Exhibit T

R. Shepard, *Nutrient Management Planning: Is It the Answer to Better Management?*, 60 J. Soil & Water Conserv. (2005)

Nutrient management planning: Is it the answer to better management?

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Date: July-August 2005
From: Journal of Soil and Water Conservation(Vol. 60, Issue 4)
Publisher: Soil & Water Conservation Society
Document Type: Article
Length: 4,859 words

Full Text:
Nonpoint source pollution is the primary cause of reduced water quality in the United States (USEPA, 1996, 2000; USGS, 1999). Agriculture is recognized as the leading source of water quality degradation, causing 59 percent of the impaired river and stream miles, and 31 percent of the impaired lake acreage (USEPA, 2000). The greatest impacts may be from excessive nitrogen and phosphorus inputs (USEPA, 1993, 2000; USDA-ERS, 2000; USGS, 1999). These nutrients can increase algae and macrophyte growth, which can create anoxic conditions as these organisms ultimately decompose (USEPA, 1993; 2000).

In the United States, producers apply approximately 19 million tons of nitrogen and four million tons of phosphorus each year in the form of commercial fertilizers and livestock manure (USGS, 1999). From 1990 to 1995, more than half the acres for specific crops (cotton, corn, potato, and wheat) in chief agricultural states had high nitrogen mass balances, where the nitrogen inputs were more than 25 percent greater than the nitrogen outputs (USDA-ERS, 2000). Similarly, estimated phosphorus inputs (fertilizers and feed) exceed the outputs (crop and livestock) by 70 percent (cited in Sharpley, et al., 1999).

In 1987, Congress amended the Clean Water Act to provide the states with additional federal support for nonpoint source pollution initiatives under the section 319 Nonpoint Source Management Program. Proposed national policies include USDA and USEPA's Unified National Strategy for Animal Feeding Operations and USEPA's Strategy for Addressing Environmental Public Health Impacts from Concentrated Animal Feeding Operations (USDA and USEPA, 1999). In addition, all permitted livestock operations are required to have a comprehensive nutrient management plan (CNMP) by 2009 (USEPA, 2000, 2002; USDA and USEPA, 1999).

In Wisconsin, nonpoint source pollution has been identified as a major cause of water quality problems (WDNR, 2000; WDNR and Wisconsin Department of Agricultural, Trade and Consumer Protection [WDATCP], 1999). The Wisconsin Department of Natural Resources indicates that 40 percent of the streams by miles, 75 percent of the inland lakes by surface area, and many of the Great Lakes coastal areas and harbors are threatened by nonpoint source pollution. Also, approximately 10 percent of the private rural wells tested for nitrate exceeded the USEPA's national drinking water standard and the state groundwater standard (Porter, 2001; WDNR, 2000). A considerable portion of this water quality degradation is directly attributed to agricultural land use, with nutrient over-application from animal manures and commercial fertilizers posing significant threats (Jackson-Smith et al., 2001). Results from a nine-year nutrient management study indicate that Wisconsin farmers over-apply nitrogen and phosphorus for corn production (Shepard, 2000). These findings stress the need for increased efforts toward nutrient management programs that mitigate nutrient loading into surface and groundwater resources.

Research from Cook et al. (1996) shows that implementation of best management practices (BMPs) in the Herrings Marsh Run Watershed of North Carolina has led to decreases in nitrate- and ammonium-nitrogen in the surface waters. While BMPs for nutrient management include a wide number of strategies (Nowak et al., 1998; Nowak and Korsching, 1998), to be adopted by farmers they must address agricultural and environmental goals, as well as being economically and socially feasible (Frame and Kivlin, 2001; Bailey and Waddell, 1979). New Wisconsin codes require crop and livestock producers to comply with agricultural performance standards for manure, commercial fertilizer, and other nutrient sources through a nutrient management plan, a type of BMP that can reduce nutrient loading to surface and groundwater. Nutrient management plans help optimize the use of on-farm sources of nutrients (manure and residual nutrients from previous crops) by matching nutrient applications to crop needs, allowing a reduction in commercial fertilizer use while maintaining soil productivity and crop yields (Beegle et al., 2000).

