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Agricultural Utilization Research Institute

Liquid Soybean Meal Fertilizer Market Assessment

Final Report

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Executive Summary

The Agricultural Utilization Research Institute (AURI), with the support of the Minnesota Soybean Research and Promotion Council (MSR&PC), assessed the market potential, performance, and commercialization opportunities for liquid soybean meal (SBM) fertilizers derived from Minnesota-grown soybeans. The goal was to evaluate whether these bio-based fertilizers can compete with conventional synthetic inputs in horticulture and controlled environment agriculture (CEA), and to identify how Minnesota can leverage its strong soybean processing base to capture value in this emerging segment.

Liquid fertilizers dominate nutrient delivery in greenhouse, nursery, and CEA systems because of their precision, compatibility with fertigation, and labor efficiency. However, most are synthetic products with high salt content and significant carbon footprints. Soy-based liquid fertilizers—produced from soybean meal, isolates, or soapstock—offer a lower-salt, renewable alternative that can enhance microbial activity, plant health, and soil quality. The project's objective was to determine current market conditions, performance potential, and the infrastructure requirements to scale a Minnesota-grown, Minnesota-made biofertilizer platform. The project combined:

- **Industry analysis:** Review of fertilizer industry literature and trade data to identify trends, competitors, and price points.
- **Stakeholder interviews:** Twelve interviews with formulators, distributors, trade editors, and growers in horticulture and CEA to gauge market attitudes.
- **Demonstration trials:** Side-by-side testing of Nature's Source (oilseed extract) and Ferticell (soy protein isolate) products at three Minnesota sites—University of Minnesota West Central Research and Outreach Center (Morris), Green Barn Garden Center (Isanti), and Riverside Farms (Elk River).
- **Outreach and promotion:** Exhibitions at the Minnesota Ag Expo, Farmfest, Big Iron, and Northern Green, supported by podcasts, media coverage, and educational materials to build awareness.

Key Findings

Performance: Both soy-based fertilizers achieved comparable growth and nutrient uptake to conventional synthetics when applied at approximately 150 parts per million (ppm) nitrogen (N). Issues such as biofilm formation were minor and operationally manageable.

- **Market awareness:** Among growers and distributors, awareness of soy-based fertilizers remains very low. Product choice is typically driven by nutrient content and reliability rather than brand or feedstock origin.
- **Demand drivers:** Adoption potential is greatest among segments emphasizing organic production, regenerative agriculture, and sustainability performance claims (e.g., CEA, turf, and high-value horticulture).
- **Market size and growth:** The current market share for soy-based liquid fertilizers is estimated below 0.25% of total liquid fertilizer use in Minnesota, equivalent to 21,000–29,000 bushels of soybeans per year by 2029. Despite its small scale, the segment is growing as environmental and low-salt alternatives gain traction.
- **Feedstock readiness:** Minnesota has abundant crush and soy protein capacity capable of supplying isolates, flours, and soapstock for fertilizer formulations, with multiple processors and biodiesel coproduct streams already available.
- **Commercial engagement:** Manufacturers such as Nature's Source, Ferticell, and AminOrganiX have demonstrated viable product lines and interest in expanding sourcing from Minnesota, particularly if new local manufacturing capacity is developed.

Opportunities and Gaps

- **Formulation innovation:** Need for optimized nitrogen and micronutrient blends tailored to specific crops and fertigation systems.
- **Demonstration expansion:** Growers remain hesitant to change established nutrient programs without clear side-by-side performance and cost data.
- **Standardization:** Fertilizer-grade specifications for soy meal and soapstock must be defined to ensure consistent quality across suppliers.
- **Manufacturing:** The absence of regional blending and concentration facilities for soy-based liquid fertilizers limits scalability and adds freight cost. There is growing interest in the Midwest region for soy-based liquid fertilizer manufacturing and blending within the

emerging soy-derived liquid fertilizer industry. Minnesota has soy crush facilities able to supply the raw ingredients for soy-derived liquid fertilizers.

- **Market education:** Clear application guidance, nutrient equivalency charts, and distributor training are required to overcome skepticism among CEA operators.

In conclusion, soy-based liquid fertilizers offer a credible and sustainable alternative for horticultural and CEA markets. While the current market is small, its growth potential is significant, particularly if tied to new Minnesota-based manufacturing investments that convert local soy feedstocks into high-value, ready-to-use fertilizer concentrates. Minnesota's robust soy crush infrastructure, combined with its leadership in bioindustrial innovation, uniquely positions the state to capture a growing share of the national market—delivering premium, renewable fertilizers that enhance economic returns for soybean growers, bolster rural employment, and strengthen the state's role in advancing low-carbon agricultural inputs. To advance commercial readiness, AURI recommends:

- **Formulation and Performance Optimization:** Conduct controlled research to refine nutrient balance, viscosity, and storage stability while quantifying nitrogen equivalence.
- **Demonstration and Validation:** Expand multi-site trials in greenhouse and CEA operations to generate comparative data on yield, quality, and cost.
- **Feedstock and Manufacturing Development:** Undertake a techno-economic analysis for a Minnesota blending and concentration plant (1–3 million gallons per year) and establish fertilizer-grade quality standards for soy meal and soapstock.
- **Market Development:** Build distributor partnerships, create technical training materials, and pursue co-branded outreach to growers.

This project demonstrates that soy-based liquid fertilizers—though currently niche—offer a viable and scalable opportunity for Minnesota. Through targeted Research and Development, performance validation, and investment in local manufacturing, Minnesota could leverage its soybean production and processing base to develop a nationally competitive biofertilizer industry, creating new rural value chains and tangible economic development.

Acknowledgments

AURI gratefully acknowledges the Minnesota Soybean Research and Promotion Council (MSR&PC) for supporting this project, and Mike Reiber of Axiom Marketing Communications, Inc. (Axiom) for work on the liquid soybean meal fertilizer market assessment. Note that AminOrganiX, a fertilizer company referenced in the report, is a sister company of Axiom.

AURI also extends its sincere appreciation to Nature's Source and Ferticell for providing the liquid soybean meal fertilizer product for the demonstrations, and to the horticultural department at the West Central Research and Outreach Center, Morris, Minnesota; Riverside Farms, Elk River, Minnesota; and Green Barn Garden Center, Isanti, Minnesota, for their contributions to the fertilizer demonstrations.

Contents

Project Goals and Objectives

The following is a summary of the project's goals and objectives, which outline the report's contents.

GOAL 1: Investigate market needs among horticulture and CEA growers for liquid soybean meal fertilizer.

- **OBJECTIVES**
  1. Identify high-value horticultural and CEA crops produced in Minnesota for liquid soybean meal fertilizers.
  2. Identify existing liquid fertilizers used for these crops. Highlight the fertilizers' nutrient content and positioning within horticulture and CEA.
  3. Identify market channels and pricing for the fertilizers.

GOAL 2: Create partnerships with up to two liquid soybean meal fertilizer manufacturers and Minnesota ingredient suppliers.

- **OBJECTIVES**
  1. Identify and assess manufacturers.
  2. Identify other Minnesota ingredient suppliers and food processors that could provide input components to improve existing liquid soy fertilizer lines.
  3. Conceive other value-added product concepts from manufacturers.

Goal 3: Demonstrate liquid soybean meal fertilizer in Minnesota.

- **OBJECTIVES**
  1. Identify desirable demonstration locations, including greenhouses and CEA facilities.
  2. Identify affordable and cost-effective demonstrations at private or academic labs.

Goal 4: Prepare a written report on potential markets and commercialization avenues.

- **OBJECTIVES**
  1. Identify commercialization opportunities and barriers for liquid soybean meal fertilizer in horticulture and CEA.
  2. Identify ways to increase market share for liquid soybean meal fertilizers.

GOAL 1: MARKET NEEDS FOR LIQUID SOYBEAN MEAL FERTILIZER

Identification of Key High-Value Horticultural and CEA Crops Produced in Minnesota for Liquid Soybean Meal Fertilizers (Goal 1, Objective 1)

Identifying key crops was based on in-depth interviews with four trade magazine editors covering CEA and horticulture, four formulators of liquid fertilizers used in horticulture and CEA, and four greenhouse growers.

- Key crops for liquid fertilizers include:
  - Horticulture: pansies, mums, petunias, geraniums, calibrachoas, coleus, dahlias, foliage, grasses, and vernalized perennials.
  - CEA: tomatoes, peppers, cucumbers, berries, strawberries, leafy greens, microgreens, and herbs such as basil, cilantro, parsley, thyme, or oregano.

Explore Existing Liquid Fertilizers used for High-Value Horticultural and CEA Crops (Goal 1, Objective 2)

To identify existing liquid fertilizers used for crops, a literature review was conducted of liquid fertilizers, targeting trade magazines covering horticulture, CEA, cannabis, and related trade associations. The areas of focus for which findings were reported included industry standards, the reasons producers use liquid fertilizers, current liquid fertilizers used in CEA and horticulture, facts, and trends.

Industry Standards

Liquid fertilizers can be categorized into three main types: conventional, natural, and organomineral.

a. Conventional Liquid Fertilizers

Conventional liquid fertilizers can be categorized into two main types. The first are true liquids, such as anhydrous ammonia and UAN (urea–ammonium nitrate solution), which are manufactured and stored in liquid form. The second type is dissolved formulations, where solid inorganic nutrient salts (e.g., urea, ammonium nitrate, potassium chloride) are dissolved into concentrated solutions and later diluted with water using proportioning devices, such as volumetric dosing pumps, before application through irrigation lines. Among synthetic nitrogen sources, urea solutions and UAN are the most widely used, followed by ammonium nitrate solutions and anhydrous ammonia.

Fertilizer grade is the guaranteed analysis of a fertilizer, expressed as three numbers on the label, identified as N-P-K (Nitrogen-Phosphorus-Potassium). It indicates the weight percentage of those compounds in fertilizer. Essential micronutrients, such as Iron, zinc, manganese, and boron, as well as others, are commonly found in liquid fertilizers and added to the product formulation in the required small amounts.

b. Natural Liquid Fertilizers

Commercial natural liquid fertilizers are manufactured from a range of materials derived from plant and animal-derived materials such as fish emulsions, seaweed extracts, protein hydrolysates, and oilseed by-products. These highly refined and concentrated fertilizers contain plant-available macronutrients and micronutrients that promote growth in organic and soilless production systems.

One of the most significant challenges in manufacturing liquid natural fertilizers is finding organic nutrients that provide the correct amount of nitrogen for plants. Organic nitrogen-rich compounds, such as protein, can be easily, although at different rates, converted to plant-available inorganic nitrogen by bacteria. Hartz et al. (2010) evaluated three commercial liquid organic fertilizers derived from distinct feedstock sources:

- Fishery waste and seabird guano (Phytamin 801)
- Soy meal and plant extracts (Phytamin 421)
- Grain fermentation by-products (Biolyzer)

They found that nitrogen availability differed substantially among these sources, with the animal-based product providing faster mineralization and plant uptake than the plant- or fermentation-based formulations.

Table 1 lists sample commercial liquid organic fertilizers in the US market.

Product Brand Name	Fertilizer Grade (N-P-K)	Ingredients
Neptune's Harvest Organic Fish Fertilizer	2-4-1	Fish emulsion
Bombardier	8-0-0	Fermented sugar beet molasses
Alaska Fish Fertilizer	5-1-1	Fermented fish
Drammatic K Fertilizer	2-5-1	Fermented fish, kelp
Nature's Source Organic	3-1-1	Fermented soybean extract
Kellogg Organic Plus Fertilizer	4-4-4	Ocean fish, molasses, kelp
SuperThrive Organic Fertilizer	4-1-1	Fermented fish
AgroThrive Organic Biofertilizer	3-3-2	Fermented fish, grain
ON-Gard	5-0-0	Soy protein hydrolysate

Table 1: List of sample commercial liquid organic fertilizers in the US market.
Agricultural Utilization Research Institute

c. Organomineral Liquid Fertilizers

According to (Pajura et al. 2023), organomineral liquid fertilizers are produced by combining organic matter with mineral components. Their input materials may include, among others, digestate, algae extracts, mine minerals (e.g., leonardite, humic substances), and plant biomass by-products such as molasses or corn grain. These formulations supply nutrients in both organic and mineral forms, supporting plant growth while contributing to circular economy objectives**.** An example of an organomineral product is Nature's Source 10-4-3 (N-P-K), a soybean oilseed extract supplemented with inorganic salts.

