Incentivizing the Adoption of Washington Made Green Fertilizer





Prepared for: Washington State Department of Agriculture
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Executive Summary

The Washington State Legislature directed the Washington State Department of Agriculture to convene a Work Group of agricultural sector professionals to examine the benefits and barriers to the use of sustainably produced green nitrogen fertilizer and recommend a program to encourage its adoption by Washington state farmers. This initiative represents a first of its kind cutting edge opportunity for Washington to be an industry leader, given that this type of fertilizer is not yet available in any global quantity to be purchased by Washington state farmers.

Green fertilizer refers to synthetic nitrogen fertilizer products that are manufactured using a "green" Haber- Bosch process. Using energy from a sustainable source, hydrogen, water, and nitrogen from the air are used to synthesize ammonia which is then used to make fertilizer.[1] Fertilizer manufactured in this way has a significantly lower greenhouse gas emission profile. Additionally, because the manufacturing process does not rely on fossil fuels, price volatility is reduced. Manufacturing plants can be located closer to points of sale and use, further reducing transportation related greenhouse gas emissions.

As shown in the table below, fertilizer represents a significant portion of variable and total costs for farmers (in some cases as much as 19 percent of variable costs).

Table ES 1. Fertilizer Share of Cost by Crop

Crop	Fertilizer Share of Variable Cost	Fertilizer Share of Total Cost	Nitrogen Share of Variable Cost	Nitrogen Share of Total Cost
Potatoes - Russet Burbank-processing (1)	19%	15%	N/A	N/A
Potatoes - Russet Norkotah-fresh (1)	19%	15%	N/A	N/A
Sweet Corn (2)	N/A	N/A	14%	8%
Onions (3)	11%	9%	7%	6%

Paired with the often high share of cost represented by fertilizer is price variability for conventional anhydrous ammonia, which follows the variability of natural gas prices (See Figure ES-1). Any effort to reduce costs and price volatility would be favorably received by farmers.

[1] About Green Ammonia. Greenfield Nitrogen Pure Green. Accessed October 6, 2024. Available here.

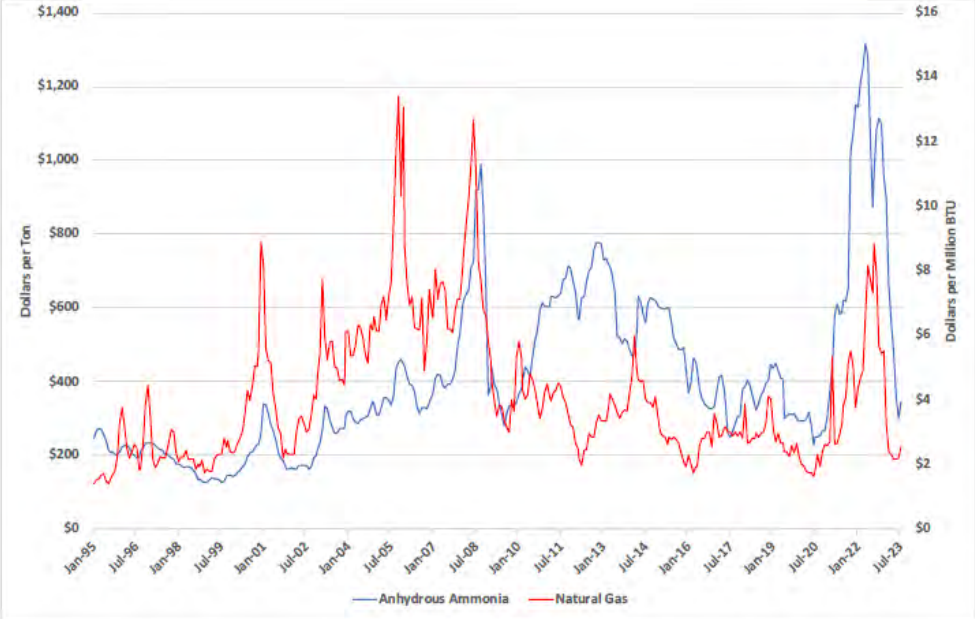

Figure ES 1. Anhydrous Ammonia and Natural Gas Prices, January 1995-July 2023[2]

WSDA retained Greene Economics to conduct research, interview stakeholders, and develop recommendations for an assistance and incentive package that would encourage and assist Washington farmers with the adoption of a Washington manufactured green fertilizer product.

Greene Economics conducted an in-depth interview process that took place over two months and included individual interviews with farmers and growers' associations as well as engagements with stakeholders and subject matter experts in a work group setting. Greene Economics also reviewed a number of existing programs, both in Washington and in other states, that might serve as models for the development of a Washington program.

These engagements revealed that Washington farmers are receptive to transitioning to a locally manufactured, sustainably produced nitrogen fertilizer. Price parity with currently used fertilizers, product effectiveness and potential staff training and equipment upgrades were expressed concerns that will need to be addressed.

Based on these findings, Greene Economics recommends that the Legislature direct WSDA to develop a reimbursement program to off-set the initially higher production cost of green fertilizer as well as provide equipment and training grants targeted at new, emerging, and traditionally under-represented farmers since these farmers may not have the resources to access the product otherwise.

As it will be a new initiative, successful development implementation of these recommendations will require adequate staffing. In addition, a portion of the funding for this transition should be dedicated to field trials to demonstrate the product's efficacy and to support farmers switching process to "green" nitrate fertilizer with confidence.

[2] Bart Fischer, J. Outlaw, H. Bryant, J. Raulston, G. Knapek. "Concentration and Competition in the U.S. Fertilizer Industry. Briefing Paper. Agricultural and Food Policy Center, Texas A&M University. March 2024. Pg. 5.

Project Overview

Greene Economics was retained by the Washington Department of Agriculture (WSDA) to conduct a comprehensive analysis and develop recommendations for structuring a grant program designed to encourage farmers to purchase "green" fertilizer products produced within the state of Washington. The work was motivated by a budget proviso from the state legislature that states,

> (29) $250,000 of the climate commitment account—state appropriation is provided solely for the department to facilitate a work group and prepare a comprehensive report with recommendations regarding the establishment of a grant program to support farmers in the purchase of "green" fertilizer produced within the state of Washington.
>
> (a) The work group convened by the department shall include representatives from the department of ecology, the department of commerce, Washington state agricultural organizations, manufacturers of "green" fertilizer products, and other relevant stakeholders as determined by the department.
>
> (b) The work group shall review, analyze, and propose the structure of a grant program designed to encourage farmers to purchase "green" fertilizer produced within the state of Washington. The review shall include considerations of:
>
> (i) The environmental benefits of "green" fertilizer;
>
> (ii) Economic impacts on farmers;
>
> (iii) The development and capacity of local "green" fertilizer manufacturers; and
>
> (iv) Ensuring equitable access to the grant program among different agricultural sectors.

The Greene Economics research team participated in three work group meetings convened by the WSDA made up of representatives from the Washington Department of Ecology (Ecology), the Washington Department of Commerce (Commerce), representatives from the Washington state agricultural community, manufacturers of "green" fertilizer products and other identified stakeholders (see Appendix A for a list of work group members).

The work group provided insights and direction that shaped the form and content of this research.

The research team conducted a number of interviews with stakeholders including a range of farmers, fertilizer manufacturers, fertilizer distributors, farm and agricultural support organizations, and subject matter experts from WSDA, Ecology and Commerce.

The analysis focused on developing an understanding of the benefits of "green" fertilizer, an assessment of the potential economic impacts to farmers from substituting a locally produced "green" product for other conventionally produced imported fertilizer, and an exploration of the development and capacity of local "green" fertilizer manufacturers. The analysis, combined with the information gathered during the interviews and discussions held as part of the work group sessions, were used to develop recommendations for incentives, including grant funding, that would support the transition to a locally manufactured "green" fertilizer product.

Concurrent to the work of Greene Economics, Yonsei Consulting was retained by WSDA to evaluate Healthy Environment for All (HEAL) act compliance. These findings and recommendations are presented in a separate report.

Background

Through the Climate Commitment Act and other climate policies, Washington has committed to reducing overall greenhouse gas emissions by 95 percent by 2050.[3] Inorganic nitrogen fertilizer production is one of the leading sources of greenhouse gas (GHG) emissions in agriculture in the United States and globally. These emissions are primarily associated with the manufacturing process for nitrogen fertilizer products, as well as those associated with shipping and transportation from point of production to the farm gate. Beyond the manufacturing process, when inorganic nitrogen products are applied to plants in the field there is also the potential for greenhouse gases to be released through volatilization. Not related to greenhouse gas emissions, but also an area of concern is when nitrogen fertilizer is incorrectly, or over applied, and there is the potential for runoff and groundwater contamination which can affect water quality.

The US Department of Agriculture (USDA) recently launched two programs designed to promote domestic fertilizer production (and thereby reducing the greenhouse gas footprint associated with shipping and transportation), and to incentivize the development of fertilizer products that are manufactured without the use of fossil fuels. In addition to having a lower manufacturing carbon footprint, fertilizer manufacturing processes that are not reliant on fossil fuels can be located closer to communities where demand is greatest, further reducing transportation related greenhouse gas emissions.[4]

In September 2022, the USDA launched the Fertilizer Production Expansion Program (FPEP) which made $500 million available to support the domestic production of fertilizer and other agricultural inputs.[5] In 2024, as part of the *Investing in America* agenda, the USDA awarded $83 million to projects in 12 states, including Washington, through the FPEP program.[6] In January 2024 the Biden-Harris administration also announced that USDA would be investing over $207 million in renewable energy and domestic fertilizer project, primarily utilizing Inflation Reduction Act funds. These awards are also part of the Justice40 Initiative which has a goal of ensuring that 40 percent of the benefits of federal investments are realized in disadvantaged and marginalized communities that are overburdened by pollution.[7]

Another program that supports the "green" fertilizer initiative was funded through the Bipartisan Infrastructure Law, which involved the US Department of Energy's Office of Clean Energy Demonstrations (OCED) selecting seven H2Hubs across the United States to begin award negotiations for up to $7 billion, one of the largest investments in clean manufacturing and jobs in American history. Following

[3] "Climate Commitment Act". Washington Department of Ecology. Accessed October 6, 2024. Available here.
[4] Tonelli, D., L. Rosa, P. Gabrielle, A. Parente &F. Contino. "Cost-competitive decentralized ammonia fertilizer production can increase food security". Nature Food. September 2023. Accessed October 7, 2024. Available here.
[5] Fertilizer Production Expansion Program. US Department of Agriculture. Accessed October 6, 2024. Available here.
[6] USDA Rural Development Fertilizer Production Expansion Program Bundle 1. May 2024. US Department of Agriculture. Accessed October 4, 2025. Available here.
[7] Biden-Harris Administration Invests $207 Million in Clean Energy and Domestic Fertilizer Projects to Strengthen American Farms and Businesses as Part of Investing in America Agenda. Press Release. January 2024. US Department of Agriculture. Accessed October 4, 2024. Available here.

negotiations, in July 2024, OCED awarded the Pacific Northwest Hydrogen Hub—led by the Pacific Northwest Hydrogen Association (PNWH2)—with $27.5 million for the first tranche of funding out of the total project federal cost share of $1 billion to begin Phase 1 of the project plan.[8] The development of this hydrogen hub will support the development of a number of different manufacturing operations, including ones that produce fertilizer.