Although nutrient management plans vary, most include: soil test reports, assessment of on-farm nutrient resources, nutrient crediting, manure inventory, a manure spreading plan, and consistency with a farm conservation plan (University of Wisconsin Extension, 1995). The 590 Nutrient Management Standard sets down the minimum requirements of a nutrient management plan as established by the USDA-Natural Resources Conservation Service (NRCS). The 590 Standard lists three criteria: 1) supply nutrients for crop need, 2) reduce nutrient loading to surface water, and 3) reduce nutrient loading to groundwater (USDA-NRCS, 1999).

In Wisconsin, there has been a steady increase in the attention given to nutrient management plans. From 1995 to 2002, a total of 4,018 nutrient management plans had been written for Wisconsin farms, covering an estimated 1.3 million acres of cropland (WDATCP, 2003). From 2000 to 2001, the number of plans increased by 27 percent, the acreage by 22 percent, and the number of participating counties by 28 percent (WDATCP, 2003). In Wisconsin, implementing the 590 Standard has focused on nitrogen as a limiting nutrient from which water quality goals of a nutrient management plans are based. Since 2002, state and federal policy has placed increasing emphasis on phosphorus ([P.sub.2][O.sub.5]) as a limiting nutrient that guides field nutrient applications in a nutrient management plans. Currently, both N and [P.sub.2][O.sub.5] are included in nutrient management plans, however the P-based plans ([P.sub.2][O.sub.5]) are considered more restrictive in allowing where on-farm sources of nutrients are applied because of the influences from manure application of [P.sub.2][O.sub.5] (Murphy, 2005; Stangel, 2005).

This study addresses the hypothesis that nutrient management plans reduce nitrogen and phosphorus application rates, while measuring the extent of adoption of such plans.

Methods and Materials

Data were collected in two Wisconsin watersheds where both private and public sector entities provided nutrient management planning assistance to farmers. A survey conducted between January and April 2000 assessed the agronomic practices of 127 farmers with and without nutrient management plans. This response rate represents 90 percent of the farmers in the studied watersheds who met the minimum farm management criteria of 15 head of dairy or beef cattle were included in the population of questionnaire recipients. The questionnaire focused on commercial fertilizer and manure applications, crop rotations, manure and legume crediting, operator knowledge and use of recommended nutrient management practices, and farmer perceptions about nutrient management plans. All 127 questionnaires were administered using personal interviews in which both the farmer and interviewer had copies of the questionnaire, and the interviewer recorded the responses. A census approach to survey delivery was used, and thus all members of the identified population were contacted. There are two main benefits of a census approach to survey delivery: 1) it creates more local credibility because each farmer who met the study criteria was offered an opportunity to participate; and 2) analysis is presented in percentages and averages, rather than inferential statistics because the data set consists of an entire population.

The two watersheds were selected based on discussions with local public agency staff (USDA-NRCS and Wisconsin's county-based Land Conservation Departments). Both watersheds are located in eastern Wisconsin, one being approximately 370 [km.sup.2] (143 [mi.sup.2]), and the second approximately 673 [km.sup.2] (260 [mi.sup.2]). These watersheds represent two different primary sources of assistance for nutrient management plans. In one watershed, farmers were believed to have relied more on agency staff to assist in the initial development of nutrient management plans. In the second watershed, farmers were believed to have relied primarily on privat-esector agronomists.

This research used a representative field rather than collecting detailed information on multiple fields due to logistical considerations. Each farmer was asked to identify the form and rate of nutrients applied to a representative cornfield. Nutrient applications from commercial sources, previous crop rotations, and manure were recorded. Results of the survey found that this field was representative of other fields in that 79 percent of the farmers responding did not differentiate amount commercial nitrogen application among their cornfields; and 64 percent of the farmers in the survey did not vary manure application rates among their cornfields.

