# Nitrogen Efficiency Program

## Practical Steps for Profitable Nitrogen Management

**Advancing Eco Agriculture**

*Helping growers make more money with regenerative agriculture since 2006*

Advancing Eco Agriculture manufactures and sells liquid, mineral plant nutrition products and offers a range of biological treatments that can help produce healthy plants and soils to bring more quality and yield to your operation.

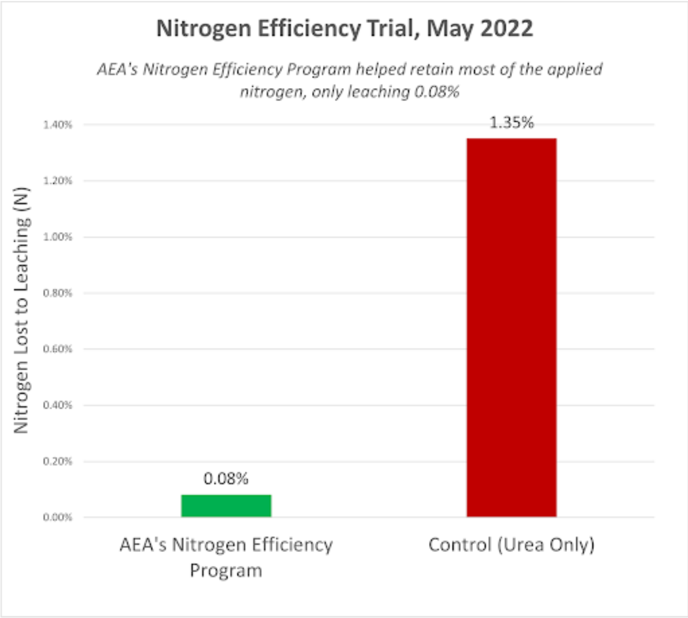
This booklet presents in-depth information about how to reduce and/or get the most out of nitrogen inputs. Additionally, AEA provides consulting services to guide the creation of custom crop nutrition programs and solutions for your operation.

# NITROGEN EFFICIENCY PROGRAM

## The 4 Rs

The rise in fertilizer costs is of increasing concern. With AEA's Nitrogen Efficiency Program, growers can work smarter to reduce nitrogen usage, save money, and farm regeneratively.

The framework of the 4 Rs—***right source, right rate, right time, and right place***—is a useful concept when strategizing to maximize fertilizer efficiency.




In a simulated rain event, AEA's Nitrogen Efficiency Program helped retain most of the applied nitrogen, only leaching 0.08%

# Right Source

## Not all forms of nitrogen are created equal

Each source of nitrogen you apply will be utilized differently by plants and soil biology. One form of nitrogen will produce completely different crop responses than another.

**Protein nitrogen** is unquestionably the ideal and most efficient from of N for plants. Microbial amino acids and proteins can be plant-absorbed directly from the soil or leaf surface. Microbial populations fix atmospheric N and process residual biomass N free of charge. Accessing biologically stable nitrogen is an integral aspect of a regenerative agriculture approach. Fields with higher microbial activity often require only a fraction of the applied N to produce an equivalent response as fields applied with high rates of conventional nitrogen sources.

AEA's **SeaShield** can deliver protein-form N as foliar or soil applications. There are many other organic materials that also help fill this need, including compost, manure, plant-based fermented amino acid products, fish hydrolysates, and corn steep liquor. These forms usually require no buffering or additional practices to enhance their efficacy. They deliver a stronger response per unit of N, but are not as concentrated as most of the conventional sources that follow.

***No matter the form applied, more N remains in the soil when bound or used by living things or soil carbon.***

**Urea** is the second most efficient form of nitrogen for most crops. Dry urea has a high potential for volatilization and must be applied in a timely fashion (see Right Time below) and with the right soil moisture. It may be hard to find in some regions.

While it *seems* more expensive, the per unit cost of urea is balanced by the fact that much less plant energy and water is required to convert amine nitrogen into complete plant proteins than other synthetic forms, and causes relatively little adverse effects on soil microbes.

***These biological facts underpin the efficiency and value of urea.***

Additionally, dry urea can be liquified on the farm. This "melted" urea can then be combined with nitrogen efficiency-enhancing materials, like AEA's **Rebound Molybdenum** and **HumaCarb**, and applied in multiple smaller shots for more efficient uptake.

Methods for liquid application include broadcast, knife-in, 2x2, side-dress, or foliar applications at very light rates.

*Beware of urea stabilizers that contain biological suppressors like formaldehyde.*

**Ammonium** is the third most efficient form of nitrogen for crop metabolization. NH4 fertilizers saturate the market, including dry ammonium sulfate and liquid UAN 28% or 32%. Ammonium thiosulfate (ATS), conveniently provides both NH4 and sulfur. Ammonium is not inherently hard on biology when used in moderation.

