United States Department of Agriculture
Agricultural Marketing Service | National Organic Program
Document Cover Sheet
https://www.ams.usda.gov/rules-regulations/organic/national-list/petitioned

Document Type:

☒ **National List Petition or Petition Update**

A petition is a request to amend the USDA National Organic Program's National List of Allowed and Prohibited Substances (National List).

Any person may submit a petition to have a substance evaluated by the National Organic Standards Board (7 CFR 205.607(a)).

Guidelines for submitting a petition are available in the NOP Handbook as NOP 3011, National List Petition Guidelines.

Petitions are posted for the public on the NOP website for Petitioned Substances.

☐ **Technical Report**

A technical report is developed in response to a petition to amend the National List. Reports are also developed to assist in the review of substances that are already on the National List.

Technical reports are completed by third-party contractors and are available to the public on the NOP website for Petitioned Substances.

Contractor names and dates completed are available in the report.

April 14, 2020

Submitted via email to: nosb@ams.usda.gov

National List Manager
USDA/AMS/NOP, Standards Division
1400 Independence Ave. SW
Room 2648-So., Ag Stop 0268
Washington, DC 20250-0268

Subject: Petition to Prohibit Ammonia Extract (also called Novel Ammonia Products)

Please accept this petition to add Ammonia Extract (AE), also known as Novel Ammonia Fertilizers, to the National List of Allowed and Prohibited Substances under Section 602, as prohibited from use in organic crop production. The petition asks the NOSB to recommend prohibition of Ammonia Extract because this material does not align with organic production principles, it risks the integrity of organic products, and it increases the risk of fertilizer fraud.

In support of the petitioned listing for Ammonia Extract on §205.602 of the National List, I have provided a definition of the term "Ammonia Extract" for addition to the other definitions in §205.2 of the NOP Regulations.

Finally, I request that the NOSB expedite action on this petition as new technologies now allow Ammonia Extract to be derived through nonsynthetic processes, which lands the material in a regulatory quagmire that requires immediate resolution. Materials Review Organizations are already receiving applications to review brand name products containing AE that has been derived using different types of nonsynthetic processes. Decisions by the MROs are being made without guidance from the NOSB/NOP, resulting in confusion, uncertainty, and a high potential for contradictory decisions by certification bodies.

Something new: A Process for Creating a Non-synthetic form of Ammonia Fertilizer

Although ammonia is a part of the nitrogen cycle and it does occur in nonsynthetic form, fertilizer manufacturers are able to capture ammonia and extract and/or concentrate it into a form of the substance that is not found in nature. Some types of Ammonia Extract are now being made using processes that can meet the "non-synthetic" designation in organic regulations, but the resulting ammonia product is the same substance found in the highly soluble fertilizers that are intended to be excluded from organic production under the NOP Regulations.

Ammonia Extract can be produced using a range of methods, however, the output of all of these processes may be defined as ammonia (NH_3) and/or ammonium (NH_4^+) that has been:

1) Produced through a biological or physical process;
2) Captured in a liquid form;
3) Concentrated and/or extracted; and
4) Packaged for application in a crop system

New Manufacturing Process; Old Agricultural Problems

Organic farmers invest their time and labor to manage soils with cover crops, mulches, compost, and manure in order to build soil fertility. These practices and inputs comply with the requirements of OFPA and the principles of organic farming. In contrast, organic pioneers demonstrated that ammonia fertilizers destroy the soil and found that production practices that excluded ammonia and other highly soluble fertilizers resulted in healthier soils and crops.

As detailed in the petition, AE is an ammonia fertilizer that is chemically identical to the ammonia fertilizers commonly used in conventional growing systems. As such, AE would provide plant-available nitrogen directly to the crop, feeding the plants without enhancing soil biology. Contrary to the organic crop production principle of "enhancing soil biological activity" and "optimizing soil health," [1] ammonia fertilizers:

1) Create detrimental chemical and biochemical effects on soil structure;
2) Are toxic to the microbial activity in the root zone or rhizosphere;
3) Foster environmental impacts through nitrogen leaching; and
4) Do not enhance soil microbiology.

Until recently, ammonia fertilizers were produced solely via chemical synthesis. However, Ammonia Extract may now be produced using mechanical and biological processes which create ammonia fertilizers that do not fall under the definition of "synthetic" as did the previous forms of manufactured ammonia fertilizers. Although ammonia fertilizers may be manufactured using either a chemical or a biological process, make no mistake; the resulting substances have the same negative impacts on soil structure and biology.

There are seven criteria that the NOSB is mandated to use when evaluating whether a substance should be allowed or prohibited in organic production (Section 6518(m) of OFPA). This petition shows that Ammonia Extract does not meet these criteria and therefore, is not compatible with a system of sustainable agriculture.

Potential for Fraud

The organic trade has recently been plagued with fraudulent activities, a reality that will soon be remedied with new proposed regulations for organic enforcement. Unfortunately, the organic fertilizer sector has already been acquainted with prosecutions for fraud, which resulted in indictments, fines, and incarceration. Unless prohibited, AE presents an opportunity ripe for further fraudulent activity

---

[1] NOSB Principles of Organic Production and Handling, October 17, 2001:

> *§1.1. Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. These goals are met, where possible, through the use of cultural, biological, and mechanical methods, as opposed to using synthetic materials to fulfill specific functions within the system.*
>
> *§1.2: An organic production system is designed to: §1.2.1 Optimize soil biological activity;*

because chemical ammonia fertilizers are very difficult to distinguish from biological ammonia fertilizers, making it close to impossible for buyers to confirm which they are receiving. The potential for fraud is further increased when it is understood that biological ammonia fertilizers are much more expensive to produce than are the chemical forms of ammonia, creating a well-recognized precondition for fraudulent commingling or substitution, while representing the product to the organic trade as the more costly biological form of ammonia.

Careful Consideration Needed

Ammonia Extract, a concentrated and extracted form of a fertilizer sourced from a nonsynthetic process, raises questions that have not yet been considered by the organic community, as well as issues never conceived by the founders of organic methods who relied the concept of "synthetic vs. nonsynthetic" as the primary factor in assessing organic inputs.

I ask the Crops Subcommittee to initiate review of Ammonia Extract, including consideration of its potential for far-reaching impacts on the foundational understanding of organic crop production methods, and further ask that this review be conducted as expeditiously as possible. In support of the petitioned listing for Ammonia Extract on §205.602 of the National List, please also consider adding the definition of the term "Ammonia Extract" (provided above) to the other definitions in §205.2 of the NOP Regulations.

Sincerely,

TRUE
ORGANIC PRODUCTS, INC

Michael E. Menes, Ph.D.
VP Food Safety & Technology

a: True Organics Products. Inc | 20225 W Kamm
Ave. Helm, CA 93627 |
e: mmenes@true.ag | w:true.ag
m: 559-333-27830 | p: 559-866-3001 EXT 413

Petition to Prohibit Ammonia Extract

This petition has been completed using NOP 3011 National List Petition Guidelines

Questions can be directed to Michael Menes, TRUE Organic Products, Inc., MMenes@true.ag

4.2 ITEMS TO INCLUDE

ITEM A1

Petition for addition of “Ammonia Extract” to the National List at §205.602 as a “Nonsynthetic substance prohibited for use in organic crop production.”

ITEM A2

OFPA Category: Not applicable. The petitioned material is a nonsynthetic substance petitioned for prohibition for organic crop production. The list of OFPA categories (7 U.S.C. §6517(c)(1)(B)(i)) applies only to synthetic materials being petitioned for use.

If this material *were* of synthetic origin, it would not fit within any of the OFPA categories of synthetic materials that may be reviewed or added to the National List as allowed substances.

ITEM A3

Inert Ingredients: Not Applicable

ITEM B

The petitioned substance, Ammonia Extract, is a liquid fertilizer that may be produced using several methods and processes. This substance has two common characteristics:

1. The source of the ammonia extract is non-synthetic; and
2. The end result is a form of soluble ammonia (NH_3), which may or may not be converted to Ammonium (NH_4^+). An explanation of the differences between ammonia and ammonium is included in Appendix A.

There are a wide variety of technologies available to manufacture Ammonia Extract. This petition includes descriptions of the current methods used for producing Ammonia Extract.

B1: SUBSTANCE COMMON NAME

Ammonia Extract — A fertilizer produced using a range of methods where the output contains ammonia (NH_3) and/or ammonium (NH_4^+) that has been:

1) Produced through a biological or physical process;
2) Captured in a liquid form;
3) Concentrated and/or extracted; and
4) Packaged for application in a crop system.

I propose that this common name be added to the other definitions in §205.2 of the NOP Regulations. Please note that this substance's name may not necessarily be found on brand name products or in marketing literature. Other names that may refer to the same substances include "Natural Ammonia," "Captured Ammonia" and "Novel Ammonia Products."

B2: PETITIONER AND MANUFACTURER INFORMATION

Petitioner:

Michael Menes, Ph.D., TRUE Organic Products, Inc.
P.O. Box 7192,
Spreckels, CA 93962
Phone:
MMenes@true.ag

Dr. Michael Menes is the Vice-President of Food Safety & Technology for TRUE Organic Products, a leading manufacturer of organic fertilizers proven to build and strengthen growers' soil.

Manufacturer: TRUE Organic Products is not the manufacturer of this product. This petition is for a substance that is being manufactured by a number of companies for use as a liquid fertilizer. There are a number of ways to manufacture these liquid ammonia fertilizers and there are a range of manufacturers producing Ammonia Extract.

The petitioner understands that multiple manufacturers have already submitted applications to Materials Review Organizations (MROs) for approval of brand name products that contain nonsynthetic ammonia from biological sources. However, since MROs maintain confidentiality about their review processes, the names and contact information for these manufacturers are unavailable for inclusion in this petition.

There are some manufacturers that have disclosed they are making Ammonia Extract intended for sale to organic producers. These manufacturers are listed in Appendix F. Please note that this list may not represent the entire set of companies producing the petitioned substance.

B3: INTENDED/CURRENT USE OF SUBSTANCE

Ammonia Extract is intended to be used as a source of nitrogen, a macronutrient that is used in production of a wide range of annual and perennial crops.

B4: INTENDED ACTIVITIES AND APPLICATION RATE

Ammonia Extract is intended to be used as a routinely applied macronutrient fertilizer. These liquids are intended for application to a wide range of organic horticultural crops through fertigation and/or foliar application. The chart below provides a small representation for the conventional ammonia fertilizer and thus can be a representation for Ammonia Extract. The rates for Ammonia Extract shown in the chart are generic and are not specific to a crop or manufacturer.

Approximate Application Rates of Liquid Ammonia Fertilizers to Soil

to provide Certain Quantities of Nitrogen Per Acre

		N (lbs/acre)					
Fertilizer Material	%N	**15**	**30**	**45**	**60**	**75**	**100**
Anydrous Ammonia (approx. 5 lbs/gal)	82%	20	35	55	75	90	120
Aqua ammonium phosphate (approx. 10 lbs/gal)	8%	190	375	560	750	940	1250
Aqua ammonia (approx. 7.5 lbs/gal)	20%	75	150	225	300	375	500
Ammonia Extract (approx. 9.3 lbs/gal)	6%	27	54	81	108	134	179

B5: MANUFACTURING PROCESS

As mentioned earlier, not all possible manufacturing processes used to produce Ammonia Extract from biological sources are addressed in this petition. This is because there are many possible combinations of methods to capture and concentrate ammonia and to adjust the pH of the ammonia product with a range of organic or mineral acids. While some processes clearly have synthetic additives or prohibited processes, others have been determined by MROs to be non-synthetic. However, the molecular structure of the final ammonia resulting from all of these manufacturing processes is exactly the same.

The scope of the manufacturing processes and technologies should not be limited to what is presented in the petition. Rather, the focus should be on the finished product, Ammonia Extract.

Some (selected, but not limited to) representative processes and pH adjusters are described in detail in Appendices A and B including:

- Anaerobic digestion - Digesting manures or food wastes without oxygen results in some heat or energy production as well as an ammonia containing liquid that can be stabilized.
- Fermentation - Using microbial digestion to separate solids from the nitrogen containing liquid which then gets extracted into ammonia.
- Wet Electrostatic Precipitator (WESP) - Exhaust containing ammonia is combined with atomized water and reacted with an acid. The resulting ionic precipitate is captured on an electrostatic grid.

B6: ANCILLARY SUBSTANCES

Not applicable. Only applies to materials petitioned for use in organic handling or processing.

B7: PREVIOUS REVIEWS

Ammonia and ammonium materials are widely used in agriculture and food handling. As previously mentioned, the focus of this petition is Ammonia Extract, a liquid fertilizer, composed of ammonia (NH_3) which may or may not be converted to ammonium (NH_4^+), manufactured from biological sources, through a variety of processes. The information provided about previous reviews includes:

- MRO reviews of brand name products containing Ammonia Extract; and
- NOSB reviews of all the ammonium crop materials listed in the NOP's Petitioned Substances (see chart below).

OMRI Status

The Organic Material Review Institute (OMRI) identifies classification of Novel Ammonia Production in their list of "Beyond Resolution" topics:

> *"OMRI's Review Program routinely encounters difficult technical issues for which industry experts are consulted for guidance and interpretation of the organic standards. In certain cases where interpretation is needed from another regulatory body before making a decision, OMRI designates an unresolved issue as "Beyond Resolution," and*

> *will no longer accept applications that pertain to that particular issue until the issue becomes resolved by the applicable regulatory body.*
>
> *ISSUE #5: Novel ammonia production*
> *Use classes: Crop Fertilizers and Soil Amendments (CF)*
>
> *The OMRI Generic Materials List© explicitly prohibits synthetic ammonia products including anhydrous ammonia, aqua ammonia, ammonia forms of micronutrients, ammonia nitrate, ammonia phosphate, ammonia sulfate, and ammonia soaps. However, a novel production method using anaerobic digestion technology may yield a similar soluble ammonia product as those listed above. It is currently unclear whether ammonia products produced by such novel technology are considered synthetic or nonsynthetic using NOP Guidance 5033-1."*

OMRI Listed Material

To our knowledge, there is only one brand name product that contains Ammonia Extract that has been approved by an MRO. The label for that material is included in Appendix F.

Review Activity by California Department of Food and Agriculture

The California Department of Food and Agriculture requested clarification from the NOP about use of "high ammoniacal nitrogen" fertilizers in organic farming systems. On October 11, 2018, NOP responded to CDFA, with information about the materials review process but demurred to provide a decision about review of a specific product. A copy of the letter from NOP to CDFA is included in Appendix C. NOP identified questions about classification of these materials and how their use complies with USDA organic regulations that require organic producers to manage crop nutrients and soil fertility. NOP's response contained no direct ruling on the use of "high ammoniacal nitrogen" fertilizers from biological sources. This Ammonia Extract petition initiates the process for NOSB to review this new material for its use in organic crop production.

NOSB: Ammonia and Ammonium Materials

A number of other ammonia materials have been petitioned for review by the NOSB. The chart below summarizes the outcomes of the ammonia materials petitioned for crop production. Where a review is particularly relevant to this Ammonia Extract petition further discussion is included after the table.

Material	Petition Area and Use	Status	Notes
Ammonium Chloride	Crops: Add to 205.601, binder for granulation, soil amendment	Prohibited substance for organic production and handling	
Ammonium Citrate	Crops: Add to 205.601, chelating agent	Not recommended for listing	See below for more information

Ammonium Glycinate	Crops: Add to 205.601, chelating agent	Not recommended for listing	
Ammonium Nonanoate	Crops: herbicide and crop desiccant/harvest aid	Petition to expand use not approved	
Ammonium Phosphates		Prohibited substance for organic production and handling	
Ammonium Soaps	Crops: Add to 205.601	Added to National List, 205.601(d), for use as a large animal repellant only, no contact with soil or edible portion of crop	
Ammonium Carbonate	Crops: Add to 205.601	Added to National List, 205.601(e), with annotations	
Ammonium	Crops: Add to 205.601, liquid fertilizer	Substance Deferred — NOSB is awaiting USDA decision on recommended synthetic vs. non-synthetic policy	See below for more information
Anaerobic Digestate	Crops: Add to 205.601, plant and soil amendment	Petition withdrawn	See below for more information
	Crops: Amend regulations so the material would not be subject to restrictions applicable to uncomposted manure (205.203)	Changes not recommended	See below for more information

NOSB: Petition for Ammonia produced via fermentation

On June 3, 2002, a petition was filed requesting allowance of "ammonia" in the form of a proprietary liquid fertilizer "NITRO-GRO®" created when ammonia gas, carbon dioxide gas, and moisture in the gaseous stream from manure fermentation were cooled to form a liquid. No extraneous acids were added, so it is foreseeable that this product, consisting of ammonium carbonate and/or ammonium bicarbonate, may be classified as nonsynthetic. The current status on the NOP website reads, "*Status of NOP Activity on NOSB Recommendation, FR Notice, Sunset: Substance Deferred – NOSB is awaiting USDA decision on recommended synthetic vs. non-synthetic policy."*

NOSB: Anaerobic Digestate

Anaerobic fermentation is one source of the gaseous ammonia under discussion in this petition for prohibition of Ammonia Extract. Petitions previously submitted to the NOSB for Anaerobic Digestate of food waste (01/06/2015) and for Anaerobic Digestate of plant and animal matter (04/05/2016) describe processes that utilize a two-step process to produce a liquid fertilizer.