Farmers were also asked to identify the predominant soil textures of their representative fields. Based on University of Wisconsin Extension recommendations of nutrient needs for corn production, and after adjusting for specific soil types (Bundy, 1989; WDATCP and UWEX, 1989; Kelling et al., 1998), an estimate of appropriate nutrient application rates for each field was calculated. A University of Wisconsin Extension recommended level of 179 kg [ha.sup.-1] (160 lb [ac.sup.-1]) of nitrogen was used for medium- and fine-textured soils, 134 kg [ha.sup.-1] (120 lb [ac.sup.-1]) of nitrogen for sandy soils (Bundy, 1989, 1998; Vanotti and Bundy, 1994; Kelling, et al., 1998). Lack of consistent use of soil tests on the representative cornfields prevented a determination of phosphorus recommendations. The average yield of the most productive cornfield across the two watersheds (89 bushels [ac.sup.-1]; 7.4 [m.sup.3] [ha.sup.-1]), when compared with University of Wisconsin guidance (Kelling, et al., 1998; UWEX, 2002) for medium textured soils, provides an estimate of 45 kg [ha.sup.-1] (40 lb [ac.sup.-1]) [P.sub.2][O.sub.5] removal by the corn crop grown during the previous year. The value is not a recommendation, but rather a conservative estimate for [P.sub.2][O.sub.5] over-application based on potential residual [P.sub.2][O.sub.5] from the previous cropping year.

The estimated manure applications were determined by asking farmers to specify field size, type of manure applied, size of manure spreader, and number of loads applied within 12 months prior to planting corn. The amount of plant-available N and [P.sub.2][O.sub.5] was estimated from University of Wisconsin Extension guidelines using a conservative measure based only on first-year nutrient availability (Bundy, et al., 1990; Kelling, et al., 1998; Madison, et al., 1998; UWEX, 2004; Wolkowski, 1992).

Nitrogen availability assumed 1.5 kg [Mg.sup.-1] (3 lb [t.sup.-1]) for dairy cow manure (0.96 kg [Mg.sup.-1] [8 lb 1000 [gal.sup.-1]] if liquid applied) and 2 kg [Mg.sup.-1] (4 lb [t.sup.-1]) for manure from beef cattle (1.2 kg [Mg.sup.-1] [10 lb 1000 [gal.sup.-1]] if liquid applied). Phosphorus ([P.sub.2][O.sub.5]) assumed 1.5 kg [Mg.sup.-1] (3 lb [t.sup.-1]) for dairy cow manure (0.96 kg [Mg.sup.-1] [8 lb 1000 [gal.sup.-1]] if liquid applied) and 3 kg/Mg (5 lb [t.sup.-1]) for manure from beef cattle (1.7 kg [Mg.sup.-1] [14 lb 1000 [gal.sup.-1]] if liquid applied). No other types of manure were applied. Nutrient credits for a first-year cornfield coming out of a legume rotation also were estimated following University of Wisconsin Extension guidelines as a fair stand (30 percent to 70 percent alfalfa) with nitrogen values of 179 kg [ha.sup.-1] (160 lbs [ac.sup.-1]) for medium- and fine-textured soils and 124 kg [ha.sup.-1] (111 lbs [ac.sup.-1]) for sandy soils. For soybean rotations, first year credits were 45 kg [ha.sup.-1] (40 lbs [ac.sup.-1]) for medium- and fine-textured soils with no credits for sandy soils. No other legume crops were grown on the studied fields.

The estimated nutrient application rates are considered conservative in four ways because: 1) they did not take into account residual soil nitrate other than first-year legume nitrogen credits, 2) they only accounted for first-year manure nitrogen credits, 3) they assumed none of the manures were incorporated, and 4) only the lowest value was used when a range was available for manure or legume credits.

