



To The Point Nutrient Management

Plants require essential nutrients – like nitrogen (N), phosphorous (P), and potassium (K) – to grow. While these nutrients exist in the soil naturally, most farmers apply fertilizers or manure to increase the amount of nutrients available to the plant and maximize the yield of their crops. Chemical fertilizers are often one of a farm's largest production expenditures, so nutrient efficiency can result in major cost savings. Farmers should develop a nutrient management plan to account for and balance the nutrients in their soils to maximize their profitability and yield. Farms often develop these plans alongside a trusted adviser, such as a USDA agent or certified crop adviser. By simply implementing a nutrient management plan, farmers can save almost \$30 per acre on land where they apply more nutrients than crops need.¹

Nutrient Application

Deciding how much nutrient to apply is a risk management equation for farmers. Apply too little, and farmers risk their crops will not have enough essential nutrients to produce a high yield. Apply too much, and farmers spend money on expensive products that never even reach their crops – and may eventually run off the field and harm local waterways and ecosystems.

Many farmers have opportunities to reduce the amount of fertilizer they apply while maintaining yields. On average, only 50% of nitrogen applied as fertilizer is delivered to a grain by harvest. Given historical application rates, soils often already contain high levels of nutrients.² While farmers generally need fertilizer to achieve their desired crop yield, they often end up applying nutrients in excess of what is needed and, as a result, spend unnecessary dollars on inputs.³ Applying very high amounts of fertilizer may also harm a crop's growth and yield.⁴

As extreme weather events increase, achieving the right fertilizer application balance becomes more complicated. In wet years, applied nutrients can be swept off the farm and into waterways. In 2013, the nitrate load to the Gulf of Mexico increased by 300% from the year before, a historically high rate due to wet conditions.⁵ Warm winters and springs can cause higher nitrogen availability in the soil, meaning farmers may be able to apply less fertilizer.⁶ As intense precipitation and temperature patterns are predicted to increase, farmers will need to adapt their nutrient strategies accordingly.

4R Framework

The "4R Framework" is a common way for farmers to apply basic principles for applying only what nitrogen fertilizer is needed – at the right source, rate, place, and time. Some frameworks, like the "SMART Management" framework from USDA's Natural Resources Conservation Service (NRCS), add a fifth assessment component, encouraging farmers to develop a nutrient management plan considering their unique site needs.

Right Source

Farmers should make sure that they choose the right source of nutrients, whether that is a commercial fertilizer or manure. Different crops have distinct requirements for key macro and micro-nutrients needed to thrive, some of which are readily available depending on soil type. For example, clay soils have particularly high phosphorous availability, while sandy soils are often low in all nutrients.⁷ Farmers should test their soil to understand their nutrient profile, then choose among fertilizers or manure to optimize for their soil and planned crop rotation. A farmer's choice of nutrient source also needs to be economically feasible since fertilizer prices can be highly volatile.

Right Rate

Once a farmer selects a certain type of fertilizer or manure, they need to optimize the amount applied. By conducting relatively inexpensive soil tests, farmers can learn which essential macro- and micro-nutrients are already in their soils, and other key soil metrics such as pH that may vary. With this in mind, farmers can use different methodologies to determine how much additional fertilizer is needed.

Some approaches, such as the Maximum Return to Nitrogen tool, can help farmers determine the precise point where applying additional nitrogen will cost more than a farmer would benefit from getting additional yield.⁸ Some state extension offices also offer calculators that help farmers in their states evaluate the most effective application rates.

Right Place

Fertilizer should be applied near the plant's root, where crops can fully uptake the nutrients. Farmers can inject fertilizers to ensure nutrients are delivered directly beneath the soil surface on the root zone for the most efficient application. Farmers with drip irrigation systems can achieve even greater precision by applying soluble fertilizers directly to the plant root through their drip irrigation systems. Some research indicates that drip irrigation systems could be cost-effective for use in corn systems in the Midwest due to the potential nitrogen fertilizer savings.⁹

Right Time

Lastly, farmers should only apply nutrients when crops need them during lifecycles. Generally, this means only applying nutrients near planting dates or during certain plant growth stages.

Farmers can achieve more precise plant growth through a "split" nitrogen application strategy. Using this method, farmers apply a smaller amount of nutrients around planting time, then apply the remainder at a stage of the plant's growth cycle when ready to use it fully. The best timing for this second application depends on the crop. Corn, for example, aims for a window of a few weeks when it reaches certain stages of growth classified as V3 – V10. Split applications increase the efficiency of nutrient application and reduce the runoff risk since farmers can avoid overapplying nutrients at the beginning of the season when they know less about upcoming weather that may affect the plant's growth rate.

Split nitrogen application can introduce risk into a farmer's management process. For Midwestern farmers, spring rains after planting might prevent a farmer from accessing fields to apply their second round of nutrients, potentially leading to crop losses or reduced yields. One major barrier to implementing split nitrogen management is the need for specialized equipment, which farmers have to purchase or rent. While cooperatives and state departments of agriculture may rent out this equipment, there is still a cost associated with the new practice, in addition to management challenges in accessing new equipment during a tight growing timeframe.

Precision Monitoring Tools

Farmers can further maximize their nutrient planning by investing in precision monitoring tools. Sensors and software solutions can help farmers to monitor soil nutrient levels and adjust application rates remotely. More advanced systems can even integrate satellite imagery that provides spatial and temporal data about nitrogen and soil moisture levels for farmers.¹⁰ Emerging AI technologies may also provide farmers precise information about crop growth stages and nutrient needs.¹¹

Reducing Nutrient Loss

Over-applied nutrients are more vulnerable to running off the field and into rivers and streams. The downstream environmental effects of nitrogen runoff can be severe. Excess nitrogen in lakes and rivers can harm local fish populations and impair water quality, impairing important ecosystem functions and preventing local neighbors from enjoying fishing, swimming, or boating.

