Right Product, Right Rate, Right Time, and Right Place...the Foundation of BMPs for Fertilizer

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The concept of agricultural best management practices (BMPs) is not a new one. First introduced almost 20 years ago, scientists at the Potash & Phosphate Institute (PPI) defined BMPs as those practices which have been proven in research and tested through farmer implementation to give optimum production potential, input efficiency, and environmental protection (PPI, 1989; Griffith and Murphy, 1991). Today, the emphasis appears to be more on environmental protection than optimal production potential as current definitions suggest BMPs are practical management practices or systems designed to reduce soil loss and mitigate adverse environmental effects on water quality caused by nutrients, animal wastes, and sediments. Common BMPs directed towards mitigation include strip cropping, terracing, contour stripping, grass waterways, special manure handling, animal waste structures, ponds, minimal tillage, grass filter strips, and nutrient application. Agronomic BMPs leading towards optimizing production potential include: variety, planting date, hybrid maturity, row-spacing, seeding rates, plant population, integrated pest management, weed control, disease control, and nutrient management.

Both soil conservation and agronomic-based BMPs can work together to meet objectives of optimal production potential and mitigation of adverse nutrient-caused environmental effects on water quality. While BMPs may differ depending on objective, to be used by farmers they must also be economic…the practices and management they employ must be profitable and sustainable. Nutrient management deserves special attention because it is critical to both optimizing production potential and to environmental stewardship.

One of the challenges we face in the fertilizer industry is that much of society does not trust us. Many believe that fertilizers are applied indiscriminately, that the industry is only interested in increased profits…through unwarranted fertilizer sales…and that farmers are willing recipients who unnecessarily over-apply nutrients to ensure high yield crops resulting in excessive levels of plant nutrients to the detriment of the environment. This, of course, is not true, but the perception is there and that drives policymakers towards regulating nutrient management, water quality guidelines, total daily load limits, and other policies or practices aimed at restricting or eliminating the use of fertilizer.

Part of the solution in gaining the public's confidence in our ability to manage nutrients responsibly is through encouraging the widespread adoption of fertilizer BMPs. As an industry we need to be unified in the promotion of BMPs designed to improve nutrient use efficiency and therefore environmental protection, without sacrificing farmer profitability. The North American industry has been advocating management practices that foster the effective and responsible use of fertilizer nutrients with a goal to match nutrient supply with crop requirements and minimize nutrient losses from fields (Canadian Fertilizer Institute, The Fertilizer Institute). The approach is simple: apply the correct nutrient in the amount needed, timed and placed to meet crop demand—right product, right rate, right time, and right place. These are the underpinning principles of fertilizer BMPs.

The following summarizes these guiding principles for fertilizer management. A more in-depth discussion is available in Roberts (2006).

- **Right product**: Match the fertilizer source and product to crop need and soil properties. Be aware of nutrient interactions and balance nitrogen, phosphorus, potassium, and other nutrients according to soil analysis and crop needs. Balanced fertilization is one of the keys to increasing nutrient use efficiency.
- **Right rate**: Match the amount of fertilizer applied to the crop needs. Too much fertilizer leads to leaching and other losses to the environment and too little results in lower yields and crop quality and less residue to protect and build the soil. Realistic yield goals, soil testing, omission plots, crop nutrient budgets, tissue testing, plant analysis, applicator calibration, variable rate technology, crop scouting, record keeping, and nutrient management planning are BMPs that will help determine the right rate of fertilizer to apply.
- **Right time**: Make nutrients available when the crop needs them. Nutrients are used most efficiently, when their availability is synchronized with crop demand. Application timing (pre-plant or split applications), controlled release technologies, stabilizers and inhibitors, and product choice are examples of BMPs that influence the timing of nutrient availability.
- **Right place**: Place and keep nutrients where crops can use them. Application method is critical for efficient fertilizer use. Crop, cropping system, and soil properties dictate the most appropriate method of application, but incorporation is usually the best option to keep nutrients in place and increase their efficiency. Conservation tillage, buffer strips, cover crops, and irrigation management are other BMPs that will help keep fertilizer nutrients where they were placed and accessible to growing crops.