***Anhydrous ammonia is detrimental to soil biology and is not recommended as part of a biologically friendly approach.***

Application rates of soluble ammonium N in excess of what a crop can immediately use are enhanced by the addition of AEA's **Rebound Molybdenum** and **HumaCarb** to extend plant availability and buffer negative results to soil biology.

**Nitrate** is the most quickly absorbed, but least efficient form of N for crops to metabolize. Plants use a significant amount of their photosynthetic energy to convert nitrate to amino acids and proteins. When a corn crop absorbs 80% of its N requirement as nitrate, it requires 16% of its total photosynthetic energy just for nitrate conversion. Also, three times more water is used to convert nitrate to amino acids compared to ammonium.

***If utilizing nitrate N, it is crucial to maximize nitrogen efficiency practices.***

Molybdenum is the critical enzyme cofactor of the nitrate reductase enzyme and is entirely responsible for converting nitrate into plant and microbial proteins. **Rebound Molybdenum** may be needed at increasing rates corresponding to applied nitrate volume. **HumaCarb** slows the rapid release of nitrate into soil systems.

No matter the form applied, N only remains in the soil when bound or used by living things or soil carbon. Ensure complete nitrate conversion by including **Rebound Molybdenum.** Stabilize free nitrogen in the tank by compounding it with the humic substances found in AEA's **HumaCarb**. Use **Rejuvenate** to promote quick microbial banking of N.

Using the right source is the first step to confidently reducing applied nitrogen.

### A Note About Sulfur

Nature maintains a balance of 10 parts N to 1 part sulfur. All living things need sulfur in order to transition nitrogen into proteins and disturbing that balance results in loss of biology, carbon, and nitrogen. It is important to always include a minimum of 1 part sulfur for every 10 parts nitrogen applied. There are many sulfur-containing products and minerals that satisfy this need, including gypsum, magnesium sulfate, ammonium thiosulfate (ATS), and any sulfur-containing product.

# Right Rate & Right Time

## Application rates and timing are inseparable

Applying nitrogen during the most demanding vegetative growth phases makes sense. Practically, however, this means there is a very tight window for applications, which strains equipment and labor capacity. Long-term soil health improvements, input savings, and crop quality gains can more than offset the costs and effort incurred by operational changes.

Seeds require no nitrogen and seedlings need only very small amounts. From review of hundreds of plant sap samples, we know that corn does not require supplemental N until V4/5. Because winter wheat grows fastest in mid-spring, that is when to apply N, not during fall or winter. Strong vegetative growth phases can better handle surplus rates of nitrogen, but excess N is highly undesirable for seedlings or senescing plants.

All fruit and vegetable crops have their own specific nitrogen needs for both rate and time. Nitrogen-fixing plants like legumes and alfalfa may not need any applied nitrogen fertilizer. Greens respond best to frequent small doses of nitrogen when in the rapid vegetative state. Potatoes thrive with as much as 50% of their nitrogen applied at planting. Cucumber and tomato vines are simultaneously reproductive and vegetative and prefer a steady rate throughout the season. Our experience at AEA indicates that nitrogen is commonly over-applied on commercially grown crops, including nut and fruit trees. This invites many common disease and insect issues. **Plant sap analysis** confirms nitrogen need at each growth stage for your unique crop.

***Do not apply more nitrogen than soils and plants can use before it is volatilized, compounded, or washed away. This advice stands the test of time and is all the more important as economic and environmental costs rise.***

# Right Place

## Soils, roots, and leaves all accept nitrogen

The right place for nitrogen is in the crop itself. Soil nitrogen is only relevant to the degree that it results in plant utilization. With this in mind, we are free to explore all pathways for uptake, including: dry and liquid soil applications; foliar applications; side-dressing; biological production from nitrogen-fixing bacteria; fungal activity; release from soil organic matter; manures; and crop residues.

***Soil applications are convenient for many growers' equipment and yearly rhythm, but it may make little sense to apply all needed nitrogen to the soil itself.***

Roots directly absorb nitrate as a soluble ion, but this highly volatile form is relatively unstable and inefficient. A more holistic and energy-efficient mechanism of root uptake is through the **rhizophagy cycle** in which roots directly strip nitrogen (and many other compounds) from living microbes, which are then cycled back into the soil along with root exudates to spur further uptake.

Microbes accumulate nitrogen to build their proteins and that N, in turn, is fed back to plants naturally. Diverse populations of microbes in the immediate vicinity of applied N can mop up excess nitrogen, preventing loss to the atmosphere and allowing later release to roots. This biological processing and management is why we often suggest soil inoculants (as in the **Regenerative Soil Primer**) to be included in, or close to, an early nitrogen application.