Nitrogen Fertilizer Production

Plants use energy in the form of sunlight to produce sugars (energy) from water and carbon dioxide through a process known as photosynthesis. Nitrogen is a key component of this process as well as an essential macronutrient, ensuring that this energy, which is vital for growth, is available when and where a plant needs it.[9] Plants typically uptake nitrogen in the form of Nitrate (NO3) or ammonium (NH4).[10] For commercial crops, organic matter in soil typically does not provide enough nitrogen to facilitate these processes, which is why growers fertilize soil or plants with nitrogen.

Nitrogen gas exists naturally in the environment, but it must be converted in order for plants to use it. The two molecules that make up a nitrogen atom have to be split before plants can use them. In a conventional fertilizer manufacturing process ammonia is created by combining nitrogen from the air with hydrogen from natural gas under high temperature and high pressure. This process is known as the "Haber-Bosch" process." Natural gas is both the feedstock for the creation of the end product and the energy source to generate the temperature and levels of pressure required for the reaction. This process is illustrated in Figure 1 below.

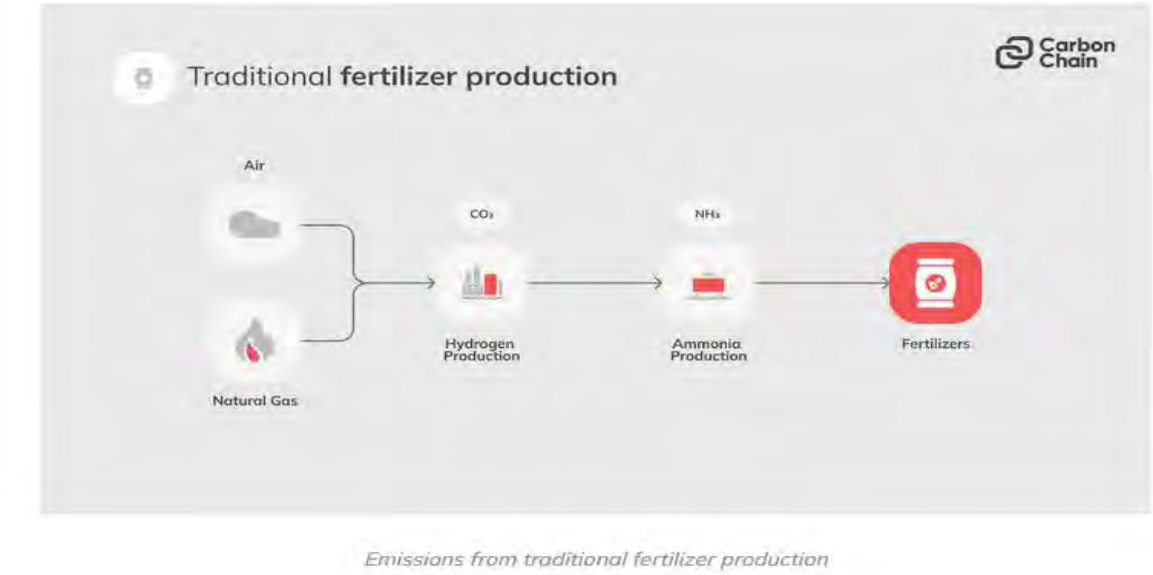

Figure 1. Traditional Fertilizer Production[11]

[8] US Department of Energy OCED Awardee Fact Sheet, July 2024.
[9] "The Role of Nitrogen in Crop Production and How to Protect It". Koch Agronomic Services. December 2023. Accessed October 6, 2024. Available here.
[10] "Nitrogen in the Environment: What is Nitrogen". University of Missouri Cooperative Extension. November 2022. Accessed October 6, 2024. Available here.
[11] "Understanding fertilizer emissions for carbon regulation". CarbonChain. March 2024. Accessed October 6, 2024. Available here.

On average 2.6 metric tons of carbon dioxide equivalent (MTCO2e)[12] are produced per ton of nitrogen-based fertilizer production, with much of these emissions (about 40 percent) occurring during the production and transportation of the product (see Figure 2).[13]

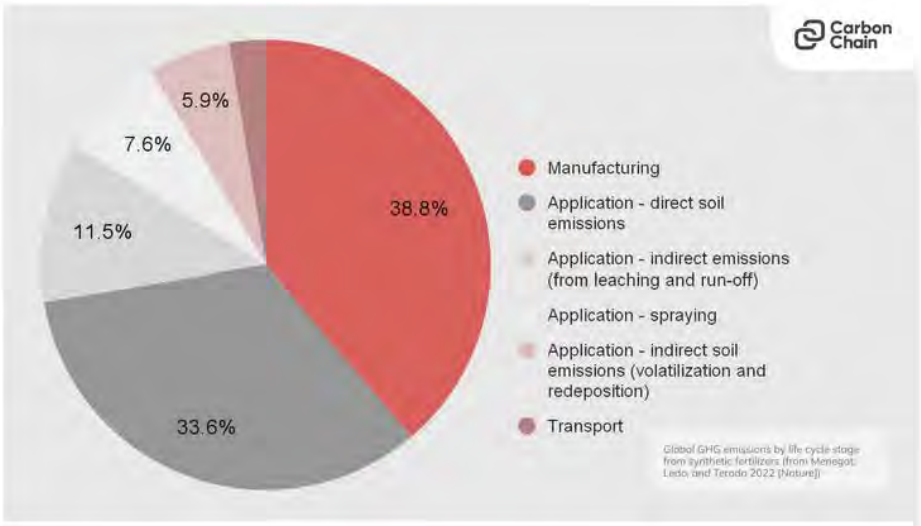

Figure 2. Lifecycle Global Greenhouse Gas Emissions from Synthetic Fertilizer[14]

Globally, ammonia production accounts for 1.3 percent of energy related CO2 emissions. By comparison, the aviation industry accounts for 2 percent.[15] The current production of ammonia is highly centralized, with the bulk of production in 2023 originating from companies based in Israel, Canada, India, Chile, Norway, Russia, Saudi Arabia and the United States.[16]

The United States is the fourth largest producer of nitrogen fertilizer, with production concentrated across 16 companies and 16 states, primarily located near large reserves of natural gas. In 2023, plans were underway to expand or build 12 new plants in the United States.[17] Even with these expansions the United States is still a net importer of ammonium as shown in the graph below (see Figure 3).

[12] Carbon credits are typically quantified in terms of metric tons of CO2-equivalent (MTCO2e), CO2 equivalents are used because GHGs vary by global warming potential (GWP). GWP is an index developed by the Intergovernmental Panel on Climate Change (IPCC) that allows comparisons of the heat-trapping ability of different gases over a period of time, typically 100 years. Consistent with international GHG reporting requirements, the Environmental Protection Agency's most recent GHG inventory (with data from 2022) uses the GWP values presented in the IPCC's 2013 Fifth Assessment Report. For example, based on these GWP values, a ton of methane is 28 times more potent than a ton of CO2 when averaged over a 100-year time frame. See EPA, Inventory of US
Greenhouse Gas Emissions and Sinks: 1990-2022, Draft, March 2024, Available here.

[13] "Understanding fertilizer emissions for carbon regulation". CarbonChain. March 2024. Accessed October 6, 2024. Available here.

[14] Ibid. CarbonChain.

[15] "From fuel to fertilizer, how green ammonia could help curb emissions". World Economic Forum. 2023. Accessed October 6, 2024. Available here.

[16] "Top 9 Fertilizer Companies in the World". IMARC. Accessed October 6, 2024. Available here.

[17] "The Fertilizer Boom: America's Rapidly Growing Nitrogen Fertilizer Industry and Its Impact on the Environment and Public Safety". April 2023. Environmental Integrity Project. Page 30. Accessed October 6, 2024. Available here.

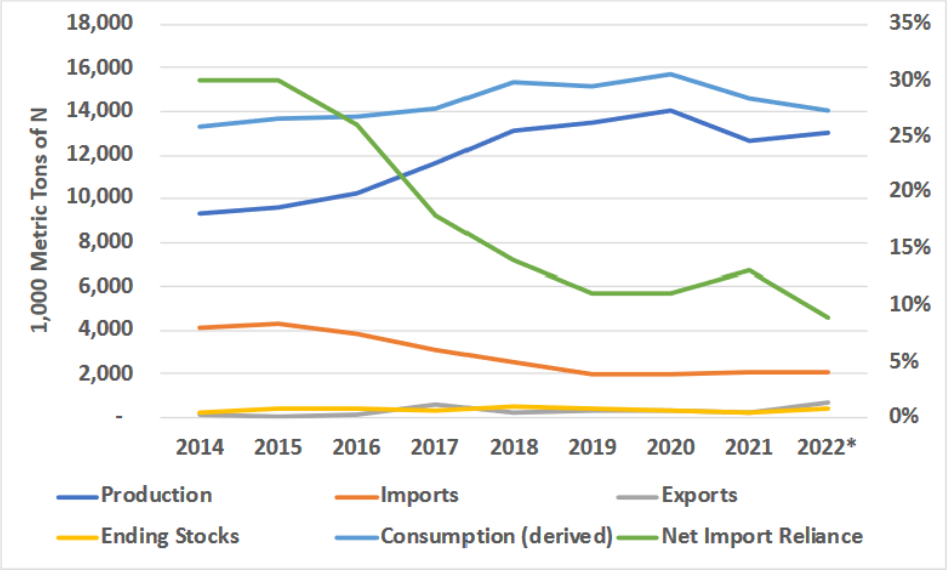

Figure 3. U.S. Ammonia Supply, Use and Net Import Reliance[18]

"Green" Fertilizer as an Alternative

It is possible to reduce the carbon intensity of fertilizer production through a synthetic fertilizer process. Natural gas can be replaced in the process, both as a fuel source and as the feed stock. Using only air and water and powered by renewable energy, "green nitrogen" fertilizer manufacturers can produce a fossil-free nitrogen fertilizer product with over a 90 percent emission reduction relative to conventional production.