In the 2015 petition, the first step is separation of the solid phase from the liquid phase; the second step is anaerobic fermentation of the liquid phase. Unlike the process described in the current petition, the ammonia discussed in the 2015 petition is *not* ‘stripped’ from the liquid matter as a third step. Rather, the pH of the liquid phase was adjusted at the end of fermentation from a pH range of 7 to 9 by adding sulfuric acid to pH 3.5, in order to inhibit microbial activity and to bind ammonia and prevent its loss to the atmosphere. This petition was withdrawn from consideration by the NOSB.

The 2016 petition asked for a lifting of restrictions that apply to use of raw manure for the solid materials that result from a two stage mixed plug-flow anaerobic digester system. In reviewing this petition, the NOSB recommended classifying the material as nonsynthetic and did not recommend the addition of anaerobic digestate the National List to be used in organic production without the “days-to-harvest” restrictions following its application. The NOSB recommendation rationale was:

> *“Because of the potential for negative effects on human health through food-borne pathogens, the unproven safety of digestate fiber, and the many alternative practices and materials already in use in organic production, the NOSB has determined that anaerobic digestate as petitioned, without pre-harvest application intervals, is not compatible with a system of sustainable agriculture.”*

NOSB: Ammonium Citrate

One example of the possible processes for making Ammonia Extract that is described in this petition includes a final step wherein gaseous ammonia is ‘absorbed’ by an aqueous citric acid solution, thus forming ammonium citrate. Two related petitions dated 3/23/2016 and 8/13/2017 requested allowance of the synthetic substance ammonium citrate as a chelating agent in organic crop production. Ammonium citrate, either the dibasic or the tribasic salt, is produced by neutralizing citric acid with ammonia [21CFR184.1140(a)]. In the related process described in this petition, ammonia is absorbed by a citric acid solution. In both cases, the resulting substance is ammonium citrate. The Technical Evaluation Report on ammonium citrate classified this substance as “synthetic” and the NOSB came to a similar conclusion.

B8: REGULATORY AUTHORITY

International Regulations

International Federation of Organic Agriculture Movements (IFOAM) standards do not allow use of ammonia extract, per their principles:

> *IFOAM's Common Objectives and Requirements of Organic Standards*: "Organic crop production systems enhance soil primarily by incorporating manures and other biodegradable inputs, and/or by nitrogen fixation from plants."

Based on information from EU 2018 Export Group of Fertilizers, there is concern over high solubility mineral fertilizers.

> "There are good reasons why the use of high solubility mineral nitrogen fertilizers is in conflict with the principles of organic production (see Art. 4(b)(iii) of Reg. 834/2007). If such fertilizers were allowed, the group is concerned that the current approach of organic crop nutrition which is primarily based on biological aspects of soil fertility would be replaced by a conventional, intensive approach focusing on nutrient supply."

State Regulations

Commercial fertilizers used for commercial food production are registered at the State level.

NOP Regulation §205.203(e) says, "The producer must not use: (1) Any fertilizer or composted plant and animal material that contains a synthetic substance not included on the National List of synthetic substances allowed for use in organic crop production." This section is widely recognized as prohibiting the use of fertilizers classified as synthetic.

Neither the NOSB nor the National Organic Program (NOP) review brand name products for use in organic production. Instead, the NOP relies upon accredited certifying agents (ACAs) and material review organizations (MROs) to consider the requirements of the Rule and, on the basis of sufficient documentation, to determine the classification of a fertilizer. If determined to be synthetic, then the fertilizer is prohibited for use in organic production unless it is specifically allowed by the National List, in which case it may be reviewed by the MRO. If determined to be nonsynthetic, the NOP relies on ACAs and MROs to consider the Rule and evaluate whether use of the fertilizer is compatible with the goals and objectives of organic agriculture-- to avoid contamination of the soil and the environment, to build the soil, and to further the other practices called for in the Rule.

B9: CHEMICAL ABSTRACTS SERVICE (CAS) NUMBER AND PRODUCT LABELS

Similar to the discussion in Section B2, the substances listed below are examples of finished products that could result from the myriad possible processes used to manufacture Ammonium Extract.

Stabilized ammonia is defined as a liquid solution of ammonia partially or totally neutralized by the addition of a solution of acid. Although some processes might not be stabilized, the concentrated forms likely contain some form of acid as a stabilizer.

The substances used to create an acidic solution that reacts with ammonia are the common acids: sulfuric acid, citric acid, and carbonic acid (carbon dioxide in water). Reaction of ammonia with each of these acids results in an ammonia substance assigned a different CAS number.

Potential acid stabilizer	CAS No.	Current listing on the National List	Nonsynthetic source	FDA affirmed GRAS for food use
Acetic acid	64-19-7	Not listed	Vinegar (fermentation)	21CFR184.1005
Carbon dioxide (aqueous solution is carbonic acid)	124-38-9	Non-synthetic form is not listed; synthetic form is listed at §205.605(b)	Alcoholic fermentation	21CFR184.1240
Citric acid	77-92-9	§205.605(a) nonsynthetic	Citrus fruit, fermentation	21CFR184.1033
Sulfuric acid	7664-93-9	Not listed	NONE - synthetic	21CFR184.1095

Using these acids to ‘stabilize’ (react with) ammonia creates salts, specifically ammonium salts. Noted in the example manufacturing process provided (Appendix A & B) in this petition, was the requirement in one patent that the pH of the stabilized ammonia solution must be less than 7 (i.e., acidic). The following chart shows that only two of these salts meet this requirement: ammonium citrate and ammonium sulfate.

Ammonium salt	CAS No.	pH	Solution strength	Food/ GRAS status
Ammonia water [hydroxide]	1336-21-6	11.6	1.0N solution (3.5%)	21CFR184.1139
Ammonium acetate	631-05-37	7.0	0.5M solution (3.8%)	INS 264
Ammonium bicarbonate	106-33-7	8.0	5% solution (0.6M)	21CFR184.1135
Ammonium carbonate	506-87-6	8.6	5% solution (0.5M)	21CFR184.1137

Ammonium citrate, dibasic	3012-65-5	**4.3**	0.1M solution (2.3%)	21CFR184.1140
Ammonium citrate, tribasic	3458-72-8	**4.3**	0.1M solution (2.4%)	Not GRAS
Ammonium sulfate	7783-20-2	**5.5**	0.1M solution (1.3%)	21CFR184.1143

Please note - Ammonia (NH3) CAS# 7664-41-7)

Product Labels

As discussed in Section B7, there is one brand name product that has been approved by an MRO that is an example of Ammonia Extract. The label for this MRO-listed brand name product is included in Appendix F.

B10: PHYSICAL AND CHEMICAL PROPERTIES

Ammonia Extract has identical physical and chemical properties as its corresponding synthetic ammonia fertilizer analogs. An overview of the physical and chemical properties for ammonia fertilizers may be found in Appendix G.

Ammonia is a colorless inorganic compound of nitrogen and hydrogen with the formula NH_3. The gaseous form has a characteristic pungent odor. Ammonia solutions (containing more than 35% but not more than 50% ammonia) appear as a clear colorless liquid consisting of ammonia dissolved in water. Ammonia solutions with more than 10% but not more than 35% ammonia appear as a colorless aqueous liquid solution with a strong odor of ammonia.

Household ammonia water currently available in the supermarket contains 3% to not more than 5% free ammonia. In years past, household ammonia contained up to 10% ammonia. However, the Consumer Product Safety Commission now regulates ammonia water sold to consumers. Any preparation containing free or chemically uncombined ammonia in a concentration of 5% or more is classified as a poison under the Federal Caustic Poison Act and requires the label to bear the signal word “poison” (16 CFR 1500.129). Note that “chemically uncombined ammonia” is an alternate description of “unstabilized ammonia.”

Stabilized ammonia, where the ammonia molecule is converted to the ammonium ion, with a variety of properties depending on the acid used. All supply nitrogen in the form of ammonia.

While not impacting physical and chemical properties, there is one difference between ammonia from the Haber-Bosch process and Ammonia Extract. (Fertilizer Institute, Ammonia) Ammonia fertilizers are typically made using a method called the Haber-Bosch process where nitrogen is captured from the air and combined with a hydrogen source. Because the nitrogen is from the air, the nitrogen isotope ratio, N^{15}/N^{14}) is very low because the nitrogen in predominantly N^{14}. Ammonia Extract, the focus of this petition, has a nitrogen isotope ratio closer to 20%. This difference is significant as it is the basis of recent research to determine a testing protocol to identify adulteration of organic fertilizers with synthetic ammonia fertilizers (Mukome, 2013).

B11: SAFETY INFORMATION

Each type of Ammonia Extract has identical safety considerations as its corresponding synthetic ammonia fertilizer analog. Both ammonia liquid and ammonia vapors are irritating to the skin, eyes, nose, throat, and lungs. A Material Safety Data Sheet for ammonia and ammonia water is included in Appendix G.

Conversion of the ammonia molecule to the ammonium ion in stabilized ammonia is desirable for safety concerns as stabilization limits emission of ammonia to the environment. Material Safety Data Sheets for ammonium citrate and ammonium sulfate, two common ammonium salts, are included in Appendix G.

B12: RESEARCH INFORMATION

A listing of relevant research information and literature concerning ammonia fertilizers is included in Appendix D.

B13: PETITION JUSTIFICATION STATEMENT FOR *INCLUSION OF A PROHIBITION OF A NONSYNTHETIC IN 7 C.F.R. §§ 205.602*

The justification for prohibition of Ammonia Extract largely rests on the principle that organic practices are based on natural cycles and that the fertilizers used in organic crop production act by encouraging soil biology, as opposed to providing simple nutrients to crop plants..

> *"The mentality of organic agriculture is not a technological mentality – though it does concern itself with technology. It does not merely ask what is the easiest and cheapest and quickest way to reach an immediate aim. It is, rather, a complex and*

> *radical attitude toward the problem of our relationship to the earth. It is concerned with the long-term questions of what humans need from the earth and what duties and devotions humans owe the earth in return for the satisfaction of their needs. It understands that the terms of a lasting agriculture are not human terms, that the final terms are nature's, that an agriculture –and for that matter, a culture–that holds in ignorance or contempt the truths and the mysteries of nature is doomed to failure, for it is out of control."*
>
> Wendell Berry, 1976. "Where Cities and Farms come Together". Chapter 2 in Radical Agriculture, p 14. Harper Colophon Books

The prohibition on using synthetic nitrogen fertilizers is a widely accepted tenet of organic food production:

> *"Organic agriculture, which is governed by strict government standards, requires that products bearing the organic label are produced without the use of toxic and persistent pesticides and synthetic nitrogen fertilizers, antibiotics, synthetic hormones, genetic engineering or other excluded practices, sewage sludge, or irradiation."* (OTA, How is organic food grown? Appendix F)
>
> *"Organic farmers rely on natural processes, biodiversity, and cycles adapted to local conditions rather than the use of synthetic inputs like chemical fertilizers."* (Rodale, Organic vs. Conventional Farming, Appendix F)
>
> *1990 Farm Bill, Senate Version* (Leahy, 1990, Appendix F): *SEC. 112. PROHIBITED CROP PRODUCTION PRACTICES AND MATERIALS.*
>
> *(c) SOIL AMENDMENTS- For a farm to be certified under this title, producers on such farm shall not--*
>
> *(1) use any fertilizers containing synthetic ingredients or any commercially blended fertilizers containing materials prohibited under this title or under the applicable State organic certification program;*
> *(2) use as a source of nitrogen--*
> *(A) anhydrous ammonia;*
> *(B) ammonium nitrate;*

With regards to the principles of organic farming and the requirements of OFPA, stakeholders in the organic marketplace have consistently held that the use of ammonia-based fertilizers do not foster management of soil biology and cannot meet the principles of the organic industry. Recently, new technology that was not anticipated when OFPA was written, has introduced Ammonia Extract to the marketplace. Ammonia Extract can be made in a variety of forms, depending on the processes used to manufacture it. However, each of these forms of chemically-related liquid ammonia fertilizer is identical — in chemical and physical properties, human health considerations, and impacts on the environment and soil health—to its synthetic ammonia fertilizer analog.

As described in Section of this petition about Previous Reviews (§B7), there have been questions about the classification of this new material, with one MRO classifying the form of Ammonia Extract that it reviewed as non-synthetic. This petition does not address the question of classification, instead acknowledging that some forms of Ammonia Extract could be determined to be nonsynthetic. In the case of the nonsynthetic forms, since they are identical to their prohibited synthetic analogs, this petition asks for the nonsynthetic forms Ammonia Extract to be included on the National List at §205.602 as “Nonsynthetic substance prohibited for use in organic crop production.”

A counter perspective to this petition is that nonsynthetic forms of Ammonia Extract are sourced from biological waste materials through a natural process thus providing an environmental benefit. Since these materials are nonsynthetic, this counter perspective calls for allowing their use in organic production.

In response, this petition asks NOSB to consider that a fundamental and widely accepted principle of organic production is the reliance on sound management of biological diversity and soil fertility. A significant difference between organic and conventional agricultural practices rests upon the method of providing nitrogen to plants. Conventional agriculture most commonly relies on ammonia, or ammonium fertilizer, delivered directly to plant roots. Organic agriculture relies on the labor and time intensive management practices such as cover-cropping, mulching, and manure application to build soil fertility through complex interactions with soil organisms as well as with chemical and physical cycles. There is a wide body of research, see Appendix D, demonstrating a host of environmental and agronomic benefits arising from organic practices.

> *"Because they are highly soluble salts, chemical fertilizers can overstimulate natural cycles. Before large-scale manufacturing of fertilizers, a balance existed between nitrogen removed from the atmosphere by natural fixation and nitrogen returned to the atmosphere by natural denitrification. Today, due to the extensive use of nitrogen fertilizers, there may be an accumulation of nearly 10 million tons per year of fixed nitrogen compounds in the biosphere.*
>
> *One consequence of this buildup of fertilizer salts has been the over enrichment of local water reserves and the destruction of aquatic animals by eutrophication[40]. Another consequence has been the accumulation of toxic forms of nitrogen in water supplies and crops.*
>
> *Finally, there is the whole controversial issue dealing with the effects of chemical fertilizers on soil fertility (as defined by the activities of soil microbes and soil animals) and the quality of crops (as defined by their nutritional value and their ability to resist diseases and pests). These questions represent fundamental gaps in traditional agricultural research, and will not be dealt with here. Suffice it to say that heavy applications of*

> *chemical fertilizers may produce plants which are susceptible to attack by insect pests*[46]*. There appear to be at least three processes involved. First, chemical fertilizers place metabolic stresses on plants, which increase production of aromatic compounds that attract pests;*[47] *second, chemical fertilizers cause plants to take up water and produce succulent growth favored by pests for shelter and food; and third, the exclusive use of NPK chemical fertilizers reduces incentives for recycling organic material and trace minerals as part of a fertilizer program."*
>
> Richard Merrill, 1976. "Toward a Self Sustaining Agriculture." Chapter 16 in Radical Agriculture, pp 298-300. Harper Colophon Books.

Congress specified in OFPA that organic crop production must “foster soil fertility.” The introduction of Ammonia Extract to the market creates a new type of input that has not been vetted for compatibility with organic principles, yet disregards the historical role as well as the foundational principal of caring for a soil system by feeding the complex ecology of soil in order to build organic matter. In light of the principles of organic farming and the requirements of OFPA, stakeholders in the organic marketplace have consistently held that the use of ammonia-based fertilizers do not foster soil fertility, and therefore, cannot meet the principles of organic production. The use of Ammonia Extract creates a basic contradiction within organic standards that weakens the integrity of the organic label.

As outlined by NOP in their letter to CDFA (Appendix C) current organic regulations call for ACAs and MROs to make determinations of both classification and use of materials. When this approach is applied to Ammonium Extract, a fertilizer with the unique combination of characteristics--being both nonsynthetic and highly soluble—this case-by-case approach risks contradictory rulings, which have been well-documented as resulting in confusion for manufacturers, farmers, certification bodies, and consumers alike. As described in the section of this petition about Previous Reviews (§B7), one form of Ammonia Extract has been already been approved for use in organic production while others are moving through the review process. Listing Ammonia Extract as a prohibited nonsynthetic material at §205.602, will provide clear guidance to farmers, present accurate information to material manufacturers, ensure consistency in decisions made by MROs and document a clear position for equivalency negotiations with other countries. In addition, listing Ammonia Extract as a prohibited nonsynthetic material, meets the widely communicated message that organic regulations prohibit the use of ammonia fertilizers, bolstering consumer’s expectations about the way organic crops are produced.

Potential for fraud

Finally, while tangential to this petition, the potential for organic fraud, related to labeling and distribution of Ammonia Extract, is an important consideration. One of the most notorious cases of fertilizer fraud occurred when organic fertilizers were adulterated with ammonia. In this case, organic fertilizers were reportedly made from approved inputs such as fish meal and bird guano but were intentionally altered to include aqueous ammonia, ammonium sulfate, and urea to increase their nitrogen content. This case resulted in a criminal conviction as well as tighter regulation of liquid fertilizers (Huffstutter & AMS No. 070-12).

Unless prohibited, AE presents an opportunity ripe for fraudulent activity because even if employing analytical testing, synthetic ammonia fertilizers are very difficult to distinguish from biologically-sourced ammonia fertilizers. This makes it close to impossible for buyers to confirm which they are receiving. Concern about fraud is heightened when it is understood that biological ammonia fertilizers are much more expensive to produce than are the chemical forms of ammonia. This creates the well-recognized precondition for fraudulent commingling or substitution and then representing the product to the organic trade as the more costly biological ammonia. Intentional addition of the synthetic form of AE would reduce the cost of fertilizer production in a deceptive manner that is both undetectable and profitable.

Organic Alternatives:

There are many long recognized organic production practices for supplying nitrogen to the soil include cover cropping, incorporation of crop residues, and sheet composting. Organic materials commonly used as nitrogen sources include manures, alfalfa meal, soy meal, cottonseed meal, fish meal, blood meal, feather meal, crab meal, shrimp meal, guano.