***The best temporary storage for soil-applied nitrogen is in living microbial populations.***

Typical side-dressing, streaming, or drip-line fertigation placement at the root zone supplies N during vegetative periods. Pivot or sprinkler applications are best considered as soil fertigation, with slight foliar benefit. When N applications are adjusted throughout seasonal growth stages, and in reach of active roots, efficiency is maximized.

With access to foliar applications and near real-time testing via plant sap analysis, the most efficient placement of N is possible. Plant stomata absorb N quite well, but in limited amounts at a time. It is recommended to use protein or amino acid forms of N for foliar applications as they have little chance of "burning" the crop compared to synthetic forms, which must be used with great care on leaves.

A typical rate of application of foliar N is in the range of 1-5 lbs per acre.. This may seem an insignificant contribution to total N requirements, but because of the immediate uptake, and energy-efficiency of conversion to plant proteins, foliar N is much more effective pound for pound. Nitrogen can also be incorporated with other needed nutrients in the same spray.

# Summary

AEA's Nitrogen Efficiency Program makes best use of expensive inputs. By complexing nitrogen with soil biology and minerals, a steady release of N is provided in accordance with crop demand. This can reduce the dependency on and total cost of nitrogen inputs while promoting biological symbiosis with plant roots.

- Use the most efficient forms of nitrogen available.
- Test for residual soil N, and only apply as and when needed.
- Utilize the best mix of N placement practices to get N exactly where it needs to be.
- Apply nitrogen just prior to or during appropriate vegetative development phases.
- Provide beneficial microbial inoculants like **BioCoat Gold** and **Spectrum** to harvest free N through productive and diverse soil biology.
- Support increased N utilization through photosynthesis by addressing whatever photosynthetic minerals are limited, including magnesium, manganese, iron, and phosphorus.
- Maintain at least 1 lb of sulfur for every 10 lbs of nitrogen in order to hold and convert N to plant proteins.
- Ensure applied N volumes can be rapidly consumed by plant and/or soil microbial populations.
- Increase plant diversity and the time soil spends in plant cover to support continuous microbial habitat and carbohydrate sources.

# Determining Nitrogen Use

While it is not realistic to make universal recommendations given the wide variability in soils, crops, and management practices, we commonly observe that many growers are able to reduce nitrogen application rates by 30%-50% from conventional recommendations in the first year. Yet, these growers are able to produce the same or higher yields.

This calculation works in the majority of situations, but the specific application rates may vary according to practice and need. For farms that have already reduced N significantly through no-tilling, cover cropping, and soil health practices, reductions of 5-25% may be more appropriate.

## AEA's Nitrogen Efficiency Program

The rates are calculated according to this formula:

- **X** = total amount of nitrogen product, not units of **N**
- Maintain 10:1 nitrogen to sulfur ratio unit per unit
- 1 pint **Rebound Molybdenum** (per acre)
- 3% of **X** as **Humacarb**
- 3% of **X** as **Rejuvenate** (optional)

### To Find X:

1. Assess current nitrogen soil inventory through Haney Analysis or estimated nitrogen release soil test, including any nitrogen credits from cover crop, compost, and residues.

2. Reduce the total crop nitrogen plan to the degree you are comfortable (5-50%).

3. Subtract soil nitrogen credits from the nitrogen plan to find applied nitrogen units/lbs needed.

4. Translate from N units to volume of fertilizer material used, as the formula below is based on total product volume—not units/lbs of nitrogen.

***Example A*** - Applying a side-dress of 30 gallons of UAN 28:

- 30 gal UAN 28
- 10% S:N ratio = 3.2 gal of ammonium thiosulfate (ATS 12-0-0-26S)
- 1 pint **Rebound Molybdenum**
- 3% of 33.2 gal = 1 gal **Humacarb**
- 3% of 33.2 gal = 1 gal **Rejuvenate**

***Example B*** - Applying a foliar of 6.75 units of N as liquified urea (21-0-0):

- 8.5 gal of liquified urea
- 10% S:N Ratio = .675 lbs of sulfur, or 1.5 pints of ATS
- 1 pint **Rebound Molybdenum**
- 3% of 8.69 gal = 1 quart **Humacarb**
- 3% of 8.69 gal = 1 quart **Rejuvenate**

***Example C*** - For a 1600 gallon pre-mixed nurse tank, using urea:

- 1000 gal Water
- 55 gal of ATS
- 4000 lbs urea (low biuret)
- 48 gal of **Humacarb**
- 48 gal of **Rejuvenate**

# Ready to get started?

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