Table 2 presents an additional list of products that are not certified organic but can still be used in greenhouse production. Some of them are considered natural because of their ingredients.

Organomineral liquid fertilizer brands and products		
Product Brand Name	**Fertilizer Grade (N-P-K)**	**Ingredients**
Nature's Source Plant Food	10-4-3	Fermented oilseed extract
Nova PeKacid	0-27-9	Phosphoric acid-
Peters Professional	24-8-16	Nitrate salts, urea
Age Old Grow	12-6-6	Fish hydrolysate, kelp
Canna Aqua Flores	4-0-6	Nitrate, ammonium salts, potassium sulfate
Agrii-Start OSR Liquid	15-20-0	Nitrate, ammonium, humic, and fulvic acids
Agroleaf Liquid	10-10-10	Urea, phosphorus pentoxide, potassium oxide-

Table 2: Organomineral liquid fertilizer brands and products.
(Agricultural Utilization Research Institute)

Why Do Producers Use Liquid Fertilizers?

No studies have presented the usage rate of liquid fertilizers compared to granular ones. However, the section below demonstrates how liquid fertilizers benefit producers, including performance, environmental, and economic benefits. In general, liquid fertilizers provide faster nutrient availability and more uniform application than granular products, although under certain conditions (such as high rainfall, sandy soil, or poor storage/handling systems) granular forms may perform equally well or even better in reducing nutrient losses.

Performance benefits:

Based on baseline standard information in the fertilizer industry, the following are the performance benefits of liquid fertilizers:

1. Liquid fertilizers are absorbed more quickly than granular products. Their rapid absorption rate increases crop nutrient availability, especially in dry conditions (Benefits of Liquid Fertilizer on Crops, n.d.; What is Liquid Fertilizer?, n.d.).
2. Liquid fertilizers are easy to handle because they integrate well with irrigation systems, especially in large-scale agriculture. The targeted sprayer application ensures uniform field coverage, allowing crops to receive nutrients when needed (Why Choose Liquid Fertiliser, n.d.).

3. Liquid fertilizers enable even and consistent fertilizer applications (Benefits of Liquid Fertilizer on Crops, n.d.); (Why Choose Liquid Fertiliser, n.d.), making them suitable for a wide range of farming methods (Why a Liquid Fertilizer Program is Better than A Dry Fertilizer Program for High-Yield Crops, 2025).

Environmental benefits:

1. Liquid fertilizers can be combined with other nutritional and protective products (Why Choose Liquid Fertiliser, n.d.), creating customized blends tailored to the specific needs of individual crops.
2. Using reusable storage tanks for liquid fertilizers significantly reduces plastic waste (Why Choose Liquid Fertiliser, n.d.).

Economic benefits:

1. Handling and applying liquid fertilizer are often a simple one-person operation and less physically intensive (Why Choose Liquid Fertiliser, n.d.; Ioó, 2025).

Important Facts

When doing the literature review of trade publications read by CEA growers, it was found that the coverage of natural products was limited. When covered, the key motivators were the following:

- Some products are covered primarily because of the innovative ingredients used to produce complete liquid fertilizers as part of a circular economy to improve the energy intensity of mineral fertilizer production. Those manufacturers are responding to the need to develop more sustainable practices, like reusing waste materials to produce full-value liquid fertilizers.
- Products are covered because of their efficiency. Fertilizer use efficiency (FUE) is a measure of the potential of an applied fertilizer to increase the productivity and utilization of the nutrients present in the soil-plant system. For example, Nature's Source liquid fertilizer has been referenced in multiple studies. A fact sheet from the University of Massachusetts presents it as the best organic fertilizer on the market. (Cox, 2014)
- Other products are covered when the companies receive significant federal grants. Since federal grants and the results are typically public, this can lead to extended coverage of relevant products. To illustrate, Dramm Corporation has received grants from the Fertilizer Production Expansion Program (FPEP) to produce liquid fish fertilizer

manufactured from fish offal collected from commercial and sports fishermen. In 2023, the USDA announced, as part of the FPEP, a $29 million grant to increase the production of American-made fertilizer. Companies have received $2.6 million to manufacture and process raw manure and fish waste into liquid fertilizers.

In addition to the search in publication reviews, multiple fertilizer associations, including the Fluid Fertilizer Foundation, the Fertilizer Institute, and the International Fertilizer Association, were searched to collect their expectations for the liquid fertilizer market. The literature search revealed that very little attention is paid to the use of liquid fertilizer in horticulture and greenhouses. When liquid fertilizer was mentioned, most research funded and displayed by those organizations examines the use of synthetic liquid fertilizers in field crops, particularly corn and soybeans.

Trends

Findings also indicated several trends that included the following:

- In the fertilizer industry, words like efficiency, sustainability, and organic have been the trend for the last couple of years, showing how innovative growers can be when producing healthier crops (Petrovic, 2015).
- The number of available liquid fertilizer brands and formulations has increased over the last two years (Petrovic, 2015).
- There are numerous challenges (i.e., misinformation about the efficacy due to an insufficient amount of relevant information, and the difficulty of accurately testing organic fertilizers), and a few recommendations in the literature for greenhouse growers interested in producing plants using liquid organic fertilizers (Petrovic, 2015).
- Some manufacturers are trending towards reduced-phosphorus liquid fertilizer formulations as there is a trend in specific markets toward liquid fertilizers with more optimized (often lower) phosphorus content, especially for use in systems sensitive to P losses (Petrovic, 2015).
- More formulators are customizing fertilizer blends to ensure optimal effectiveness based on the type of water (tap or pre-treated) and growing media used. To illustrate, many fertilizer blends were developed using water and growing media samples sent to the company's lab (Petrovic, 2015).

- Fertilizer manufacturers are working towards fertilizers with low sodium levels. Due to tightening regulations on greenhouse runoff, growers are likely to request formulations with lower sodium levels (Petrovic, 2015). Greenhouse production runoff refers to the excess water that drains or flows from greenhouse operations, typically as a result of irrigation or precipitation, which often carries dissolved fertilizers, pesticides, salts, and other contaminants. This runoff can pose environmental risks by contaminating both surface and groundwater if not properly managed (Texas A&M, 2025).
- An increasing number of commercial fertilizer products are becoming more available in organic production to supplement slow-release organic materials to supply more soluble forms of nitrogen.

Summary and Implications*

- Current soybean and soybean meal prices may offer an opportunity for liquid organic fertilizers formulators. These ingredients need to support both competitive pricing and the growing demand for sustainable agricultural inputs.
- There may be opportunities to differentiate against conventional fertilizers by emphasizing Minnesota-grown soybeans and Minnesota-sourced soybean meal.
- Growers interested in plant health, sustainability, efficiency, and organic inputs may offer a pathway for liquid soy-based fertilizers.
- Manufacturers of liquid soy-based fertilizers position themselves around their fertilizer products, containing virtually no salts, unlike synthetic competitors.
- There is some demand for liquid natural fertilizers in horticulture and CEA, as evidenced by existing soy-based liquid fertilizer manufacturers already selling in these markets.
- Liquid fertilizers are widely used in horticulture and CEA.
- Soybeans contain macro and micronutrients like nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur that are necessary for these liquid fertilizers.

**Based on in-depth interviews conducted by Axiom and literature searches.*

Market Channels and Pricing for Fertilizers (Goal 1, Objective 3)

In-depth interviews with four trade magazine editors (labeled TME) covering CEA and horticulture, four formulators (labeled FF) of liquid fertilizers used in horticulture and CEA, and four greenhouse growers (labeled GG) helped define needs further. Notable

commentary is summarized below, grouped by topic, and sometimes paraphrased for easier review. Detailed findings can be found in Appendix A of this report.

Disclaimer: These comments are verbatim and the opinions of interview respondents.

Summary of Interviews

- There is relatively low brand and manufacturer awareness of specific liquid fertilizers. There is a higher awareness of liquid fertilizers by their nutrient content or function during key plant growth cycles, and there are few clear market leaders. Brand and manufacturers mentioned include Peters, Dramm, Espoma, Ferticell, Fox Farms, ICL, Jack's, Nature's Source/Daniels®, Neptune's, Plant Marvel, Yara, and others. Nutrient mentions include 10-20-10, 10-30-20, 14-14-14, and Calcium-Magnesium (Cal-Mag), among others. Plant function mentions include Bloom Booster, Petunia Feed, and others.
- Previous, sometimes decades-long, grower experience with liquid fertilizers and overall performance on individual crops dictates perceptions of market leadership, efficacy, purchase, and use. Because of this, horticultural and CEA growers are reluctant to change their liquid fertilizer program.
- The ability of the liquid fertilizer to function without problems in hydroponic systems is critical. Easy and reliable integration with proportioner technology to increase or decrease micronutrients is very important.
- Based on responses, the key nutrients that growers focus on include the percentage of two macronutrients, nitrogen and phosphorus, and the inclusion of micronutrients, like calcium, sulfur, zinc, boron, manganese, etc., and nitrogen (ammoniacal, nitrate, urea) and phosphorus (phosphate rock) form and source. Micronutrients, often in sulfate form, are essential, too. Natural ingredients cited include soybeans, seaweed, kelp, and fish emulsion. Yet, there is little to no awareness among growers about the specific ingredients and what nutrients they provide. Unless growers focus on selling organic products, they generally do not focus on natural nutrition ingredients. A key point among formulators of soy-based fertilizers is that they contain no salt (sodium), unlike synthetic fertilizers, which contain nitrates. The benefit to growers of these fertilizers is that they do not burn plants.

- The nutritional needs of liquid fertilizers are based on the propagation method, plant variety, and growth stage. Nitrogen and phosphorus are essential for horticulture crops, particularly leafy greens and herbs, during the early stages of growth. Potassium and calcium are important in the later stages of CEA fruits and vegetables to increase cell wall strength and shelf life.
- Fertilizer formulators and distributors typically supply plant nutrition needs based on the crop and growing phases. The propagation method, whether from seed, plugs, liners, cuttings, or tissue, is particular.
- Collaborations with horticulture distributors (e.g., BFG, Tessman, Griffin, and Carlin) or from agrichemical distributors with CEA divisions (e.g., Wilbur Ellis, Helena, or Simplot) are essential. Distributors' sales staff usually present new liquid fertilizers, but growers rarely consider them seriously unless there are sufficient demonstrations, research, and cost-competitive information
- It is important to note that these distributors are not typically blenders who offer special blends. Fertilizer formulators often offer specialized blends for larger horticulture and CEA operations, allowing for on-site mixing and storage.
- Growers are highly price sensitive. They are focused on controlling the cost of all inputs, especially nutrition, and carefully track input costs. In fact, the nation's largest growers are tracking the price per square foot. They view conventional fertilizers as a commodity product. They perceive natural and organic fertilizers as more expensive and less effective than conventional fertilizers.
- Growers positioning their products as organic and those interested in sustainability or regenerative agriculture are more likely to be interested in natural fertilizers.
- Natural or organic could be most important in cannabis production, which outpaces other crops regarding the grower's willingness to test new inputs, which often have higher price tags.
- None of the grower segments was able to name specific natural liquid fertilizers. Nor were any of the growers using natural liquid fertilizer, despite being willing to participate in AURI's demonstration program.
- Natural fertilizer opportunities include improved shelf life, in-store product appearance, and sustainability practices.

