Learning Series: Nutrient Cycling

What to Expect from this Resource

In the early months of 2025, the Regenerative Organic Oats (ROO) program hosted a series of virtual gatherings that created farmer-to-farmer learning opportunities focused on key topics in regenerative organic agriculture. This resource shares the experiences, insights, and advice of ROO farmers on nutrient cycling, highlighting multiple approaches to increasing nutrient cycling in a regenerative organic system. Explore this resource to gain first-hand insights into real-life scenarios and discover approaches that might be a perfect fit for your own context.

A Quote About Soil Health

"*Soil health is closely tied to human health. By enhancing soil health, we cultivate healthier food and ecosystems. Treating food as medicine, we aim to regenerate both soil and human health, fostering nutrient-dense farming systems that support our overall well-being.*" - Ruth Knight

Understanding Nutrient Cycling

Nutrient cycles are ecological processes that are closely tied to other ecosystem functions, such as energy flow, the water cycle, and community dynamics. To really understand how nutrient cycling works (i.e., how nutrients move from the soil to the plants), you need to recognize how the cycles depend on these interconnected processes. For example, if the water cycle is disrupted, nutrient cycling will also be affected.

Nutrient Cycling Goals

The first step in understanding nutrient cycling is figuring out what your goals and objectives are.

- How are you managing your nutrients?
- Are you focused on making sure you have enough to reach your target yield, or are you also considering whether you need extra nutrients to support soil health?
- Do you want to improve crop development or boost microbial systems?
- Are you planning on managing nutrient toxicity (e.g., excess of a certain nutrient that might be causing stunted growth, tissue damage, etc.)?

It is important to think about how your approach balances productivity and profitability, while also considering the ecology and overall care and function of the system.

Goal Setting with Crops in Mind

When setting goals, make sure nutrient additions align with your crops' needs. Timing is crucial; nutrients must be available when crops need them most, which is especially important in organic production. The goal is to direct nutrients to the crops, not the weeds.

Placement and Timing Considerations
Strategic placement and timing of nutrients are key, particularly for crops that need a lot. If the timing is off, weeds may take those nutrients instead. Timing is also critical when using cover crops or green manures, especially during transition stages. Properly managing decomposition ensures nutrients are released at the right time to support the next round of crops. If mismanaged, excess nutrients can accumulate, thereby disrupting the system.

Different Approaches to Nutrient Cycling

In nutrient management, there are different approaches to take: feed the soil, feed the biology, or directly feed the plants. There are several ways to amend nutrients and improve soil health. These can include adding green manures, cover crops, livestock manures, or integrating livestock into the system. Mineral or biological soil amendments, such as compost extract for soil application, compost tea for foliar application, or seed inoculants, can introduce beneficial biology into the system. Additionally, management practices like reducing or properly timing tillage are essential in preventing nutrient loss caused by soil erosion or degradation.

Unlocking Nutrient Potential
It is often said that our soils have plenty of nutrients (hundreds or even thousands of pounds), but they are "locked up" and not accessible to plants. Instead of constantly adding more inputs, the focus should be on unlocking those nutrients. In certain cases, adding a bit of something to get things started makes sense from an economic standpoint. But the real goal should be to get the soil biology to do the work of making those nutrients available to the plants.

Monitoring Nutrient Cycling

Why invest in monitoring? The primary reason is to eliminate guesswork and ensure you are addressing exactly what is needed. A common issue is nutrient bias, or an overemphasis on adding more nutrients to improve soil and plant health. This approach assumes that the problem is always related to nutrient levels or cycling, but that is not always the case.

Monitoring the Ecological Processes
The nutrient cycle is just one part of a much larger system. While it is important to monitor this

cycle, we must also consider other interconnected processes. For example, if the water cycle is not functioning properly, plants will not be able to access the nutrients already present in the soil. Monitoring helps you see the system as a whole, not just individual components.

An Example of Nutrient Cycling Deficiency
A great example of ineffective nutrient cycling due to inefficient water cycling is blossom end rot in tomatoes. The most common conclusion that most people consider is a calcium deficiency, which is both right and wrong. The deficiency is that the calcium cannot reach the tomato due to lack of water or inconsistent watering. However, adding calcium to the soil will not help because it is not due to a lack of calcium in the soil, just the inability for the plant to access it.

Monitoring as a Holistic Tool
A challenge with organic amendments is that they may not always be perfectly suited to your specific needs. For example, you might add phosphorus to address a deficiency, but the amendment could also introduce excess potassium, creating a new imbalance in the soil. This could solve one problem but cause another. Monitoring helps pinpoint these issues, providing the data needed to assess the system as a whole and make adjustments where necessary.

