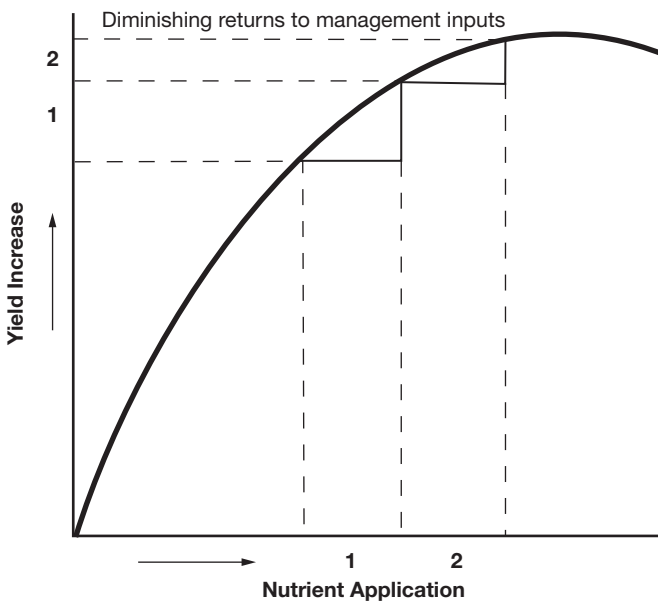




A nutrient management approach for Pennsylvania: Introduction to the concepts

Nutrient management has taken on new meaning in recent times. Soil fertility traditionally dealt with supplying and managing nutrients to meet crop production requirements. The predictable response of a crop to the application of a deficient nutrient (Figure 1) has been the focus. Ways of farming to optimize agronomic production and economic returns to crop production were developed to take advantage of these expected crop responses. Changes in the supply of plant nutrients for this purpose have been dramatic since the end of World War II.

Figure 1. A typical response curve for nutrient application when nutrients are limiting.



Contemporary nutrient management deals with these same production concerns, but protecting water resources from nutrient losses is also important. When nutrients no longer limit crop production, they must be managed carefully to protect environmental quality. And, ways of farming, especially on farms with livestock, must now balance the limits of soil and crop nutrient use with the demands of intensive animal production.

The challenge is not necessarily to change “bad” nutrient management. Rather, the challenge is to reorganize our ways of farming based on new expectations that are sensitive to the potential environmental impacts. This new emphasis will require more than just changes in nutrient management practices on farms. It will require changes in our agriculture as a whole. Many solutions will extend beyond the farm gate and may take a long time to implement.

Current ways of farming developed rapidly after WW II when the use of fertilizers became widespread (Figure 2). Readily available fertilizers meant that nutrients removed in farm products or lost to the environment in a variety of ways could easily be replaced. Nutrients can become an environmental concern when they:

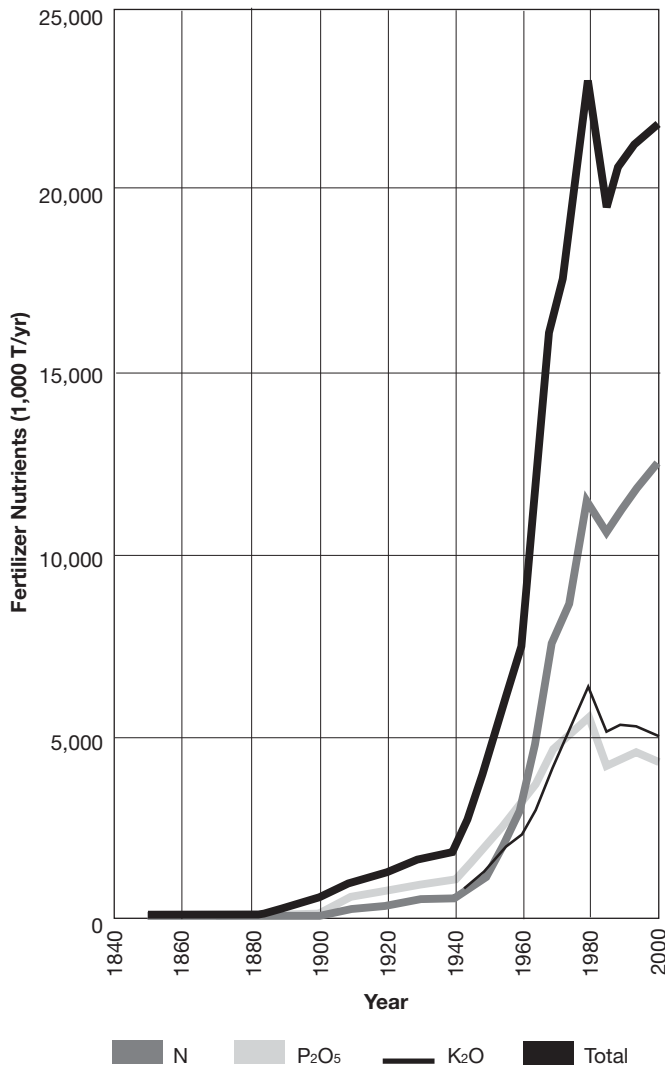
- become so cheap that there is little economic incentive to use them conservatively,
- need not be recycled on a farm in order to maintain the productivity of the farm, or
- are imported to a farm in feeds to support livestock with no relationship to the ability of on-farm crops to use them.