> *"Many organic materials serve as both fertilizers and soil conditioners – they feed both soils and plants. This is one of the most important differences between a chemical approach and an organic approach toward soil care and fertilizing. Soluble chemical fertilizers contain mineral salts that are readily available for uptake by plant roots. However, these salts do not provide a food source for soil microorganisms and earthworms, and will even repel earthworms because they acidify the soil. Over time, soil treated only with synthetic chemical fertilizer with have decreased organic matter and altered biological activity. And as soil structure declines and water-holding capacity diminishes, a greater proportion of the soluble chemical fertilizer applied will leach from the soil. Ever-increasing amounts of chemicals will be needed to feed the plants." (Bradley, p. 223-228)*

In organic agriculture, fertilizer inputs are used to supplement the soil building practices such as green manuring, composting, and rotating crops. Mined minerals serve as the backbone of an organic fertilization program as they breakdown slowly and provide small amounts of plant nutrients as they interact as part of soil biology and chemistry.

Proponents of natural ammonia products claim that they are different from chemical ammonia (Appendix I), based on how they are generated and because they have different isotope configurations. However, there is no evidence that these factors result in any differences in the ammonia's behavior, either in the plant or in the soil.

Nitrogen fertilizers traditionally used in organic production systems, such as meat and feather meal, fish, soy or alfalfa meal, and guano, all have their nitrogen content bound with varying amounts of carbon and a complex mix of other plant nutrients. This not only balances the supply of nitrogen with provision of other nutrients, it provides plant nutrition over a longer period of time than does a soluble fertilizer. The end result is healthier plants that are more resistant to stress, coupled with less concern about nitrogen leaching or run-off. Other characteristics of Ammonia Extract raise concerns, especially in the context of the NOSB's recent discussions about hydroponics. Ammonia Extracts are "clear" homogeneous solutions and perform better in fertigation systems compared to other liquid fertilizers such as fish emulsions, which routinely clog the tiny hole in drip irrigation emitters. This clarity, coupled with the ability of Ammonia Extract to deliver nitrogen immediately when plants need it are indeed useful, however these characteristics contrast strongly with other nitrogen fertilizers with regard to meeting goals for soil building and providing slow release plant nutrition.

<u>Conclusion:</u>

In summary, Ammonia Extract is an entirely new input that has not been vetted for compatibility with organic principles. Its use disregards the historical role and foundational importance of caring for a soil system. It encourages use of agricultural practices that do not promote human health and the environment. Finally, use of Ammonia Extract contradicts the progress of farmers to employ a systems-based approach to soil building instead of relying on the highly soluble, salt-based fertilizers on which conventional agriculture is completely reliant.

Appendix A

SYNTHETIC AND NONSYNTHETIC PROCESSES FOR CONCENTRATING AMMONIA

Nonsynthetic concentrated ammonia containing liquid fertilizers can be created two ways. Any of these methods of production of ammonia results in the same molecular structure and, as a result, plants interact with either form of ammonia fertilizer in exactly the same way, regardless of the method used to produce it.

The first is by dissolving gaseous ammonia (NH_3) into water to the point of saturation. This is temperature dependent where the amount of ammonia (NH_3) will “gas off” or evaporate as the temperature of the liquid increases.

The second way to concentrate ammonia is through stabilization of ammonia into ammonium. “Stabilized ammonia solutions” are defined as aqueous liquid solutions of ammonia that are “stable,” in the sense that they do not emit ammonia gas at room temperature or when they are warmed by exposure to ambient temperatures normally encountered in the summer.

This ‘stability’ of a “stabilized ammonia solution” is not a characteristic of “ammonia water” or “ammonium hydroxide,” common names for simple solutions of water and the gas ammonia. Ammonia gas is extremely soluble in water, especially in cold water. Water holds 47% ammonia at 0°C (32°F), 38% at 20°C (68°F), 28% at 30°C(77°F), and 18% at 50°C (112°F). However, the form of over 99% of the ammonia in ammonia water is as the molecule ammonia. Only 0.4% of ammonia is ionized (CRC, p 1739). Ammonium hydroxide is a “weak base.” This low ionization is the reason that the ammonia content of ammonium hydroxide falls if the container is not tightly closed: the dissolved ammonia gas simply ‘evaporates.’ This low ionization also accounts for the pH of ammonia water ranging between 10.6 and 11.6, depending on the concentration of ammonia. In contrast, the pH of a “strong base” such as sodium hydroxide ranges between pH 12 and pH 13.

The pH values of “stabilized ammonia solutions” are less than 7, which is neutral to slightly acidic. The only way to create an ammonia solution with a pH of less than 7 is to neutralize the ammonia with an acid, thus forming a ‘salt.’ In fact, the two patents cited later that describe the process for production of ammonia and its collection for use as a fertilizer claim use of an acid solution to ‘absorb’ the ammonia from the gaseous effluent of the fermentation wherein the ammonia is synthesized by bacteria. When the acid in the ammonia-absorbing solution is citric acid, the salt formed is ammonium citrate.

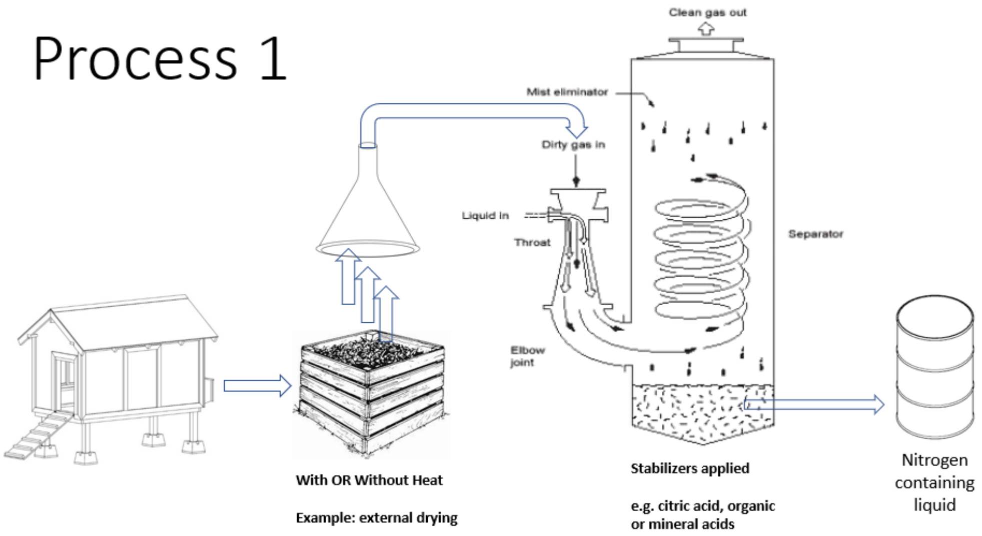
Nonsynthetic ammonia is produced in a number of biological processes including the anaerobic fermentation of animal manure, food waste, and plant and crop waste. If nonsynthetic ammonia is collected in a solution of a nonsynthetic acid such as carbon dioxide, lactic acid, citric acid, acetic acid, tartaric acid, malic acid, or a similar acid produced by microorganisms or plants, the resulting “stabilized ammonia solution” is claimed to be “nonsynthetic” because it is the reaction product of two nonsynthetic materials. Historically, however, ammonium salts have been classified as synthetic substances. Ammonium bicarbonate and ammonium carbonate are synthetic; both are allowed in organic food handling at §205.605(b). In 2019, the NOSB unanimously voted to classify ammonium citrate as a synthetic substance.

If nonsynthetic ammonia is partially or totally neutralized or with a synthetic ‘mineral’ acid solution (e.g., hydrochloric acid, phosphoric acid, or nitric acid, or sulfuric acid), the stabilized ammonia solution is recognized that to be synthetic and thus would require inclusion of the National List at § 205.601 to be allowed in organic crop production.

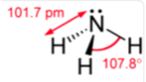
Appendix B

EXAMPLES OF POSSIBLE MANUFACTURING PROCESSES FOR NONSYNTHETIC AMMONIA

Process 1

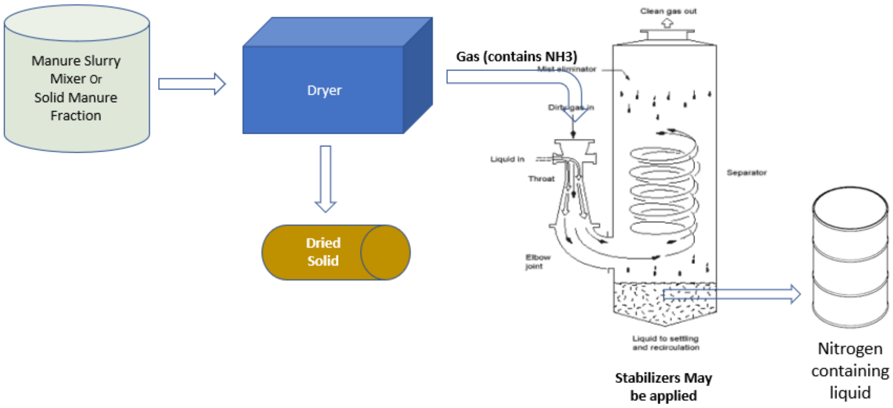


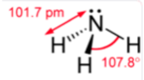
Manure is gathered directly from chicken house. Gases escaping from material that may or may not be heated, are directed (example: by fan or contained exhaust) to separator. Stabilizers are added resulting in an ammoni<u>um</u> containing solution.



Ammonia

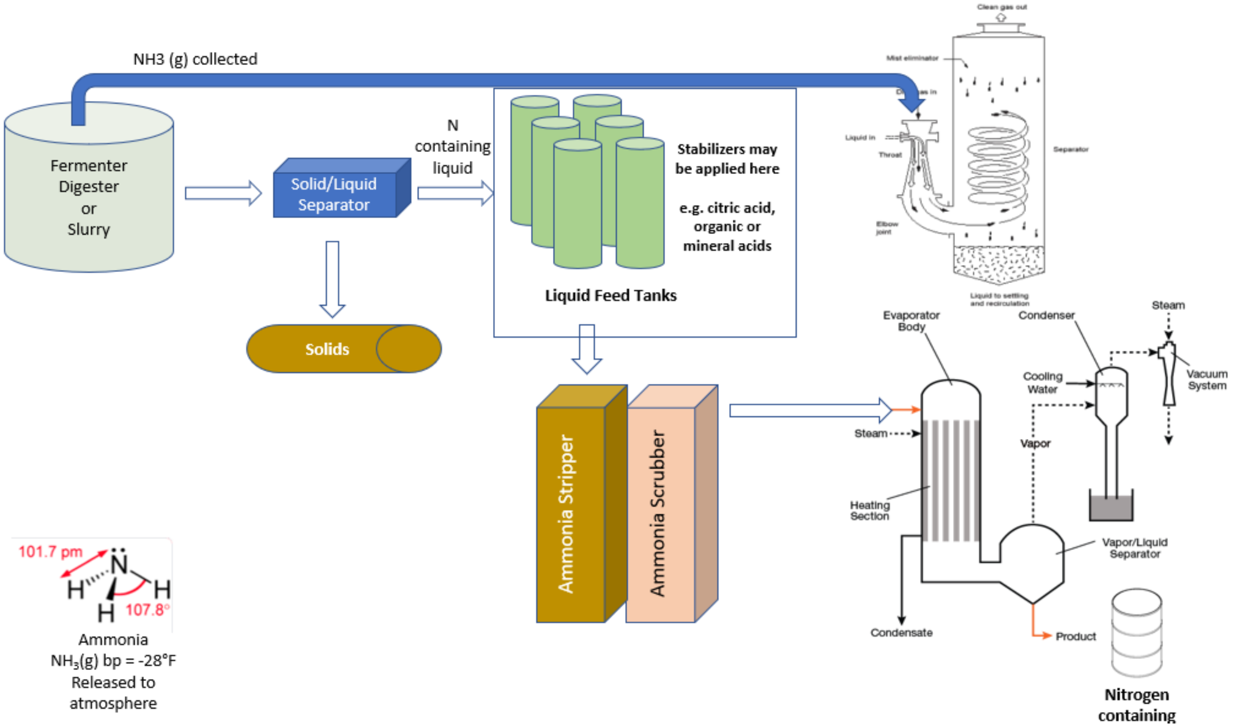
Process 2





Ammonia
$NH_3(g)$ bp = -28°F

Process 3



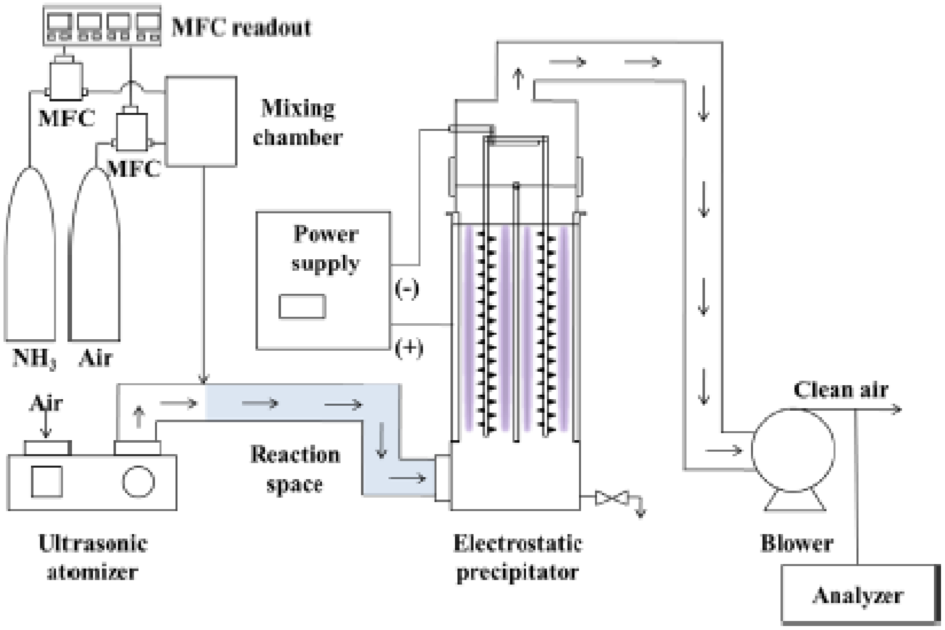
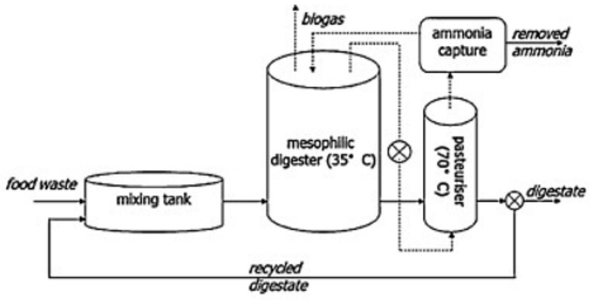
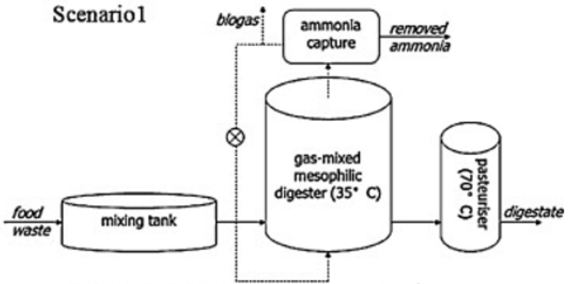


Fig. 1 Schematic diagram of Wet-ESP system for the removal of NH_3

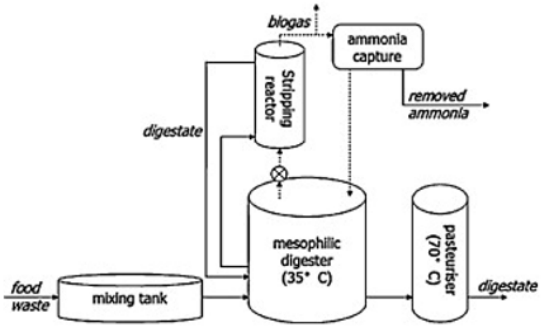
Examples of Ammonia Capture



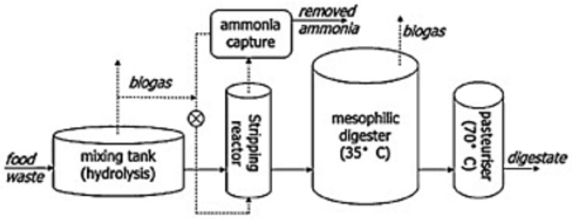
Scenario 1 Post digestion ammonia removal



