

Nutrient Management

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As a young or beginning farmer, you may be raising crops to reduce feed costs or to sell. One of the important decisions in crop production is managing the nutrient needs of the crop you'll grow. If you apply too many nutrients and potential profits are reduced; supply too few and plant growth may be limited. Correctly managing nutrients can help you optimize crop production and achieve your farm goals.

How To Get Started

Many factors go into nutrient management. Understanding the soil is the first consideration since the properties and characteristics of the soil can greatly affect how pre-existing and added nutrients are available for the plant to use. Soil test results can tell you what nutrients are already present and if they are available to the intended crop. This is crucial information as you start to think about the amount, types and forms of nutrients needed overall.

A nutrition management plan is influenced by what the yield goals are and whether the soil needs to be built up. You'll also need to learn about the available forms of fertilizer. Using the information collected from both the soil and the available fertilizer options, you'll begin to create a nutrient management plan for the farm. Deciding how to apply the fertilizer completes the decision factors needed for a successful and profitable crop. Every few years, evaluate your nutrition management plan with repeated soil tests and recalibrate your plan to maintain optimal plant and soil health.

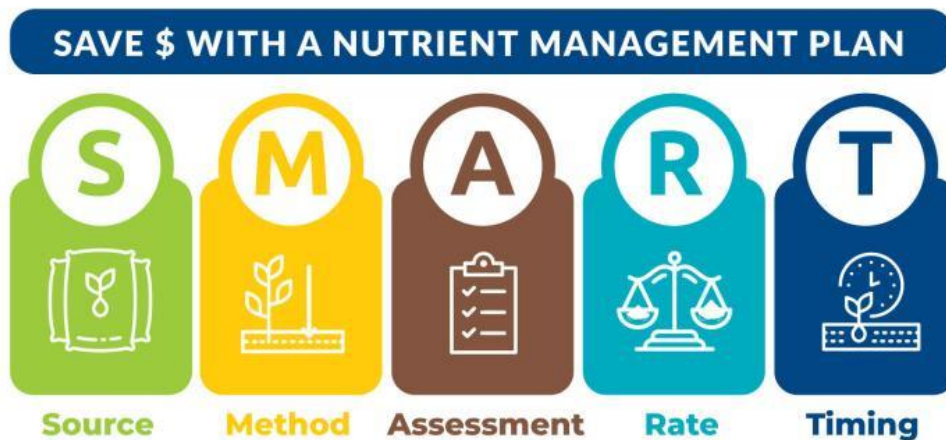


Figure 1. The USDA Natural Resources Conservation Service (NRCS) has a SMART nutrition management plan framework. It focuses on the source, method, assessment, rate, and timing of nutrient applications. Source: USDA NRCS (<https://www.nrcs.usda.gov/getting-assistance/other-topics/nutrient-management>)

Primary considerations

Source - Whether you use commercially produced fertilizer, manure, or compost, ensure that the fertilizer content matches your soil needs. Soil testing and plant tissue tests can inform your source selection. Keep in mind that your nutrition management program can only be as successful as the most limiting nutrient.

Not all compost is created equal! Composting can lead to issues with pest, disease, and weed pressure. Learn how to compost effectively before getting started. <https://compost.css.cornell.edu/>

Method - There are many methods of fertilizer applications. Consider how you will introduce the amendment into the environment. If you are planting perennial crops, it is significantly easier to make larger soil adjustments on bare ground before planting. Application methods can include injection, broadcasting, incorporating with tillage, fertigation, and foliar applications. For more information, visit the *TNAU Agritech Portal's Methods of Fertilizer Application* (https://agritech.tnau.ac.in/agriculture/agri_nutrientmgt_methodsoffertilizerappln.html).

Assessment - Successful nutrition management requires an understanding of the baseline soil conditions. Assess the baseline land conditions, such as water and air drainage, and submit a comprehensive soil test. This will inform your soil nutrient amendments and use of the land.

Soil testing can alert you to heavy metal or PFAS contamination in your soil before you get started. Soil components can inform you of your most successful use of the land. For example, pH can be difficult to make large adjustments to and different crops have different pH requirements to efficiently uptake nutrients.