Using energy from a sustainable source, hydrogen, water, and nitrogen from the air are used to synthesize ammonia which can be used to make fertilizer.[19] This process is often referred to as a "green" Haber-Bosch process. In this process hydrogen is made through water electrolysis, using renewable energy sources. Nitrogen is then taken from the air and mixed with hydrogen to produce ammonia. The ammonia is converted into nitric acid and then into calcium ammonium nitrate, as illustrated in Figure 4 below.

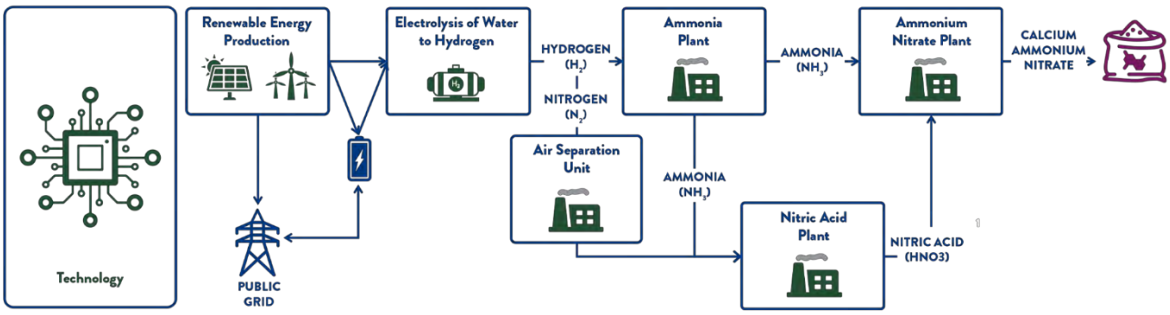

Figure 4. Green Fertilizer Production Process[20]

[18] Fischer, B. J. Outlaw, H. Bryant, M. Raulston & G. Knapek. "Concentration and Competition in the U.S. Fertilizer Industry". Agricultural and Food Policy Center, Texas A&M University. March 2024. Accessed October 6, 2024. Available here.
[19] About Green Ammonia. Greenfield Nitrogen Pure Green. Accessed October 6, 2024. Available here.
[20] Atlas Agro. Accessed October 2024. Available here.

In addition to the greenhouse gas emission reductions associated with fossil fuel replacement in the manufacturing process itself, these facilities can be located closer to points of use—further reducing transportation costs and the associated emissions. Transportation-related emissions depend on the origin and route of shipping, can add an additional 0.3 CO2e (carbon dioxide equivalent)[21] per metric ton of Urea Ammonium Nitrate and 0.5 CO2e per metric ton of Urea[22] for fertilizer imported into Washington state.[23]

Fertilizer Use in Washington State

Commercial farmers in Washington state apply over 575,000 tons of nitrogen fertilizer to their crops each year[24]. For row crops grown at scale, the cost of this input can vary widely.[25] In Washington state, commercial grade nitrogen fertilizer is used on tree fruit orchards, bush fruit, vineyards, and row crops, with potatoes leading this category.

The term "fertilizer" is a general term that can include a number of products and combinations of products. Traditional liquid nitrogen fertilizer is typically applied through irrigation while granular fertilizer is applied with a spinner spreader or pneumatic spreader. Industry experts interviewed cited the need to minimize the number of trips around the field as a key requirement for any fertilizer. Each trip around the field impacts the farmer costs and increases the amount of fuel used and associated greenhouse gas emissions required to produce the commodity.

The cost of any fertilizer product is key to farmers' decisions about whether to use a product. The cost of fertilizer as a share of variable costs and as a share of total costs to farmers is a principal element of this decision. It is critical to understand how changes in cost may affect farm profitability for any crop produced. As "green" fertilizer is most likely to be used (at least initially) in the production of potatoes, corn, onions, and stone tree fruits, the team reviewed enterprise budgets for two varieties of potatoes, and one each for sweet corn, cherries, and peaches in order to understand the cost of conventional fertilizer use in these farm operations. In the future, "green" fertilizer products may be used on other crops, so the team also looked at fertilizer used in growing apples because they are such an important part of Washingtons agricultural economy.

Enterprise and crop budgets have been developed by extension services in both Idaho and Washington through Washington State University (WSU) and University of Idaho to help farmers understand the costs associated with growing a particular crop. Depending on the crop, these budgets are not always updated regularly, and the data can be anywhere between 5 and 35 years old. Therefore, some of these enterprise budgets we used, and the associated costs are older than others, but they are the most current available. Ideally when looking at costs to farmers, the best comparison for the "green" fertilizer product would be a similar conventional nitrogen product. However, only some of the reviewed enterprise budgets included a specific nitrogen product separate from other fertilizer costs, while the rest included only one line item called "fertilizer". Therefore, a comparison was made of total fertilizer costs, and where provided, liquid

[21] As noted above carbon dioxide equivalent means the number of metric tons of CO2 emissions with the same global warming potential as one metric ton of another greenhouse gas. US EPA. Available here.
[22] Urea is a low-cost form of nitrogen fertilizer that has a high nitrogen content relative to other forms of nitrogen fertilizer. It has lower transportation and storage costs, relative to other forms of nitrogen and can be applied as a solid, in solution or as a spray. University of Minnesota Extension Service. Accessed October 8, 2024. Available here.
[23] Atlas Agro, professional communication. October 2024.
[24] 2021-2022 WSDA Annual Tonnage Report, Agr Pub 632-336, 2024. Available here..
[25] Costs can range from $700 - $1,300 per acre, depending upon fuel costs, transportation and labor costs, and other factors. Matt Harris, WA State Potato Commission, Professional communication. September 2024.

nitrogen (or ammonium nitrate in some cases) costs as a portion of both total variable costs and total costs on a unit basis to calculate the share of costs spent on fertilizer or nitrogen products.

Table 1 provides a summary of the findings. Figure 5 presents the graphic representation of the same information. For these crops, conventional fertilizer makes up between 1 percent and 19 percent of variable costs to farmers for crop production, and between 1 percent and 15 percent of total costs to farmers, depending on the crop. The cost of nitrogen products as a share of costs falls within these ranges as well. Fertilizer is a significant cost consideration for potatoes, sweet corn, and onions, all with ten percent or higher of their variable costs spent on fertilizer, while the stone fruits reviewed (cherries and peaches) show only one percent spent on fertilizer, a much lower, though not inconsequential, share. These findings are consistent with what farmers told the research team during the stakeholder interviews. Clearly, when the cost is such a high percentage of variable and total costs to a farmer, transitioning to a more expensive product for any reason could well be cost-prohibitive.

Table 1. Fertilizer Share of Cost by Crop

Crop	Fertilizer Share of Variable Cost	Fertilizer Share of Total Cost	Nitrogen Share of Variable Cost	Nitrogen Share of Total Cost
Potatoes - Russet Burbank-processing (1)	19%	15%	N/A	N/A
Potatoes - Russet Norkotah-fresh (1)	19%	15%	N/A	N/A
Sweet Corn (2)	N/A	N/A	14%	8%
Onions (3)	11%	9%	7%	6%
Apples (4)	0.4%	0.3%	N/A	N/A
Cherries (5)	1%	1%	N/A	N/A
Peaches (6)	N/A	N/A	1%	1%

Sources:
1: Washington State University. 2019. Cost Estimates of Producing Fresh and Processing Potatoes in Washington. Available here.
2: Washington State University. 2002. Cost of Producing Dry Beans, Sweet Corn and Green Peas Under Center Pivot Irrigation in The Columbia Basin of Washington State. Available here.
3: University of Idaho, College of Agricultural Life Sciences. 2013. Southwestern Idaho and Eastern Oregon: Treasure Valley Onions. Available here.
4: Washington State University. 2020. 2019 Cost Estimates of Establishing, Producing, and Packing Honeycrisp Apples In Washington. Available here.
5: Washington State University. 2022. 2021-2022 Cost Estimates of Establishing, Producing and Packing Chelan Sweet Cherries in Washington. Available here.
6: Washington State University, Cooperative Extension. 1989. Estimated Costs of Producing Peaches in the Yakima Valley, Washington. Available here.