Scenario 2 *In situ* ammonia removal

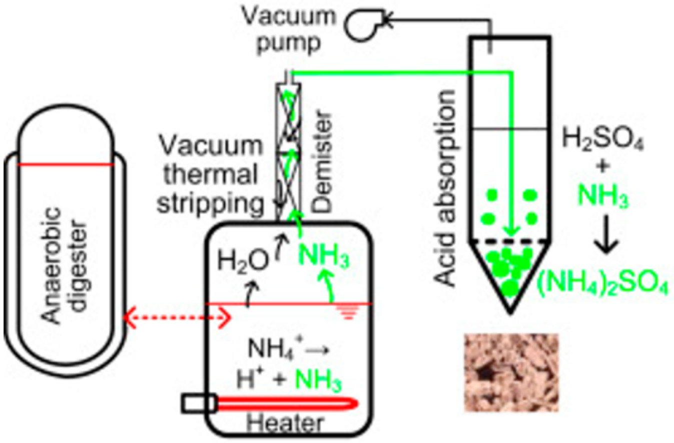


Scenario 3 Side-stream ammonia removal



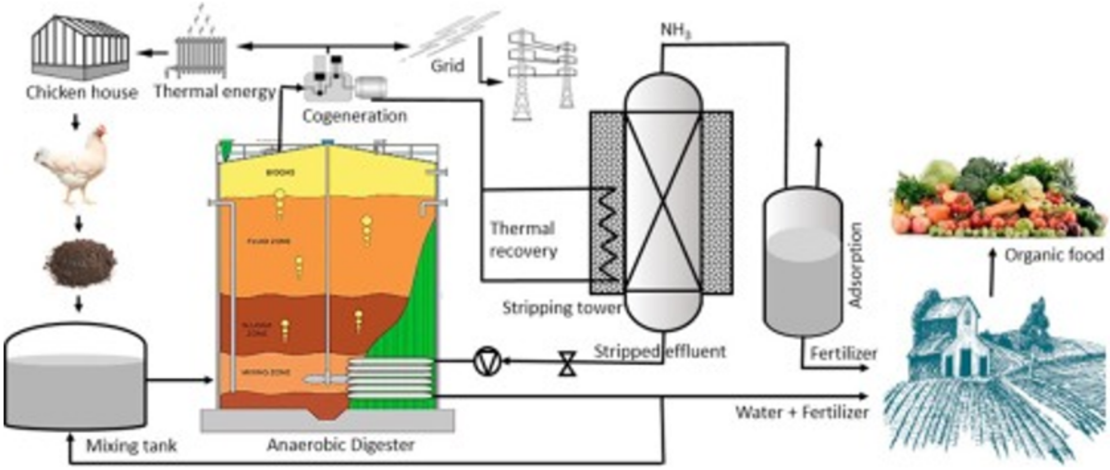
Scenario 4 Pre-digestion ammonia removal

Example of the mechanism of Ammonia Stripping



- Note the use of sulfuric acid
- Acid absorption can be equated to a chemical reaction
- The outcome is a Ammonium Sulfate aka a chemical fertilizer made through a biological process

General Layout of Anaerobic Digester

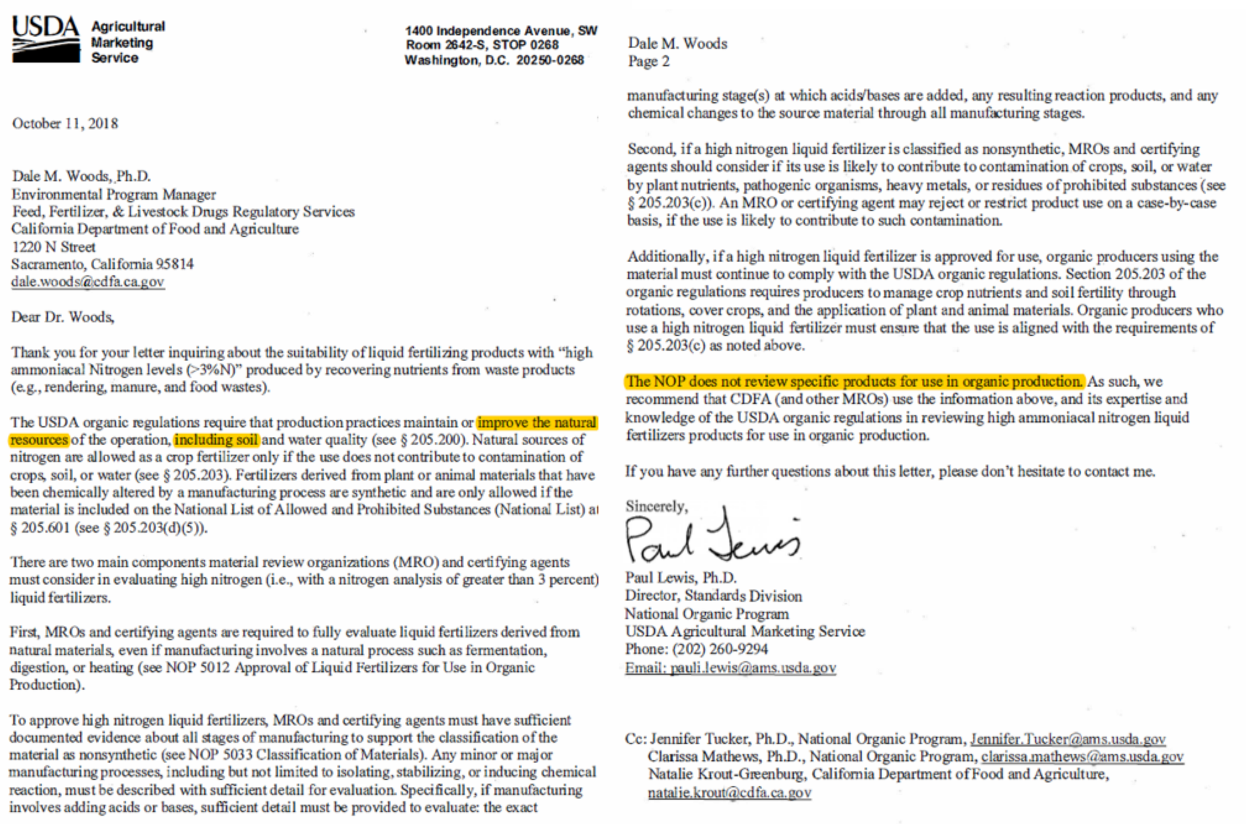


- Note the ammonia adsorption process
- Previous slide showed the use of Sulfuric acid
- Inappropriate use of the word “Organic”
- Article tells of ammonia stripping optimization through the use of NaOH or CaO, i.e. chemicals used in a chemical reaction

https://www.sciencedirect.com/science/article/pii/S138589471830439X

Appendix C

LETTER FROM NOP IN RESPONSE TO REQUEST FOR CLARIFICATION BY CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE (CDFA)



USDA Agricultural Marketing Service

1400 Independence Avenue, SW
Room 2642-S, STOP 0268
Washington, D.C. 20250-0268

October 11, 2018

Dale M. Woods, Ph.D.
Environmental Program Manager
Feed, Fertilizer, & Livestock Drugs Regulatory Services
California Department of Food and Agriculture
1220 N Street
Sacramento, California 95814
dale.woods@cdfa.ca.gov

Dear Dr. Woods,

Thank you for your letter inquiring about the suitability of liquid fertilizing products with "high ammoniacal Nitrogen levels (>3%N)" produced by recovering nutrients from waste products (e.g., rendering, manure, and food wastes).

The USDA organic regulations require that production practices maintain or improve the natural resources of the operation, including soil and water quality (see § 205.200). Natural sources of nitrogen are allowed as a crop fertilizer only if the use does not contribute to contamination of crops, soil, or water (see § 205.203). Fertilizers derived from plant or animal materials that have been chemically altered by a manufacturing process are synthetic and are only allowed if the material is included on the National List of Allowed and Prohibited Substances (National List) a § 205.601 (see § 205.203(d)(5)).

There are two main components material review organizations (MRO) and certifying agents must consider in evaluating high nitrogen (i.e., with a nitrogen analysis of greater than 3 percent) liquid fertilizers.

First, MROs and certifying agents are required to fully evaluate liquid fertilizers derived from natural materials, even if manufacturing involves a natural process such as fermentation, digestion, or heating (see NOP 5012 Approval of Liquid Fertilizers for Use in Organic Production).

To approve high nitrogen liquid fertilizers, MROs and certifying agents must have sufficient documented evidence about all stages of manufacturing to support the classification of the material as nonsynthetic (see NOP 5033 Classification of Materials). Any minor or major manufacturing processes, including but not limited to isolating, stabilizing, or inducing chemical reaction, must be described with sufficient detail for evaluation. Specifically, if manufacturing involves adding acids or bases, sufficient detail must be provided to evaluate: the exact manufacturing stage(s) at which acids/bases are added, any resulting reaction products, and any chemical changes to the source material through all manufacturing stages.

Dale M. Woods
Page 2

Second, if a high nitrogen liquid fertilizer is classified as nonsynthetic, MROs and certifying agents should consider if its use is likely to contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances (see § 205.203(c)). An MRO or certifying agent may reject or restrict product use on a case-by-case basis, if the use is likely to contribute to such contamination.

Additionally, if a high nitrogen liquid fertilizer is approved for use, organic producers using the material must continue to comply with the USDA organic regulations. Section 205.203 of the organic regulations requires producers to manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials. Organic producers who use a high nitrogen liquid fertilizer must ensure that the use is aligned with the requirements of § 205.203(c) as noted above.

The NOP does not review specific products for use in organic production. As such, we recommend that CDFA (and other MROs) use the information above, and its expertise and knowledge of the USDA organic regulations in reviewing high ammoniacal nitrogen liquid fertilizers products for use in organic production.

If you have any further questions about this letter, please don't hesitate to contact me.

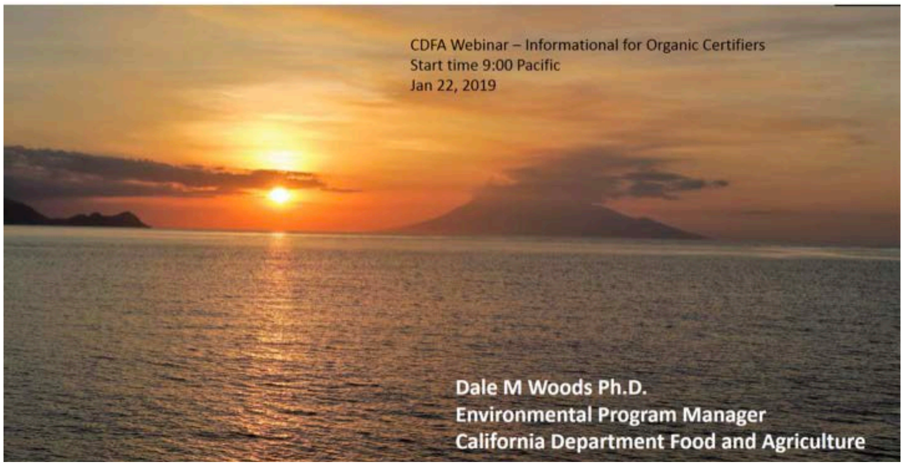
Sincerely,

Paul Lewis

Paul Lewis, Ph.D.
Director, Standards Division
National Organic Program
USDA Agricultural Marketing Service
Phone: (202) 260-9294
Email: pauli.lewis@ams.usda.gov

Cc: Jennifer Tucker, Ph.D., National Organic Program, Jennifer.Tucker@ams.usda.gov
Clarissa Mathews, Ph.D., National Organic Program, clarissa.mathews@ams.usda.gov
Natalie Krout-Greenburg, California Department of Food and Agriculture, natalie.krout@cdfa.ca.gov

On January 22, 2019, the CDFA Fertilizer Materials Inspection Program (FMIP) conducted a webinar for Organic Certifiers on the FMIPs Organic Input Material Program. Included in the webinar was a discussion of "Novel Fertilizing Material Products" and FMIPs response to the letter received from NOP on these products. Slides from the webinar are shown in Appendix H of this Petition. The webinar is also posted online and discussion of these materials begins at minute 26:55 of the presentation.

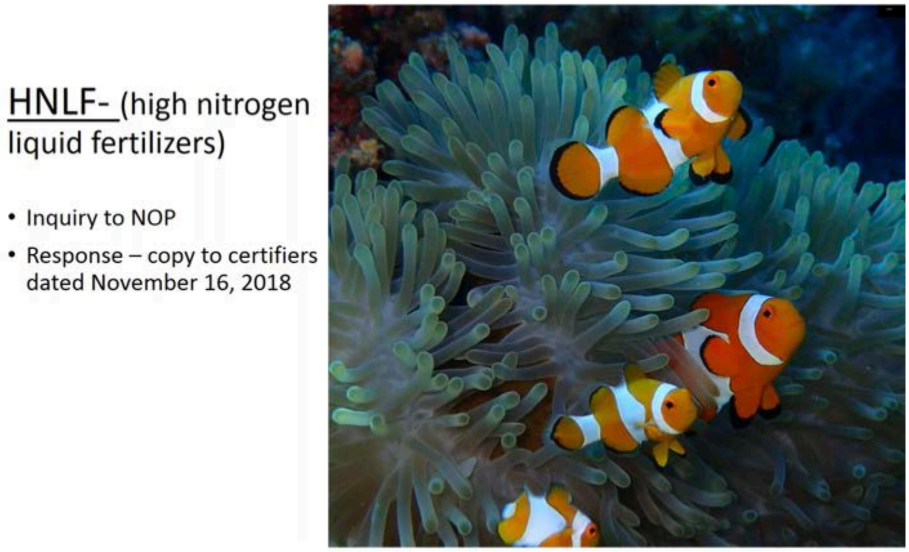


CDFA Webinar – Informational for Organic Certifiers
Start time 9:00 Pacific
Jan 22, 2019

Dale M Woods Ph.D.
Environmental Program Manager
California Department Food and Agriculture

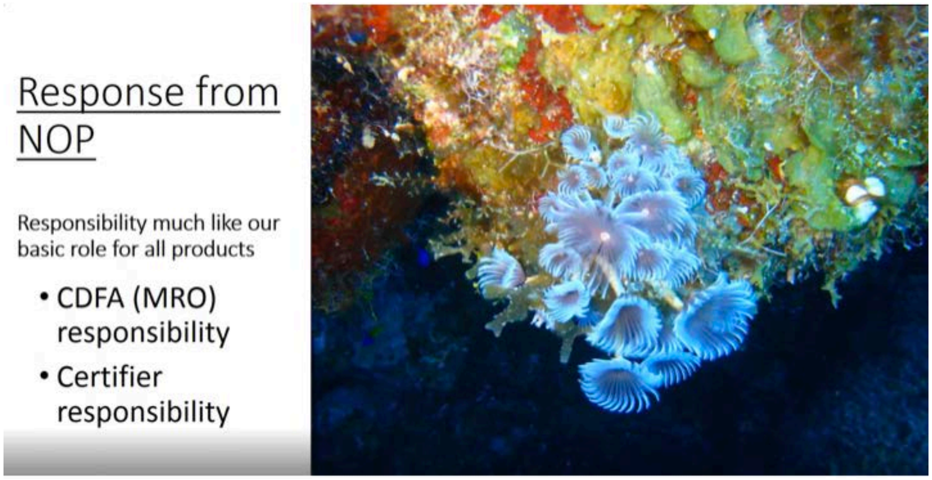
Novel Fertilizing Material Products

- Multiple applications from several firms
- Liquid, >2% ammoniacal nitrogen
- Most are 5-7% Nitrogen
- Biological sources
- Purified/separated from other materials
- Concentrated
- Packaged (bottled)



HNLF- (high nitrogen liquid fertilizers)

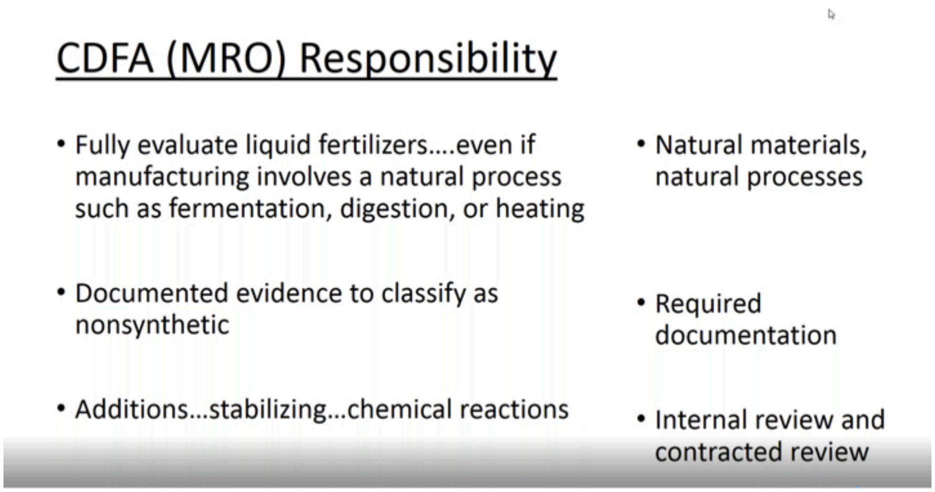
- Inquiry to NOP
- Response – copy to certifiers dated November 16, 2018



Response from NOP

Responsibility much like our basic role for all products

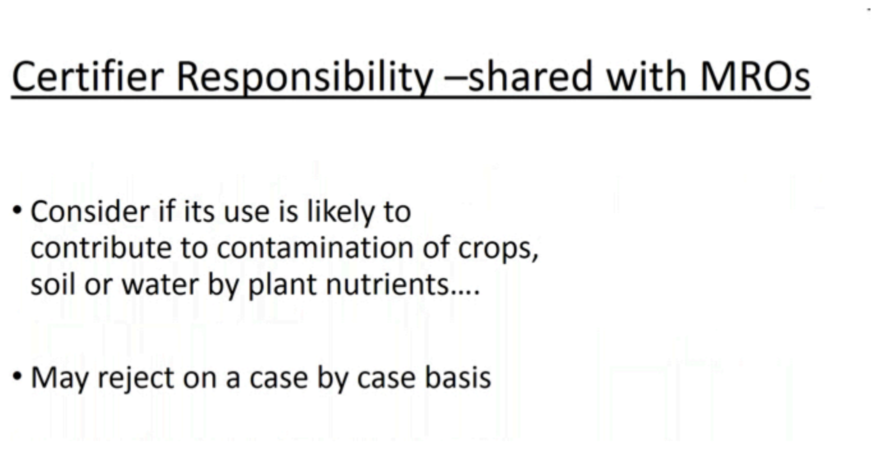
- CDFA (MRO) responsibility
- Certifier responsibility



CDFA (MRO) Responsibility

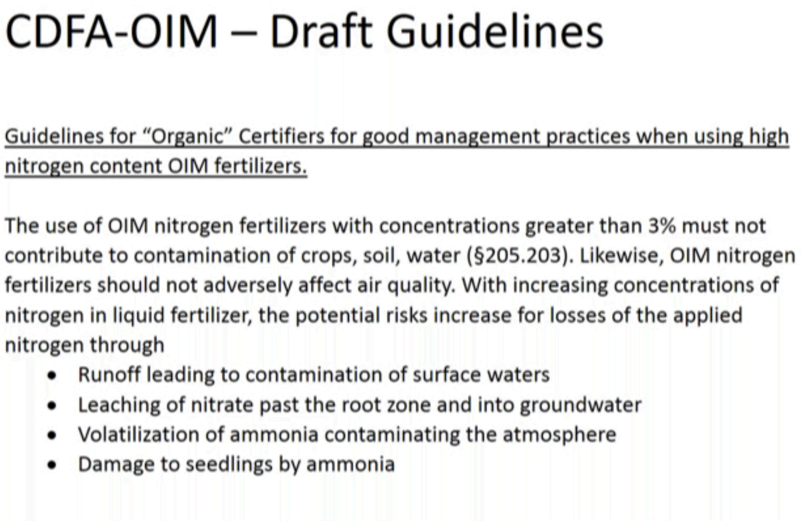
- Fully evaluate liquid fertilizers….even if manufacturing involves a natural process such as fermentation, digestion, or heating
- Documented evidence to classify as nonsynthetic
- Additions…stabilizing…chemical reactions

- Natural materials, natural processes
- Required documentation
- Internal review and contracted review



Certifier Responsibility –shared with MROs

- Consider if its use is likely to contribute to contamination of crops, soil or water by plant nutrients….
- May reject on a case by case basis



CDFA-OIM – Draft Guidelines

Guidelines for "Organic" Certifiers for good management practices when using high nitrogen content OIM fertilizers.