Rate - Consider your base line nutrient availability, how your farming practices are impacting soil health, and the technology available to you when deciding rates. Rate calculations are highly dependent on the nutrient content of the product you are applying compared to the soil needs. For examples on rate calculations, visit Penn State Extension's *Calculations Used to Determine the Amount of Fertilizer Needed to Treat Turf* at <https://extension.psu.edu/calculations-used-to-determine-the-amount-of-fertilizer-needed-to-treat-turf>.

Timing - Nutrients should be applied when plants can uptake them. Consider whether spring, summer, fall, or split scheduled fertilizer timings are right for your crops. Rainfall can also have a significant impact on application success. For example, nitrate, a form of nitrogen readily accessible to plants, is water soluble and will leach out of soil. Available technology will also impact nutrient application timing.

- Fruit crops: <https://blog-fruit-vegetable-ipm.extension.umn.edu/2021/10/fertilizing-fruit-crops-in-fall.html>
- Row crops: <https://apps.msuextension.org/publications/pub.html?sku=4449-11>
- Vegetable crops: <https://monroe.cce.cornell.edu/resources/fertilizing-established-vegetable-gardens>

Process for getting started

As you get started with managing nutrition, it is important to understand plant nutrition fundamentals. This can include soil characteristics and nutrient movement.

Soil Characteristics

Soil pH and Nutrient Availability - Soil pH is KEY. Make sure you know your soil's pH- especially before planting. The pH of the soil impacts the nutrient's ability to move within the soil and into the plants.

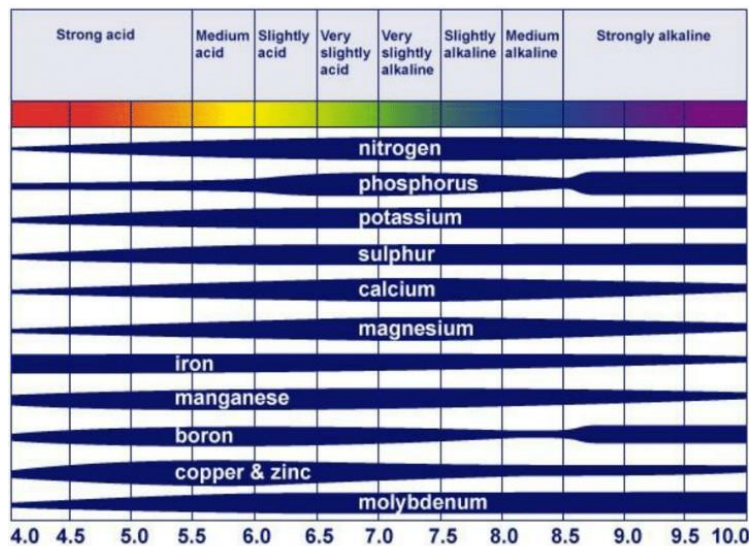


Figure 2. Review of the non-NPKS nutrient requirements of UK cereals and oilseed rape. Scientific Figure on ResearchGate available from: https://www.researchgate.net/figure/The-effect-of-soil-pH-on-nutrient-availability_fig2_277669269

Soil Texture - Inherent to your farm- can't really change. Texture greatly impacts water retention and cation exchange capacity (CEC). Check out your farm's soil texture here: <https://websoilsurvey.nrcs.usda.gov/app/>.

Soil Organic Matter - Hard to build, easy to lose. Prevent soil organic matter loss by putting more carbon in than you take out (ex. compost, manure etc.). Resources include:

- <http://nmisp.cals.cornell.edu/publications/factsheets/factsheet41.pdf>
- <https://extension.umn.edu/soil-management-and-health/soil-organic-matter-cropping-systems>

Cation Exchange Capacity (CEC) – CEC is largely dependent on your soil texture. The more organic matter in your soil, the higher the CEC value. Sandy soils often have low CEC levels, while Clay type soils have higher CEC levels. For more information, review: <https://ohioline.osu.edu/factsheet/anr-81>

Nutrient Movement

According to the Law of the Minimum, your crop can only perform as well as the most restrictive nutrient allows, even if all other nutrient needs are met. Addressing the holistic nutrient availability of your soil allows for maximum yields.