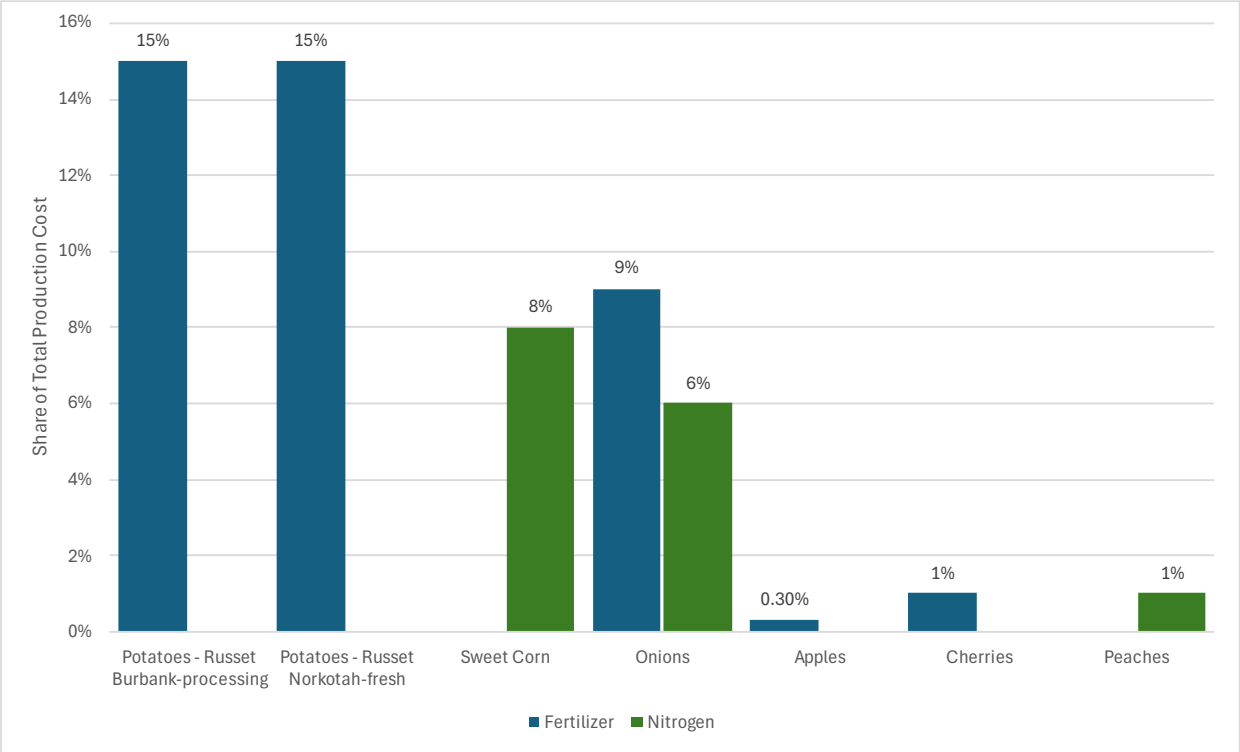

Figure 5. Fertilizer and Nitrogen Share of Cost by Crop

Two other costs have the potential to affect the price of conventional fertilizers, and in turn affect farm-level decisions to transition to "green" fertilizer. These are transportation costs, and the price variability and vulnerability of carbon fuel used in the production of conventional fertilizer. The farther a product needs to be transported, the higher the transportation cost as a part of the product price. If a fertilizer is produced locally, its transportation cost as a part of total price will be lower than the transportation costs and associated total costs of a product imported into the region. Similarly, the production of conventional fertilizer uses carbon-based fuels, which experience significant price volatility over time, and in turn affects prices to farmers for conventional fertilizer products. The correlation between and volatility of natural gas and conventional fertilizer prices is illustrated in the figure below.

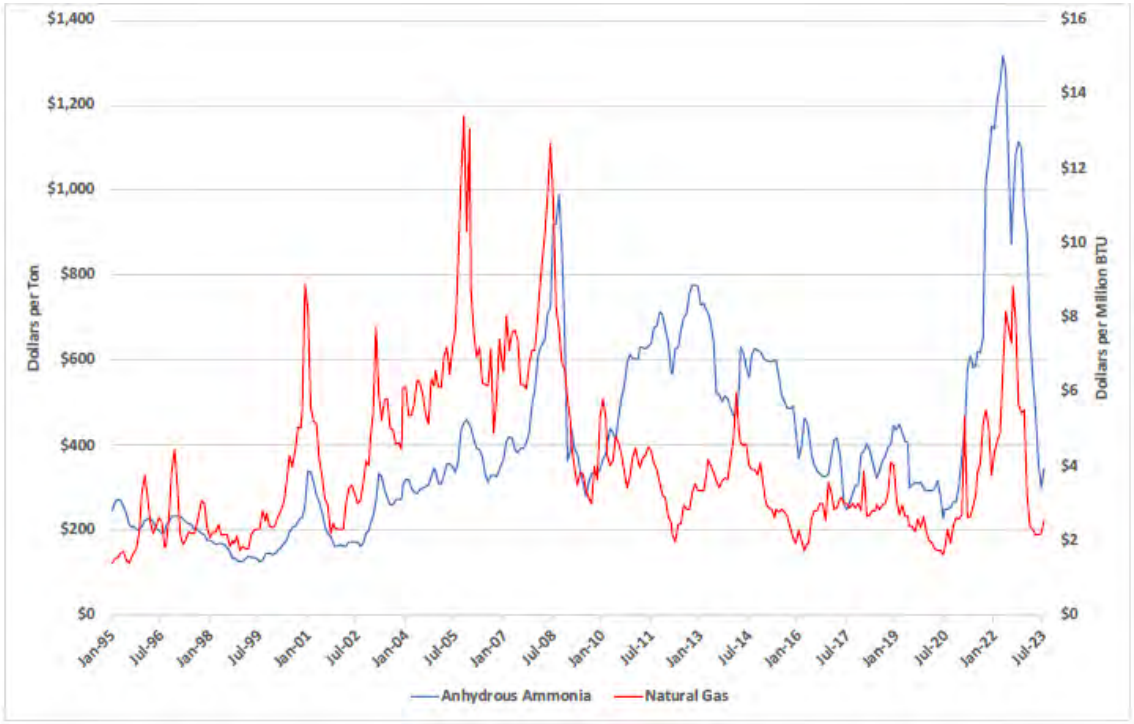

Figure 5. Anhydrous Ammonia and Natural Gas Prices, January 1995-July 2023[26]

These two concerns would be mitigated for farmers using a "green" fertilizer produced in Washington State with local renewable energy sources.

Piloting "green" Fertilizer in Washington

As part of its commitment to achieving the emission reduction goals of the Climate Commitment Act and in order to offer Washington farmers more secure access to a locally made, less price volatile product, Atlas Agro, an international company, has determined that the green hydrogen opportunities in Washington State make it an ideal location to manufacture four green nitrogen fertilizer products commonly used in row crops, tree fruit, and other commodities grown in Washington (see product fact sheets in the Appendix B).

Atlas Agro was founded in 2021 to manufacture "green" nitrogen fertilizer. Its founders, Petter Østbø and Knut Karlsen, bring expertise in both the global fertilizer industry and the energy transformation sector. In addition to the Pacific Green Fertilizer facility they are building in Richland, Washington, they will site a second facility in Uberaba, Brazil.

The company will soon break ground on what will be Washington's first "green" fertilizer manufacturing facility in Richland on property that was formerly part of the Hanford Nuclear Site. The fertilizer plant will function as an anchor partner of the Pacific Northwest Hydrogen Hub (PNWH2).

The fertilizer manufacturing facility represents a $1.5 billion investment in Washington state's agricultural infrastructure. The plant is expected to produce 650,000 tons annually of four initial fertilizer products

[26] Bart Fischer, J. Outlaw, H. Bryant, J. Raulston, G. Knapek. "Concentration and Competition in the U.S. Fertilizer Industry. Briefing Paper. Agricultural and Food Policy Center, Texas A&M University. March 2024. Pg. 5.

commonly used in commercial-scale agriculture and employ approximately 200 people directly. Commercial production is targeted to begin in 2027.

This plant represents the first opportunity for Washington state to invest in the development of manufacturing facilities that will make locally produced non-fossil fuel-based products available to Washington farmers.

Incentive Programs

As stated above, the goal of this project is to develop recommendations for establishing a grant program to support farmers in the purchase of "green" fertilizer produced within the state of Washington based on the input from a multidisciplinary workgroup. Information collected by the research team and reviewed by the work group was used to identify types of farmers who might be well suited to adopting the product, barriers to adopting "green" fertilizer, potential incentive programs, and some model programs that have been used successfully elsewhere and establish a platform for the recommendations.

Potentially Appropriate Farming Sectors

The team interviewed and met with WSDA agronomists and subject matter experts to better understand the properties and use applications of different fertilizer products as well as the primary sectors where "green" fertilizer products might be appropriate. Based on product characteristics as described in data sheets provided by Atlas Agro and expert knowledge of fertilizer use in Washington these experts indicated that initially these products would likely be used in the production of potatoes, tree fruit, wine grapes and possibly corn and onions. Over 300 commodities are grown in Washington, and in the future, it is possible that these "green" fertilizer products could be used in association with most of those commodities. Given the time constraint, for the purposes of this research, interviews and stakeholder engagements focused on potatoes, vine crops and fruit trees.

Over a six-week period, the team conducted 21 interviews with farmers and representatives from commodity associations representing potato, tree fruit, and diversified row crop farmers, as well as fertilizer distributors and sellers and agency staff. The team also held four one-hour listening sessions to enable members of Washington State's Environmental Justice Council and others to drop in, receive an overview of the process, ask questions, and provide feedback to the team.

Based on these interviews, the team determined that these products would have the greatest potential for adoption in the potato, tree fruit, and wine grape sectors, with additional potential associated with other row crops.

Potatoes as a Prime Commodity

Washington state boasts over 250 potato farmers and dedicates 150,000 acres to growing potatoes. Potato farms in Washington yield an average of 30 tons of potatoes per acre – double that of the average US potato farmer, producing 20% of US-grown potatoes. Large commercial buyers represent an increasing percentage of potatoes sold. These buyers are being pressured by their consumers to demonstrate a lower carbon footprint in their end product. With over 4.5 million tons of potatoes grown in Washington, a transition to "green" fertilizer could have a significant impact.

Throughout these interviews it was clear that farmers, in every sector, and of every size, are interested in reducing their carbon footprint and in exploring the use of inputs that are more sustainable. There was also considerable interest in products that are made in the United States and in products that are made "closer to home." There is a practical as well as philosophical motivation for this, in that locally made products that do not rely on fossil fuels are less subject to price volatility, due to changes in fossil fuel prices, and are not subject to global supply chain disruptions. These factors aside, there are still concerns and barriers to adoption that will need to be overcome if farmers are going to switch to a "green ammonia" product. These barriers are discussed in detail in the next section.

Barriers to Substitution and Adoption

Interviewees identified four main sources of uncertainty or barriers to the potential adoption of this product. These included:

- Cost
- Labor and Equipment Needs
- Training Needs
- Risks (yield and supply chain uncertainty)

Cost Concerns

At the end of the day "nitrogen is nitrogen, it's all the same to the plant"

Cost was consistently identified as the most significant barrier to adoption regardless of farm size or crop. All farmers and commodity representatives, save one, ranked this as their number one concern.

Farmers are already operating on thin and declining margins. All other factors being equal, cost considerations will be the primary driver of any decision to transition to this type of product.

Cardenas Agricultural Products and Services, Pasco, WA

Cardenas Agricultural Products and Services is a family-owned distributor of agricultural products. Lupe Cardenas has supplied the region's farmers for 24 years. He supplies fertilizer for farms ranging from five to 2,000 acres. Farmers bring soil samples to Cardenas and a tailored fertilizer is mixed for them. Cardenas staff deliver the product to the farm and usually apply the mixed product on site. Whatever mechanism is used to encourage farmers to transition to "green" fertilizer, the bottom line is simple: it must cost the farmer no more than their current product …

This was particularly true for potato farmers where in 2019, fertilizer costs represented roughly 18 percent of the total variable cost of production.[27] Using 2022 figures, fertilizer costs represented between 17 and 20 percent of their total variable costs on a per acre basis.[28] As noted above, more than 20 percent of the potatoes grown in the United States are grown in Washington and in 2023 potatoes were second only to apples in the total dollar value of production ($1,160,712,000).[29] Adoption of "green" fertilizer by potato farmers has the potential to be one of, if not, the largest impact area for this product.