- A Minnesota-based company, AminOrganiX, located in Bloomington, has decided to add a lower-priced soy protein isolate, applied as a liquid fertilizer product without organic certification, to its product line in response to requests from conventional strawberry growers in the Southeast U.S. *Note that AminOrganiX is a sister company of Axiom.*

Summary and Implications

- Liquid fertilizers are well established in horticulture and controlled environment agriculture; however, brand and ingredient awareness are low. Products are recognized by their nutrient content or function.
- Growers are increasingly adopting specialty liquid fertilizer blends tailored by crop phase or propagation method. Horticultural and agricultural distributors offer these fertilizers.
- Growers of premium crops (and the distributors who supply those growers with fertilizers) who have demonstrated an interest in sustainability or organic produce are good targets.
- Demonstrations must address grower concerns about ease of use, performance parity, and cost-effectiveness relative to synthetics.
- Avoid positioning liquid-soy fertilizers as a direct substitute for synthetics and instead focus on complementing or partially replacing them in nutrition programs.
- Opportunities exist to highlight certain advantages of natural fertilizers. Unlike many synthetic products, they typically do not add soluble salts to the soil, and they provide nutrients in organic forms. Their composition can be matched to plant growth stages, for example, by supplying soy-based sources of nitrogen, amino acids, and biostimulant compounds. These inputs have been shown to support outcomes such as greater root development, higher flower counts, and improved post-harvest shelf life.
- There may be an opportunity to highlight the potential increased affordability of soy-based plant nutrients to formulators.

Conventional Fertilizer Ingredient Content, Distribution Channels, and Pricing Analysis

Below is a summary of various conventional fertilizer products available in the marketplace, including ingredient content, distribution, channels, and pricing analysis.

Jack's Professional – JR Peters Inc. (https://www.jrpeters.com/water-soluble-fertilizer)

- The products are widely used and recognized by greenhouse and nursery growers throughout North America.
- The product line was started by the son of the founder of JR Peters Inc. after ICL, a global specialty minerals company, purchased the company.

- All products are water-soluble and are specialty crop formulations.
- Table 3 details the specific characteristics of JR Peters Inc.'s fertilizer 20-20-20 Jack's Professional General Purpose.

Jack's Professional Fertilizer Content, Distribution Channels, and Pricing					
Fertilizer Grade (N-P-K)	**Nutrient Sources***	**Packaging**	**Price Estimate**	**Distribution Examples**	**Markets**
20-20-20	Urea	25 lb. bag	$75-90	Amazon	B2B Marketplace
	Ammonium Phosphate	10 bag case	$770-825	Arrett	Horticulture, Nurseries
	Potassium Nitrate			BFG Supply	Horticulture, CEA, Cannabis
	Magnesium Sulfate			Greenhouse Megastore	Horticulture, CEA, Cannabis
	Boric Acid			Walmart.com	B2B marketplace

**Also include Iron EDTA, Manganese EDTA, Zinc EDTA, Copper EDTA, and Ammonium Molybdate.*

Table 3: Jack's Professional Fertilizer Content, Distribution Channels, and Pricing.
(https://www.jrpeters.com/20-20-20-general-purpose)

Grower Select - Plant-Prod (https://www.plantprod.com/)

- The products are widely used by bedding plant and cannabis growers in the U.S. and Canada.
- They are produced in Brampton, Canada.
- Grower Select features water-soluble fertilizers with a complete macronutrient and micronutrient lineup and produces controlled-release granular fertilizers with coatings.
- Table 4 details the specific characteristics of Plant-Prod's fertilizer Grower Select 20-20-20.

Grower Select's Fertilizer Content, Distribution Channels, and Pricing					
Fertilizer Grade (N-P-K)	**Nutrient Sources***	**Packaging**	**Price Estimate**	**Distribution Examples**	**Markets**
20-20-20	Potassium Nitrate	50 lb. bag	$40-60	BFG Supply	Horticulture, CEA, Cannabis
	Ammonium Phosphate	80 bag pallet	$2,800-3,200	Growcycle	B2B marketplace
	Urea			Horticultural Source	Horticulture, CEA, Cannabis

**Also includes Iron EDTA, Manganese EDTA, Zinc EDTA, and Boric Acid.*

Table 4: Grower Select's Fertilizer Content, Distribution Channels, and Pricing.
https://www.plantprod.com/product/plant-prod-20-20-20-classic/

Yara (https://www.yara.us/crop-nutrition/fertilizer-products/)

- Yara's products are widely used agricultural fertilizers for premium specialty crops and premium agriculture in the U.S. and Canada.
- Yara has a Norwegian-owned global fertilizer parent company that focuses on sustainability.
- Table 5 identifies the specific characteristics of Yara's fertilizer Yara Calcinit 15.5-0-0 (Greenhouse Solution Grade).

Yara's Fertilizer Content, Distribution Channels, and Pricing					
Fertilizer Grade (N-P-K)	**Nutrient Sources***	**Packaging**	**Price Estimate**	**Distribution Examples**	**Markets**
15.5-0-0	Ammonium Calcium Nitrate (19% Calcium)	50 lb. bag	$30-48	Custom Hydro	Horticulture, CEA, Cannabis
		42-bag pallet	$1,700-2,300	Greenhouse Megastore	Horticulture, Cannabis
				SiteOne	Turf, Landscaping
				Veseris	Horticulture, Turf & Ornamentals

Table 5: Yara's Fertilizer Content, Distribution Channels, and Pricing.
(https://www.yara.us/crop-nutrition/fertilizer-products/yaraliva/yaraliva-calcinit15.5-0-0/)

Helena (https://www.helenaagri.com/)

- Helena is a widely used agricultural fertilizer and crop protection input supplier for row crops, premium agriculture, and CEA in the U.S. and Canada.
- It has a Japanese-owned global agricultural input parent company.
- Helena is unique among the big four agricultural chemical distributors (others are Nutrien, WinField® United, and Growmark), because it has an extensive research and development team that formulates proprietary product lines.
- Table 6 identifies the specific characteristics of Helena's fertilizer, Coron 14-2-14 Plus Micros.

Helena's Fertilizer Content, Distribution Channels, and Pricing					
Fertilizer Grade (N-P-K)	**Nutrient Sources***	**Packaging**	**Price Estimate**	**Distribution Examples**	**Markets**
14-2-14	Urea	2.5-gallon jug	$80-100	Do My Own.com	B2B marketplace
	Methylene Diurea	275-gallon tote	Unavailable	Farmers Business Network	Ag buying group
	Methylene Ureas			G&D Farms	Ag
	Phosphoric Acid			Helena Agri Enterprises	Ag, CEA Horticulture, Cannabis
	Potassium Carbonate			Intermountain Turf	Turf & Ornamental

**Also includes Copper EDTA, Iron, EDTA, Manganese EDTA, and Zinc EDTA.*

Table 6: Helena's Fertilizer Content, Distribution Channels, and Pricing.
(https://s3-us-west-1.amazonaws.com/agrian-cg-fs1-production/pdfs/CoRoN_14-2-14_Plus_Micros_Code_60_HAE_MSDS.pdf)

Summary and Implications of Fertilizer Ingredient, Distribution, and Pricing

- The conventional fertilizer market is well-established and highly competitive, with pricing pressures and distributor loyalty largely favoring proven synthetic products.
- Multi-nutrient formulations, including micronutrients, are the market norm.
- To compete with entrenched synthetic brands, soy-based liquid fertilizers must offer parity nutrition (including micronutrients), pricing, and performance.
- Co-branded or private label formulations for distributors may accelerate adoption.

GOAL 2: LIQUID SOYBEAN MEAL FERTILIZER MANUFACTURERS AND MINNESOTA INGREDIENT SUPPLIERS

Manufacturers Assessment (Goal 2, Objective 1)

Axiom and AURI identified two manufacturers of liquid soy fertilizers, Nature's Source (oilseed-based fertilizer) and Ferticell (soy protein isolate fertilizer). They analyzed the existing liquid product lines that could be included in this project.

Nature's Source Plant Foods (https://www.naturessourceplantfood.com/)

- Its product lines are made from patented oilseed extract and are organic (OMRI approved).
- Nature's Source was initially founded in 1994 by Ralph Daniels as Daniels® Plant Food and was purchased in 2019 by Ball Horticulture and renamed Nature's Source.
- The company was divested by Ball in 2024 and purchased by Bruce Odens and Chance Finch.
- Originally, Nature's Source only served greenhouses, and it now serves CEA, premium agriculture, and regenerative row crop agriculture.
- It is based in Sherman, Texas, and has a wide distribution in horticulture and CEA.
- Table 7 contains a summary of specific characteristics of Nature's Source's fertilizers: 10-4-5 Nursery & Landscape Special Plant Food, 3-2-1 Soil Essentials Root & Soil BioNutrition, and 2-1-1 Foliar Essentials.

Nature's Source Fertilizer Products' Characteristics				
Fertilizer Grade (N-P-K)	**Nutrient Sources***	**Function**	**Application**	**Other Benefits**
10-4-5*	Oilseed Extract	Horticulture	Foliar	Low salt index reduces salt burn
	Phosphoric Acid	Nursery & Landscape	Root feed	Reduces salt buildup
3-2-1	Oilseed Extract	Horticulture	Root feed	Stimulates soil biology
	Corn Steep Liquor	Premium Agriculture		Low salt index reduces salt burn
		Turf & Ornamentals		Reduces salt buildup
2-1-1	Oilseed Extract	Horticulture	Foliar	Natural plant growth regulator (PGR)
		Nursery		Toning

**Also includes Potassium Hydroxide. Ammonium Nitrate, Urea, Magnesium Sulfate, Boric Acid, Copper Sulfate, Manganese Sulfate, Zinc Sulfate, L Amino Acids, and Soil Microbes.*

Table 7: Nature's Source Fertilizer Products' Characteristics.

(https://www.naturessourceplantfood.com/store/BioNutrition/Agriculture)

- Table 8 contains a summary of the specific characteristics of Ferticell's fertilizers 16-0-0 Explorer and 10-0-0 Explorer.

Ferticell Fertilizer Products' Characteristics				
Fertilizer Grade (N-P-K)	**Nutrient Sources**	**Function**	**Application**	**Other Benefits**
16-0-0	Soy Protein Isolate	Row Crop Regenerative Ag	Foliar Root Feed	No salt
	Other "beneficial plant materials"			Reduces abiotic stress
				Reduced use of synthetic N fertilizers
10-0-0	Soy Protein Isolate	Row Crop Regenerative Ag	Foliar Root Feed	No salt
	Other "beneficial plant materials"			Reduces abiotic stress
				Reduced use of synthetic N fertilizers

Table 8: Ferticell Fertilizer Products' Characteristics.
(https://irp.cdn-website.com/42740342/files/uploaded/Explorer_16-0-0_Label.pdf *and*
(https://irp.cdn-website.com/42740342/files/uploaded/Explorer_10-0-0_Label.pdf)

Other Minnesota ingredient suppliers and food processors that could provide input components for improving existing liquid soy fertilizer lines (Goal 2, Objective 2)

Soy isolate or soy protein powder is the main input component for soy-based fertilizers. Tables 9-11 list potential suppliers in Minnesota, North Dakota, and South Dakota.