Results and Discussion

In the two watersheds, 53 percent of the farmers in the study had nutrient management plans and 47 percent did not have plans. To assess the extent to which nutrient management plans influence agrichemical usage, the mean application rates of total nitrogen (N) and phosphorus (in the form of [P.sub.2][O.sub.5]) were determined for farmers with and without plans and then compared to University of Wisconsin Extension recommendations. The average recommended N rate for the study is 142 kg [ha.sup.-1] (127 lb [ac.sup.-1]), and the estimated amount of [P.sub.2][O.sub.5] above which excess or buildup could occur based on average crop yields is 45 kg [ha.sup.-1] (40 lb [ac.sup.-1]). Overall, this study showed that two out of three farmers applied excess N and three out of four farmers applied [P.sub.2][O.sub.5] that would exceed what the previous corn crop removed.

When results for farmers with nutrient management plans were separated from those without nutrient management plans, they showed that farmers with plans applied, on average, less N and [P.sub.2][O.sub.5] than farmers without plans. For farmers with nutrient management plans, the mean application rate of N was 139 kg [ha.sup.-1] (124 lb [ac.sup.-1]), and for farmers without nutrient management plans the mean application rate of N was 188 kg [ha.sup.-1] (168 lb [ac.sup.-1]). For [P.sub.2][O.sub.5], those with nutrient management plans had a mean application rate of 72 kg [ha.sup.-1] (64 lb [ac.sup.-1]), and those without nutrient management plans had a mean application rate of 100 kg [ha.sup.-1] (89 lb [ac.sup.-1]).

The range and variation in total N and [P.sub.2][O.sub.5] applications can also be used to display the entire distribution (Figures 1 and 2). The maximum N application for farmers with a plan is 419 kg [ha.sup.-1] (374 lb [ac.sup.-1]) and 481 kg [ha.sup.-1] (429 lb [ac.sup.-1]) for farmers without a plan, respectively. Similarly, the maximum [P.sub.2][O.sub.5] rate for farmers with a plan is 264 kg [ha.sup.-1] (236 lb [ac.sup.-1]) and 389 kg [ha.sup.-1] (348 lb [ac.sup.-1]) for farmers without a plan.

Overall, results suggest that a small number of farmers are responsible for disproportionately high amounts of excess N and [P.sub.2][O.sub.5] application. For example, while some farmers dramatically over-apply nutrients, less than 15 percent apply more than 280 kg [ha.sup.-1] (250 lbs [ac.sup.-1]) of nitrogen. It is important to note, however, that application values calculated by this study for N and [P.sub.2][O.sub.5] are conservative estimates and may under-represent actual nutrient application rates.

Although this study uses conservative determinations for recommended application rates, the results indicate that 37 percent of farmers with nutrient management plans over-apply N, approximately one in seven (14 percent) are within recommended rates, and the remaining 49 percent under-apply. A considerably greater percentage of farmers without plans (62 percent) over-apply N, eight percent are within recommended rates, and the remaining 30 percent under-apply. A similar pattern was revealed in rates of [P.sub.2][O.sub.5], where a greater percentage of farmers without plans than with plans exceeded crop replacement rates. For farmers with plans, 48 percent exceeded [P.sub.2][O.sub.5] replacement rates and the remaining 52 percent apply at or below replacement rates. For farmers without plans, 57 percent exceed [P.sub.2][O.sub.5] replacement rates and the remaining 43 percent apply at or below that value.

Analysis of how farmers engage in nutrient crediting, where a farmer reduces commercial fertilizer use by taking advantage of available on-farm sources, shows less than half (45 percent) of the farmers with nutrient management plans reduced the amounts of commercial N fertilizer applied to the representative field due to manure applications. Slightly more, (48 percent) of the farmers without nutrient management plans reduced the amounts of commercial N applied after applying manure to the representative field in the previous year. Importantly to note, all farmers in the study population applied manure and could have credited available on-farm nutrients to some extent on the representative field.