While fertilizer costs do not make up as large a portion of total variable costs for tree fruit farmers as their largest input cost is labor, cost was still important to these farmers.

Cost neutrality will be one of the most important drivers of adoption of this new product.

Preliminary analysis provided by Atlas Agro indicates that, at least for the first ten years after the plant comes online, there will likely be a $200 per ton cost differential at the manufacturing gate between conventionally produced fertilizer products and the products made using the "green" process. It is unclear what costs will be covered or what volume of tons of sale would be required to break even with a $200 per ton subsidy as Atlas Agro did not share a breakdown of the actual costs and calculations used to develop this cost with the Green Fertilizer Work Group. The costs that make up the differential appear to be primarily tied to investment and start-up costs associated with bringing a plant online. Depending on actual start-up costs and sales volume, that per ton figure might be higher (or lower). Atlas Agro has indicated that these costs will likely be recovered by the manufacturer after 10 years at which point the products would be cost competitive without a subsidy.[30] To close this cost gap and encourage the adoption of green fertilizers, the Work Group recommends a biennial investment of $50-$65 million in CCA funds to support this grant program. The intent is to offset any cost difference between local green and conventional fertilizer, so farmers are incentivized to purchase local green fertilizer.

[27] Nadreau, T. "Washington Potato Economic Contribution Statement." Impact Center, School of Economic Sciences, Washington State University, Pullman WA. Pg 11. Accessed October 6, 2024. Available here.
[28] Based on draft potato enterprise budgets supplied by the Potato Growers Association during an interview with Matt Harris, Director of Government Affairs and Assistant Executive Director, September 6, 2024.
[29] US Department of Agriculture. 2023 State Agriculture Overview. Accessed October 6, 2024. Available here.
[30] Atlas Agro - professional communication. October 2024.

Labor and Equipment Needs

A second commonly identified area of concern (which also has a cost component) was whether or not there would be added labor requirements associated with transportation, storage and application of the products and whether or not additional or different equipment would be needed to apply the products. Seven out of eight farmers interviewed identified this as an area of concern.

As with conventional nitrogen products, "green" fertilizer products can come in either liquid or granular forms. Nitrogen fertilizer is typically applied through ground application and irrigation systems and is often (increasingly) applied using a precision agriculture approach.

Nitrogen is seldom purchased or applied as a stand-alone application. Farmers typically bring a soil sample to a local or regional distributor and a custom mix is developed that includes nitrogen and other nutrients and micronutrients that address the specific needs of the crop and the specific conditions of the soil. There are three primary pathways for the purchase and application of fertilizer:

1. A farmer purchases inputs based on their soil profile, then stores, mixes, and applies the product directly with their own equipment and labor;
2. A farmer shares the soil profile with a distributor, who mixes a custom product, which is transported to the farm and the farmer then stores and applies the product with their own equipment and labor;
3. A farmer shares the soil profile with the distributor who then mixes, delivers, and applies the product on the farm.

Under the first pathway, to the extent that a farmer is already using a particular form of the product, the tools and techniques associated with the application itself would remain the same, regardless of the product. However, if a farmer were to switch from one form to another, there would likely be new costs associated with the purchase of new equipment and tools in the form of tanks and pumps. These costs are not necessarily unique to the transition from conventional to "green" nitrogen and would be present if the farmer made a switch with either.

There will likely be additional equipment requirements associated with storage and transportation. According to information provided by Atlas Agro, "green" products are less nitrogen dense than urea or urea ammonium nitrate products and will require added storage volume, so there will likely need to be investments in dry storage sheds and liquid storage tanks. Further analysis will need to be done to determine exactly where along the distribution chain these investments will need to occur and what the size of that investment will be.

It is unclear from our analysis whether, and to what extent, differences in product density would change the rate of application of the "green" product., Even so, to the extent that laying down a less dense product would require either larger equipment or a greater number of passes using the same equipment -- this will create an additional cost—either in equipment or labor.

The point is that ultimately these are costs that will need to be considered and mitigated to incentivize a substitution.

Training and Education Needs

Related to concerns about equipment, interviewees raised questions around whether there would be added training needs associated with adopting a new product. As with storage and application, the degree

to which added training support might be needed will depend on the delivery and application model the farmer employs. For those who rely on a supplier to mix and apply the products, no added training should be required. For those who self-mix and self-apply there might be some support needed associated with application rates and any changes in the way the product should be mixed or stored.

It is worth noting that there does not appear to be new or different exposure risks associated with "green" products. In fact, these products may be less volatile and less subject to vaporization than conventional nitrogen, so new or added training and information regarding handling and storage would not be required.

Risk Concerns

Farmers raised two different sets of concerns, both of which are fundamentally about risks. When thinking about programs and packages to incentivize adoption, tools that mitigate these risk concerns may be an important part of the package, particularly for smaller, lower resource farmers.

Effectiveness

While on the one hand those interviewed were quick to point out that "nitrogen is nitrogen" and "it's all the same to the plant" they still expressed concerns that this product might not be as effective as conventional nitrogen and that its use might result in a decline in yields. "There's going to be a transition period between the grower saying, 'I want to buy what I have traditionally because I don't know this product' -- it's going to be disruptive and that's okay."

Supply Chain Vulnerability

Finally, because the manufacturing plant (or plants) will be new ventures, and the production process will be a "new" approach, some concerns were raised related to what the risk might be if a farmer made the investment to switch, then at some point production of the new product ceased.

Incentive Approaches

The terms of the Proviso directed the development of "recommendations for the establishment of a grant program to support farmers in the purchase of "green" fertilizer produced within the state of Washington". Based on our findings, it is likely that a successful program will require more than grant funds to compensate for the added cost of this new product. Marrying a subsidy or incentive with an income-replacement tool and, further, offering training and/or equipment rental or loans if needed, would offer a comprehensive approach attractive to farms of various sizes and product.

Cash incentives could take one or more of several forms:

- Coupons that could be redeemed and processed at one of several levels (supplier, distributor, or retailer);
- Rebates to be distributed to farmers once the product is purchased and applied;
- Point of Sale (POS) programs in which the supplier, distributor, and/or retailer is reimbursed and manages the subsidy transaction; and/or
- Direct subsidy to the manufacturer.

Farmers expressed varying degrees of interest in these mechanisms. Farmers have familiarity with coupons and rebates, having used them successfully in other contexts. However, farmers were also clear that the paperwork and reporting burdens, particularly associated with rebates, made this tool less

attractive to them. They also were clear that the time lags between having to make a cash outlay and receiving the rebate was also something that made this approach less attractive.

Another approach recently piloted in two farming areas in northern California and Idaho is a type of "crop guarantee". This program, outlined in detail below, ensures that if farmers experience a decline in yield as a result of the adoption of a new conservation practice, they are compensated for that loss. This incentive could either stand alone or be combined with any of the above and would work as a type of guarantee against losses or decreased in yield. The State could set up a fund that would guarantee income-replacement if a farmer using a "green" fertilizer product experiences lower yield or quality as a result of the substitution.

All of these approaches could be undertaken in partnership with Washington State University. Interviewees consistently reported critical need for trials that not only yielded demonstratable and citable results but were available for farmers to visit and see for themselves.

In addition, identifying and recruiting a small number of farmers who are motivated to transition to "green" fertilizer as an early-adoption cohort may be an effective and efficient approach to both beta-test an incentive approach and partner with WSU to achieve results to highlight to a broader agricultural constituency.

Based on the information gathered during the stakeholder interviews and the concerns outlined in the previous section, the team has determined that there is not a single approach that will uniformly overcome barriers to adoption and incentivize substitution. This is due to the fact that the relative importance of the factors that impact decisions are quite different and the tools that would effectively mitigate those drivers also vary. This was observed both among farmers growing the same crops and between farmers growing different crops. In addition, there are significant differences in where along the supply chain an intervention might need to be placed in order for it to be effective. Further information and research are needed to better understand the costs associated with each factor and to understand the distribution and level of concern related to each.

Yakama Nation Farms

Yakima Nation Farms cultivates 1,500 acres of which 500 is certified organic and 1,000 is conventional. They grow between 23 and 25 different products annually, all of which, with the exception of grapes, are row crops. The 2023 fall/2024 growing season was their first, after purchasing the legacy Inaba Farm, farmed on the Yakama reservation by three generations of the Japanese-American Inaba family. Transitioning to a "green" fertilizer is exciting for them, although they envision needing financial support for equipment upgrades as well as staff training. "We're excited," says Farm Manager Jonalee Squeoch. "It aligns with our values."

Based on our analysis we have determined that to successfully incentivize the adoption of a Washington produced "green" nitrogen product, a package needs to be developed that offers a suite of options that includes:

1. A mechanism to offset the cost differential of the product – which could be in the form of a rebate, coupon or reimbursement paid either to a wholesaler, a retailer, a distributor or directly to the farmer;
2. A guarantee that offsets the risks associated with the potential for declining yield or product unavailability which would be targeted to the farmers themselves;
3. A mechanism that offsets the cost of investments in equipment and materials – which could be a grant or a loan offered to a wholesaler, a retailer, a distributor, or directly to the farmer or an equipment share or loan program that would eliminate the need for a farmer to purchase equipment to apply the product

It is important to note that items two and three may prove to be particularly important tools and guarantees for new, emerging, and traditionally underrepresented farmers.

While not directly part of an incentive package that could be offered to farmers, retailers, or distributors, the majority of the interviews cited lack of information, and uncertainty regarding effectiveness, as potential barriers to adoption or substitution. In addition to incentives and guarantees, independent clinical trials that show the effectiveness of the product will be critical to successful adoption. Funding should be allocated to support partnering with independent third parties to conduct independent research that shows the efficacy of the product.

Model Incentive Programs

Based on these recommendations, the team has identified programs that are currently in operation, in Washington and elsewhere, that can serve as models for the development of a package for Washington farmers. Each of these programs illustrates the successful implementation of a component or a suite of components that has been identified through interviews and stakeholder engagements. These programs are detailed below. Adoption of any or a combination of the approaches described below would need to be evaluated and designed to be HEAL Act compliant, ensuring a goal of 40 percent of benefit accrue to overburdened communities and vulnerable populations in Washington state.