Minnesota Soy Protein Producers			
Company Name	**Product Type**	**Location(s)**	**Facility Details**
Cargill	Soy protein isolate, soy protein/flour	Mankato, Minnesota; Ohio; Asia-Pacific; Europe	Produces soy protein isolate in Ohio; soy protein/flour in Mankato; regional sites in Asia-Pacific and Europe
Great Plains Processing	Soy protein flour	Luverne, Minnesota	Offers soy protein flour at its plant in Luverne
Cenex Harvest States (CHS)	High-protein soy flour	Mankato, Minnesota	Produces high-protein soy flour at its processing plant
SunOpta	High-protein soy-based powders	Hope, Moorhead, Alexandria, Eden Prairie, Minnesota	Plants in Hope and Moorhead; warehouse and processing facility in Alexandria; innovation and pilot plant in Eden Prairie
Northland Organic Foods	Organic soy flours and whole soybean powders	St. Paul, Minnesota	Produces organic soy flours and whole soybean powders at its plant
Puris	Non-GMO and organic soybeans for powders and flours	Randolph, Minnesota	Sells proprietary non-GMO and organic soybeans; soy processing facility in Randolph

Table 9: Minnesota Soy Protein Producers.
(Axiom Marketing Communications, Inc.)

Minnesota Soy Crush Operations		
Company	Plant Location(s)	Type of Plant
Archer Daniels Midland (ADM)	Mankato, Red Wing, MN	Soy Crush
Ag Processing Inc. (AGP)	Dawson, MN	Soy Crush
CHS	Fairmont, Mankato, Hallock, MN	Soy Crush
Minnesota Soybean Processors	Brewster, MN	Soy Crush
Renewable Energy Group	Albert Lea, MN	Biodiesel

Table 10: Minnesota Soy Crush Operations.
(Axiom Marketing Communications, Inc.)

North and South Dakota Soy Crush Operations			
Company	**Location(s)**	**State**	**Status**
ADM	Spiritwood, Enderlin, Velva	North Dakota	Operational
Ag Processing Inc. (AGP)	Aberdeen	South Dakota	Operational
Cargill	West Fargo	North Dakota	Operational
North Dakota Soybean Processors	Casselton	North Dakota	Operational
Epitome Energy	Grand Forks area	North Dakota	Proposed / In Development
South Dakota Soybean Processors	Volga, St. Lawrence	South Dakota	Operational

Table 11: North and South Dakota Soy Crush Operations.
(Axiom Marketing Communications, Inc.)

Soy Byproducts and Liquid Fertilizers

The Minnesota Department of Agriculture has compiled the following data in Table 12, relating to the agricultural and non-farm use of fertilizers (Minnesota Department of Agriculture, 2017-2023). Also included in Table 13 is a breakdown of the amount of liquid fertilizers used by both sectors. Non-farm consists of the following uses: sports turf, parks, residential, greenhouses, nurseries, and cemeteries. It is defined as fertilizer sold for non-agricultural purposes, such as lawns, gardens, turf (including parks, golf courses, and sports fields), nurseries, and greenhouse crops. Agricultural use ("Farm") is fertilizer sold for use in field crops, horticultural crops, and other on-farm production purposes. This includes products applied to corn, soybeans, small grains, sugar beets, potatoes, fruits, vegetables,

and other agricultural commodities. Fertilizer dealers and registrants classify sales as "farm" if the intended use is crop production. Liquid fertilizer, on the other hand, refers to fluid fertilizer formulations—fertilizers that are manufactured, sold, and applied in liquid solution or suspension form (as opposed to dry granular or anhydrous ammonia). Examples included: Urea-ammonium nitrate (UAN) solutions, ammonium polyphosphate (APP) liquids, mixed-grade NPK liquid solutions, and other specialty fluid fertilizers.

Historical Fertilizer Use by Year, Minnesota								
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	***Compound Average Annual Growth Rate****
Agricultural (Tons)	2,963,083	3,186,811	2,941,572	3,178,364	3,356,376	2,955,361	3,260,070	*1.6%*
Non-Farm (Tons)	62,507	72,288	67,000	73,343	95,839	80,968	77,614	*3.67%*
Total (Tons)	3,025,590	3,259,099	3,008,572	3,251,707	3,452,215	3,306,329	3,337,684	*1.65%*

NOTE: Formula for compound average growth rate (CAGR) calculation: CAGR (Ending Value/Beginning Value)*1/number of years-1

Table 12: Historical Fertilizer Use by Year, Minnesota

(Minnesota Department of Agriculture, 2017-2023)

Historical Fertilizer Use by Year, Minnesota								
	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	***Compound Average Annual Growth Rate****
Liquid (Tons)	596,703	650,174	663,061	720,224	742,783	655,422	718,110	*3.13%*

NOTE: Formula for compound average growth rate (CAGR) calculation: CAGR (Ending Value/Beginning Value)*1/number of years-1

Table 13: Historical Fertilizer Use by Year, Minnesota

(Minnesota Department of Agriculture, 2017-2023)

According to an email dated August 21, 2025, Chance Finch, the president of Nature's Source, estimates that specialty liquid fertilizers account for 10 percent of the entire liquid fertilizer market. He estimates the percentage of true liquid fertilizer in greenhouse production is 20-30 percent of the total fertilizer consumption. The remaining 70-80 percent of greenhouse production is predominantly blended fertilizer powders (e.g., Jack's Professional, Peters, Grower Select) mixed with water.

Table 14 below summarizes the projected growth rates for liquid fertilizers in Minnesota. The potential growth rate estimates are based on Finch's estimate that specialty fertilizers account for 10% of the liquid fertilizer market, the 2023 tonnage information, and a 3.13% compounded annual growth rate from the Minnesota Department of Agriculture.

Projected Growth Rates for Liquid Fertilizers, Minnesota							
	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Liquid Fertilizer (Tons)	718,100	740,577	763,757	787,662	812,316	837,741	863,963
Specialty Liquid Fertilizers (Tons)	71,810	74,058	76,376	78,766	81,232	83,774	86,396

Note: Calculation for specialty liquid fertilizers starts with 2023 tons and is multiplied by 3.13% CAGR; specialty liquid fertilizers are 10% of total liquid fertilizer tons

Table 14: Projected Growth Rates for Liquid Fertilizers, Minnesota

(Axiom Marketing Communications, 2025; C. Finch personal communications, August 21, 2025; Minnesota Department of Agriculture, 2017-2023)

Axiom estimates that greenhouses and nurseries account for less than 25% of the non-farm fertilizer use. Table 15 estimates the potential growth rates based on the 3.67% annual growth rate and the 2023 tonnage information from the Minnesota Department of Agriculture.

Projected Growth Rates for Non-Farm Liquid Fertilizers, Minnesota							
	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Non-Farm Fertilizer (Tons)	77,614	80,462	83,415	86,476	89,650	92,940	96,350
Greenhouse and Nursery (Tons)	19,404	20,116	20,854	21,619	22,413	23,235	24,088

Note: The calculation for non-farm fertilizers starts with 2023 tons and is multiplied by 3.67% CAGR. Greenhouse and Nursery are calculated by multiplying non-farm tonnage by 25%.

Table 15: Projected Growth Rates for Non-Farm Liquid Fertilizers, Minnesota

(Axiom Marketing Communications, 2025; Minnesota Department of Agriculture, 2017-2023)

In an email dated June 17, 2024, Finch estimates that 0.5 to 1.0 bushels of soybeans are used in every gallon of Nature's Source concentrated liquid fertilizer produced, depending on protein levels and overall quality of the soybeans. Typically, there are 11 pounds of concentrated liquid fertilizer in every ton of use-ready liquid fertilizer. Axiom estimates that liquid soy fertilizers account for less than 0.25% of the market, as reflected in Figure 1 and Table 16, which summarizes projected soybean use for liquid fertilizers in Minnesota from 2023 to 2029.

Projected Growth of Soybean-Based Specialty Liquid Fertilizers, Minnesota							
	2023	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Total Specialty Liquid Fertilizer Market (Tons)	71,810	74,058	76,376	78,766	81,232	83,774	86,396
0.25% of Specialty Liquid Fertilizer Market is Soy-Based (Tons)	180	185	191	197	203	209	216
Soy-Based Specialty Liquid Fertilizer Market (Gallons)	32,641	33,663	34,716	35,803	36,923	38,079	39,271
Soybean Bushel Equivalent Used in Soy-Based Liquid Fertilizers	24,481	25,247	26,037	26,852	27,693	28,559	29,453

Note: Total Specialty Liquid Fertilizer Market (Tons) is from Table 14. Row 2 assumes that .25% of the Specialty Liquid Fertilizer Market is soy-based. Soy-based Specialty Liquid Fertilizer (Gallons) assumes that one gallon weighs 11 pounds. Soybean Bushel Equivalent Used utilizes Nature's Source formula of .75 bushels of soybeans used per gallon.

Table 16: Projected Growth of Soybean-Based Specialty Liquid Fertilizers, Minnesota

(Axiom Marketing Communications, 2025; C. Finch, personal communication, June 17, 2024; Minnesota Department of Agriculture, 2017-2023)

In an email dated July 29, 2024, Bruce Roberts, Ferticell Vice President and Operating Executive, estimates that approximately two bushels of soybeans are used to make 10.5 pounds of soy protein isolate, which is then mixed with one gallon of water.

Axiom estimates that soy-based liquid fertilizers account for less than 0.25% of the greenhouse and nursery market, as reflected in Table 17, which summarizes projected soybean use for greenhouse and nursery fertilizers in Minnesota from 2023 to 2029.

Projected Soybean Use for Greenhouse and Nursery Fertilizers, Minnesota							
	2023	2024	2025	2026	2027	2028	2029
Greenhouse and Nursery (Tons)	19,404	20,116	20,854	21,619	22,413	23,235	24,088
Greenhouse and Nursery (Gallons)	3,528,000	3,657,455	3,791,636	3,930,727	4,075,091	4,224,545	4,379,636
0.25% of Greenhouse and Nursery Market is Soy-Based Fertilizers (Gallons)	8,820	9,144	9,479	9,827	10,188	10,561	10,949
Soybeans Used (Bushels)	17,640	18,287	18,958	19,654	20,375	21,123	21,898

Note: Greenhouse and Nursery (Tons) is from Table 15. 2000 Lbs = 1 ton. Greenhouse and Nursery (Gallons) assumes that one gallon weighs 11 pounds. Row three assumes that .25% of the Greenhouse and Nursery market is soy-based. Soybeans Used (Bushel) utilizes Ferticell's formula of 2 bushels of soybeans used to make 1 gallon of fertilizer.

Table 17: Projected Soybean Use for Non-Farm Fertilizers, Minnesota

(Axiom Marketing Communications, 2025; Minnesota Department of Agriculture, 2017-2023; B. Roberts, personal communications, July 29, 2024)

Both Nature's Source and Ferticell are selling to both row crop and specialty crop growers who are keenly interested in regenerative agriculture. Both are conducting tests in the Midwest, the Southwest, and the western U.S. The tests focus on improving plant health, enhancing nutrient uptake efficiency, and enhancing soil quality, made possible because their fertilizers do not contain salts.

Both Ferticell and Nature's Source product lines are especially important in the Southwest and the West U.S., where soils are sodic and ground and surface water contain higher-than-normal levels of sodium and bicarbonates. One of Ferticell's tests is being conducted on the farm of a member of the Minnesota Soybean Research and Promotion Council's board.

Summary and Implications

- There are a variety of crush plants throughout the Upper Midwest that can provide adequate and consistent supplies of soy-based inputs for liquid fertilizer manufacturers.
- Nature's Source estimates that it consumes between one-half and one bushel of soybeans for every gallon of liquid fertilizer it produces.
- Ferticell estimates that two bushels of soybeans are used in every 10.5 pounds of soy protein isolate.
- All crop nutrients found in Nature's Source and Ferticell fertilizers are natural and do not contain salts.
- The market for soy liquid fertilizers is just beginning. The projections indicate that 42,961 bushels of soybeans could be utilized in 2023 and increase to 52,394 bushels by 2029. Axiom estimates Nature's Source sales at $3-5 million and Ferticell at $2-3 million. Note: Both companies are privately held and do not release sales figures.