[1]Fertilizer Best Management Practices. General Principles, Strategy for their Adoption and Voluntary Initiatives vs Regulations. Proceedings of the IFA International Workshop on Fertilizer Best Management Practices, 7-9 March 2007, Brussels, Belgium. Published by International Fertilizer Industry Association, Paris, France, 2007.

There is not one set of universal fertilizer BMPs. By definition BMPs are site-specific and crop-specific; they vary from one region to the next and one farm to the next depending on soils, climatic conditions, crop and cropping history, and management expertise. BMPs can be implemented in large, extensive farming operations and on small family farms. Right rate, right time, and right place offer sufficient flexibility that these guiding principles can be applied to fertilizer management for rice production in Indonesia, banana production in Latin America, maize production in the U.S. Corn Belt, or any farming system used throughout the world.

Fertilizer BMPs should help ensure that fertilizer uptake and removal by target crops is optimized and fertilizer loss to the environment is minimized. Fertilizer BMPs should increase nutrient use efficiency, but maximum use efficiency is not the primary objective. The goal is to use fertilizers efficiently and effectively in providing adequate nutrition for crops.

If maximizing fertilizer efficiency was the goal, we just need to work lower on the yield response curve. For a typical yield response curve, the lower part of the curve is characterized by low yields since few nutrients are available or applied (**Figure 1**). Nutrient use efficiency is high at the bottom of the yield curve because any addition of a limiting nutrient gives a relatively large yield response as much of the applied nutrient is taken up by the nutrient-limited crop. If highest nutrient use efficiency were the only goal, it would be achieved here in the lower part of the yield curve and by applying the first increments of fertilizer. Lower rates of fertilizer appear better for the environment, because more nutrients are removed by the crop, leaving less in the soil for potential loss. But lower yielding crops produce less biomass and leave fewer residues to protect the land from wind and water erosion and less root growth to build soil organic matter. As you move up the response curve, yields continue to increase, albeit at a slower rate, and nutrient use efficiency typically declines. However, the extent of the decline in nutrient use efficiency will be dictated by the BMPs employed as well as soil and climatic conditions.

Fertilizer nutrients are essential for modern agriculture to meet its crop yield and quality goals, but fertilizers must be used responsibly. Development and adoption of BMPs for fertilizer are necessary for the fertilizer industry to demonstrate its commitment to product and environmental stewardship, and to help the farmer produce sustained, profitable yields. Every farm and field is different. Fertilizer BMPs must be adaptable to all farming systems…one size does not fit all. Right nutrient, right rate, right time, and right place provide a framework for a farmer to select those BMPs best suited to the farm's soils, crops, and climate and to the farmer's management capabilities. BC

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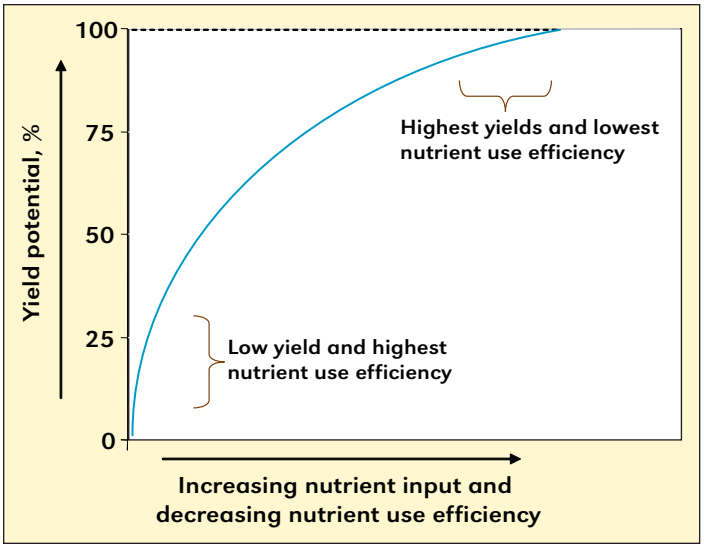

Figure 1. Relationship between yield response and nutrient use efficiency (adapted from Dibb, 2000).

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Editor's Note: The article which begins on the next page, titled "Best Management Practices to Minimize Greenhouse Gas Emissions Associated with Fertilizer Use", takes a closer look at the current science on this timely question. It is an executive summary of a more comprehensive literature review to be available soon.