WSDA Compost Reimbursement Program – Rebate

The WSDA Compost Reimbursement Program[31] is an example of an effective use of a rebate mechanism to offset costs that private commercial famers incur when they choose to apply locally sourced compost as a soil amendment.

WSDA recently launched a program aimed at incentivizing Washington farmers to use compost as a soil amendment that has soil health benefits and greenhouse gas emission ramifications consistent with Climate Commitment Act goals. The Compost Reimbursement Program, which is currently funded through the Climate Commitment Act, offers a rebate to offset added expense in choosing an organically based soil amendment. As this program already exists within the department, it invites review.

WSDA launched a Compost Reimbursement Program for commercial farmers at the beginning of FY 2023 (July 2023) to encourage the use of organic compost at scale and reduce carbon emissions on-site. Farms of all sizes are eligible but must have a Statewide Vendor Number and Washington UBI number, as required by the State. Additionally, they must agree to share information about their farm, purchase

[31] Washington Department of Agriculture. Compost Reimbursement Program. Available here.

compost from WSDA-approved facilities only, and conduct periodic soil sampling over the course of 10 years. Once approved for the rebate, farmers must sign a contract with WSDA to be eligible.

Each program year begins in July and concludes on June 30th. Participating farms are eligible for 50 percent reimbursement on qualifying costs, including compost purchases and associated transportation, equipment, and labor costs (for a full breakdown of the reimbursable costs, please see the Eligibility Application subpage). Funding limits for participating farms vary based on farm size and proposed budgets. Participating farms are required to collect soil samples from fields where the compost was applied for several years.

The total appropriation for this program by the Legislature is $1.5 million per year. In its first year, a little over $1M in grant funds were allocated and WSDA dispersed over $360,000. There are a number of factors that led to a lower amount being dispersed than was allotted. Some of these included participants having trouble sourcing the compost, timeline issues for participants, as well as the way funds were required to be allotted per participant. Recent changes to the statute (RCW 15.04.420), such as allowing compost to be purchased from more facilities, should increase impact this year.

Summary of the first year (FY 2024) of the Compost Reimbursement Program

A total of over $360,000 in grant funds were awarded to 84 farms across the state.

The map below shows the counties where farms were reimbursed during the first year of the program. Spanning 25 counties, the highest funding went to Okanogan County with nearly $60,000. Values are rounded to the nearest $100 for convenience. Counties with more than $10,000 in funding to farms are yellow, orange or red.

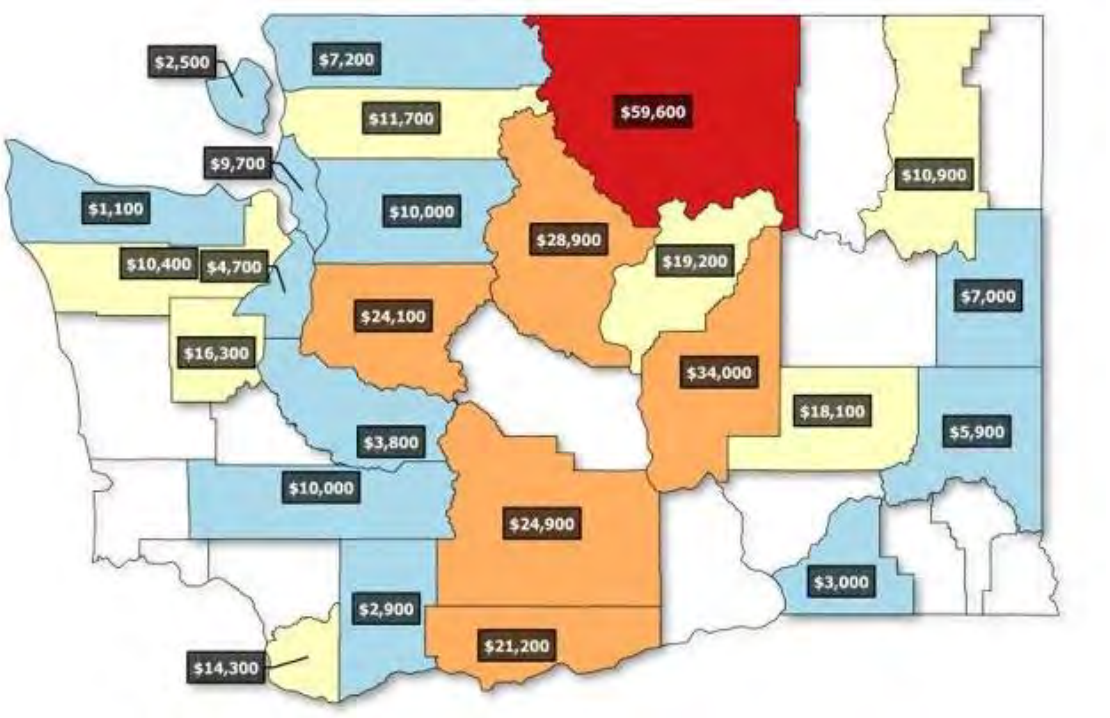

Figure 6. Total Value of Rebates Processed by County[32]

- Over 9,900 yards of compost were purchased by participating farms, with over 100 yards on average per farm.
- The projected quantity of reduced GHG emissions was around 880 MTC02e.[33]

A summary of the program outcomes is presented in Table 2 below.

Table 2. 2024 Program Highlights[34]

FY 2024	Overall Total	Per Farm Average
Funding Distributed	$361,272	$4,301
Compost Purchased (yards)	9,917	118
GHG Emission Reduction (metric tonnes)	880	10.5

[32] Amy Clow, Quarantine, Compost & Rules Coordinator. Washington Department of Agriculture, email communication. October 2024.

[33] Emissions were calculated using data from USDA's COMET Planner (http://comet-planner.com/). Due to incomplete information from participating farms and self-reported data, assumptions were made in calculating this data and there may be errors.

[34] Amy Clow, Quarantine, Compost & Rules Coordinator. Washington Department of Agriculture, email communication. October 2024.

Summary of the current program year 2025 (FY 25)

For the current fiscal year (FY 25), the program has just gotten underway. The application period ended on September 12th and 146 applications were received. A second round of applications will be accepted in the fall of 2025.

- The map below shows applicant locations (green and red circles) and eligible compost facilities (yellow and black symbol).
- 127 applicants, shown as green circles, said they would be buying compost containing food waste feedstock. Under the program's prioritization structure, these farms would be priority level 1.
- 19 applicants are not purchasing compost containing food waste feedstocks. Applicants that indicated it wouldn't be practicable for them to purchase compost containing food waste feedstock are placed in priority level 2. All other applicants are put in priority level 3.

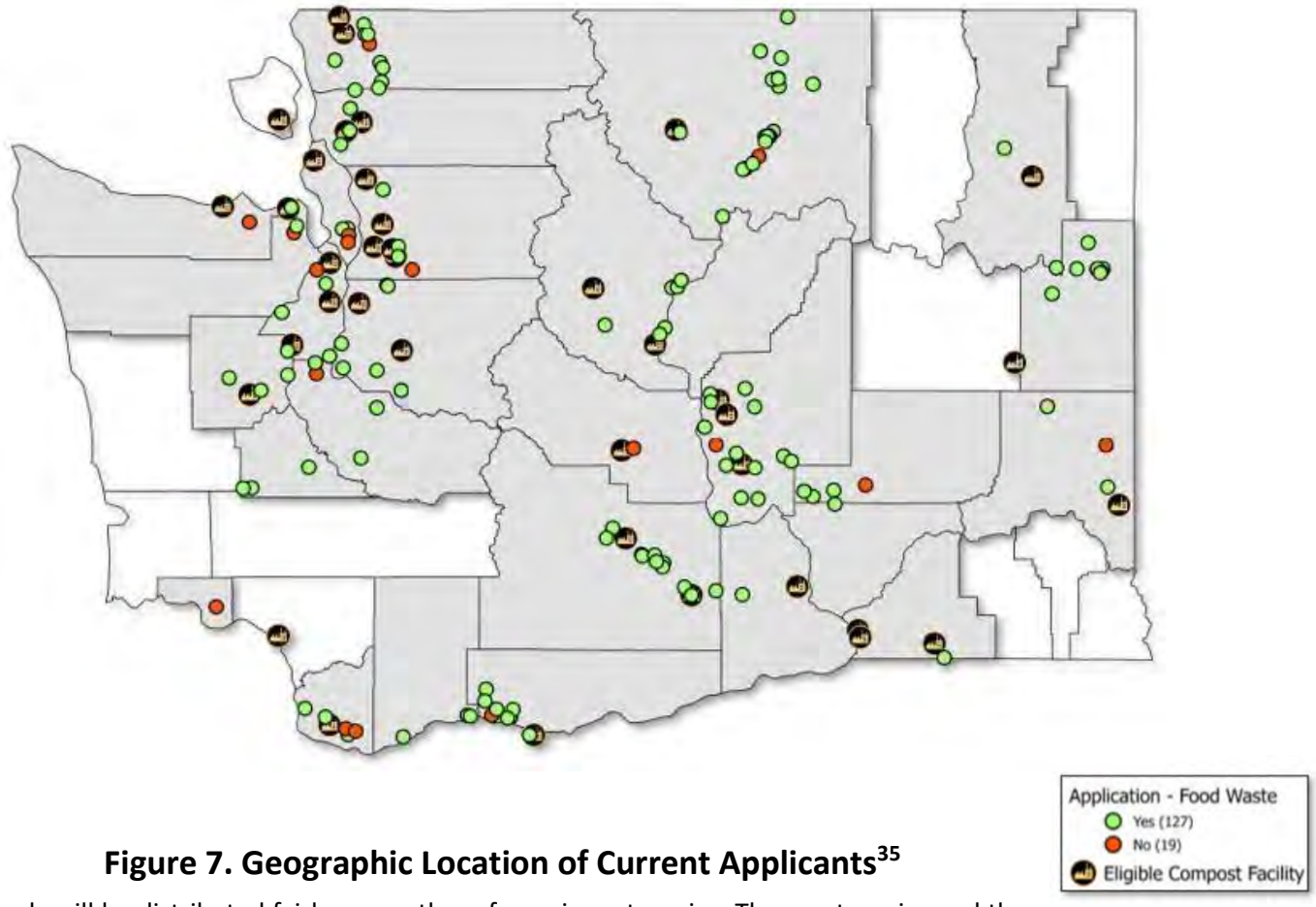

Figure 7. Geographic Location of Current Applicants[35]

Funds will be distributed fairly across three farm size categories. These categories and the distribution of applicants can be found in the pie chart below.