What Producers Are Doing in the Field

The material discussed in the following slides was compiled in a producer-centric gathering in Spring 2025. In these slides, we share the perspectives of ROO farmers regarding their experience with monitoring the nutrient cycle and how they have adapted their farm management based on their learnings, successes, and challenges. Each farmer's context is completely unique and emphasizes the necessity to apply changes within your own management based on your own context.

Saskatoon, SK
A ROO participant from Saskatoon, SK noticed nitrate spikes during his sap analysis when he was foliar spraying fish and molasses, which also seemed to boost weed pressure. Mixing fish with humates in a previous year helped reduce the spike. He has recently applied compost extracts low in fish and high in micronutrients to Faba beans; he saw better results in oats, but wild mustard seemed to respond more than the crops. He is still unsure what is driving the nitrate spikes and losses, and he is exploring how microorganisms, like protozoa and nematodes, might help improve nitrogen cycling. He is also interested in modeling how young plants take up and release nitrates.

Liberty, SK
ROO participants from Liberty, SK are just beginning to explore nutrient cycling by under-seeding cover crops with cash crops, including legumes, to help cycle nutrients and manage nitrogen levels. They are also dealing with weed pressure, like wild mustard, in some fields.

Shellbrook, SK
A ROO participant from Shellbrook, SK has struggled with wild mustard in the past when using pure alfalfa as a cover crop, which was likely due to high spring nitrogen. He later mixed in more grass with the alfalfa and saw a noticeable improvement; the wild mustard came on later and was better controlled. He also applied cattle manure with a lot of straw but did not see the expected benefits the following year, possibly due to nutrients getting tied up during straw decomposition. The manure seemed high in bacteria and low in fungi. He is curious about how to better balance this and increase fungal presence in the soil.

Balcarres, SK
A ROO participant from Balcarres, SK received monitoring results that confirmed low potassium and phosphorus levels, which led to his interest in trying green manure as a possible way to build those nutrients, though he is still unsure about its effectiveness. Nitrogen levels were better than expected. He is also exploring a new idea for black beans; since there is no inoculant available, he is considering using soil from the 2025 crop area to make a microbial tea for next season. He is curious if others have experience with that approach.

Pigeon Lake, AB
A ROO participant from Pigeon Lake, AB tried soft rock phosphate but did not see much difference, and he still uses calcium. He is hoping it is helping, but remains unsure. He is inspired by Christine Jones' message that having a diverse mix of plants builds a healthy soil microbiome, and when that happens, the system begins to take care of itself, which reduces the need to manage nitrogen or phosphorus. That idea really stuck and has guided the shift over the past few years toward more plant diversity and cover crops. Interestingly, his sap analysis shows nutrient levels are good, even though soil tests report low calcium, phosphorus, and sulfur. Somehow, the plants are still getting what they need, which is suggesting that the biology is making those nutrients available.

Putting Soil and Foliar Tests Into Context

Lab results can be hard to interpret, and they do not always translate easily into practical next steps. As one farmer put it, "I'd never done a soil test in my life before last year. So now I see all these numbers... and they're just that — numbers. It's kind of like a speed limit sign. Sure, it's a number, but what does it actually mean or where should it be?"

Understanding Test Results
The true first step to understanding test results is putting aside all the numbers and identifying the challenges you are seeing in field. For example, if your plants are not showing signs of nutrient deficiency, does pursuing a result of "low nutrient x" accomplish anything? When one test shows

good values and another shows poor ones, you should ask: Does this make sense based on what I'm seeing in the field? Think about the crop performance in those areas. Are the test results aligned with what you are actually getting from the crop?

Deep Roots Access Hard-to-Reach Nutrients
Nutrients can move deeper into the soil profile, so they might not appear in topsoil tests but could still be present and available in the subsoil. Rather than assuming a deficiency and adding more nutrients (which can lead to overapplication), the focus should be on how to access what is already there. Deep-rooted crops can help pull those nutrients back into the upper root zone where they are more available to other plants. If the plant's roots go deeper than the top six inches, it may access nutrients like sulfur or nitrogen from deeper layers of the soil profile. Alternatively, plants with shallow roots may share nutrients with neighboring plants that have deeper roots, helping them access what they need.

Comparing Lab Analyses
Different labs use different methods to test for micronutrients in the soil. For example, a bicarb test is often used to measure phosphorus in the soil, while a malic test is commonly used for micronutrients like boron and zinc. These tests involve using specific solutions to "extract" the nutrients from the soil so they can be measured. However, different labs may use different methods, and this can affect how the results compare. If you do not know which method was used, it can be hard to compare results accurately.

Lab Consistency
It is helpful to compare results from the same lab at the same time each year. By using the same lab year after year, you can track changes in your soil. However, if you switch labs, the results may not be directly comparable because each lab might use slightly different testing methods.