The use of OIM nitrogen fertilizers with concentrations greater than 3% must not contribute to contamination of crops, soil, water (§205.203). Likewise, OIM nitrogen fertilizers should not adversely affect air quality. With increasing concentrations of nitrogen in liquid fertilizer, the potential risks increase for losses of the applied nitrogen through

- Runoff leading to contamination of surface waters
- Leaching of nitrate past the root zone and into groundwater
- Volatilization of ammonia contaminating the atmosphere
- Damage to seedlings by ammonia

Appendix D

FURTHER DETAIL ON THE PHYSICAL AND CHEMICAL PROPERTIES OF AMMONIA, AMMONIUM SALTS AND AMMONIA FERTILIZERS

Part 1: Agricultural Interactions and Impacts

The use of nitrogen fertilizers in agriculture is broadly studied, as well as, specifically studied for impact on soil fertility, carbon sequestration, soil acidification and other areas related to the principles of organic production. Given the wide scope of available information, an exhaustive literature review about properties and environmental impact of nitrogen fertilizers is not feasible. Below, in this appendix, we highlight articles that broadly address the topics::

(a) Chemical interactions with other substances;

(b) Toxicity and environmental persistence; and

(c) Environmental impacts from its use and/or manufacture; and

(d) Effects on soil organisms, crops, or livestock.

Biederbeck, V. O., et al. "Soil microbial and biochemical properties after ten years of fertilization with urea and anhydrous ammonia." *Canadian Journal of Soil Science* 76 (1996: 1): 7-14.

> The influence of nitrogen (N) fertilizers, especially anhydrous ammonia, on soil quality has been questioned frequently by proponents of organic farming and low input sustainable agriculture. A 10-yr experiment was conducted on an Orthic Dark Brown Chernozemic loam, at Scott, Saskatchewan, to examine the influence of urea and anhydrous ammonia, at rates of N up to 180 kg h^{-1}, on yields of cereals and oilseeds. In the 10th yr, we sampled soil from the 0- to 7.5- and 7.5- to 15-cm depths of each treatment 3 d before and 6 and 26 d after fertilization to assess the impact of applied N on microbial populations and soil biochemical properties. The long-term residual effects of N fertilization on soil properties were evident prior to the 10th annual N application. The short-term effects were most pronounced 6 d after the 10th N application. Generally, effects were greater in the 7.5- to 15-cm depth, where N was placed. The soil, which was already acidic (pH = 5.2 in 0.01 M $CaCl2$), decreased in pH in proportion to N rate and more so for anhydrous ammonia than urea. Generally, fungal and bacterial populations (plate counts) were positively related to N rate and were greater in soil treated with anhydrous ammonia than in urea-treated soil. In contrast, the actinomycete population was inversely related to N rate and was less for anhydrous ammonia than for urea. Nitrifier counts were increased by low rates of N (added substrate) but were similar to the check at high N rates (high acidity). There were no significant effects of N treatment on denitrifiers or yeasts. In contrast to the plate count results, microbial biomass decreased with increasing rates of N and was lower for anhydrous ammonia than for urea. However, the authenticity of this response is questionable because the fumigation-incubation method of biomass determination is compromised under acid conditions. Carbon mineralization was unaffected but N mineralization and nitrification tended to decrease at the 180 kg N ha^{-1} rate of anhydrous ammonia. Significant nitrification occurred at $pH < 5.0$ suggesting possible adaptation of nitrifiers in this acid soil. Wet aggregate stability (WAS) was unaffected by N treatments. We concluded that, if producers in the Dark Brown soil zone apply fertilizers at rates less than 90 kg N h^{-1}, deterioration of soil quality should be minimal.

Bouman, O. T., D. Curtin, C. A. Campbell, V. O. Biederbeck, and H. Ukrainetz, “Soil Acidification from Long-Term Use of Anhydrous Ammonia and Urea”, *Soil Science of America Journal* 59 (1995).

> Acidity generated by N fertilizers depends on factors such as the composition of the fertilizer, climatic and soil conditions, and the crops grown. Our objective was to quantify the acidifying effects of urea and anhydrous NH_3 when used as fertilizers for cereal production in Saskatchewan, Canada. The fertilizers were injected annually (at 10-cm depth) into a medium-textured, moderately acid (pH =5.5) Typic Haploboroll, at rates of 0, 45, 90, and 180 kg N ha*' for 9 yr. Soil acidity increased as N application rate increased, with anhydrous NH_3 causing greater acidification than urea. Although pH values as low as 4.3 were recorded in soil treated with anhydrous NH_3, KCl-exchangeable acidity remained low. The major effect of acidification was a depletion of exchangeable Ca and Mg. The solubility of Mn (but not Al) increased substantially as pH decreased, with solution concentrations of almost 30 mg Mn L-' being recorded 6 d after injection of NH_3. Acidity generated by anhydrous NH_3 compared well with values predicted assuming that all of the applied NH_3 was oxidized to NO3 (with the production of 1 mol H+ mol-' of N) and that these protons were partly neutralized by OH- released when NO3- was taken up and assimilated by plants. Acidification due to export of bases in grain was insignificant because wheat (Triticum aestivum L.) and barley (Hordeum vulgare L.) remove only a slight excess of cations over anions. Urea failed to realize its full acidification potential because of an apparent loss of urea-N from the soil by NH, volatilization.

Bremner, J. M. and M. J. Krogmeier. "Elimination of the adverse effects of urea fertilizer on seed germination, seedling growth, and early plant growth in soil." *Proceedings of the National Academy of Sciences* 85 (1988: 13): 4601-4604.

> The rapidly increasing importance of urea fertilizer in world agriculture has stimulated research to find methods of reducing the problems associated with the use of this fertilizer. One of these problems is that urea has adverse effects on seed germination, seedling growth, and early plant growth in soil. Because there is evidence that these adverse effects are caused largely, if not entirely, by ammonia produced through hydrolysis of urea fertilizer by soil urease, we explored the possibility that they could be reduced or eliminated by amending urea fertilizer with a small amount of a urease inhibitor. Studies with seeds of alfalfa (Medicago sativa L.), barley (Hordeum vulgare L.), oats (Avena sativa L.), rye (Secale cereale L.), sorghum [Sorghum bicolor (L.) Moench], and wheat (Triticum aestivum L.) showed that phenylphosphorodiamidate and N-(n-butyl)thiophosphoric triamide were the most effective of 10 urease inhibitors evaluated for reduction of the adverse effect of urea on seed germination. N-(n-butyl)-thiophosphoric triamide was superior to phenylphosphorodiamidate for reducing the adverse effects of urea solutions on seed germination and seedling growth in soil, and it completely eliminated the adverse effect of urea granules on early plant growth in soil. The data reported indicate that the adverse effects of urea fertilizer on seed germination, seedling growth, and early plant growth in soil could be eliminated or markedly reduced by amending the fertilizer with as little as 0.01% (wt/wt) of N-(n-butyl)thiophosphoric triamide.

Bremner, J. M. and M. J. Krogmeier. "Evidence that the adverse effect of urea fertilizer on seed germination in soil is due to ammonia formed through hydrolysis of urea by soil urease." *Proceedings of the National Academy of Sciences* 86(1989: 21): 8185-8188.

> Studies using seeds of wheat (Triticum aestivum L.), rye (Secale cereale L.), barley (Hordeum vulgare L.), and corn (Zea mays L.) indicated that the adverse effect of urea fertilizer on seed germination in soil is due to ammonia formed through hydrolysis of urea by soil urease and is not due to urea itself, to urea fertilizer impurities such as biuret, or to nitrite formed by nitrification of urea nitrogen. Support for this conclusion was obtained from (i) comparison of the effects on seed germination in soil of purified urea, urea fertilizers, urea fertilizer impurities, and compounds formed by enzymatic and microbial transformations of urea in soil; (ii) studies showing that ammonia volatilized from soils treated with urea completely inhibited germination of seeds close

to, but not in contact with, these soils; and (iii) experiments showing that the adverse effect of urea fertilizer on seed germination in soil was completely eliminated when the soil was autoclaved to destroy urease or was treated with phenylphosphorodiamidate to inhibit soil urease activity before treatment with urea fertilizer.

Bulluck, L. R., et al. "Organic and synthetic fertility amendments influence soil microbial, physical and chemical properties on organic and conventional farms." *Applied Soil Ecology* 19 (2002: 2): 147-160.

Field experiments were conducted to examine the effects of organic and synthetic soil fertility amendments on soil microbial communities and soil physical and chemical properties at three organic and three conventional vegetable farms in Virginia and Maryland in 1996 and 1997. Two treatments, including either an alternative organic soil amendment (composted cotton-gin trash, composted yard waste, or cattle manure) or synthetic soil amendment (fertilizer) were applied to three replicated plots at each grower field location. Production history and time affected propagule densities of Trichoderma species which remained higher in soils from organic farms. Propagule densities of Trichoderma species, thermophilic microorganisms, and enteric bacteria were also detected in greater numbers in soils amended with alternative than synthetic amendments, whereas propagule densities of Phytophthora and Pythium species were lower in soils amended with alternative than synthetic fertility amendments. Concentrations of Ca, K, Mg, and Mn were higher in soils amended with alternative than synthetic fertility amendments. Canonical correlations and principle component analyses indicated significant correlation between these soil chemical factors and the biological communities. First-order canonical correlations were more negative in fields with a conventional history, and use of synthetic fertilizers, whereas canonical correlations were more positive in fields with a history of organic production and alternative soil amendments. In the first year, yields of corn or melon were not different in soil amended with either synthetic or organic amendments at four of six farms. In the second year, when all growers planted tomatoes, yields were higher on farms with a history of organic production, regardless of soil amendment type. Alternative fertility amendments, enhanced beneficial soil microorganisms reduced pathogen populations, increased soil organic matter, total carbon, and cation exchange capacity (CEC), and lowered bulk density thus improving soil quality.

DePasquale, D. A. and T. J. Montville (1990). "Mechanism by which ammonium bicarbonate and ammonium sulfate inhibit mycotoxigenic fungi." Applied and environmental microbiology 56 (1990: 12): 3711-3717.

In this study we examined the mechanism by which ammonium bicarbonate inhibits mycotoxigenic fungi. Elevated extracellular pH, alone, was not responsible for the antifungal activity. Although conidia of Penicillium griseofulvum and Fusarium graminearum had internal pH (pHi) values as high as 8.0 in buffer at an external pH (pHo) of 9.5, their viability was not markedly affected. The pHi values from conidia equilibrated in glycine-NaOH-buffered treatments without ammonium bicarbonate or ammonium sulfate were similar to values obtained from buffered treatments containing the ammonium salts. Thus, inhibition did not appear to be directly related to increased pHi. Ammonium sulfate in buffered media at pH greater than or equal to 8.7 was as inhibitory as ammonium bicarbonate, but was completely ineffective at pH less than or equal to 7.8. The hypothesis that free ammonia caused the fungal inhibition was tested by using ammonium sulfate as a model for ammonium bicarbonate. Viability, expressed as log CFU/ml, and percent germination of P. griseofulvum and F. graminearum decreased dramatically as the free ammonia concentration increased. Germination rate ratios (the germination rate in buffered ammonium sulfate divided by the germination rate in buffer alone) decreased linearly as the free ammonia concentration increased, further establishing NH_3 as the toxic agent. Ammonium bicarbonate inhibits fungi because the bicarbonate anion supplies the alkalinity necessary to establish an antifungal concentration of free ammonia.

Fliessbach, A., and Mader, P. "Microbial biomass and size-density fractions differ between soils of organic and conventional agricultural systems." *Soil Biology & Biochemistry* 32 (2000): 757-768.

> Agricultural production systems have to combine management practices in order to sustain soil quality and also profitability. We investigated microbial biomass and size-density fractions of soils from a long-term field trial set up in 1978 at Therwil, Switzerland. It compares the economic and ecological performance of organic and conventional agricultural systems. Main differences of the systems were the amount and form of fertiliser as well as the plant protection strategy, whilst crop rotation and soil tillage were the same. Microbial biomass C and N as well as their ratios to the total and light fraction C and N pools in soils of the organic systems were higher than in conventional systems. This is interpreted as an enhanced decomposition of the easily available light fraction pool of soil organic matter (SOM) with increasing amounts of microbial biomass. The role of microbial biomass as a regulator and light fraction organic matter as an indicator of decomposition is discussed. The presented results indicate that labile pools of SOM are distinctly affected by long-term management practices. U 2000 Elsevier Science Ltd. All rights reserved.

Fookes, C. “Organic Food and Farming: Myth & Reality, Organic vs non-organic — The Facts.” The Soil Association & Sustain. 2001.

> The long-term security of our food supply relies on sustainable forms of food production. The evidence shows: 1) Intensive farming destroys the fertility of the land and 2) Sustainable farming helps communities to produce food at low cost.

Geisseler, D. and K. M. Scow (2014). "Long-term effects of mineral fertilizers on soil microorganisms – A review." *Soil Biology and Biochemistry* 75 (2014): 54-63.

> Increasing nutrient inputs into terrestrial ecosystems affect not only plant communities but also associated soil microbial communities. Studies carried out in predominantly unmanaged ecosystems have found that increasing nitrogen (N) inputs generally decrease soil microbial biomass; less is known about long-term impacts in managed systems such as agroecosystems. The objective of this paper was to analyze the responses of soil microorganisms to mineral fertilizer using data from long-term fertilization trials in cropping systems. A meta-analysis based on 107 datasets from 64 long-term trials from around the world revealed that mineral fertilizer application led to a 15.1% increase in the microbial biomass (Cmic) above levels in unfertilized control treatments. Mineral fertilization also increased soil organic carbon (Corg) content and our results suggest that Corg is a major factor contributing to the overall increase in Cmic with mineral fertilization. The magnitude of the effect of fertilization on Cmic was pH dependent. While fertilization tended to reduce Cmic in soils with a pH below 5 in the fertilized treatment, it had a significantly positive effect at higher soil pH values. Duration of the trial also affected the response of Cmic to fertilization, with increases in Cmic most pronounced in studies with a duration of at least 20 years. The input of N per se does not seem to negatively affect Cmic in cropping systems. The application of urea and ammonia fertilizers, however, can temporarily increase pH, osmotic potential and ammonia concentrations to levels inhibitory to microbial communities. Even though impacts of fertilizers are spatially limited, they may strongly affect soil microbial biomass and community composition in the short term. Long-term repeated mineral N applications may alter microbial community composition even when pH changes are small. How specific microbial groups respond to repeated applications of mineral fertilizers, however, varies considerably and seems to depend on environmental and crop management related factors.

Khan, S. A., R. L. Mulvaney, T. R. Ellsworth, and C. W. Boast. “The Myth of Nitrogen Fertilization for Soil Carbon Sequestration.” *Journal of Environmental Quality* 36 (2007): 1821-1832.

> Intensive use of N fertilizers in modern agriculture is motivated by the economic value of high grain yields and is generally perceived to sequester soil organic C by increasing the input of crop residues. This perception is at odds with a century of soil organic C data reported herein for the

Morrow Plots, the world's oldest experimental site under continuous corn (Zea mays L.). After 40 to 50 yr of synthetic fertilization that exceeded grain N removal by 60 to 190%, a net decline occurred in soil C despite increasingly massive residue C incorporation, the decline being more extensive for a corn–soybean (Glycine max L. Merr.) or corn–oats (Avena sativa L.)–hay rotation than for continuous corn and of greater intensity for the profile (0–46 cm) than the surface soil. These findings implicate fertilizer N in promoting the decomposition of crop residues and soil organic matter and are consistent with data from numerous cropping experiments involving synthetic N fertilization in the USA Corn Belt and elsewhere, although not with the interpretation usually provided. There are important implications for soil C sequestration because the yield-based input of fertilizer N has commonly exceeded grain N removal for corn production on fertile soils since the 1960s. To mitigate the ongoing consequences of soil deterioration, atmospheric CO enrichment, and NO –pollution of ground and surface waters, N fertilization should be managed by site-specific assessment of soil N availability. Current fertilizer N management practices, if combined with corn stover removal for bioenergy production, exacerbate soil C loss.