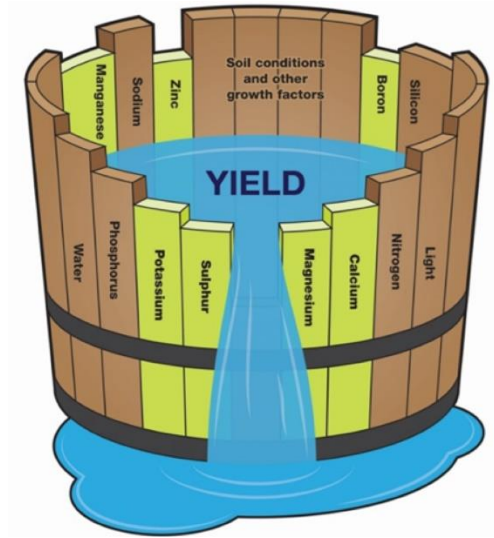


Figure 3. This old stave barrel shows if one board is short or missing, the barrel cannot be filled to its potential. Likewise, if any one nutrient is deficient, your crop cannot perform to full potential. (<https://andersonsplantnutrient.com/agriculture/market-feed/668>)

“Nutrients important for plant growth vary in their ability to move within the plant. Knowing how they move can be helpful when diagnosing deficiency problems,” per the article [Knowing nutrient mobility is helpful in diagnosing plant nutrient deficiencies](https://www.canr.msu.edu/news/knowning_nutrient_mobility_is_helpful_in_diagnosing_plant_nutrient_deficienc) (https://www.canr.msu.edu/news/knowning_nutrient_mobility_is_helpful_in_diagnosing_plant_nutrient_deficienc).

“Changes in root architecture, induction of root-based transport systems and associations with beneficial soil microorganisms allow plants to maintain optimal nutrient content in the face of changing soil environments,” per the [Plant-Soil Interactions: Nutrient Uptake Publication from Nature Education Knowledge](https://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112/) (<https://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112/>).

To learn about the importance of roots to nutrient movement, review [Chapter 3.3: Roots from The Science of Plants guide](https://open.lib.umn.edu/horticulture/chapter/3-3-roots/) (<https://open.lib.umn.edu/horticulture/chapter/3-3-roots/>) and [Vegetative plant parts from Oregon State University Extension Service](https://extension.oregonstate.edu/gardening/techniques/vegetative-plant-parts) (<https://extension.oregonstate.edu/gardening/techniques/vegetative-plant-parts>).

Disclaimer: For additional resources, view the Research & Recommendation Resources area of this section.

Common Questions for Nutrient Management

1. *How do I get a soil test?*

Soil tests are available through Michigan State University as well as multiple commercial companies. Be sure to review soil sampling procedures to get the most out of your test.

- <https://hometownsoiltest.msu.edu/get-started>

2. *When do I take a soil test?*

Soil test late fall or in spring prior to planting every 3-4 years. Regular testing ensures that your nutrient management plan continues to improve your soil health. Try to test at the same time each year. General rule of thumb: sampling in spring will give you an idea of this year's nutrients, sampling in the fall will give you a more long-term outlook on soil nutrition.

- <https://www.canr.msu.edu/resources/a-field-guide-to-soil-sampling>

3. *I got a soil test, now what?*

Once you have completed the soil test, it is time to decide on a course of action. Review the following resources on understanding soil test reports prior to making soil amendments. And never hesitate to reach out to a local extension office for help with interpreting the results.

- <https://www.canr.msu.edu/resources/the-anatomy-of-a-soil-test-report>
- <https://www.canr.msu.edu/fertrec/about/detailed-instructions>
- https://www.canr.msu.edu/foodsystems/uploads/files/soil_test_interpretation.pdf

4. *How do I calculate the required nutrition based on my soil test?*

Start with the example worksheets below to better understand how to calculate fertilizer rates.