The developing interest in nutrient management for crop production *and* environmental protection means that nutrient management considerations must extend beyond crop production requirements to establishing a balanced way of farming that is based on comprehensive decision making. The newly emerging decisions will include crop and animal production factors, economic factors, and the integrity of local surface water and groundwater, as well as the fate of far-away environmental systems such as the Chesapeake Bay. Nutrient management for environmental protection will involve farmers, input suppliers, technical support services, government policy experts, and, perhaps ultimately, consumers.

MANAGEMENT DECISION MAKING

We have borrowed from basic business management principles to create the management decision-making process described in this and two other fact sheets. The

Figure 2. The use of fertilizer in the United States over the past 150 years.



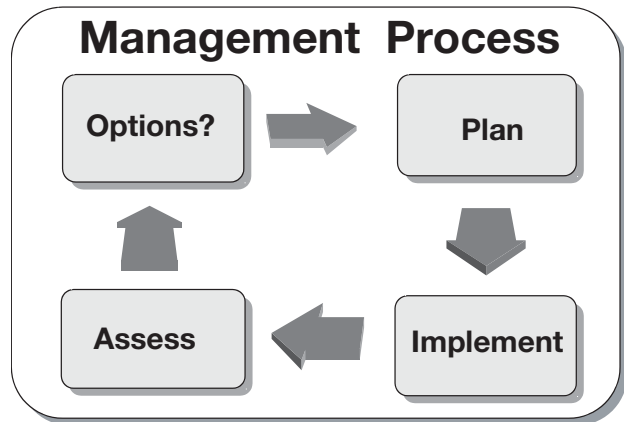
process is a formal presentation of the generally informal process that a farm manager might follow for both short-term and long-term decision making. Nutrient management decision making described in these fact sheets focuses on the farmer and the way the farmer might approach nutrient management in order to meet specific expectations. Nutrient management decisions must be made within the complex context of real, everyday farm management. The decisions, not simply specific practices, must fit each situation for different farmers and farms at different times. In an area where the major farm income is related to animal production, neither crop production guidelines nor environmental quality protection standards may carry enough influence to change the way farms are managed. Good, profitable crop production according to the best management practices does not translate directly into profitable farm production.

Elements of the process

The basic management process described here applies primarily to a one- to five-year planning period. It has four activities: assessment, management option selection, plan

development, and plan implementation (Figure 3). These elements are linked and form part of an ongoing process that is repeated in the appropriate time period. For instance, as one year is completed, another version of the annual plan can be prepared. Other planning periods, both shorter and longer, and their relationships to each other and to farm decisions are described in Agronomy Facts 38-C.

Figure 3. A schematic of the basic nutrient management decision-making process.



Since each activity in the basic process is connected, it is actually possible to begin to work with a nutrient manager at almost any point in the process. Also, since the process is repetitive, the outcome need not be (and will likely not be) in perfect agreement with all the expectations in the performance criteria on the first attempt. For instance, a nutrient management plan could be developed that is expected to meet all performance criteria, but due to unforeseen problems the crop yields in the plan were not harvested. Assessment of plan implementation would show that the outcomes of the plan were not met. The next iteration of the process could then focus on crop management options to improve yields, or adjust the plan to incorporate more realistic yield performance.

The way nutrients are currently managed on a farm can be a starting point to determine the need for changes to meet environmental protection performance criteria. Farm conditions or activities can be assessed according to the guidelines established by the performance criteria. Appropriate management options can then be selected to modify the existing nutrient management based on the outcome of the assessment. Possible changes in farm operations or changes in performance criteria for the next repetition of the nutrient management process can be developed in the management option selection phase. Actual farm conditions or the reasonableness of the performance criteria can be considered in this step. The response will balance farm production and environmental protection.