Kramer, S. B., J. P. Reganold, J.D. Glover, B. J. M. Bohannan, and J. A. Mooney. "Reduced nitrate leaching and enhanced denitrifier activity and efficiency in organically fertilized soils." *Proceedings of the National Academy of Sciences of the U.S.A.* 103 (2006: 12): 4522-4527.

Conventional agriculture has improved in crop yield but at large costs to the environment, particularly off-site pollution from mineral N fertilizers. In response to environmental concerns, organic agriculture has become an increasingly popular option. One component of organic agriculture that remains in question is whether it can reduce agricultural N losses to groundwater and the atmosphere relative to conventional agriculture. Here we report reduced N pollution from organic and integrated farming systems compared with a conventional farming system. We evaluated differences in denitrification potential and a suite of other soil biological and chemical properties in soil samples taken from organic, integrated, and conventional treatments in an experimental apple orchard. Organically farmed soils exhibited higher potential denitrification rates, greater denitrification efficiency, higher organic matter, and greater microbial activity than conventionally farmed soils. The observed differences in denitrifier function were then assessed under field conditions after fertilization. N(2)O emissions were not significantly different among treatments; however, N(2) emissions were highest in organic plots. Annual nitrate leaching was 4.4-5.6 times higher in conventional plots than in organic plots, with the integrated plots in between. This study demonstrates that organic and integrated fertilization practices support more active and efficient denitrifier communities, shift the balance of N(2) emissions and nitrate losses, and reduce environmentally damaging nitrate losses. Although this study specifically examines a perennial orchard system, the ecological and biogeochemical processes we evaluated are present in all agroecosystems, and the reductions in nitrate loss in this study could also be achievable in other cropping systems.

Mahal, N. K., et al. "Nitrogen Fertilizer Suppresses Mineralization of Soil Organic Matter in Maize Agroecosystems." *Frontiers in Ecology and Evolution* 7(2009: 59).

The possibility that N fertilizer increases soil organic matter (SOM) mineralization and, as a result, reduces SOM stocks has led to a great debate about the long-term sustainability of maize-based agroecosystems as well as the best method to estimate fertilizer N use efficiency (FNUE). Much of this debate is because synthetic N fertilizer can positively or negatively affect SOM mineralization via several direct and indirect pathways. Here, we test a series of hypotheses to determine the direction, magnitude, and mechanism of N fertilizer effect on SOM mineralization and discuss the implications for methods to estimate FNUE. We measured the effect of synthetic N fertilizer on SOM mineralization via gross ammonification at two long-term experiments in central and southern Iowa, USA with replicated plots of continuous maize that received one of three "historical" N fertilizer rates (zero, moderate or high) from 1999 to 2014. In 2015, prior to our measurements, we split the historical N fertilizer rate plots into two subplots that received either the site-specific agronomic optimum N rate or zero N fertilizer. At the onset of rapid maize N uptake, N fertilizer reduced gross ammonification by 13–21% (2–5 kg NH4-N ha−1 d−1). A companion laboratory experiment rejected the hypothesis that differences in net primary productivity between fertilized and unfertilized treatments explained the negative effect of N fertilizer on SOM mineralization. Moreover, the NH+4 pool size was negatively correlated with the gross ammonification rate ($r2 = 0.85$, $p < 0.001$). Thus, we conclude that NH+4-N fertilizer had a direct suppressive effect on SOM mineralization. These results demonstrate that the direct effect of N fertilizer on microbial activity can exceed the indirect effects of N fertilizer via large changes in NPP that alter organic matter inputs, soil temperature and moisture content. The magnitude of this effect and specificity to NH+4-N has significant implications for fertilizer management as well as the measurement and modeling of agroecosystem N dynamics including FNUE.

Mulvaney, R. L., S. A. Khan, and T. R. Ellsworth. “Synthetic Nitrogen Fertilizers Deplete Soil Nitrogen: A Global Dilemma for Sustainable Cereal Production.” *Journal of Environmental Quality* 38 (2009): 2295-2314.

Cereal production that now sustains a world population of more than 6.5 billion has tripled during the past 40 yr, concurrent with an increase from 12 to 104 Tg yr−1 of synthetic N applied largely in ammoniacal fertilizers. These fertilizers have been managed as a cost-effective form of insurance against low yields, without regard to the inherent effect of mineral N in promoting microbial C utilization. Such an effect is consistent with a net loss of soil organic C recently observed for the Morrow Plots, America’s oldest experiment field, after 40 to 50 yr of synthetic N fertilization that substantially exceeded grain N removal. A similar decline in total soil N is reported herein for the same site and would be expected from the predominantly organic occurrence of soil N. This decline is in agreement with numerous long-term baseline data sets from chemical-based cropping systems involving a wide variety of soils, geographic regions, and tillage practices. The loss of organic N decreases soil productivity and the agronomic efficiency (kg grain kg−1 N) of fertilizer N and has been implicated in widespread reports of yield stagnation or even decline for grain production in Asia. A major global evaluation of current cereal production systems should be undertaken, with a view toward using scientific and technological advances to increase input efficiencies. As one aspect of this strategy, the input of ammoniacal N should be more accurately matched to crop N requirement. Long-term sustainability may require agricultural diversification involving a gradual transition from intensive synthetic N inputs to legume-based crop rotations.

Mulvaney, R. L., S. A. Khan, and T. R. Ellsworth. “Reply to Comments on: Synthetic Nitrogen Fertilizers Deplete Soil Nitrogen: A Global Dilemma for Sustainable Cereal Production.” *Journal of Environmental Quality* 39 (2010): 753-756.

The focus of this article is the reply to the contrasting perspective on the work that was done to evaluate how synthetic N fertilization has affected soil storage of organic carbon and nitrogen. It further elaborates on the experimental conditions and the long and short term impacts on the use of synthetic N fertilizers.

Rapisarda, P., et al. "Nitrogen metabolism components as a tool to discriminate between organic and conventional citrus fruits." *Journal of Agriculture and Food Chemistry* 53 (2005: 7): 2664-2669.

The aim of this work was to develop a method for authenticity control of organically grown orange fruits. Due to the different kinds of nitrogen fertilization of the soil in organically and conventionally managed farms, the study tried to verify the possibility to differentiate Navelina and Tarocco orange fruits obtained by these production systems through the detection of markers linked to nitrogen metabolism. In addition to the classic quality parameters, total nitrogen (N) and synephrine contents in juice and (15)N/(14)N isotope ratio (expressed as delta(15)N per thousand) in proteins of pulp and amino acids of juice were determined. The results obtained indicated that total N and synephrine contents were significantly higher in conventional fruits, whereas the delta(15)N per thousand values were higher in the organic ones. The new markers identified in this research by linear discriminant analysis of the data may constitute a useful tool to differentiate organic citrus fruits or juices from conventional ones.

Reeve, J. R., et al. "Influence of biodynamic preparations on compost development and resultant compost extracts on wheat seedling growth." *Bioresource Technology* 101 (2010: 14): 5658-5666.

> Biodynamic (BD) agriculture, a form of organic agriculture, includes the use of specially fermented preparations, but peer-reviewed studies on their efficacy are rare. Composting of a grape pomace and manure mixture was studied in two years (2002 and 2005) with and without the BD compost preparations. Water extracts of finished composts were then used to fertigate wheat seedlings, with and without added inorganic fertilizer. BD-treated mixtures had significantly greater dehydrogenase activity than did untreated (control) mixtures during composting, suggesting greater microbial activity in BD-treated compost. In both years there was a distinct compost effect on wheat shoot and root biomass irrespective of supplemental fertilizer. Shoot biomass was highest in all treatments receiving 1% compost extract. Wheat seedlings that received 1% compost extract in 2005 grew similar root and shoot biomass as fertilized seedlings, despite only containing 30% as much nitrogen as the fertilizer treatment. In both years seedlings that received fertilizer plus 1% compost extract produced 22-61% more shoot biomass and 40-66% more root biomass than seedlings that received fertilizer alone, even at higher rates. In 2002 a 1% extract of BD compost grew 7% taller wheat seedlings than did 1% extract of untreated compost. At 0.1% only BD extract grew taller plants than water, but in 2002 only. No effect on shoot or root biomass was seen at 0.1%. Our results support the use of compost extracts as fertilizer substitutes or supplements, testimonial reports on the growth promoting effects of compost extracts, and the occasional superiority of BD compost to untreated compost.

Reeve, J. R., et al. "Effects of soil type and farm management on soil ecological functional genes and microbial activities." *The ISME Journal* 4 (2010: 9): 1099-1107.

> Relationships between soil microbial diversity and soil function are the subject of much debate. Process-level analyses have shown that microbial function varies with soil type and responds to soil management. However, such measurements cannot determine the role of community structure and diversity in soil function. The goal of this study was to investigate the role of gene frequency and diversity, measured by microarray analysis, on soil processes. The study was conducted in an agro-ecosystem characterized by contrasting management practices and soil types. Eight pairs of adjacent commercial organic and conventional strawberry fields were matched for soil type, strawberry variety, and all other environmental conditions. Soil physical, chemical and biological analyses were conducted including functional gene microarrays (FGA). Soil physical and chemical characteristics were primarily determined by soil textural type (coarse vs fine-textured), but biological and FGA measures were more influenced by management (organic vs conventional). Organically managed soils consistently showed greater functional activity as well as FGA signal intensity (SI) and diversity. Overall FGA SI and diversity were correlated to total soil microbial biomass. Functional gene group SI and/or diversity were correlated to related soil chemical and biological measures such as microbial biomass, cellulose, dehydrogenase, ammonium and sulfur. Management was the dominant determinant of soil biology as measured by microbial gene frequency and diversity, which paralleled measured microbial processes.

Robertson, G. P., et al. "Nitrogen–climate interactions in US agriculture." *Biogeochemistry* 114 (2013): 41-70.

> Agriculture in the United States (US) cycles large quantities of nitrogen (N) to produce food, fuel, and fiber and is a major source of excess reactive nitrogen (Nr) in the environment. Nitrogen lost from cropping systems and animal operations moves to waterways, groundwater, and the atmosphere. Changes in climate and climate variability may further affect the ability of agricultural systems to conserve N. The N that escapes affects climate directly through the emissions of nitrous oxide (N2O), and indirectly through the loss of nitrate (NO3 -), nitrogen oxides (NOx) and ammonia to downstream and downwind ecosystems that then emit some of the N received as N2O and NOx. Emissions of NOx lead to the formation of tropospheric ozone, a greenhouse gas that can also harm crops directly. There are many opportunities to mitigate the impact of

agricultural N on climate and the impact of climate on agricultural N. Some are available today; many need further research; and all await effective incentives to become adopted. Research needs can be grouped into four major categories: (1) an improved understanding of agricultural N cycle responses to changing climate; (2) a systems-level understanding of important crop and animal systems sufficient to identify key interactions and feedbacks; (3) the further development and testing of quantitative models capable of predicting N-climate interactions with confidence across a wide variety of crop-soil-climate combinations; and (4) socioecological research to better understand the incentives necessary to achieve meaningful deployment of realistic solutions.

Savci, S. "Investigation of Effect of Chemical Fertilizers on Environment." *APCBEE Procedia* 1 (2012): 287-292.

Consumer society, in order to meet the growing need for food, agricultural land per unit area required to achieve maximum efficiency and highest quality product. It is known that the nutrition of the plant is the one of the most important factors to control agricultural productivity and quality. Rates of nutrients in the soil affects the quality of yield. In the permanent agricultural land, the soil will be very poor in nutrients, as a result, inefficient. Therefore, producers, fertilize the soil, combat pests, irrigation and process of agricultural activities to make more efficient to soil. Fertilization among these activities remains a priority at all times. Recent studies, however, excessive use of fertilizers is the need for additional land outside the public and environmental health of the reported adverse affects. Excessive fertilization and mindless, but there were soil salinity, heavy metal accumulation, water eutrophication and accumulation of nitrate, to consider in terms of air pollution in the air of gases containing nitrogen and sulfur, giving and can lead to problems such as the greenhouse effect. In this review, aims to reveal environmental and health problems caused by improper fertilization provides recommendation toward solving these problems.

Varis, E., et al. "Comparison of conventional, integrated and organic potato production in field experiments in Finland." *Acta Agriculturae Scandinavica. Section B, Soil and Plant Science*. 46 (1996: 1): 41-48.

The results of field trials on reduced chemical inputs for potato production carried out at the Potato Research Institute, Lammi, Finland, during 1987-90 are reported. The main plots in a split-plot designed trial series consisted of three cropping systems: conventional, integrated and organic. The subplots included three cultivars differing especially in their late blight (Phytophthora infestans) resistance: Bintje, Record and Matilda. Canopy measurements showed differences that could be attributed to different nitrogen supply in decreasing order from conventional to integrated to organic system. The trial sites were very heavily infested with potato scab, resulting in a very low percentage of I-class yield in susceptible cultivars Bintje and Matilda. Late blight was a serious problem in organically grown Bintje, as expected. Total yields in the integrated and organic systems were 10% and 36% lower, respectively, than in the conventional system. There was an interaction between cropping system and cultivar in favour of Bintje and the conventional system and Record in the organic system. The percentage of I-class yield was lowest in the conventional system. Some of the quality characteristics were slightly improved in the integrated and/or organic systems. Storage losses, caused mainly by tuber blight, were high in organically grown potatoes. There were no large differences in production costs between the cropping systems. The main determinants of the unit production cost of potatoes were total yield and yield of I-class potatoes. The average unit costs were 1.76 FIM kg-1 in the conventional, 1.68 FIM kg-1 in the integrated and 2.36 FIM kg-1 in the organic system. Record showed the lowest unit production costs in all systems: 1.33, 1.37 and 1.80 FIM kg-1, respectively.

Wang, S. Y. and H. S. Lin. "Compost as a soil supplement increases the level of antioxidant compounds and oxygen radical absorbance capacity in strawberries." *Journal of Agriculture and Food Chemistry* 51 (2003: 23): 6844-6850.

Compost as a soil supplement significantly enhanced levels of ascorbic acid (AsA) and glutathione (GSH) and ratios of AsA/dehydroascorbic acid (DHAsA) and GSH/oxidized

> glutathione (GSSG) in fruit of two strawberry (Fragaria x ananassa Duch.) cultivars, Allstar and Honeoye. The peroxyl radical (ROO(*)) as well as the superoxide radical (O(2)(*)(-)), hydrogen peroxide (H(2)O(2)), hydroxyl radical (OH(*)), and singlet oxygen ((1)O(2)) absorbance capacity in strawberries increased significantly with increasing fertilizer strength and compost use. The planting medium (compost) x fertilizer interaction for phenolics and flavonoids was significant. Fruit from plants grown in full-strength fertilizer with 50% soil plus 50% compost and 100% compost yielded fruit with the highest levels of phenolics, flavonol, and anthocyanin content. A positive relationship between antioxidant activities and contents of AsA and GSH and ratios of AsA/DHAsA and GSH/GSSG existed in fruit of both strawberry cultivars. Correlation coefficients for the content of antioxidant components versus antioxidant activity [against ROO(*), O(2)(*)(-), H(2)O(2), OH(*), or (1)O(2)] ranged from r( )()= 0.7706 for H(2)O(2) versus GSH/GSSH in cv. Allstar to r = 0.9832 for O(2)(*)(-) versus total flavonoids in cv. Allstar.

Part 2: Effects on human health

As discussed in Section B11, Material Safety Data Sheets for some examples of Ammonia Extract materials are included in Appendix G.

Ammonia is a toxic material that can cause death. It can cause severe irritation of the nose and throat and life-threatening accumulation of fluid in the lungs (pulmonary edema). Symptoms may include coughing, shortness of breath, difficult breathing and tightness in the chest. Symptoms may develop hours after exposure and are made worse by physical effort. Long-term damage may result from a severe short-term exposure.

The gas irritates or burns the skin. Permanent scarring can result. Direct contact with the liquefied gas can chill or freeze the skin (frostbite). Symptoms of more severe frostbite include a burning sensation and stiffness. The skin may become waxy white or yellow. Blistering, tissue death and infection may develop in severe cases.

The gas irritates or burns the eyes. Permanent damage including blindness can result. Direct contact with the liquefied gas can freeze the eye. Permanent eye damage or blindness can result.

Effects of long-term (chronic) exposure may harm the respiratory system. It can irritate and inflame the airways.

Appendix E

MANUFACTURERS OF MATERIAL ADDRESSED IN THE PETITION

We are aware of several manufacturers of Ammonium Extract products. These manufacturers are listed here, with the understanding that our listing must not be construed to represent the entire set of companies producing products containing Ammonium Extract.