- [Calculating Rates to Meet Fertilizer Needs Worksheet](#) by Benjamin Phillips, Michigan State University (https://drive.google.com/file/d/1P8wiXL7V7cr-TEenFSqDXAfqNaCkoSUs/view?usp=drive_link)
- <https://extension.psu.edu/calculations-used-to-determine-the-amount-of-fertilizer-needed-to-treat-turf>

5. *Where do I source fertilizers?*

Local agriculture stores and gardening centers have fertilizer. Consider your previous rate calculation when choosing ratios of products. Additionally, organic sources of fertilizer like manure will have lower rates of nutrition content.

When reading a fertilizer label, it will have three numbers that are usually referred to as the fertilizer analysis. These numbers represent the percentage of Nitrogen(N), Phosphorus(P), and Potassium(K) and will be presented in the format N-P-K. If there are any other nutrients outside of those, it will be listed further down the label. Experienced growers might refer to a fertilizer as its analysis so if someone says they applied 20-20-20, they're talking about their fertilizer!

Macronutrients & Micronutrients

Macronutrients and micronutrients are both required for plant growth and development. Macronutrients are required in larger quantities while micronutrients are needed in smaller amounts within plants.

Macronutrients

- *Nitrogen* - [Nitrogen in the Plant | MU Extension](https://extension.missouri.edu/publications/wq259) (<https://extension.missouri.edu/publications/wq259>)
- *Potassium* - [Elevate your knowledge of the potassium cycle | UW-Madison](https://cropsandsoils.extension.wisc.edu/articles/elevate-your-knowledge-of-the-potassium-cycle/) (<https://cropsandsoils.extension.wisc.edu/articles/elevate-your-knowledge-of-the-potassium-cycle/>) and [Potassium Uptake and Ohio Crop Response | OhioLine](https://ohioline.osu.edu/factsheet/anr-0147) (<https://ohioline.osu.edu/factsheet/anr-0147>)
- *Phosphorus* - [Understanding phosphorus fertilizers | UMN Extension](https://extension.umn.edu/phosphorus-and-potassium/understanding-phosphorus-fertilizers) (<https://extension.umn.edu/phosphorus-and-potassium/understanding-phosphorus-fertilizers>)
- *Sulfur* - [Sulfur | UMN Extension](https://extension.umn.edu/micro-and-secondary-macronutrients/sulfur-minnesota-soils) (<https://extension.umn.edu/micro-and-secondary-macronutrients/sulfur-minnesota-soils>) and [Crop Requirements for Sulfur Vary | MSU Extension](https://www.canr.msu.edu/news/crop_requirements_for_sulfur_vary) (https://www.canr.msu.edu/news/crop_requirements_for_sulfur_vary).
- *Calcium* - [Beware of Liquid Calcium Products | PennState Extension](https://extension.psu.edu/beware-of-liquid-calcium-products) (<https://extension.psu.edu/beware-of-liquid-calcium-products>) and [Understanding Plant Nutrients: Soil and Applied Calcium | UW-Madison](https://learningstore.extension.wisc.edu/products/understanding-plant-nutrients-soil-and-applied-calcium-p795) (<https://learningstore.extension.wisc.edu/products/understanding-plant-nutrients-soil-and-applied-calcium-p795>)
- *Magnesium* - [Magnesium for crop production | UMN Extension](https://extension.umn.edu/micro-and-secondary-macronutrients/magnesium-crop-production) (<https://extension.umn.edu/micro-and-secondary-macronutrients/magnesium-crop-production>)