Nutrient management planning integrates the selected management options into a nutrient management plan of a suitable time frame for the farm. The plan involves invento-

rying farm conditions and operations, and allocating nutrient sources to the fields based on farmer specifications, field conditions, and operational feasibilities. Since each farmer has an existing nutrient management plan, even though many are very informal and emphasize only farm production performance criteria, a plan based on modifications to the current operation is likely to be more readily implemented than an attempt to impose a completely new plan.

Plan implementation represents the day-to-day activities affecting nutrient flow to, from, and within the farm. Since the daily decisions must be made on a routine basis, based on the actual conditions existing at the time, the activities are frequently different from the plans. Accordingly, actual activities should be tracked and records kept for use in the assessment stage of the process.

Implementation assessment compares actual activities to the activities specified in the plan or other criteria for farm performance. Adequate information must be available from the plan implementation phase to test whether the outcome of the assessment meets the relevant performance criteria. The amount of information necessary for an assessment will depend not only on the complexity of the farm operation, but on the detail and rigor expected in the performance criteria. Compliance with very general performance guidelines will require information of a more general nature (rather than very precise, quantitative performance criteria) and much less of it. After completing this assessment, the process can begin again.

Management strategy and time

The basic decision-making process does not stand alone. Instead it supports the accomplishment of an overall farm management strategy. A strategy is generally determined in a much more complex way than the development and implementation of tactical or operational nutrient management plans. Current pressures for competitiveness and for environmental protection in agriculture will require strategies that balance farm production with the demands of environmental protection criteria. Strategies represent longer time horizons, generally five years or more, than do basic tactical plans. Consequently, changes in nutrient management must sometimes be implemented over a period of years. Different farms may require different lengths of time to reconcile changing environmental protection criteria with the financial business plan of the operation. Farmers with heavy capital investments may be limited in the new expenses that can be successfully combined with their other financial commitments.

Nutrient management requires that decisions be made on various time scales: from multiple years, such as over a crop rotation, to day-to-day, such as particular fields for manure application. Off-farm assistance is likely to be most involved in the annual time scale of the nutrient management decision making. Day-to-day decisions will be made within the context of the overall plan. As conditions change on the farm, the management process may have to be repeated at

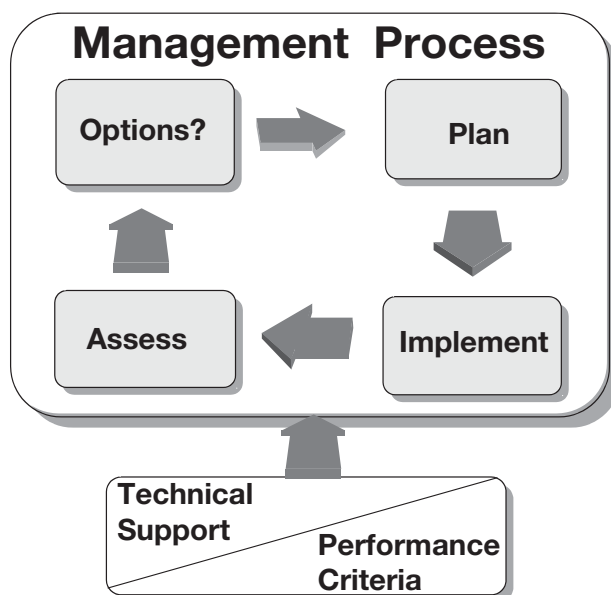
more frequent time interval. However, regardless of the time scale, decisions must be consistent with the overall goals and strategy of nutrient management.

PERFORMANCE CRITERIA VERSUS STANDARDIZED PRACTICES

One approach to farm nutrient management is to specify what should be done on all farms as a recipe for nutrient management. Lists of standard practices from which selections are made are an example of this approach. Even though this method is simple to administer, it does not accommodate specific conditions of particular farming operations or the nature, interests, abilities, or local conditions of individual farmers. Nor does this approach address needed changes in the current ways of farming. Closely specifying particular farming practices can limit innovative options created by farmers and farm advisors to deal with the new requirements of nutrient management for crop production *and* environmental protection.