Biostar Perfect Blend, LLC
Dba/ Perfect Blend Organics
10900 N.E., 8th St., Suite 615
Bellevue, WA 98004
Phone: 425-456-8890

Farm Nutrients
4949 Hwy 71
Rembrandt, IA 50576
Phone: (712) 286-5700

California Organic Fertilizers, Inc. (application submitted to an MRO)
7600 N. Ingram Ave., Suite 121
Fresno, CA 93711
Phone: 800- 269-5690

As discussed in Section B7, there is one brand name product that has been approved by an MRO that is an example of the material that is the subject of this petition. The label for this MRO-listed brand name product is included on the following page:

BioStar Organics

PERFECT ORGANICS BLEND

OMRI LISTED
For Organic Use

Perfect Blend
SuperSix Plus 6-0-0
Liquid Organic Fertilizer

Guaranteed Analysis

Total Nitrogen........................6.00%

Ammoniacal N............5.6%

Other soluble N..........0.01%

Other insoluble N.......0.39%

Available Phosphate (P2O5) .... <0.10%

Soluble Potash (K2O) .... <0.10%

Physical Properties

Consult your crop advisor prior to use. This product is an organic liquid and contains suspended solids. Store in a cool, dry location and agitate well prior to use.

Derived from Chicken Manure

Information regarding the contents and levels of metals in this product is available on the internet at **http://www.aapfco.org/metals.htm**

Pounds per Gallon..............9.3 @ 68°F

Perfect Blend LLC and BioStar Organics warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used according to the directions. Seller and manufacturer make no other warranties, expressed or implied. Buyer assumes responsibility and risks associated with product use.

Lot No.________

Manufactured by:
Perfect Blend, LLC
Dba/ Perfect Blend Organics
10900 N.E., 8th St., Suite 615
Bellevue, WA 98004

Appendix F

REFERENCES CITED AND USED — EXCEPTING LIST OF ARTICLES IN APPENDIX D, WHICH ARE REFERENCED THERE

Berry, Wendell, 1976, "Where Cities and Farms come Together". Chapter 2 in Radical Agriculture, p14. Harper Colophon Books

Bradley, F. M. and B. W. Ellis, editors. “Fertilizers.” Rodale’s All-New Encyclopedia of Organic Gardening. Emmaus, Pennsylvania, Rodale Press: 223-228. (1992). Hodgman, C. D., et al., Eds. CRC Handbook of Chemistry and Physics. CRC Press, (1959).

Fertilizer Institute. “Fertilizer Product Fact Sheet: Ammonia.” tfi.org. The Fertilizer Institute, undated. Web.

Gershuny, Grace; Smille, Joseph 1999 (4th ed.). The Soul of Soil. Chelsea Green Publishing

Huffstutter, P. J. “Organic fertilizer maker accused of using synthetic chemicals.” *Los Angeles Times* March, 11, 2011. Web.

Kim, Soo “California Fertilizer Manufacturer Pleads Guilty to Fraudulently Selling.” ams.usda.gov Agricultural Marketing Service, U.S. Department of Agriculture, AMS No. 070-12Web.

Leahy, Patrick. “S.2830 - Food, Agriculture, Conservation, and Trade Act of 1990.” congress.gov. Library of Congress. 1990. Web.

Merrill, Richard 1976. "Toward a Self Sustaining Agriculture". Chapter 16 in Radical Agriculture, pp298-300 Harper Colophon Books.

Mukome, F. N. D., T. A. Doane, L. C. R. Silva, S. J. Parikh and W. R. Horvath. “Testing protocol ensures the authenticity of organic fertilizers.” *California Agriculture* 67 (2013: 4): 210-216.

NCBI. “National Center for Biotechnology Information.” ncbi.nim.hig.gov, U.S. National Library of Medicine. Web.

OMRI. “Out of Scope and Beyond Resolution.” OMRI.org. Organic Materials Review Institute, undated. Web.

OTA. “How is organic food grown?” OTA.org. Organic Trade Association, undated. Web.

Pfeiffer, E.1983. Soil Fertility, the Lanthorn Press

Rodale. “Organic vs. Conventional Farming.” rodaleinstitute.org. Rodale Institute, undated. Web.

USDA, 1938, Soils and Men - Yearbook of Agriculture 1938. US Government Printing Office.

Appendix G

MATERIAL SAFETY DATA SHEETS

Please refer to the MSDS information provided on the following pages of this petition.

Part 1: Ammonium Hydroxide—8 pages

Part 2: Ammonium Citrate Dibasic—7 pages

Part 3: Ammonium Sulfate—7 pages

Part 4: Ammonia—11 pages

ThermoFisher
SCIENTIFIC

SAFETY DATA SHEET

Creation Date 23-Nov-2009 **Revision Date** 25-Apr-2019 **Revision Number** 7

1. Identification

Product Name	**Ammonium hydroxide**
Cat No. :	**A667-212, A669-212, A669-500, A669P-500; A669-612GAL, A669-385LB, A669C-212, A669S-212, A669S-212EA, A669S-500; NC1020689**
Synonyms	Ammonia solution; Ammonia water; Ammonium hydrate
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Skin Corrosion/irritation	Category 1 B
Serious Eye Damage/Eye Irritation	Category 1
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Danger

Hazard Statements
Causes severe skin burns and eye damage
May cause respiratory irritation

Precautionary Statements
Prevention
Do not breathe dust/fume/gas/mist/vapors/spray
Wash face, hands and any exposed skin thoroughly after handling
Wear protective gloves/protective clothing/eye protection/face protection
Use only outdoors or in a well-ventilated area
Response
Immediately call a POISON CENTER or doctor/physician
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Skin
IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower
Wash contaminated clothing before reuse
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
Ingestion
IF SWALLOWED: Rinse mouth. DO NOT induce vomiting
Storage
Store locked up
Store in a well-ventilated place. Keep container tightly closed
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
Very toxic to aquatic life

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Water	7732-18-5	70-75
Ammonium hydroxide	1336-21-6	25-30
Ammonia	7664-41-7	-

4. First-aid measures

General Advice	Immediate medical attention is required. Show this safety data sheet to the doctor in attendance.
Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Immediate medical attention is required.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Immediate medical attention is required.
Inhalation	Move to fresh air. If breathing is difficult, give oxygen. Do not use mouth-to-mouth method if victim ingested or inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Immediate medical attention is required.
Ingestion	Do not induce vomiting. Call a physician or Poison Control Centre immediately.

Most important symptoms and effects	Causes burns by all exposure routes. . Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	CO_2, dry chemical, dry sand, alcohol-resistant foam. Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.
Unsuitable Extinguishing Media	No information available
Flash Point	No information available
Method -	No information available
Autoignition Temperature	651 °C / 1203.8 °F
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical

Keep product and empty container away from heat and sources of ignition. Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products

Nitrogen oxides (NOx)

Protective Equipment and Precautions for Firefighters

As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. Thermal decomposition can lead to release of irritating gases and vapors.

NFPA

Health	Flammability	Instability	Physical hazards
3	1	0	N/A

6. Accidental release measures

Personal Precautions	Ensure adequate ventilation. Use personal protective equipment. Keep people away from and upwind of spill/leak. Evacuate personnel to safe areas. Avoid contact with skin, eyes and inhalation of vapors.
Environmental Precautions	Should not be released into the environment. Keep out of waterways. Collect spillage. See Section 12 for additional ecological information.
Methods for Containment and Clean Up	Soak up with inert absorbent material. Keep in suitable, closed containers for disposal.

7. Handling and storage

Handling	Use only under a chemical fume hood. Wear personal protective equipment. Do not get in eyes, on skin, or on clothing. Do not ingest. Do not breathe vapors or spray mist.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place. Corrosives area.

8. Exposure controls / personal protection

Exposure Guidelines	This product does not contain any hazardous materials with occupational exposure limitsestablished by the region specific regulatory bodies.

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Ammonia	TWA: 25 ppm STEL: 35 ppm	(Vacated) STEL: 35 ppm (Vacated) STEL: 27 mg/m^3 TWA: 50 ppm TWA: 35 mg/m^3	IDLH: 300 ppm TWA: 25 ppm TWA: 18 mg/m^3 STEL: 35 ppm STEL: 27 mg/m^3	TWA: 25 ppm STEL: 35 ppm

Engineering Measures	Use only under a chemical fume hood. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166. Tightly fitting safety goggles. Face-shield.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure. Long sleeved clothing.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Liquid
Appearance	Colorless
Odor	Ammonia-like
Odor Threshold	No information available
pH	12
Melting Point/Range	-57 °C / -70.6 °F
Boiling Point/Range	38 °C / 100.4 °F
Flash Point	No information available
Evaporation Rate	No information available
Flammability (solid,gas)	Not applicable
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	500 hPa @ 20 °C
Vapor Density	0.59
Specific Gravity	0.88-0.91
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	651 °C / 1203.8 °F
Decomposition Temperature	No information available
Viscosity	No information available

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Incompatible products. Excess heat.
Incompatible Materials	Strong oxidizing agents, Metals, Acids, Fluorine, Halogens

Hazardous Decomposition Products	Nitrogen oxides (NOx)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information

Oral LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Dermal LD50	Based on ATE data, the classification criteria are not met. ATE > 2000 mg/kg.
Vapor LC50	Based on ATE data, the classification criteria are not met. ATE > 20 mg/l.

Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Water	-	Not listed	Not listed
Ammonium hydroxide	-	Not listed	Not listed
Ammonia	LD50 = 350 mg/kg (Rat)	Not listed	LC50 = 2000 ppm (Rat) 4 h

Toxicologically Synergistic Products	No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation	Causes burns by all exposure routes
Sensitization	No information available
Carcinogenicity	The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Water	7732-18-5	Not listed	Not listed	Not listed	Not listed	Not listed
Ammonium hydroxide	1336-21-6	Not listed	Not listed	Not listed	Not listed	Not listed
Ammonia	7664-41-7	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects	No information available
Reproductive Effects	No information available.
Developmental Effects	No information available.
Teratogenicity	No information available.
STOT - single exposure	Respiratory system
STOT - repeated exposure	None known
Aspiration hazard	No information available
Symptoms / effects,both acute and delayed	Ingestion causes severe swelling, severe damage to the delicate tissue and danger of perforation: Product is a corrosive material. Use of gastric lavage or emesis is contraindicated. Possible perforation of stomach or esophagus should be investigated
Endocrine Disruptor Information	No information available
Other Adverse Effects	The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity

Very toxic to aquatic organisms. The product contains following substances which are hazardous for the environment.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Ammonium hydroxide	-	0.53 mg/l LC50 96h	-	EC50: 0.66 mg/L/48h

		0.75 - 3.4 mg/l LC50 96h 8.2 mg/L LC50 96h		
Ammonia	Not listed	LC50: > 1.5 mg/L, 96h (Poecilia reticulata) LC50: = 5.9 mg/L, 96h static (Pimephales promelas) LC50: 0.73 - 2.35 mg/L, 96h (Pimephales promelas) LC50: = 1.17 mg/L, 96h flow-through (Lepomis macrochirus) LC50: 0.26 - 4.6 mg/L, 96h (Lepomis macrochirus) LC50: = 0.44 mg/L, 96h (Cyprinus carpio) LC50: = 1.19 mg/L, 96h static (Poecilia reticulata)	EC50 = 2.0 mg/L 5 min	EC50 = 25.4 mg/L 48h

Persistence and Degradability	Persistence is unlikely based on information available.
Bioaccumulation/ Accumulation	No information available.
Mobility	No information available.

Component	log Pow
Ammonia	-1.14

13. Disposal considerations

Waste Disposal Methods	Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT	
UN-No	UN2672
Proper Shipping Name	AMMONIA SOLUTIONS
Hazard Class	8
Packing Group	III
TDG	
UN-No	UN2672
Proper Shipping Name	AMMONIA SOLUTIONS
Hazard Class	8
Packing Group	III
IATA	
UN-No	UN2672
Proper Shipping Name	AMMONIA SOLUTION
Hazard Class	8
Packing Group	III
IMDG/IMO	
UN-No	UN2672
Proper Shipping Name	AMMONIA SOLUTION
Hazard Class	8
Packing Group	III

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Water	7732-18-5	X	ACTIVE	-
Ammonium hydroxide	1336-21-6	X	ACTIVE	-

Ammonia	7664-41-7	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories

Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Water	7732-18-5	X	-	231-791-2	X	-	X	X	KE-35400
Ammonium hydroxide	1336-21-6	X	-	215-647-6	X	X	X	X	KE-01688
Ammonia	7664-41-7	X	-	231-635-3	X	X	X	X	KE-01625

U.S. Federal Regulations

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Ammonium hydroxide	1336-21-6	25-30	1.0
Ammonia	7664-41-7	-	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Ammonium hydroxide	X	1000 lb	-	-
Ammonia	X	100 lb	-	-

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration Not applicable

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Ammonia	-	TQ: 10000 lb TQ: 15000 lb

CERCLA This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302)

Component	Hazardous Substances RQs	CERCLA EHS RQs
Ammonium hydroxide	1000 lb	-
Ammonia	100 lb	100 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Water	-	-	X	-	-
Ammonium hydroxide	X	X	X	-	-
Ammonia	X	X	X	-	X

U.S. Department of Transportation
Reportable Quantity (RQ): Y

DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security

This product contains the following DHS chemicals:
Legend - STQs = Screening Threshold Quantities, APA = A placarded amount

Component	DHS Chemical Facility Anti-Terrorism Standard
Ammonia	Release STQs - 10000lb (anhydrous) Release STQs - 20000lb (concentration >=20%)

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By	Regulatory Affairs Thermo Fisher Scientific Email: EMSDS.RA@thermofisher.com
Creation Date	23-Nov-2009
Revision Date	25-Apr-2019
Print Date	25-Apr-2019
Revision Summary	This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

ThermoFisher
SCIENTIFIC

SAFETY DATA SHEET

Creation Date 07-May-2014 **Revision Date** 25-Apr-2019 **Revision Number** 5

1. Identification

Product Name	**Ammonium Citrate Dibasic (Certified ACS)**
Cat No. :	**A663-212; A663-500**
CAS-No	3012-65-5
Synonyms	Ammonium monohydrogen citrate; Citric acid diammonium salt; Diammonium citrate
Recommended Use	Laboratory chemicals.
Uses advised against	Food, drug, pesticide or biocidal product use

Details of the supplier of the safety data sheet

Company
Fisher Scientific
One Reagent Lane
Fair Lawn, NJ 07410
Tel: (201) 796-7100

Emergency Telephone Number
CHEMTREC®, Inside the USA: 800-424-9300
CHEMTREC®, Outside the USA: 001-703-527-3887

2. Hazard(s) identification

Classification
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Serious Eye Damage/Eye Irritation	Category 2
Specific target organ toxicity (single exposure)	Category 3
Target Organs - Respiratory system.	

Label Elements

Signal Word
Warning

Hazard Statements
Causes serious eye irritation
May cause respiratory irritation

Precautionary Statements
Prevention
Wash face, hands and any exposed skin thoroughly after handling
Wear eye/face protection
Avoid breathing dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
Inhalation
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Call a POISON CENTER or doctor/physician if you feel unwell
Eyes
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
If eye irritation persists: Get medical advice/attention
Storage
Store in a well-ventilated place. Keep container tightly closed
Store locked up
Disposal
Dispose of contents/container to an approved waste disposal plant
Hazards not otherwise classified (HNOC)
None identified

3. Composition/Information on Ingredients

Component	CAS-No	Weight %
Ammonium citrate, dibasic	3012-65-5	100
Ammonia	7664-41-7	-

4. First-aid measures

Eye Contact	Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. Get medical attention.
Skin Contact	Wash off immediately with plenty of water for at least 15 minutes. Get medical attention if symptoms occur.
Inhalation	Move to fresh air. Obtain medical attention. If not breathing, give artificial respiration.
Ingestion	Do not induce vomiting. Obtain medical attention.
Most important symptoms and effects	No information available.
Notes to Physician	Treat symptomatically

5. Fire-fighting measures

Suitable Extinguishing Media	Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.
Unsuitable Extinguishing Media	No information available
Flash Point	Not applicable

Method -	No information available
Autoignition Temperature	No information available
Explosion Limits	
Upper	No data available
Lower	No data available
Sensitivity to Mechanical Impact	No information available
Sensitivity to Static Discharge	No information available

Specific Hazards Arising from the Chemical
Thermal decomposition can lead to release of irritating gases and vapors.

Hazardous Combustion Products
Nitrogen oxides (NOx) Carbon monoxide (CO) Carbon dioxide (CO_2)
Protective Equipment and Precautions for Firefighters
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

NFPA

Health	Flammability	Instability	Physical hazards
2	0	0	N/A

6. Accidental release measures

Personal Precautions	Use personal protective equipment. Ensure adequate ventilation. Avoid dust formation. Avoid contact with skin, eyes and clothing.
Environmental Precautions	Avoid release to the environment. See Section 12 for additional ecological information.
Methods for Containment and Clean Up	Sweep up or vacuum up spillage and collect in suitable container for disposal. Avoid dust formation.

7. Handling and storage

Handling	Wear personal protective equipment. Ensure adequate ventilation. Avoid dust formation. Avoid contact with skin, eyes and clothing. Avoid ingestion and inhalation.
Storage	Keep containers tightly closed in a dry, cool and well-ventilated place.

8. Exposure controls / personal protection

Exposure Guidelines

Component	ACGIH TLV	OSHA PEL	NIOSH IDLH	Mexico OEL (TWA)
Ammonia	TWA: 25 ppm STEL: 35 ppm	(Vacated) STEL: 35 ppm (Vacated) STEL: 27 mg/m^3 TWA: 50 ppm TWA: 35 mg/m^3	IDLH: 300 ppm TWA: 25 ppm TWA: 18 mg/m^3 STEL: 35 ppm STEL: 27 mg/m^3	TWA: 25 ppm STEL: 35 ppm

Legend

***ACGIH** - American Conference of Governmental Industrial Hygienists*
***OSHA** - Occupational Safety and Health Administration*
***NIOSH IDLH:** The National Institute for Occupational Safety and Health Immediately Dangerous to Life or Health*

Engineering Measures	Ensure adequate ventilation, especially in confined areas. Ensure that eyewash stations and safety showers are close to the workstation location.