[35] Amy Clow, Quarantine, Compost & Rules Coordinator. Washington Department of Agriculture, email communication. October 2024.

- <10 acres will have a funding limit of $10,000 - 52 applications were received in this size category.
- 10-50 acres will have a funding limit of $15,000 - 38 applications were received in this size category.
- 50+ acres will have a funding limit of $20,000 - 56 applications were received in this size category. These distributions are represented graphically in the figure below.

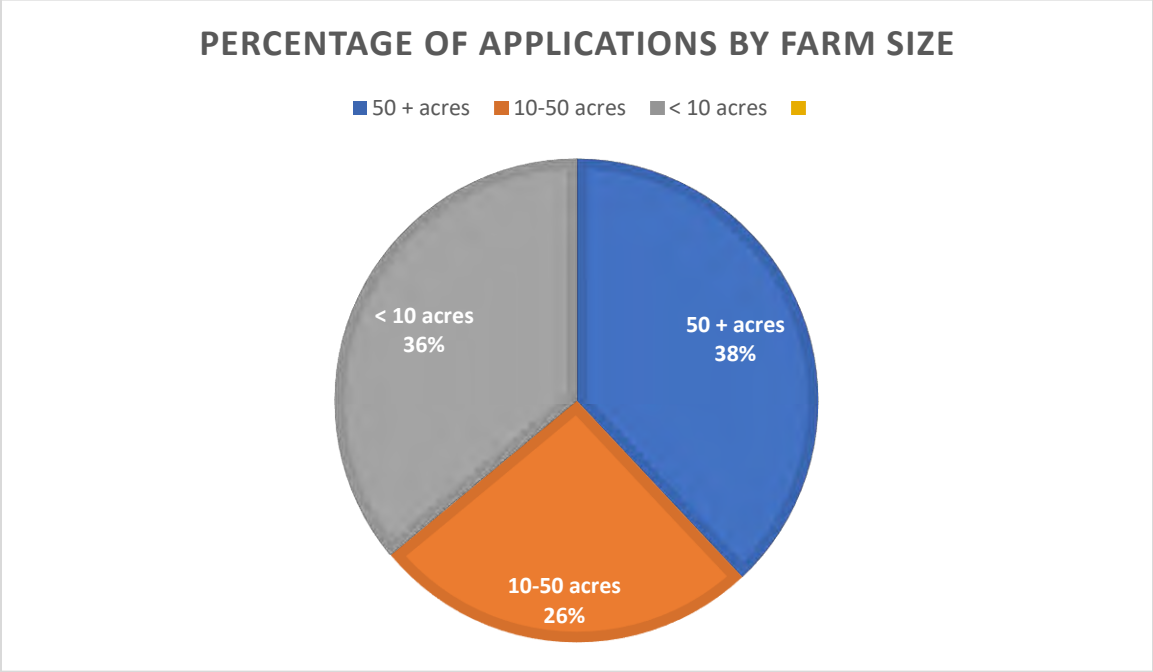

Figure 8. Percentage of Applications by Farm Size[36]

Based on these preliminary results for the current fiscal year, it would appear that the changes made thorough HB 2301[37] have increased the inclusivity for compost facilities and farms across the state. Compost facilities are reaching out to the program, requesting to be added to the list of eligible facilities. Farms across the state also have better access to eligible facilities. HB 2301 appears to have provided the agency with more precision with fund distribution, which will ultimately allow more farms to participate in the program.

Department of Commerce EV Rebate Program

Commerce's new Electric Vehicle (EV) Rebate program offers another interesting case study that has particular relevance to the suite of alternatives being considered for a fertilizer incentive package given that this program in some way addresses all three of the pathways outlined above. At its most basic level, the EV rebate program is a "Point of Sale" rebate that brings down the cost to the consumer of transitioning to an electric vehicle (#1). However, given the uncertainty concerning the performance (range) of EVs that still exists, the program also compensates the consumer for real or perceived risk (#2).

[36] Amy Clow, Quarantine, Compost & Rules Coordinator. Washington Department of Agriculture, email communication. October 2024.
[37] Initiative 2301: Improving Outcomes Associated with Wate Material Management Systems. Available here.

Finally, at its most basic, a car is equipment, and the rebate is an investment in an equipment upgrade (#3).

In Summer 2024, Commerce launched a state-wide instant rebate program to complement federal tax incentives in place at the time to encourage consumers to buy or lease EVs. Commerce is one of the seven Washington agencies included in the HEAL Act and thus faces similar restrictions and requirements regarding publicly funded incentive programs as WSDA.

Rebates to the EV consumer take place at the dealership at the point of sale (POS). To be eligible, the consumer's household must not earn more than 300 percent of the current federal poverty level.

Car buyers are automatically eligible if they already participate in one or more of these programs:

- Washington State Food Assistance Program
- Apple Health
- Refuge Cash Assistance
- Pregnant Women Assistance
- Aged, Blind or Disabled Cash Assistance
- Housing and Essential Needs Program
- Washington State Opportunity Grant
- Working Connections Child Care
- ORCA Lift
- C-Tran Reduced ID
- Temporary Assistance for Needy Families (TANF)
- Women, Infants and Children (WIC)
- Individual Development Account holders
- Low-Income Home Energy Assistance Program (LIHEAP)

Rebates are highest on a new 36-month lease at $9,000 and drop to $2,500 for a used EV lease.

Proof of income levels is not required at POS but consumers taking advantage of the rebate are informed that some consumers will be selected for income verification at a later date.

Rebates are applied as a purchase price adjustment, so there are no federal income tax implications. Washington state sales tax is levied on the pre-rebate price, however.

The program was funded with $45M in CCA funds dedicated to rebate. It launched on August 1st and as of September 27th, the total funds dispersed was $27.5M. The program is expected to exhaust all dedicated funding before the end of calendar year 2024.

Department of Licensing Agriculture Support Program

Washington's Department of Licensing (DOL) Agriculture Support Program was developed for farmers and agricultural transporters to mitigate added expenses incurred by a fuel supplier or retailer related to the Cap-and-Invest program under the CCA. These factors, and the fact that it is also a recently launched effort, make it relevant for review in association with this analysis.

In late August 2024, DOL launched a rebate program to compensate farmers for the cost to them of the fuel surcharge imposed by the fuel supplier or retailer between January 1, 2023, and December 31, 2023. The program received $30 million in CCA funds for FY 2025.

Eligible parties include farmers, excluding cannabis, and agricultural transporters, including farmers markets. Applicants can claim any qualifying fuel used in the production or transport of farm products.

DOL is not one of the seven agencies tasked with HEAL compliance and thus navigates a different regulatory landscape regarding the distribution of public funds than WSDA. To apply for a refund,

applicants fill out a simple 5-page form either online or on paper, estimate the gallons of eligible fuel they used during the allotted timeframe, include their bank information for direct deposit or mailing address to receive a check, and then sign an affidavit in front of a notary.

As of October 9, 2024, DOL had received 661 applications and has earmarked just under $1,900,000 for distribution.

The Nature Conservancy – NRCS Regenerative Farm and Ranch Program

Risk prevention and risk avoidance were identified as areas of concern for farmers – particularly smaller or lower resource farmers who may have less of a capital cushion. This program is specifically designed to mitigate this type of risk. This program is a useful example of a supporting mechanism that has been used effectively to incentivize adoption of new methods and practices that are not yet proven in the minds of farmers.

In 2017, The Nature Conservancy (TNC) received a Conservation Innovating Grant from the USDA's Natural Resource Conservation Service (NRCS) to evaluate opportunities to increase the adoption of conservation practices on the ground that would result in improved soil health, water quality, and/or increased instream flows in two locations in Idaho and northern California.[38]

The purpose of the grant was to develop and test tools that would encourage conservation practices to improve water usage and soil health and evaluate their impact by decreasing uncertainty and risk to farmers who chose to participate.

The researchers wanted to test eight separate practices and evaluate both the economic impact on the farmer(s) incorporating each practice as well as the conservation benefit of implementing each practice.

TNC implemented two pilot projects on over 300 acres in 2018, enrolled three new farms in 2019, and developed additional farm projects for 2020. For each pilot project TNC contracted with farmers and committed risk mitigation funding over a 5-year period to be paid out only in the event the implementation of the practice resulted in lost revenues.

The program aimed to demonstrate positive economic and conservation impacts resulting from the implementation of alternative water management and regenerative farming practices; and encourage adoption of these practices by landowners that might be willing but unable to assume the financial risk of significant changes to their operation. Collectively, project goals were to:

- Improve soil health using cover crops and no-till farming practices;
- Demonstrate an alternative means to resolve surface water/groundwater conflict through the installation of water efficiency infrastructure and then using the conserved water to pilot groundwater recharge strategies;
- Demonstrate an alternative cropping schedule that results in decreased water application and usage; and
- Demonstrate improved agricultural business return while implementing agricultural practices intended to improve soil health, reduce soil erosion, reduce water consumption, and improve water quality.

[38] Campell, Amy and Davidson, Mark, "Agriculture Viability Project – Final Report." NRCS Grant Number 69-3A75-16-1186, September 2019.

In general, the payment structure was based on historic expected operating income vs. income lost due to implementation of the conservation practice over the period of the agreement. Each agreement was tailored to meet the needs of the individual farmer, with a long-term goal of creating a replicable template to expand the use of this approach. This approach could also be structured as a profit-sharing model once the application of regenerative farming practices is operationalized.

The authors of the study concluded that to support this approach on this scale moving forward, there was a need to, "Establish a $5,000,000 regenerative agriculture fund. This fund would provide a catalyst to increase adoption of regenerative agriculture in the southern Idaho food production region."

At the conclusion of the study, the researchers shared that this approach had succeeded in recruiting farmers to beta-test new methods that improved environmental health of their fields. As expected, some of the practices improved both economic bottom-line and environmental health, while some improved the health of soil and water at the expense of yield. Establishing a mechanism to compensate the farmers for any loss of expected/traditional revenue enabled both the researchers and the farmers to evaluate the cost-benefit of adoption of these practices in a no- or low-risk way.