Micronutrients

- *Iron* - [Understanding Plant Nutrients: Soil and Applied Iron | UW-Madison](https://learningstore.extension.wisc.edu/products/understanding-plant-nutrients-soil-and-applied-iron-p789) (<https://learningstore.extension.wisc.edu/products/understanding-plant-nutrients-soil-and-applied-iron-p789>)
- *Manganese* - [Manganese in Minnesota soils | UMN Extension](https://extension.umn.edu/micro-and-secondary-macronutrients/manganese-minnesota-soils) (<https://extension.umn.edu/micro-and-secondary-macronutrients/manganese-minnesota-soils>)
- *Copper* - [Copper for crop production | UMN Extension](https://extension.umn.edu/micro-and-secondary-macronutrients/copper-crop-production) (<https://extension.umn.edu/micro-and-secondary-macronutrients/copper-crop-production>)
- *Zinc* - [Zinc for crop production | UMN Extension](https://extension.umn.edu/micro-and-secondary-macronutrients/zinc-crop-production) (<https://extension.umn.edu/micro-and-secondary-macronutrients/zinc-crop-production>)
- *Boron* - [Boron for Minnesota soils | UMN Extension](https://extension.umn.edu/micro-and-secondary-macronutrients/boron-minnesota-soils) (<https://extension.umn.edu/micro-and-secondary-macronutrients/boron-minnesota-soils>)
- *Chloride* - [Chloride is Crucial for Crops! | UCONN Extension](https://publications.extension.uconn.edu/2023/05/15/chloride-is-crucial-for-crops/) (<https://publications.extension.uconn.edu/2023/05/15/chloride-is-crucial-for-crops/>)
- *Molybdenum* - [Soil and Applied Molybdenum \(A3555\) | UW-Madison](https://corn.aae.wisc.edu/Management/pdfs/a3555.pdf) (<https://corn.aae.wisc.edu/Management/pdfs/a3555.pdf>)

Research & Recommendation Resources

Soil Testing

- <https://homesoiltest.msu.edu/get-started>
- <https://www.canr.msu.edu/resources/a-field-guide-to-soil-sampling>
- <https://www.canr.msu.edu/resources/the-anatomy-of-a-soil-test-report>
- <https://www.canr.msu.edu/fertrec/about/detailed-instructions>
- https://www.canr.msu.edu/foodsystems/uploads/files/soil_test_interpretation.pdf

Nutrient Movement

- https://www.canr.msu.edu/news/knowning_nutrient_mobility_is_helpful_in_diagnosing_plant_nutrient_deficiency
- <https://www.nature.com/scitable/knowledge/library/plant-soil-interactions-nutrient-uptake-105289112/>
- <https://open.lib.umn.edu/horticulture/chapter/3-3-roots/>
- <https://extension.oregonstate.edu/gardening/techniques/vegetative-plant-parts>

SMART Nutrition Management

- <https://www.farmers.gov/conservation/nutrient-management>.

Northeast Region Certified Crop Adviser Nutrient Management Study Materials

- <https://nrcca.cals.cornell.edu/nutrient/CA2/index.php>

Cornell Soil Science Full Course

- <https://www.youtube.com/playlist?list=PLs7Y2nGwfz4HPoRAaB64c-MdF1kK-P-Wy>

A Guide to Understanding Fertilizers

- <https://extension.oregonstate.edu/gardening/techniques/guide-understanding-fertilizers>

Crop Nutrition 101

- <https://cropsandsoils.extension.wisc.edu/articles/crop-nutrients-101/>

Cornell Nutrient Management Program

- <http://nmsp.cals.cornell.edu/guidelines/nutrientguide.html>

Cornell Soil Health Assessment Training Manual

- https://www.canr.msu.edu/foodsystems/uploads/files/cornell_soilhealth.pdf

Fertilizer Rate Calculation

- <https://extension.psu.edu/calculations-used-to-determine-the-amount-of-fertilizer-needed-to-treat-turf>

Fertilizer Application Methods

- https://agritech.tnau.ac.in/agriculture/agri_nutrientmgt_methodsoffertilizerappln.html

Building Soils for Better Crops

- <https://www.sare.org/resources/building-soils-for-better-crops/>

SARE Soil Health Resources

- <https://www.sare.org/publications/what-is-sustainable-agriculture/soil-health/>

Nutrient Application Timing

- <https://apps.msuextension.org/publications/pub.html?sku=4449-11>

Composting Resources

- <https://compost.css.cornell.edu/>

Industry Partners & Organizations

- Sustainable Agriculture Research and Education (SARE) - <https://www.sare.org/>
- USDA-NRCS: National Resources Conservation Service - <https://www.nrcs.usda.gov/>