in the range of 3 million pounds annually were common, twice current discharge rates.

These reductions in nutrient discharges are well documented and show the dramatic influence of technology and invention in reducing water pollution. Bear in mind that only a few generations ago many communities discharged raw sewage directly into Minnesota's rivers and lakes. Only after recognition that this was a problem were solutions pursued, as was the case with farmers' efforts to reduce visible soil erosion. A primary difference exists, however, in our ability to measure the results when dealing with point sources; solutions to non-point runoff do not lend themselves to the same regulatory approach.

While the Clean Water Act has been relatively successful in dealing with point sources, application to non-point sources has been challenging. Non-point sources are diffuse, widespread sources, like agricultural runoff, and by their very nature are difficult to quantify. Again, we have water data, we have crop data, but we do not have adequate data on the interaction of soil and water in agricultural landscapes. In order to establish load estimates, the pollutant source assessment process relies on statistical models to generate estimates of runoff. While these models may generate pollutant loading numbers useful for planning on large scales, farmers typically find that these estimates have little value in making management decisions at the field level.

The Clean Water Act is intended principally to address anthropogenic impacts, and thus efforts are made to sort out "natural background" levels. Variable definitions and expectations of natural background complicate application of the Clean Water Act, both in the process of setting water quality standards and in pollutant source assessments. Natural background is sometimes defined as occurring in nature, and at other times is defined as loadings from manmade sources that are essentially uncontrollable. This is especially troublesome for the agricultural community and other clean water advocates in addressing "turbidity" impairments, which are caused by sediment or plant material suspended in water, causing it to appear murky or cloudy. The absence of water quality data from the early years of European settlement hampers efforts to determine natural background levels, though it may be of interest to note that the most common lake name in Minnesota is Mud Lake.

The application of turbidity standards is just one example of the challenges in implementing water quality programs in agricultural regions. Similar challenges plague discussions on nutrients and bacteria, which are also natural components of the environment. Implementation of water resource protection, like agriculture, is constantly evolving, incorporating scientific advances and invention along with changing expectations and definitions. As more is learned about nutrient cycles, sedimentation processes and the life cycle of bacteria, standards can be updated to better reflect the full range of landscape characteristics, the best technology available to farmers, widespread geological variation and weather extremes. In the process, actual, not modeled, positive and negative farm runoff impacts must be discovered at field scale, and then connected to other activities within a watershed. How do farmed areas, wetlands and urban areas interact, relative to water quality? There are many theories, even a few models, but the conversation is dominated by perceptions because science can only get us to the point of "sometimes" or "under certain conditions." Hugh Hammond Bennett, leader of the soil conservation movement in the 1920s and 1930s and the first head of the Soil Conservation Service (now the Natural Resources Conservation Service), summed up the situation this way: "If there were some standardized simple remedy for the ills of the land that could be applied indiscriminately, the job of soil conservation would be comparatively easy. But there is about as much variety in erosion and the performance of the water and wind as in the landscape of the country."

Bennett made these comments in 1943. Ward et. al. wrote of the need to measure the right things in order to manage the right things in 1986. And it is still true today; until adequate water monitoring data is collected in such a way that it can be linked to practices on farmland, under a full range of different farming systems and landscape and climatic conditions, water quality discussions will continue to languish well into the 21st century.