A critical component of a nutrient management plan is regular soil testing. University of Wisconsin Extension recommends that each field be sampled frequently, at least every three to four years (UWEX, 1995; USDA-NRCS, 1999). More than three-quarters (79 percent) of farmers with nutrient management plans conduct regular soil tests, whereas only 41 percent of farmers without nutrient management plans conduct regular soil tests. Seventy-nine percent of farmers with plans reported that their last test was within the past three years; 65 percent of farmers without plans said their last test was within the past three years.

Finally, farmers with nutrient management plans were asked to what extent they were able to follow their plans. Slightly more than three-quarters (78 percent) of those farmers have been able to implement it on more than three-fourths of the acres covered by their plan. This indicates that full implementation of a nutrient management plans is not occurring on every farm where a plan exists.

In this study, farmers were asked to identify the primary person who helped him or her develop the nutrient management plans. Of those farmers with plans, 37 percent indicated that government agencies (e.g., NRCS staff or technicians with the local county Land Conservation Department) were primary sources of information and assistance in the development of their plans. About one-half (47 percent) of the farmers also turned to the private sector for assistance (e.g., private crop consultants and local coop agronomists). A smaller number (16 percent) of the farmers stated they were the primary developers of, or had written, their own plans.

Although farmers with a nutrient management plan on average apply less N and [P.sub.2][O.sub.5] than farmers without a nutrient management plan, there are still many who over-apply nutrients. Over-application of N and [P.sub.2][O.sub.5] by farmers with nutrient management plans often results when they fail to credit on-farm sources of nutrients, particularly manure. Additionally, the mean N application rates from commercial fertilizers are nearly the same for farmers with and without nutrient management plans. This is somewhat disconcerting since nutrient management plans attempt to optimize the use of on-farm sources of nutrients and reduce dependency on commercial fertilizers.

Great concern has been expressed by agencies and environmental stakeholders over the influence wielded by the person or group that assists the farmer during development of a nutrient management plan. Agency (e.g., public sector) supporters of nutrient management plan development are more conservative than private sector information providers (Figure 3). Public sector supported nutrient management plans had mean application rates of 121 kg [ha.sup.-1] (108 lbs [ac.sup.-1]) nitrogen and 75 kg [ha.sup.-1] (67 lbs [ac.sup.-1]) phosphorous; private sector-supported nutrient management plans had a higher mean nitrogen application rate of 155 kg [ha.sup.-1] (138 lbs [ac.sup.-1]), while phosphorus application rates were lower at 70 kg [ha.sup.-1] (62 lbs [ac.sup.-1]). Results further show that when a farmer develops his/her own nutrient management plan, the nitrogen and phosphorus applications are lower than those of farmers without a nutrient management plan; however, the farmer's self-generated plan has higher nitrogen and phosphorus application rates than either the public or private sector plans. This suggests that public agencies, which are entrusted with some responsibility for natural resource protection and conservation, are more environmentally conservative than those with a direct financial incentive for crop production. However, these results do not support claims that private sector plan providers would use a nutrient management plan to dramatically increase commercial fertilizer sales.

Summary and Conclusion

This study shows that farmers with nutrient management plans apply less total N and [P.sub.2][O.sub.5] than farmers without nutrient management plans. However, results indicate that more emphasis needs to be placed on manure as an on-farm nutrient source. For confined livestock operations, manure management is a critical component to successful implementation of a nutrient management plan. Farmers who apply excess commercial fertilizer while ignoring the potential for on-farm nutrients via crediting practices are disregarding manure as a resource and treating it as a waste or by-product of the farming operation.

Results from this study strongly suggest that the promotion and requirement of nutrient management plans as part of government conservation programs should also address how plans are implemented and maintained, not merely written. Furthermore, public policy should go beyond simply setting goals for the number of nutrient management plans generated by a given date. Given the 37 percent of the farmers with a plan who still over-apply N. Mechanisms and provisions in conservation programs should be established which help farmers understand, and implement their nutrient management plans.