Other Value-added Product Concepts from Manufacturers for Consideration (Goal 2, Objective 3).

The agricultural input market presents several gaps where soy-based nutritional ingredients can deliver unique value propositions. These gaps span multiple product categories, including liquid starter fertilizers, foliar sprays, biostimulants, amino acid booster fertilizers, and carbon supplements. Each category offers distinct benefits and target markets, particularly within CEA and horticulture (Axiom Marketing Communications, 2025).

Liquid Starter Fertilizers

Soy-based ingredients in liquid starter formulations typically provide approximately 6–7 percent nitrogen in organic forms, such as amino acids and peptides. These compounds mineralize more gradually than synthetic nitrogen salts, reducing the risk of root or foliar burn and providing a steadier nutrient supply. Their low salt content makes them suitable for sensitive crops, and they also contribute readily degradable organic matter that can stimulate microbial activity in the root zone.

Target Markets:

- CEA: Seed crops such as leafy greens and herbs
- Horticulture: Seed crops including petunias and begonias

Foliar Sprays

Soy-based foliar sprays are typically formulated for high solubility and compatibility with spraying systems, which can facilitate nutrient uptake through the leaf cuticle. The amino acids they contain can chelate micronutrients, enhancing their delivery and utilization. In some crops, amino acid-based foliar products have been shown to enhance root growth, increase stress tolerance, and improve post-harvest quality. However, responses vary depending on the species and growing conditions.

Target Markets:

- CEA: Leafy greens, tomatoes, strawberries
- Horticulture: Finished annual bedding plants

Biostimulants

Soy-derived biostimulants supply amino acids and peptides that can enhance plant tolerance to abiotic stresses, including heat, drought, and salinity. They have been shown to stimulate root development, support photosynthetic activity, and improve nutrient uptake, partly through natural chelation of micronutrients. In some crops, these effects have been linked to greater resilience and enhanced post-harvest quality, aligning with the broader demand for sustainable agricultural practices.

Target Markets:

- CEA: Leafy greens, tomatoes, peppers, strawberries
- Horticulture: Annual bedding plants, vegetable plants, woody ornamentals

Amino Acid Booster Fertilizers

Amino acids from soy can be incorporated into booster fertilizers to improve plant performance under stress. Key amino acids and their roles include:

- Glutamic acid: Chlorophyll synthesis, nitrogen metabolism, drought/salt stress protection
- Aspartic acid: Photosynthesis support, early root growth
- Arginine: Growth regulation, drought/pathogen resistance
- Glycine: Micronutrient chelation, chlorophyll formation
- Proline: Heat/drought stress protection, membrane stability
- Phenylalanine: Structural strength via lignin biosynthesis
- Alanine: Stress recovery, Carbon: Nitrogen balance

- Tyrosine: Defense metabolite synthesis
- BCAAs (Valine, Leucine, Isoleucine): Energy redistribution during stress

Target Markets:

- CEA: Leafy greens, herbs, tomatoes, peppers, strawberries
- Horticulture: Annual bedding plants

Carbon Supplements

Soy-derived carbon inputs can stimulate microbial activity, support soil aggregation, and improve water-holding capacity. While they provide a readily available organic carbon source, their contribution to long-term humus formation is limited compared with more persistent amendments such as biochar or manure. Nonetheless, they can still be attractive in systems where bulk organic inputs are impractical. Their advantages lie in being clean, uniform, easy to apply through fertigation or foliar systems, and free from contaminants sometimes associated with manures. This makes them useful as supplementary soil amendments, particularly in high-value cropping systems where targeted, low-volume applications are preferred.

Target Markets:

- CEA: Tomatoes, cucumbers, peppers
- Horticulture: Woody ornamentals, annual bedding plants

This analysis highlights significant opportunities for soy-based inputs to address unmet needs in CEA and horticultural markets. By leveraging their natural properties, soy-based inputs can improve crop health, sustainability, and retail performance.

Possible Opportunities for Minnesota soybean meal may exist.

Nature's Source:

Nature's Source has expanded its oilseed formulations to include products other than soybeans because there are not sufficient high-protein and high-organic-matter soy soapstock supplies. Nature's Source is interested in further evaluating soapstock from the Midwest for future formulation improvements. They are currently sourcing soapstock from the Southern U.S.

AURI forwarded copies of soy soapstock analytical reports to Nature's Source, but the reports were inconclusive as they did not provide an adequate level of detail.

A 2025 crop one-quart sample of soapstock from a Midwest crushing facility was then provided to Nature's Source for further evaluation. Nature's Source will be analyzing it using its own test methods.

Ferticell:

Ferticell is investigating its 16-0-0 liquid soybean meal fertilizer product and how it can benefit organic growers with higher-value crops. This investigation may lead to further projects.

AURI met with faculty at the University of Minnesota Horticulture Department. There may be opportunities to collaborate with the horticulture department on further value-added uses for soy-based liquid fertilizer products in higher-value crops and golf course care. The West Central Research and Outreach Center (WCROC) at the University of Minnesota (UM) Morris is also interested in evaluating the 16-0-0 fertilizer product in 2026. The 16-0-0 product will be applied to the 2026 plants, as the application window for 2025 was missed.

Ferticell has expressed interest in locating potential manufacturing facilities in the U.S. for its product. It is anticipated that if that occurs, Ferticell may be interested in soy isolate sources in the U.S.

AminOrganiX:

AminOrganiX, based in Bloomington, MN, has added a 14-0-1 soy protein isolate to its golf course product line. The product is a food-grade soy isolate. While it is natural and safe for human consumption, it is not OMRI-certified because manufacturers have not disclosed the details of its production process to OMRI. *Note that AminOrganiX is a sister company of Axiom.*

Summary and Implications

- Market gaps exist that could be exploited to accelerate the use of soy-based liquid fertilizers in collaboration with manufacturers and formulators.
- Soy-based liquid starter fertilizers for preplant provide slow-release nutrition and will not burn.
- Soy-based foliar sprays lengthen and enhance appearance at retail.
- Amino acids in liquid soy-based fertilizers have a natural ability to chelate micronutrients.
- Naturally occurring biostimulants in soy-based liquid fertilizers enhance stress tolerance and stimulate root development.
- Liquid soy-based fertilizers are a naturally occurring carbon source that does not contain manure and biochar.

GOAL 3: LIQUID SOYBEAN MEAL DEMONSTRATIONS IN MINNESOTA

Greenhouse and CEA Facility Demonstrations (Goal 3, Objective 1)

As part of AURI's outreach efforts, liquid soybean meal fertilizer products were applied to demonstration sites at the University of Minnesota, West Central Research and Outreach Center, Morris, MN; Green Barn Garden Center, Isanti, MN; and Riverside Farms, Elk River, MN. Feedback from the demonstrations will increase the visibility and utilization of liquid soybean meal fertilizers in the horticulture sector. Private and academic lab demonstrations were deemed unnecessary.

Liquid Soybean Meal Fertilizer Demonstration and Evaluation, West Central Research & Outreach Center. University of Minnesota – Morris, MN.

As part of the liquid soybean meal fertilizer assessment, University of Minnesota Horticulturist Ella VanKempen demonstrated and evaluated two liquid soy inclusion fertilizers in a controlled environment at the University of Minnesota (UM) West Central Research and Outreach Center (WCROC) in Morris, MN. As seen in Image 1, the two fertilizers evaluated were Ferticell (F) 5-10-10 and Nature's Source (NS) 10-4-3. The fertilized plants were later transplanted to the WCROC's Horticultural gardens (Image 2).

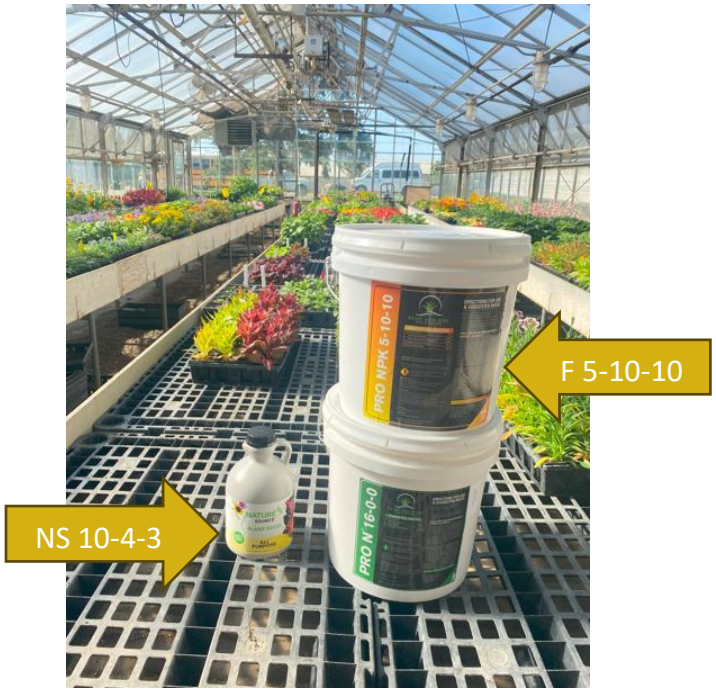

Image 1: Ferticell 5-10-10 and Nature's Source 10-4-3 Liquid Soybean Meal Fertilizers

These fertilizers were applied to young annual flowers in a CEA facility, which were then transplanted to the UM WCROC Horticulture Garden (Image 2). Ferticell was applied to

garden baskets and potted containers. The UM in Morris WCROC has long evaluated annual flowers in the All-American Selections trial ground. The trial signage is shown below (Image 3) at the 2025 UM WCROC Horticulture Night held on July 31st. Photos taken of the demonstration sites are included in Images 4 and 5. Nearly 800 people attended the event.

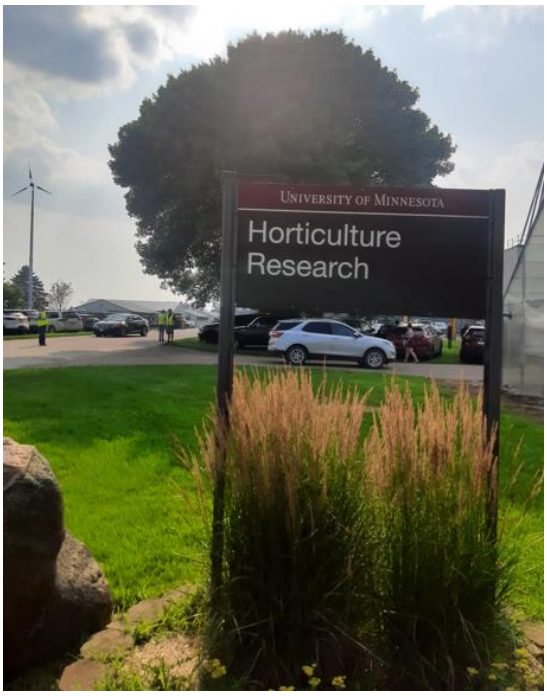

Image 2: University of Minnesota-Morris, Horticulture Research Center
(Harold Stanislawski, Agricultural Utilization Research Institute)