Summary and Conclusions

This analysis provides an overview of key areas of concern for Washington state farmers as they contemplate shifting away from fossil-fuel based fertilizers towards a locally produced alternative that has a lower carbon footprint. There is no doubt that it is in the interest of Washington agriculture to move towards utilization of these types of products. "Green" fertilizer reduces greenhouse gas emissions, helping the state meet its Climate Commitment Act targets. "Green" fertilizer reduces dependance on global markets and vulnerability to price shocks associated with those markets. "Green" fertilizer reduces dependence on imports which can also be subject to supply chain bottlenecks and challenges. Farmers were clear in our interviews that these aspects of the product made adoption attractive.

Farmers were equally clear that price neutrality was likely to be the single limiting factor affecting a substitution followed by risk and concerns about effectiveness. While there were differences in priority depending on the crop being grown and the size of the farm operation, these three themes were consistent across all interviews.

Given these findings, it is our recommendation that the legislature authorize the WSDA to develop a suite of tools and incentives that can be used to design packages that best meet the needs of farmers – rather than a single mechanism. A blended package also gives the WSDA the flexibility to design and implement solutions that are consistent with HEAL Act requirements for equity.

A grant program alone will not meet the needs or address the concerns of a significant portion of the Washington agricultural community. There are also real barriers in terms of accessibility, application and reporting requirements that have the potential to significantly impact the effectiveness of a grant program in achieving the desired outcome (substitution towards a "green" fertilizer product) particularly for small and lower resource farmers.

Rebates and coupons also have their drawbacks from the perspective of some farmers. Again, timing and paperwork are the main sources of concern.

At this time there is not enough information, either about the costs associated with the products, or the anticipated use patterns and costs, to accurately evaluate how much money to allocate or how to

distribute that allocation across the potential alternatives. Additional research will need to be done to determine optimal distribution and funding levels for each component.

It was also clear that financial support alone would not be enough to incentivize adoption. Proof of concept is still needed. Farmers need independent evidence that these products do in fact work the same as (or better than) conventional products. It is our recommendation that a portion of whatever funds are allocated to this effort be set aside to fund independent field trials run either by the WSDA or Washington State University.

The initiative to design a program to support the transition to locally produced "green" fertilizer is a "first of its kind" effort and represents a unique opportunity aimed at one of Washington's key economic sectors. Because this would be a broad, statewide program directing resources to farms of vastly different sizes and products and farmers from diverse backgrounds and access to capital, this precedent-setting endeavor should be appropriately resourced. Funds for a program to transition Washington farmers to a locally-produced "green" fertilizer should include support for a robust program staff, including not only a Program Manager, but also a Grant Administrator, and Outreach and Education Specialist to ensure the program is well understood and accessible. It also should include Small Farm and Limited English Proficiency technical assistance to ensure equity in access to and delivery of funding and benefits.

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APPENDIX A

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APPENDIX B

Product Fact Sheets

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FERTILIZER PRODUCT DATA SHEET

Atlas Agro North America
723 The Parkway, Richland WA 99352
www.atlasagro.ag

Ammonium Nitrate Solution 20-0-0

Total Nitrogen	20%	Specific Gravity (68° F)	1.26
➢ Nitrate N (NO_3)	10%	Density (lb/gal)	10.5
➢ Ammoniacal N (NH_4)	10%	pH	5-7.0
pH	5-7.0	Salt out typical Temp.	42°

ANSol-20 is a liquid fertilizer made from ammonium nitrate that provides plants with a secure supply of nitrogen. This fertilizer is a great choice for any agricultural crop and soil type, as it contains both ammonium and nitrate nitrogen and does not have an acidifying effect on the soil. It is an important component in a liquid fertilizer program.

Nitrate is the preferred nitrogen form for many crops, including high-value and horticultural crops. ANSol-20 provides nitrate that is immediately available for plant uptake, resulting in timely and predictable growth responses. It is not absorbed into soil particles and is non-volatile, making it readily available to plants.

- Can be banded on or in the soil or applied through drip or sprinkler irrigation systems
- Nitrate nitrogen immediately available to plants
- Neutral soil reaction creates optimal conditions for nitrogen uptake by plants
- Fast and needs-based plant nutrition with nitrate and ammonium nitrogen
- Reduces the need for liming
- Extremely well suited for precision ag applications

Handling and Storage
This product is not classified as an oxidizer and is not regulated by DOT

Please read and follow the label

APPLICATION RECOMMENDATIONS
Apply as needed guided by soil and tissue sampling and consultation with an agronomist

Each gal of ANSol-20 contains:

- 2.1 lb of Nitrogen

Product attributes are planned and subject to change

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ATLAS AGRO PRODUCT FACT SHEET

Atlas Agro North America
723 The Parkway, Richland WA 99352
www.atlasagro.ag

Calcium Ammonium Nitrate, CAN-17 — 17-0-0-9 Ca

Total Nitrogen (N)	17%	Specific Gravity (68° F)	1.52
➢ Nitrate N (NO_3)	12%	Density (lb/gal)	12.6
➢ Ammoniacal N (NH_4)	5%	pH	5.0-7.0
Calcium (Ca)	9%	Salt out temp.	25°F

Calcium ammonium nitrate (CAN-17, 17-0-0) is a liquid fertilizer made from ammonium nitrate and calcium nitrate that provides plants with a secure supply of nitrogen. CAN- 17 is a great choice for any agricultural crop and soil type, it contains both ammonium and nitrate nitrogen. It direct to the soil surface, inject or band into the soil, or through surface or sprinkler irrigation systems.

Nitrate is the preferred nitrogen form for many crops, including high-value and horticultural crops. CAN-17 provides nitrate that is immediately available for plant uptake, resulting in timely and predictable growth responses and immediate 'green up'. It is not absorbed into soil particles and is non-volatile, making it readily available to plants.

Calcium plays a crucial role in enhancing cell wall strength, which results in better quality yields, longer shelf life and increased marketable crop yields. This increased strength helps plants become more resilient to diseases, prevents infections and assists in the plant's ability to cope with stress caused by heat and drought.

HANDLING AND STORAGE

To avoid the formation of insoluble precipitates, DO NOT MIX WITH MATERIALS CONTAINING PHOSPHATE OR SULFATE. Rinse out all equipment before and after use.
CAN- 17 is a non-pressurized, odorless liquid that's simple to store and apply to various crops.

APPLICATION RECOMMENDATIONS
Apply as needed guided by soil and tissue sampling and consultation with an agronomist

Each gal of CAN- 17 contains:

- 2.1 lb of Nitrogen
- 1.1 lb of Calcium

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FERTILIZER PRODUCT DATA SHEET

Atlas Agro North America
723 The Parkway, Richland WA 99352
www.atlasagro.ag

Calcium Ammonium Nitrate, CAN-27 27-0-0

GRANULAR FERTILIZER		Other Data	
Total Nitrogen (N)	27.0%	Stabilizer	Limestone (20%)
➢ Nitrate N (NO_3)	13.5%	Range of Particle size (SGN)	2-4 mm (200-400)
➢ Ammoniacal N (NH_4)	13.5%	Bulk Density	62 lb/ft^3
Calcium (Ca)	5.0%	Angle of Repose	28°

Calcium ammonium nitrate (CAN-27), a dry, granulated nitrogen fertilizer, guarantees a secure supply of nitrogen to plants. The combination of ammonium- and nitrate-nitrogen and no soil acidifying effect makes CAN the best choice for fertilizer applications to any agricultural crop and soil type. It is produced by mixing ammonium nitrate solution with fine limestone, followed by granulation of the mixture. The excellent granulation and specific surface coating guarantee that it can be stored optimally and has very good spreading properties.

Nitrate is the preferred nitrogen form for many crops, including high-value and horticultural crops. CAN-27 provides nitrate that is immediately available for plant uptake, resulting in timely and predictable growth responses. It is not absorbed into soil particles and is non-volatile, contributing to its ready availability to plants. Nitrate also improves plant uptake of the essential cations potassium, calcium and magnesium.

Benefits and Value

- Nitrate-nitrogen to immediately alleviate N stress
- N fertilizer with a neutral soil reaction creates optimal conditions for nitrogen uptake by plants.
- Fast and needs-based plant nutrition with nitrate nitrogen and ammonium nitrogen
- Lower ammonia emissions, compared to urea, ensures higher nitrogen supply for plants
- Non-hazardous, provides a secure alternative to AN
- Reduces the need for soil liming
- Extremely well suited for site-specific applications using precision ag technologies

Recommendations

Please Read and follow the label.

Apply as needed guided by soil and tissue sampling and consultation with an agronomist

Handling and Storage

This product is not classified as an oxidizer and is not regulated by DOT

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FERTILIZER PRODUCT DATA SHEET

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Calcium Nitrate, CN-9

9-0-0-11 Ca

CALCIUM NITRATE SOLUTION			
Total Nitrogen (N)	9%	Specific Gravity (68° F)	1.47
➢ Nitrate N (NO_3)	9%	Weight per Gallon (lbs)	12.2
		pH	5.0-7.0
Calcium (Ca)	11%	Salt out Temp.	9°F

Calcium nitrate, 9-0-0, CN-9, is a clear liquid fertilizer that provides nitrogen to a growing crop, and calcium needed for cell wall development, particularly in fruiting trees, vines and bushes.

CN-9 has both calcium and nitrate to optimize growth, yield and yield quality. Nitrate is the most desirable form of nitrogen for several crops, especially high-value and horticultural crops. Nitrate is optimal for plant absorption with predictable and timely growth responses, enhancing uptake of essential cations such as potassium, calcium, and magnesium. It does not get absorbed into soil particles and is non-volatile, which ensures its easily available to plants.

Calcium plays a crucial role in enhancing cell wall strength, which results in better quality yields, longer shelf life and increased marketable crop yields. This increased strength helps plants become more resilient to diseases, prevents infections, and assists in the plant's ability to cope with stress caused by heat and drought.

It can be applied directly to the soil surface, injected or banded into the soil, or applied through surface or sprinkler irrigation systems.

HANDLING AND STORAGE

DO NOT MIX WITH MATERIALS CONTAINING PHOSPHATE OR SULFATE. Rinse out all equipment before and after use.

CN-9 is not an oxidizer and not a DOT-regulated product.

APPLICATION RECOMMENDATIONS
Apply as needed guided by soil and tissue sampling and consultation with an agronomist

Each gal of CN-9 contains:

- 1.1 lb of Nitrogen
- 1.4 lb of Calcium