More specifically related to policy implications, a main objective of the USDA-EPA Unified National Strategy for Animal Feeding Operations (AFOs) is for all AFOs to develop and implement comprehensive nutrient management plans (CNMPs) by the year 2009 (USDA and USEPA, 1999). Under the Joint Strategy, a CNMP would be mandatory for permitted operations, such as CAFOs, and voluntary for all other AFOs. Approximately 20,000 animal operations will be required to develop CNMPs, due to National Pollutant Discharge Elimination System (NPDES) permits under the Clean Water Act, and 427,500 will voluntarily develop CNMPs (USEPA 2000). The state of Wisconsin also requires all permitted AFOs to have nutrient management plans. Under these rules, producers are required to follow a nutrient management plan by January 1, 2005 in priority areas and January 1, 2008 in all other areas (WDNR, 1999). Such expectations seem unobtainable, even unrealistic. For example, there is already a large gap in enforcing CAFO regulations, where 80 percent of CAFOs have not obtained the required NPDES permits (Centner, 2001). As more financial incentives are targeted at cost-sharing nutrient management plans and CNMPs, and even if non-agency (private, technical service providers) are involved in expanding CNMP programs, the success of nutrient management plans is not dependent on merely writing them, but also on helping farmers overcome the barriers to their implementation.

Study results show implementation of current nutrient management plans is far from fully achieved, and the evolution to phosphorus (P)-based CNMPs would require even more follow up assistance to farmers. The complexity of P-based plans, and because so few farmers currently credit on-farm sources of [P.sub.2][O.sub.5], will make widespread success difficult, possibly unrealistic. Given the information and education needs associated with implementing a plan, it may be more effective to work extensively with a few farmers in targeted areas that are determined to be more susceptible to nutrient loss (Eghball and Power, 1999; Heathwaite, et al., 2000; Nowak and Cabot, 2004).

Although tremendous effort has gone into federal and state programs to protect water resources from nonpoint sources of pollution by promoting and/or requiring a nutrient management plan, just having a NMP does not reduce excess nutrient application nor does it guarantee improvements in water quality. Only half of the farmers with a nutrient management plan in the studied watershed actually credit on-farm manure nitrogen and only three-fourths implement their nutrient management plans on the majority of the acres it covers. Therefore, support beyond the development of the nutrient management plan should include on-farm follow-up by providing assistance aimed at long-term implementation, plan maintenance, and plan modifications due to changes in the farming operation over time. This study shows that nutrient management plans can influence N and [P.sub.2][O.sub.5] application rates and reduce the threat of nonpoint sources of pollution. However, if the agencies that promote nutrient management plans assume that each plan is fully implemented, the intended widespread environmental benefits will not be fully realized.

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Figure 3 Nutrient application rates and primary source for nutrient management plan information. The average rate of Nitrogen (N) and phosphorus ([P.sub.2][O.sub.5]) application to corn for farmers with plans (n=62) and farmers without plans (n=57) based on who was of primary assistance in the development of the nutrient management plan. Total N applied Total [P.sub.2][O.sub.5] applied kg/ha A 160 80 B 155 70 C 121 75 D 193 101 A = Farmer plans (n=10) B = Private plans (n=23) C = Government plans (n=23) D = No plan (n=57) Note: Table made from bar graph.

Source Citation (MLA 9th Edition)
Shepard, R. "Nutrient management planning: Is it the answer to better management?" *Journal of Soil and Water Conservation*, vol. 60, no. 4, July-Aug. 2005, pp. 171+. *Gale Academic OneFile*, link.gale.com/apps/doc/A135773515/AONE?u=googlescholar&sid=bookmark-AONE&xid=0ca84b98. Accessed 10 Oct. 2023.
Gale Document Number: GALE|A135773515