Another approach to farm nutrient management is to establish performance criteria for farmers to meet as part of their farm management (Figure 4). Performance criteria are outcomes to be achieved through nutrient management, such as nutrient balance for a certain area or part of the farm operation. These criteria are not lists of specific activities or even best management practices (BMPs) that each farmer must follow. Carefully established outcomes can promote solutions to meet the environmental challenges faced by farmers based on local conditions while stimulating innovation at the same time. Clearly defined, measurable outcomes, or performance criteria, are essential to this approach to nutrient management for crop production *and* environmental protection. Performance criteria are explained in more detail in Agronomy Facts 38-D.

Figure 4. The relationship of performance criteria and technical support to the basic nutrient management decision-making process.



SUPPORT FOR THE NUTRIENT MANAGEMENT PROCESS

Technical support

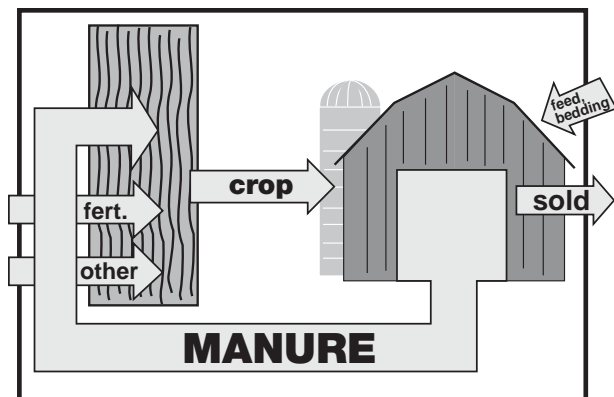
Practitioners in the field who work with on-farm nutrient managers provide the technical support for nutrient management (Figure 4). Technical support can be involved in all phases of the decision-making process. Assistance may be required to develop nutrient management farm plans that include environmental quality protection expectations or for the other activities of implementation, assessment, or management option selection.

The specific technical assistance required for nutrient management is likely to vary from farm to farm depending on each particular situation. Therefore, providers of nutrient management assistance generally will not do the same thing on every farm. Assistance must be flexible to meet the specific needs. Some practitioners may provide basic services such as manure sampling, manure spreader calibration, yield estimates, and other activities that are necessary to physically describe the nutrient flow on the farm. Other practitioners may be more directly involved in management decision making by providing interpretations of farm information and recommendations. The recommendations, planning assistance, or interpretation of nutrient management performance assessments require additional agronomic and management expertise on the part of the practitioner beyond that necessary to collect information about nutrient management activities in the field. However, the unique character of each farm will not be adequately considered if only one type of assistance is available to the farmer. It will be critical to the success of any nutrient management program to balance crop production *and* environmental protection that a range of appropriate, qualified, technical assistance be readily available to farmers.

MANAGING FARM MATERIAL MOVEMENT

The movement of farm materials to, from, and within farms is the basic physical process to be managed by nutrient management decisions. Most common farm materials (crops, manure, fertilizer, and animal feeds) contain plant nutrients

Figure 5. A schematic of the farm material movements for a crop and livestock farm that are influenced by nutrient management decisions.



such as nitrogen, phosphorus, and potassium. The materials come onto farms such as dairy farms in both crop and animal inputs (Figure 5). Nutrient management decision making must distribute these materials so that the performance criteria are met for the nutrients they contain.

SUMMARY

The nutrient management concepts described apply to farm material movement and to outcomes that meet specific performance criteria. In the past, nutrient management criteria have emphasized farm production, but environmental protection is a new criterion to be included. Farmers can change the management of some farm material movements on a daily basis, others can be changed in an annual planning period, but other changes in the strategy of farming may require a period of years. The ability of farmers to respond will depend on the extent of the modifications that are required to meet the changing performance criteria. The possible responses to the challenges of nutrient management are too many and too different to be completely specified in a rigidly defined list. They will ultimately be “created” by concerned farmers and their technical support practitioners and reinforced by government officials and the general public.

The approach to nutrient management in Pennsylvania has been developed to be readily adaptable to a variety of conditions, not to use the same “recipe” for everyone. This approach to nutrient management is a process aimed at outcomes, not at implementing specific practices or following preset procedures.

This fact sheet is one of a set of four dealing with nutrient management. The other three are: Agronomy Facts 38-B, *Plant nutrient stocks and flows*, Agronomy Facts 38-C, *Nutrient management decision-making*, and Agronomy Facts 38-D, *Exploring performance criteria*. These fact sheets are available from the Publications Distribution Center, 112 Agricultural Administration Building, University Park, PA 16802-2602.

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