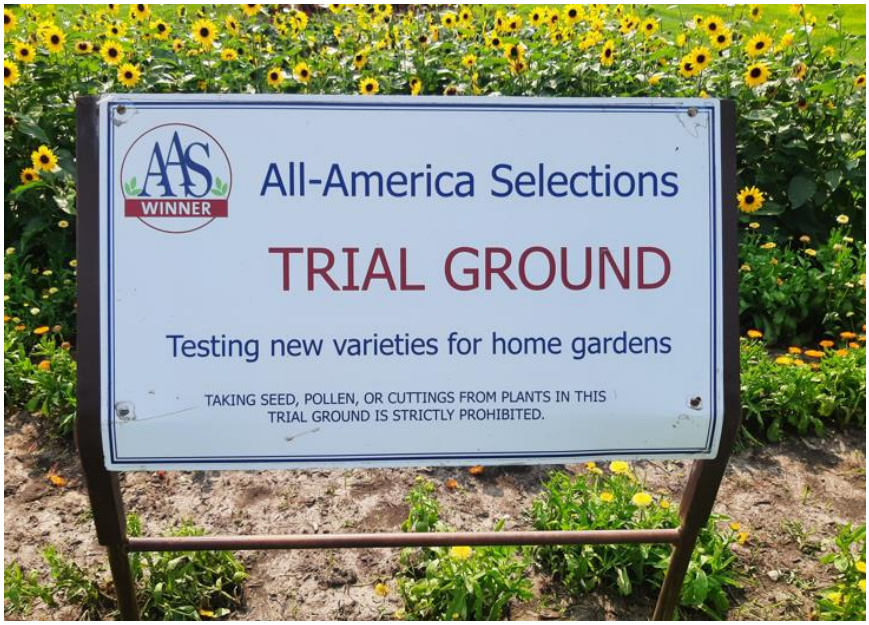

Image 3: University of Minnesota-Morris Horticulture Night All-American Sections Trial Ground
(Harold Stanislawski, Agricultural Utilization Research Institute)

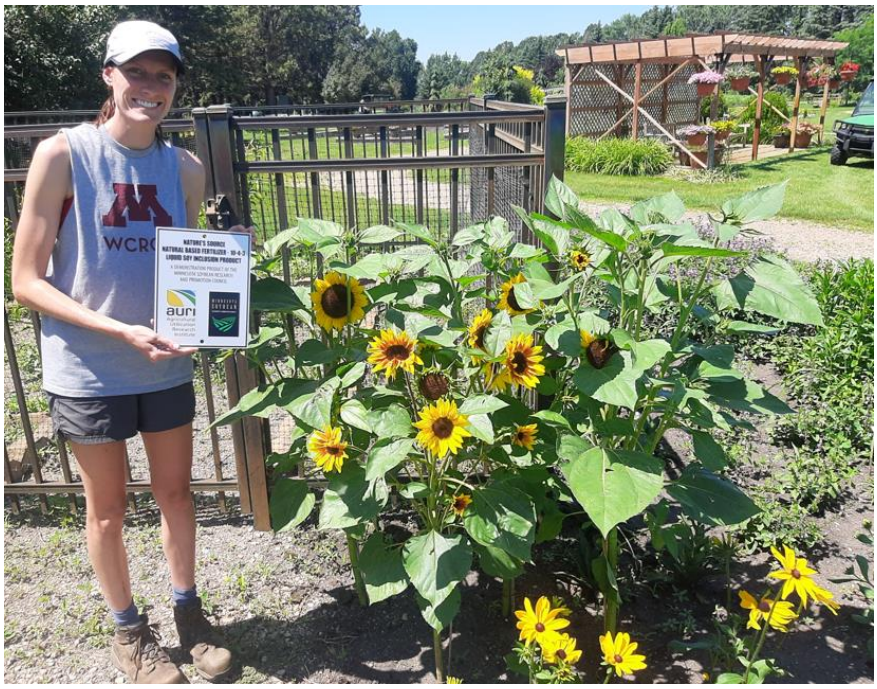

Image 4: Nature's Source 10-4-3 Fertilizer Demonstration with UM WCROC Horticulturist Ella VanKempen
(Harold Stanislawski, Agricultural Utilization Research Institute)

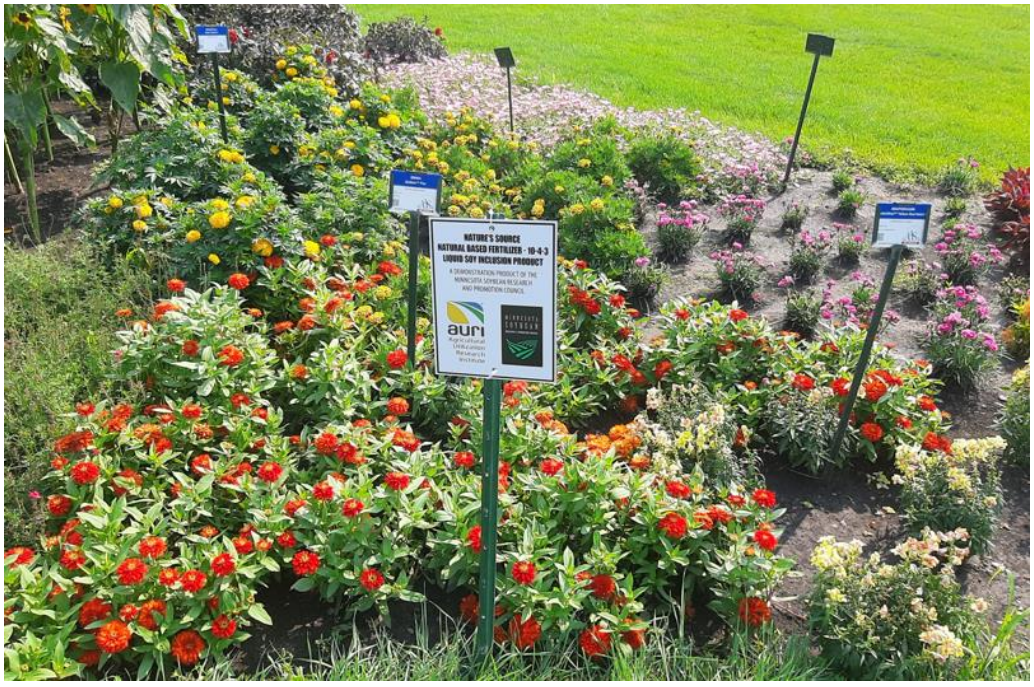

Image 5: Annual flowers treated with Nature's Source 10-4-3
(Harold Stanislawski, Agricultural Utilization Research Institute)

After each demonstration, participants completed an evaluation survey. A copy of the survey completed by Horticulturist VanKempen is provided in Appendix B. Both fertilizers—Nature's Source 10-4-3 and Ferticell 5-10-10—were effective for meeting the nutrient needs of annual ornamental flowers. No plant nutritional issues were observed, though clearer application instructions on the labels would be beneficial. Ferticell presented minor challenges, including an odor during equipment cleanout and somewhat more difficult mixing, but these issues were manageable.

Liquid Soybean Meal Fertilizer Demonstration and Evaluation, Green Barn Garden Center, Isanti, Minnesota.

As part of the liquid soybean meal fertilizer assessment project, Green Barn owner Donny Sparks demonstrated and evaluated a liquid soybean inclusion fertilizer in their greenhouse in Isanti, MN. The fertilizer evaluated was Nature's Source 10-4-5.

When the mums were planted, fertilizer was applied through the fertigation system using a proportional pump set at 100 ppm. The plants initially arrived green but soon began to show yellowing (see Image 6). In response, the soy-based fertilizer was discontinued and replaced with conventional fertilizer. After the switch, the mums regained their green color (see Image 7).

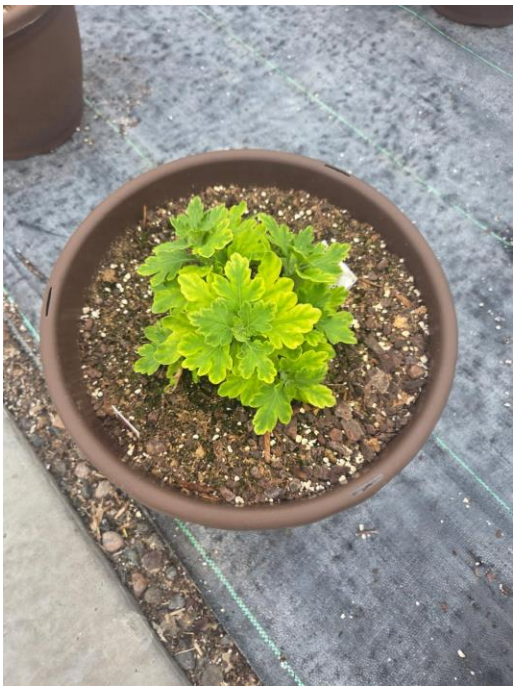

Image 6: Example of mum yellowing at the Green Barn demonstration site
(Green Barn Garden Center, Isanti, Minnesota)

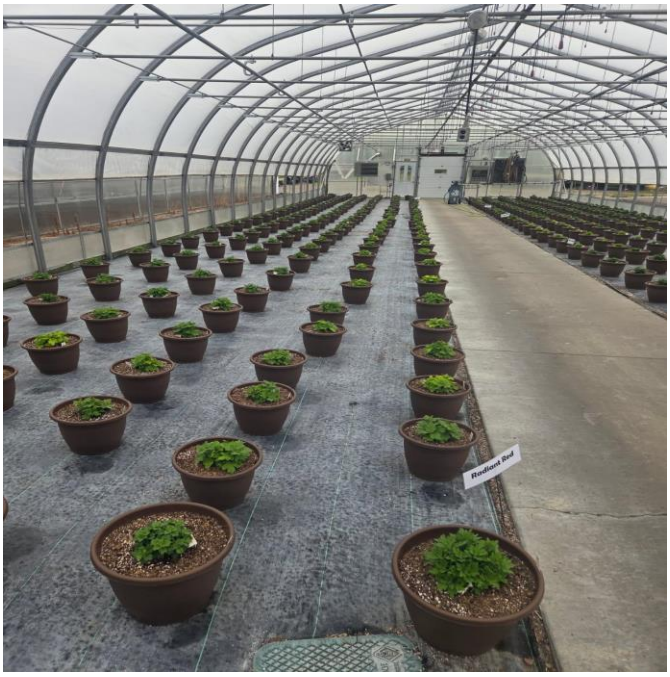

Image 7: Greening up of mums after switching back to conventional fertilizer.
(Green Barn Garden Center, Isanti, Minnesota)

Following the demonstration period, an evaluation survey was conducted. A copy of the Green Barn's Fertilizer Demonstration Evaluation Survey is included in Appendix C.

Conclusion:

While the proportional pump was relatively easy to use, mix, and calibrate, clogging issues and worker safety concerns were low, and product performance was lacking. After discussions with the owner and manufacturer, it was determined that the dosage rate of 100 ppm was too low for heavy nitrogen feeding mums. Refer to the conclusion from the second site, Riverside Farms, for additional positive results from a higher dosage rate.

Liquid Soybean Meal Fertilizer Demonstration and Evaluation, Riverside Farms, Elk River, Minnesota.

As part of the liquid soybean meal fertilizer assessment project, Eric Nathe, owner of Riverside Farms, demonstrated and evaluated a liquid soy inclusion fertilizer in their greenhouse in Isanti, MN. The fertilizers evaluated were Nature's Source 10-4-5 and 10-4-3.

The fertilizer was pumped into a feed tank and blended with water. A biofilm formed on the top of the tank, and the owner was concerned about the injectors plugging. They stopped blending in the feed tank and fed the proportional pump directly from the 55-gallon drum of fertilizer, as seen in Image 8. Under this setup, no biofilm formation was observed. At a rate

of 100 ppm, the mums came in green and began to turn yellow. When the yellowing was observed, they increased the rate to 150 ppm, and the mums greened up again, as seen in Image 9.