Farmers may be able to sell emerging "ecosystem service credits" by reducing the amount of nitrogen fertilizers. These credits work similarly to carbon credits, generating a financial reward for an environmental outcome like reduced nitrous oxides or improved water quality. Many states have set targets to reduce nitrogen runoff, so there are also local and state incentive programs to help farmers reduce their nutrient application.

In addition to reducing runoff, there are other strategies that farmers can use to reduce the risk of nutrient loss. Cover crops and soil health practices increase the stability of soil organic matter and help reduce the amount of erosion that can carry fertilizers off the field and into waterways.

Farmers can also consider "edge of field" solutions, like planting vegetative buffers around streams on their land or converting marginal lands around a farm into native prairies. These strategies reduce runoff and erosion and promote wildlife habitats that benefit farmers and their neighbors.

Another way to increase nutrients in the soil is by integrating more legumes into a crop rotation. Legumes, like soybeans or peas, are "nitrogen fixing" crops, meaning they supply nitrogen into the soil. They don't require additional nitrogen fertilizer to be directly applied and can even add enough nitrogen to the soil to reduce the fertilizer requirements of other crops in the rotation.¹²

Importance of Nutrient Management

For farmers, nutrients are a way to reduce the risk of a low yield in a growing season, and decisions about nutrients are based on variable costs and agronomic conditions, making changing nutrient management strategies a risk for farmers. When considering nutrient management, farmers should evaluate the benefits of nutrient management, including:

- Reducing input costs.
- Decreasing reliance on volatile input markets.
- Preventing nutrient runoff.
- Protecting downstream and community water quality.
- Accessing emerging water quality credit markets.
- Protecting local ecosystems.

Learn More & Connect

For more information about protecting your company, contact your local Chubb Risk Engineer, email us at RiskEngineeringServices@chubb.com, or visit www.chubb.com/engineering.

Resources

Technical Guidance

- How to Get Started with Nutrient Management, www.farmers.gov/conservation/nutrient-management
- A Farmer's Guide to Nitrogen and Profitability, www.precisionconservation.org/a-farmers-guide-to-nitrogen-profitability/
- Nitrogen Use Efficiency: A Guide to Creating Your Own Assessment, uwdiscoveryfarms.org/wp-content/uploads/sites/1255/2020/07/NUE-A-guide-to-conducting-your-own-assessment.pdf
- Split Nitrogen Decision Support Tool, toolkit.climate.gov/tool/corn-split-nitrogen-decision-support-tool
- Sample Nutrient Management Plan, extension.umd.edu/sites/extension.umd.edu/files/2023-07/Showfelder_Complete_2024.pdf
- Find a Certified Crop Adviser, www.certifiedcropadviser.org/certifications/professional-search/

Funding Opportunities

- States with water quality goals may provide cost-share for farmers to adopt runoff-reducing practices through conservation programs or funds like:
 - Maryland's Agricultural Water Quality Cost Share, mda.maryland.gov/resource_conservation/pages/macs.aspx
- State and local opportunities can be identified through trusted organizations:
 - Find Your Extension Office, www.uaex.uada.edu/about-extension/united-states-extension-offices.aspx
 - Find Your Soil and Water Conservation District, www.nacdnet.org/general-resources/conservation-district-directory/
 - Find Your NRCS Office, www.nrcs.usda.gov/contact/find-a-service-center

1. Nutrient Management, www.farmers.gov/conservation/nutrient-management
2. Farming for Our Future, Environmental Law Institute. www.eli.org/eli-press-books/farming-our-future-science-law-and-policy-climate-neutral-agriculture
3. How Much Nitrogen Does Corn Get? aces.illinois.edu/news/how-much-nitrogen-does-corn-get-fertilizer-less-farmers-think
4. 5 Tips for Avoiding Nitrogen Injury Loss, www.farmprogress.com/corn/5-tips-for-avoiding-nitrogen-injury-loss
5. Managing Nitrogen Application During a Drought, www.no-tillfarmer.com/articles/10870-managing-nitrogen-application-during-a-drought
6. How Does Warm Winter & Spring Affect Nitrogen Availability for Upcoming Crop? www.no-tillfarmer.com/articles/13242-how-does-warm-winter-and-spring-affect-nitrogen-availability-for-upcoming-crop
7. Phosphorus Basics www.aces.edu/blog/topics/crop-production/understanding-phosphorus-forms-and-their-cycling-in-the-soil
8. What to Know About the Maximum Return to Nitrogen (MRTN) Approach, blog-crop-news.extension.umn.edu/2022/01/what-to-know-about-maximum-return-to.html
9. Farming for Our Future, Environmental Law Institute. www.eli.org/eli-press-books/farming-our-future-science-law-and-policy-climate-neutral-agriculture
10. Site-Specific Nutrient Management, www.cropnutrition.com/nutrient-management/site-specific-nutrient-management
11. This AI Tool Predicts a Crop's Future Growth, health, and Yield Based on a Single Image, www.anthropocenemagazine.org/2024/06/this-ai-tool-predicts-a-crops-future-growth-health-and-yield-based-on-a-single-image/
12. Legumes Can Reduce Need for Nitrogen Fertilizer, www.montana.edu/news/8289/legumes-can-reduce-need-for-nitrogen-fertilizer

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