Refractometers as Monitoring Tools
A refractometer is a helpful tool for checking plant health, and it can be used to compare different plants, even weeds. It helps farmers understand how plant root systems and plant types affect their ability to take up nutrients, especially depending on the depth and function of their roots. The refractometer can also help track changes in nutrient levels over time. Learn more about Brix and refractometers here.

Circular Farming: Nutrient Budgeting

The Conservation Learning Center studied how much phosphorus alfalfa pulls up from the soil. The results showed that alfalfa is very effective at scavenging phosphorus. When alfalfa is harvested as hay, the phosphorus that is pulled up is exported from the system. If you are green

manuring (leaving alfalfa to decompose in the field), this process helps break down unavailable phosphorus, making it more accessible for future crops.

What Is Circular Farming?
The key question is whether enough nutrients (e.g., phosphorus) remain in the soil to support continued cropping once soil biology has made them accessible. The ideal approach is circular farming, where nutrients are recycled within the system (e.g., through green manure), and management practices are effectively implemented to replenish the soil.

Traditional vs. Biological Approaches to Nutrient Cycling
Traditional approaches focus on adding external inputs, assuming that nutrients need to be replaced each time they are removed from the system. Biological approaches focus on enhancing soil biology to make better use of the nutrients already in the soil, reducing the need for constant additions. The goal is to strengthen the natural processes in the soil to unlock and recycle nutrients.

Managing Nitrogen

Nitrogen is released into the soil mainly through the breakdown of organic matter, but its availability also depends on things like microbial activity, moisture, and temperature. As plants grow, their demand for nitrogen increases. The big question is whether the nitrogen in the soil can keep up with the plant's growing needs.

Tillage and Nitrogen
Tillage can also affect nitrogen levels. When soil is disturbed, it can release nitrogen in two forms: one is in a gas form that escapes into the air, and the other is nitrate, which is water-soluble and can be absorbed by plants. Tillage increases specific microbial activity, which breaks down organic matter in the soil and releases nitrogen. This can lead to a burst of nitrogen, which might encourage weed growth.

Nitrate in Soil Tests
Sometimes, soil tests show that there are low nitrate levels, but that does not always mean the plant is lacking nitrogen. The soil may also have nitrogen in ammonium form or as part of organic matter that is not immediately available to plants. Therefore, low nitrate levels in a soil test do not always reflect the total nitrogen available to plants, as nitrate is just one part of the picture. But remember, nitrogen does not have to be available to plants in plant available forms at all times. It can be held in the soil and in the bodies of microbes in other more stable forms, and then released when the plant needs it. In this way, apparent deficiencies are (in reality) non-existent.

Nitrogen in a Plant Life Cycle

Early tissue or sap analysis is useful when the plant is small; in the early leaf stage, testing early can catch nitrogen problems. When plants are small, they have not grown enough to make their own adjustments, so if the plant is lacking nitrogen early on, you will see the deficiency in a tissue or sap test. As the plant grows, it gets better at using the nitrogen it has. If the plant had a deficiency earlier, it might not show up later because the plant adjusts to what it has available, and the plant may be fine even though it seemed deficient at first. This begs the question: if the plant is able to adjust, why should you care that it had an early season deficiency?

How Plant Roots Indicate Nitrogen Problems

It is also important to look at a plant's root system to identify nitrogen problems. Even if there is enough nitrogen in the soil, a plant with a weak or small root system may not be able to take up all the nutrients it needs. This could be why a plant looks like it is lacking nitrogen when, in reality, the problem is that the roots are not working properly to absorb the available nutrients. In addition to checking the plant's sap, taking a soil sample from the root zone to assess the nutrient levels in the soil can provide valuable insight.

Soil Sampling Throughout the Season

Testing throughout the season, instead of relying on a single test, is essential because it allows you to track how nutrient levels evolve as the plant grows. This ongoing testing gives you a more comprehensive understanding of how nutrients are interacting with the plant at different stages of growth. Relying on just one test can lead to limited insights, while consistent testing over time ensures a more accurate and informed interpretation of the plant's nutrient needs and soil health, offering a clearer, more complete picture of the plant's overall nutritional status.

Reflections and Takeaways

Modeling nutrient cycling in biological farming is a big riddle and requires more thought. There is a need for more data and science-based studies (particularly nitrogen label studies) to better understand the transfer of nutrients and the cycling of nitrates and ammonium. Nutrient cycling was once less of a concern, as organic farmers do not rely on synthetic nitrogen, phosphorus, or potassium inputs. However, nutrient cycling is now recognized as a valuable monitoring tool. If land management practices are effective, nutrient cycling should be reflected in soil and plant analyses. It can then serve as a guide, rather than a tool for deciding which nutrients need to be added. If the soil biology is functioning properly, there may not be a need for additional actions.