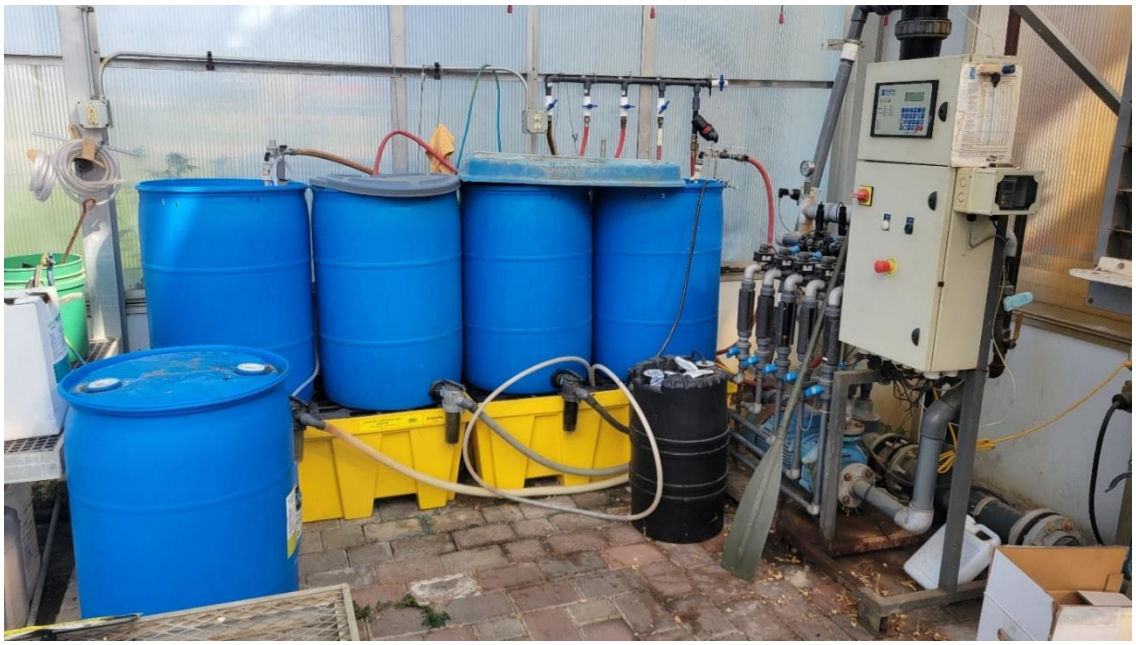

Image 8: Blending system at Riverside Farms.
(Riverside Farms)

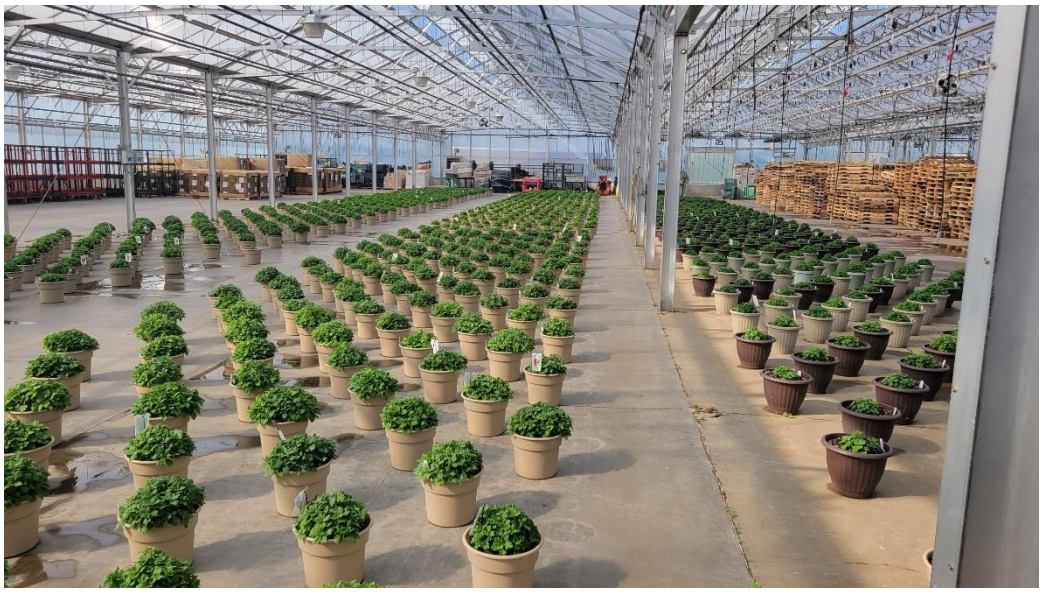

Image 9: Mum crop observed after increasing dosage.
(Riverside Farms)

Following the demonstration period, an evaluation survey was conducted. A copy of the Riverside Farm's Fertilizer Demonstration Evaluation Survey is included in Appendix D.

Conclusion:

While the proportional pump was relatively easy to use, mix, and calibrate, the initial formation of biofilm in the feed tank was concerning. After switching to a direct feed from the supplier tank, biofilm was no longer a problem. After discussions with the owner, he was quite pleased with the results and would consider continued use of the product if the price is competitive with his current conventional fertilizer.

GOAL 4: POTENTIAL MARKETS AND COMMERCIALIZATION AVENUES

Outreach and Commercialization

In support of Goal 4, outreach and commercialization efforts were accomplished through multiple pathways. In January 2025, AURI showcased Nature's Source and Ferticell liquid soybean meal fertilizers in its booth at the 2025 Minnesota Ag Expo. Total attendance was estimated at 700 people. Approximately 300 attendees visited the AURI booth, with around 100 engaging with AURI staff during the two-day event. Attendees expressed great interest in both fertilizers, and AURI fielded many questions about them.

Signage (see Images 4 and 5) was prepared for the 2025 Horticulture Night at the WCROC in Morris, Minnesota, on July 31, to spotlight the liquid soybean meal fertilizer demonstration sites. As noted in an earlier section of this report, nearly 800 people attended the event.

During Minnesota Farmfest, held August 5-7, 2025, AURI showcased soybean meal fertilizers (Image 10). AURI staff discussed its potential with attendees visiting AURI's tent, including Senator Amy Klobuchar and Governor Tim Walz, as seen in Images 11 and 12, respectively. Over 26,000 people attended the three-day event.

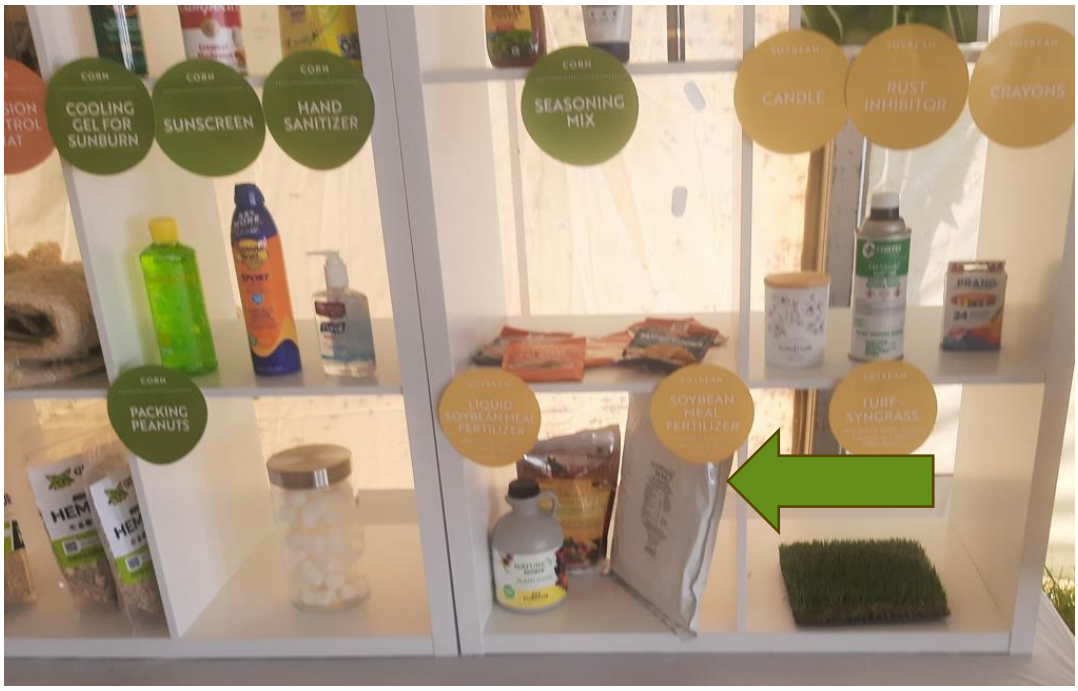

Image 10: AURI 2025 Minnesota Farmfest Display.
(Harold Stanislawski, AURI)

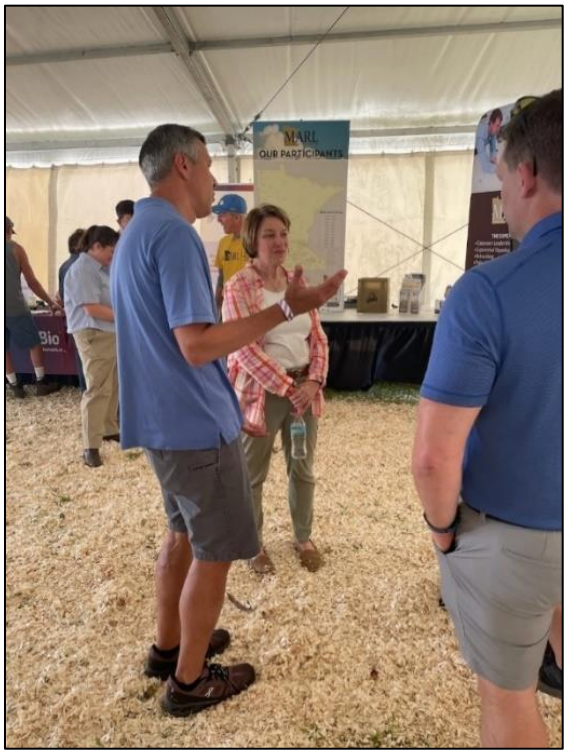

Image 11: *Senator Klobuchar in the AURI Minnesota Farmfest exhibit booth, visiting with staff and attendees in Redwood Falls, Minnesota, on August 5-7, 2025.*
(Agricultural Utilization Research Institute)

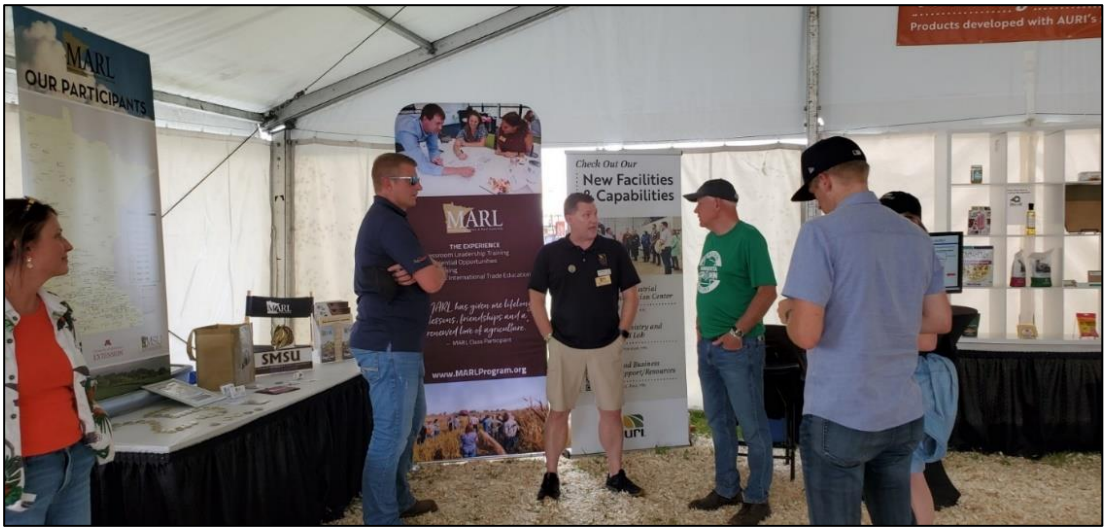

Image 12: Governor Walz in the AURI Minnesota Farmfest exhibit booth, visiting with staff and attendees in Redwood Falls, Minnesota, on August 5-7, 2025.
(Agricultural Utilization Research Institute)

The liquid and granular soybean meal fertilizer blends were also showcased in AURI's booth at the 2025 Big Iron Farm Show, which was held September 8-11 in West Fargo, North Dakota. AURI staff spoke with Stephanie Sinner, executive director of the North Dakota Soybean Council (NDSC). AURI will provide samples to the NDSC to further outreach efforts for the soybean meal-derived fertilizers. Big Iron officials reported record attendance at this year's event, with over 78,000 attendees and over 900 exhibitors. (Forum staff, 2025) .

On September 12, 2025, AURI hosted a podcast titled "Turning Soy into Liquid Fertilizer," which explored how soybeans are being turned into liquid fertilizer. Podcast guests included AURI's Stanislawski, Ella VanKempen of the UM WCROC, and Mike Reiber of Axiom Marketing and AminOrganiX. The podcast recording can be viewed on AURI's website (https://auri.org/auri-news/2025/09/12/turning-soy-into-liquid-fertilizer/). AURI promoted the podcast in cooperation with the Red River Farm Network and through various social media channels (see Appendix E), including LinkedIn, X, and AURI's YouTube channel (https://www.youtube.com/watch?v=KsJpYFVZ7hk). It will also be promoted in an upcoming AURI e-newsletter, *AURI Ag Innovation News Update.* To date, the recording has been downloaded 19 times, with 89 percent of the listens being impactful. It has also garnered 53 views on X (formerly Twitter), 152 organic impressions on LinkedIn, and 113 views on Facebook.

AURI also prepared an article titled “Opportunity Blooms for Soybean-Based Fertilizer,” which will be published in the October 2025 issue of AURI’s Ag Innovations News.

Stanislawski attended Bio Innovations Midwest on September 15-16, 2025, in Omaha, Nebraska. This event highlights bio innovations, value chains, and supply chains. Opportunities to advance the soy complex within these areas will be explored.

A one-page handout on liquid soybean meal fertilizers is in development as part of the project for use at future trade shows and expos, such as the 2025 Prairie Grains Conference and the 2026 Minnesota Ag Expo. A copy of the handout is forthcoming.

AURI Business Development Director of Biomass Feedstocks, Brad Matuska, participated with a booth at Northern Green 2025 on January 22, 2025, in St. Paul, MN (Image 13). The purpose of attending the expo was to gain a clearer understanding of industry needs for liquid and dry fertilizers, identify potential distribution channels for soy-based products, and establish relationships within the sector. Northern Green is the largest green industry trade show and educational conference in the north-central region of Minnesota, attracting a well-attended audience of industry professionals. (Northern Green, 2025).

According to the Northern Green website, the 2025 conference had approximately 5,000 registered attendees, comprised of various industry professionals representing areas such as landscape contractors, arborists, golf courses, sports turf, and parks/recreation professionals. Notably, 42.4 percent of attendees were decision-makers. AURI showcased liquid soybean meal-based fertilizers from Nature’s Source and Ferticell, securing the interest of growers in product trials. It was discovered that many distributors in Minnesota carry Nature’s Source’s liquid soybean fertilizer product. Copies of the handout, “Minnesota Grown Soybean Meal Fertilizer Blends for Lawn and Garden,” were also distributed. Many connections were made and questions fielded. One particular follow-up was with the sales manager for Carlin Horticultural Suppliers, which led to the identification of demonstration sites at Riverview Farms and Green Barn Garden Center.

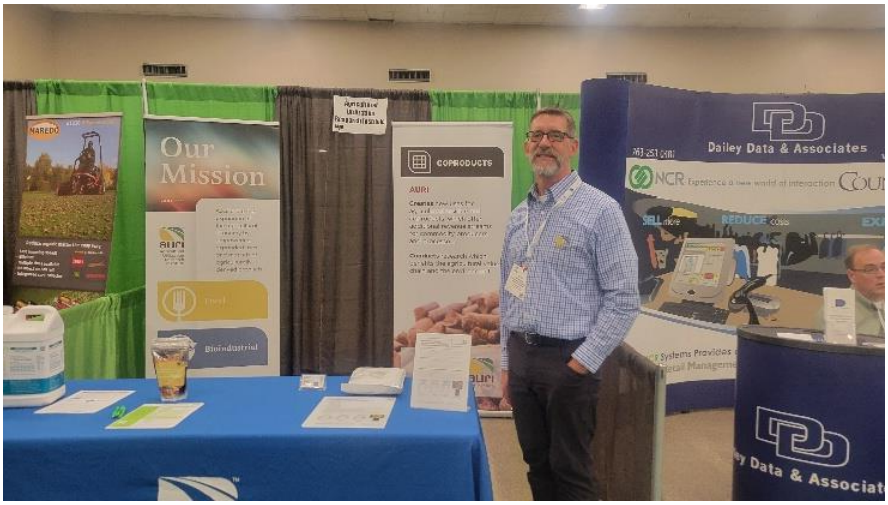

Image 13: AURI (Brad Matuska) at Northern Green 2025
(Agricultural Utilization Research Institute)

AURI Business Development Director Harold Stanislawski spoke with Dr. Dominic Petrella, an assistant professor of managed turfgrass systems in the University of Minnesota Horticultural Science Department. He is a recent hire at the university and is interested in liquid and granular soybean meal fertilizers for enhancing turf performance. AURI intends to share the project's outcomes with the Departments of Horticulture at the University of Minnesota-Morris and the Twin Cities campuses and will continue to dialogue with Dr. Petrella to utilize his expertise as a resource to advance the liquid and granular soybean meal fertilizer products.

Stanislawski had initial conversations with Chris Gaeth, Director of Tech Operations at OMNI Technologies, Inc. There may be opportunities to network with technical experts at the United Soybean Board to better understand marketing and distribution channels for soybean meal-derived fertilizers.

AURI is also in discussions with a Minnesota fertilizer formulator that is currently developing a liquid soybean meal fertilizer for the market.

Conclusion and Recommendations

The overall outlook for Minnesota soybean meal and its derivatives in soy-based liquid fertilizer production is promising, though the market remains in its early stages. The results of this project—spanning literature reviews, interviews, product demonstrations, and outreach—confirm that soy-based liquid fertilizers, such as Nature's Source and Ferticell, can perform competitively with conventional liquid fertilizers when properly formulated and applied. Both demonstrated effective nutrient delivery, low salt index, and the potential to improve soil and plant health, aligning with the broader market trend toward sustainable and regenerative agriculture.

Key Insights

- **Performance validation:** Greenhouse and CEA demonstrations confirmed that soy-based fertilizers meet crop nutrient needs when applied at approximately 150 ppm N. Minor operational issues, such as biofilm formation, can be managed through improved handling and storage practices.
- **Market readiness:** Liquid fertilizers dominate horticultural and CEA markets, yet organic and organomineral products remain <5% of use—offering both a challenge and opportunity for differentiation.
- **Supply infrastructure:** Minnesota's strong soy crush and processing network provides a robust base for sourcing, blending, and distributing soy-derived fertilizer inputs locally.
- **Economic potential:** Even a 0.25% market share could translate into 21,000–29,000 soybean bushels per year by 2029, generating additional economic value for Minnesota's growers and processors. If market share were calculated for the entire United States, the soybean acreage would be significantly larger.

Recommendations and Follow-Up Work

Advancing soy-based liquid fertilizers from early validation to commercial adoption requires targeted follow-up work in formulation, demonstration, and supply chain development. The next phase should convert Minnesota's strong feedstock base—soybeans, soybean meal, and soapstock—into finished, market-ready fertilizer products capable of competing regionally and nationally.

Product Optimization (New follow-up work required)

- **Formulation refinement:** Conduct controlled studies to optimize nitrogen concentration, micronutrient composition, and viscosity for consistent fertigation performance. Address biofilm formation by using stabilizers or by revising the feed system design.
- **Performance benchmarks**: Develop standardized nutrient-equivalency curves comparing soy-based and synthetic fertilizers for key horticultural and CEA crops (mums, petunias, leafy greens, herbs).
- **Product line development:** Create new targeted specialty formulations, such as seedling-safe starter blends, foliar amino-acid boosters, and carbon-supplemented products, to meet specific crop and growth-stage needs.

Demonstration Expansion (New follow-up work required)

- **Targeted trials:** Expand demonstrations to additional greenhouses and CEA facilities using varied water and media chemistries to confirm consistency and economics
- **Regenerative and organic agriculture trials:** Extend testing to field applications emphasizing soil health, nitrogen efficiency, and reduced salt accumulation.
- **Economic validation:** Quantify cost per unit of plant-available N and return on investment (ROI) under both organic and conventional systems.

Supply Chain and Manufacturing (New follow-up work required)

- **Feedstock standardization:** Finalize fertilizer-grade specifications for Minnesota-produced soy meal, soapstock, and isolates (protein, organic matter (OM), ash, free fatty acids (FFA)).
- **Local manufacturing feasibility:** Conduct a techno-economic analysis (TEA) for a Minnesota-based blending and concentration facility (1–3 million gallons per year) to leverage existing crush infrastructure and serve regional demand.
- **Stability and packaging:** Test product stability under different temperatures and packaging configurations to ensure storage and distribution reliability.

Market Development and Education (Requires continued engagement)

- **Grower education tools:** Create practical mixing and injection guides, nutrient equivalency charts, and troubleshooting references for greenhouse operators.
- **Distributor partnerships:** Collaborate with major distributors (e.g., BFG, Carlin, Tessman) for co-branded demonstrations and training programs.

- **Segment expansion:** Target early adopters in premium horticulture, turf, and specialty crop markets that prioritize low-salt, sustainable inputs.

Regional and National Market Leverage (Strategic priority)

Minnesota's soy crush and logistics assets position the state to serve much larger out-of-state horticulture and CEA markets with fertilizers derived from locally grown soybeans and meal. Producing and shipping high-value liquid fertilizers from rural Minnesota would:

- Increase value capture for growers by transforming meal and byproducts into higher-margin specialty inputs.
- Stimulate new bioindustrial and employment growth in rural counties through blending, packaging, and distribution.
- Strengthen Minnesota's role as a regional bioindustrial hub supplying sustainable agricultural inputs across the United States.

Commercialization and Investment (Requires strategic follow-up)

- **Partnership development:** Facilitate collaboration among AURI, MSR&PC, private formulators, and distributors to establish manufacturing capacity within Minnesota.
- **Funding opportunities:** Pursue USDA BioPreferred, state bioindustrial, and MDA value-added grant programs to de-risk early commercialization.
- **Business models:** Develop value-sharing frameworks among growers, processors, and distributors to ensure Minnesota soy remains central in the emerging biofertilizer value chain.

In summary, while today's market is small, the growth upside—especially if paired with novel, Minnesota-based manufacturing and focused on the whole U.S. horticultural and CEA sectors—justifies further development and anal. Future work should concentrate on formulation enhancement, demonstration scale-up, feedstock standardization, and building regional manufacturing capacity to capture a larger, growing downstream market. Minnesota has a feedstock base, infrastructure, and technical capacity to become a national supplier of soy-based liquid fertilizers, transforming locally grown soybeans into products that serve horticultural and CEA markets nationwide. This adds opportunities and diversification to Minnesota's soybean agriculture, driving rural economic development through product diversification and new market acquisition.

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Appendices

NOTE: Please see the PDF Attachment Section to view each Appendix included herein.

Appendix A. Notable Interview Commentary, Axiom

Appendix B. UMN WCROC Fertilizer Demonstration Evaluation Survey

Appendix C. Green Barn Fertilizer Demonstration Evaluation Survey

Appendix D. Riverside Farm Fertilizer Demonstration Evaluation Survey

Appendix E. AURI Podcast Social Media Promo, *Turning Soy into Liquid Fertilizer*