Personal Protective Equipment

Eye/face Protection	Wear appropriate protective eyeglasses or chemical safety goggles as described by

	OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin and body protection	Wear appropriate protective gloves and clothing to prevent skin exposure.
Respiratory Protection	Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.
Hygiene Measures	Handle in accordance with good industrial hygiene and safety practice.

9. Physical and chemical properties

Physical State	Solid
Appearance	White
Odor	Ammonia-like
Odor Threshold	No information available
pH	4.8 - 5.3 (5 %)
Melting Point/Range	No data available
Boiling Point/Range	No information available
Flash Point	Not applicable
Evaporation Rate	No information available
Flammability (solid,gas)	No information available
Flammability or explosive limits	
Upper	No data available
Lower	No data available
Vapor Pressure	No information available
Vapor Density	No information available
Specific Gravity	1.5
Solubility	Soluble in water
Partition coefficient; n-octanol/water	No data available
Autoignition Temperature	No information available
Decomposition Temperature	No information available
Viscosity	No information available
Molecular Formula	$(NH_4)_2C_6H_6O_7$
Molecular Weight	226.11

10. Stability and reactivity

Reactive Hazard	None known, based on information available
Stability	Stable under normal conditions.
Conditions to Avoid	Avoid dust formation. Incompatible products. Excess heat.
Incompatible Materials	Strong oxidizing agents
Hazardous Decomposition Products	Nitrogen oxides (NOx), Carbon monoxide (CO), Carbon dioxide (CO_2)
Hazardous Polymerization	Hazardous polymerization does not occur.
Hazardous Reactions	None under normal processing.

11. Toxicological information

Acute Toxicity

Product Information
Component Information

Component	LD50 Oral	LD50 Dermal	LC50 Inhalation
Ammonia	LD50 = 350 mg/kg (Rat)	Not listed	LC50 = 2000 ppm (Rat) 4 h

Toxicologically Synergistic Products No information available

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Irritation Irritating to eyes and respiratory system

Sensitization No information available

Carcinogenicity The table below indicates whether each agency has listed any ingredient as a carcinogen.

Component	CAS-No	IARC	NTP	ACGIH	OSHA	Mexico
Ammonium citrate, dibasic	3012-65-5	Not listed	Not listed	Not listed	Not listed	Not listed
Ammonia	7664-41-7	Not listed	Not listed	Not listed	Not listed	Not listed

Mutagenic Effects No information available

Reproductive Effects No information available.

Developmental Effects No information available.

Teratogenicity No information available.

STOT - single exposure Respiratory system
STOT - repeated exposure None known

Aspiration hazard No information available

Symptoms / effects,both acute and delayed No information available

Endocrine Disruptor Information No information available

Other Adverse Effects The toxicological properties have not been fully investigated.

12. Ecological information

Ecotoxicity
Do not empty into drains.

Component	Freshwater Algae	Freshwater Fish	Microtox	Water Flea
Ammonia	Not listed	LC50: > 1.5 mg/L, 96h (Poecilia reticulata) LC50: = 5.9 mg/L, 96h static (Pimephales promelas) LC50: 0.73 - 2.35 mg/L, 96h (Pimephales promelas) LC50: = 1.17 mg/L, 96h flow-through (Lepomis macrochirus) LC50: 0.26 - 4.6 mg/L, 96h (Lepomis macrochirus) LC50: = 0.44 mg/L, 96h (Cyprinus carpio) LC50: = 1.19 mg/L, 96h static (Poecilia reticulata)	EC50 = 2.0 mg/L 5 min	EC50 = 25.4 mg/L 48h

Persistence and Degradability No information available

Bioaccumulation/ Accumulation No information available.

Mobility .

Component	log Pow
Ammonia	-1.14

13. Disposal considerations

Waste Disposal Methods Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. Chemical waste generators must also consult local, regional, and national hazardous waste regulations to ensure complete and accurate classification.

14. Transport information

DOT	Not regulated
TDG	Not regulated
IATA	Not regulated
IMDG/IMO	Not regulated

15. Regulatory information

United States of America Inventory

Component	CAS-No	TSCA	TSCA Inventory notification - Active/Inactive	TSCA - EPA Regulatory Flags
Ammonium citrate, dibasic	3012-65-5	X	ACTIVE	-
Ammonia	7664-41-7	X	ACTIVE	-

Legend:
TSCA - Toxic Substances Control Act, (40 CFR Part 710)
X - Listed
'-' - Not Listed

TSCA 12(b) - Notices of Export Not applicable

International Inventories
Canada (DSL/NDSL), Europe (EINECS/ELINCS/NLP), Philippines (PICCS), Japan (ENCS), Australia (AICS), China (IECSC), Korea (ECL).

Component	CAS-No	DSL	NDSL	EINECS	PICCS	ENCS	AICS	IECSC	KECL
Ammonium citrate, dibasic	3012-65-5	X	-	221-146-3	X	X	X	X	KE-20833
Ammonia	7664-41-7	X	-	231-635-3	X	X	X	X	KE-01625

U.S. Federal Regulations

SARA 313

Component	CAS-No	Weight %	SARA 313 - Threshold Values %
Ammonium citrate, dibasic	3012-65-5	100	1.0
Ammonia	7664-41-7	-	1.0

SARA 311/312 Hazard Categories See section 2 for more information

CWA (Clean Water Act)

Component	CWA - Hazardous Substances	CWA - Reportable Quantities	CWA - Toxic Pollutants	CWA - Priority Pollutants
Ammonium citrate, dibasic	X	5000 lb	-	-
Ammonia	X	100 lb	-	-

Clean Air Act Not applicable

OSHA - Occupational Safety and Health Administration

Component	Specifically Regulated Chemicals	Highly Hazardous Chemicals
Ammonia	-	TQ: 10000 lb TQ: 15000 lb

CERCLA

Component	Hazardous Substances RQs	CERCLA EHS RQs
Ammonium citrate, dibasic	5000 lb	-
Ammonia	100 lb	100 lb

California Proposition 65 This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

Component	Massachusetts	New Jersey	Pennsylvania	Illinois	Rhode Island
Ammonium citrate, dibasic	X	X	X	-	-
Ammonia	X	X	X	-	X

U.S. Department of Transportation

Reportable Quantity (RQ):	N
DOT Marine Pollutant	N
DOT Severe Marine Pollutant	N

U.S. Department of Homeland Security This product contains the following DHS chemicals:
Legend - STQs = Screening Threshold Quantities, APA = A placarded amount

Component	DHS Chemical Facility Anti-Terrorism Standard
Ammonia	Release STQs - 10000lb (anhydrous) Release STQs - 20000lb (concentration >=20%)

Other International Regulations

Mexico - Grade No information available

16. Other information

Prepared By Regulatory Affairs
Thermo Fisher Scientific
Email: EMSDS.RA@thermofisher.com

Creation Date 07-May-2014
Revision Date 25-Apr-2019
Print Date 25-Apr-2019
Revision Summary This document has been updated to comply with the US OSHA HazCom 2012 Standard replacing the current legislation under 29 CFR 1910.1200 to align with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Disclaimer
The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text

End of SDS

Safety Data Sheet

according to 29CFR1910/1200 and GHS Rev. 3

Effective date : 12.28.2014 Page 1 of 7

Ammonium Sulfate,

SECTION 1 : Identification of the substance/mixture and of the supplier

Product name :	**Ammonium Sulfate,**
Manufacturer/Supplier Trade name:	
Manufacturer/Supplier Article number:	**S25176A**

Recommended uses of the product and uses restrictions on use:

Manufacturer Details:

AquaPhoenix Scientific
9 Barnhart Drive, Hanover, PA 17331

Supplier Details:

Fisher Science Education
15 Jet View Drive, Rochester, NY 14624

Emergency telephone number:

Fisher Science Education Emergency Telephone No.: 800-535-5053

SECTION 2 : Hazards identification

Classification of the substance or mixture:

Irritant
Skin irritation, category 2
Eye irritation, category 2A
Acute toxicity (oral, dermal, inhalation), category 3

Eye irrit. cat 2
Skin Sens, cat 2
STOT SE 3
AcTox Oral 4
Hazards Not Otherwise Classified - Combustible Dust

Signal word :Warning

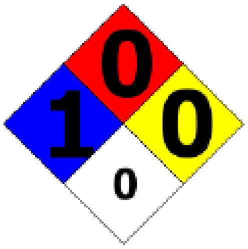
Hazard statements:
Harmful if swallowed
Causes skin irritation
Causes serious eye irritation
May cause respiratory irritation
Precautionary statements:
Wash ... thoroughly after handling
Do not eat, drink or smoke when using this product
Avoid breathing dust/fume/gas/mist/vapours/spray
Use only outdoors or in a well-ventilated area
Wear protective gloves/protective clothing/eye protection/face protection
Specific treatment (see supplemental first aid instructions on this label)
Rinse mouth
Take off contaminated clothing and wash before reuse
IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell
IF ON SKIN: Wash with soap and water
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing

If skin irritation occurs: Get medical advice/attention
If eye irritation persists get medical advice/attention
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses if present and easy to do.
Continue rinsing
Store locked up
Store in a well ventilated place. Keep container tightly closed
Dispose of contents/container to ...

Combustible Dust Hazard: :
May form combustible dust concentrations in air (during processing).

Other Non-GHS Classification:

WHMIS
NFPA/HMIS



NFPA SCALE (0-4)

Health	1
Flammability	0
Physical Hazard	0
Personal Protection	X

HMIS RATINGS (0-4)

SECTION 3 : Composition/information on ingredients

Ingredients:		
CAS 7783-20-2	Ammonium Sulfate,ACS	>95 %
		Percentages are by weight

SECTION 4 : First aid measures

Description of first aid measures

After inhalation: Move exposed individual to fresh air. Loosen clothing as necessary and position individual in a comfortable position.Seek medical advice if discomfort or irritation persists.If breathing difficult, give oxygen.

After skin contact: Wash affected area with soap and water. Rinse/flush exposed skin gently using water for 15-20 minutes. Seek medical advice if discomfort or irritation persists.

After eye contact: Protect unexposed eye. Rinse/flush exposed eye(s) gently using water for 15-20 minutes. Remove contact lens(es) if able to do so during rinsing. Seek medical attention if irritation persists or if concerned.

After swallowing: Rinse mouth thoroughly. Do not induce vomiting. Have exposed individual drink sips of water. Seek medical attention if irritation, discomfort or vomiting persists.

Most important symptoms and effects, both acute and delayed:

Irritation, Nausea,Headache, Shortness of breath.;

Indication of any immediate medical attention and special treatment needed:

If seeking medical attention, provide SDS document to physician.

SECTION 5 : Firefighting measures

Extinguishing media

Suitable extinguishing agents: If in laboratory setting, follow laboratory fire suppression procedures. Use appropriate fire suppression agents for adjacent combustible materials or sources of ignition

For safety reasons unsuitable extinguishing agents:

Special hazards arising from the substance or mixture:

Combustion products may include carbon oxides or other toxic vapors.Thermal decomposition can lead to release of irritating gases and vapors.Avoid generating dust; fine dust dispersed in air in sufficient concentrations, and in the presence of an ignition source is a potential dust explosion hazard.

Advice for firefighters:

Protective equipment: Use NIOSH-approved respiratory protection/breathing apparatus.

Additional information (precautions): Move product containers away from fire or keep cool with water spray as a protective measure, where feasible.Use spark-proof tools and explosion-proof equipment.

SECTION 6 : Accidental release measures

Personal precautions, protective equipment and emergency procedures:

Wear protective equipment. Transfer to a disposal or recovery container.Use spark-proof tools and explosion-proof equipment.Use respiratory protective device against the effects of fumes/dust/aerosol. Keep unprotected persons away. Ensure adequate ventilation.Keep away from ignition sources. Protect from heat.Stop the spill, if possible. Contain spilled material by diking or using inert absorbent.

Environmental precautions:

Prevent from reaching drains, sewer or waterway. Collect contaminated soil for characterization per Section 13

Methods and material for containment and cleaning up:

If in a laboratory setting, follow Chemical Hygiene Plan procedures.Place into properly labeled containers for recovery or disposal. If necessary, use trained response staff/contractor.Dust deposits should not be allowed to accumulate on surfaces, as these may form an explosive mixture if they are released into the atmosphere in sufficient concentration. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air). Collect solids in powder form using vacuum with (HEPA filter)

Reference to other sections:

SECTION 7 : Handling and storage

Precautions for safe handling:

Minimize dust generation and accumulation. Wash hands after handling. Avoid dispersal of dust in the air (i.e., clearing dust surfaces with compressed air). Routine housekeeping should be instituted to ensure that dusts do not accumulate on surfaces. Dry powders can build static electricity charges when subjected to the friction of transfer and mixing operations. Follow good hygiene procedures when handling chemical materials. Do not eat, drink, smoke, or use personal products when handling chemical substances. If in a laboratory setting, follow Chemical Hygiene Plan.Use only in well ventilated areas.Avoid generation of dust or fine particulate.Avoid contact with eyes, skin, and clothing.

Conditions for safe storage, including any incompatibilities:

Store in a cool location. Provide ventilation for containers. Avoid storage near extreme heat, ignition sources or open flame. Store away from foodstuffs. Store away from oxidizing agents.Store in cool, dry conditions in well sealed containers. Keep container tightly sealed.Store with like hazards

SECTION 8 : Exposure controls/personal protection

Control Parameters: , , OSHA PEL TWA (Total Dust) 15 mg/m3 (50 mppcf*)
, , ACGIH TLV TWA (inhalable particles) 10 mg/m3

Appropriate Engineering controls: Emergency eye wash fountains and safety showers should be available in the immediate vicinity of use/handling.Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapor or dusts (total/respirable) below the applicable workplace exposure limits (Occupational Exposure Limits-OELs) indicated above.Use under a fume hood. It is recommended that all dust control equipment such as local exhaust ventilation and material transport systems involved in handling of this product contain explosion relief vents or an explosion suppression system or an oxygen deficient environment.Ensure that dust-handling systems (such as exhaust ducts, dust collectors, vessels, and processing equipment) are designed in a manner to prevent the escape of dust into the work area (i.e., there is no leakage from the equipment).

Respiratory protection: Not required under normal conditions of use. Use suitable respiratory protective device when high concentrations are present. Use suitable respiratory protective device when aerosol or mist is formed. For spills, respiratory protection may be advisable.

Protection of skin: The glove material has to be impermeable and resistant to the product/ the substance/ the preparation being used/handled.Selection of the glove material on consideration of the penetration times, rates of diffusion and the degradation.

Eye protection: Safety glasses with side shields or goggles.

General hygienic measures: The usual precautionary measures are to be adhered to when handling chemicals. Keep away from food, beverages and feed sources. Immediately remove all soiled and contaminated clothing. Wash hands before breaks and at the end of work. Do not inhale gases/fumes/dust/mist/vapor/aerosols. Avoid contact with the eyes and skin.

SECTION 9 : Physical and chemical properties

Appearance (physical state,color):	Colorless Solid	**Explosion limit lower**: **Explosion limit upper**:	Not Determined Not Determined
Odor:	Odorless	**Vapor pressure**:	Not Determined
Odor threshold:	Not Determined	**Vapor density**:	Not Determined
pH-value:	5-6 (5% aq. sol.)	**Relative density**:	1.8
Melting/Freezing point:	280 C	**Solubilities**:	Material is water soluble.
Boiling point/Boiling range:	Not Determined	**Partition coefficient (n-octanol/water)**:	n-octanol/water: log Pow: -5.1
Flash point (closed cup):	Not Determined	**Auto/Self-ignition temperature**:	Not Determined

Evaporation rate:	Insignificant	**Decomposition temperature**:	350 C
Flammability (solid,gaseous):	Not Determined	**Viscosity**:	a. Kinematic:Not Determined b. Dynamic: Not Determined
Density: Not Determined			

SECTION 10 : Stability and reactivity

Reactivity: Nonreactive under normal conditions.
Chemical stability: No decomposition if used and stored according to specifications.
Possible hazardous reactions: None under normal processing
Conditions to avoid: Store away from oxidizing agents, strong acids or bases.Incompatible Materials.excess heat.Dust generation.
Incompatible materials: Strong acids.Strong bases.Strong oxidizing agents.
Hazardous decomposition products:sulfur dioxide.nitrogen.Ammonia.ammonium bisulfate.

SECTION 11 : Toxicological information

Acute Toxicity:		
Oral:	2840mg/kg	APS: LD50 orl-rat
Chronic Toxicity: No additional information.		
Corrosion Irritation: No additional information.		
Sensitization:		No additional information.
Single Target Organ (STOT):		No additional information.
Numerical Measures:		No additional information.
Carcinogenicity:		No additional information.
Mutagenicity:		No additional information.
Reproductive Toxicity:		No additional information.

SECTION 12 : Ecological information

Ecotoxicity Persistence and degradability: Readily degradable in the environment.
Bioaccumulative potential:
Mobility in soil:
Other adverse effects:

SECTION 13 : Disposal considerations

Waste disposal recommendations:

Product/containers must not be disposed together with household garbage. Do not allow product to reach sewage system or open water.It is the responsibility of the waste generator to properly characterize all waste materials according to applicable regulatory entities (US 40CFR262.11). Consult federal state/ provincial and local regulations regarding the proper disposal of waste material that may incorporate some amount of this product.

SECTION 14 : Transport information

UN-Number

Not Dangerous Goods

UN proper shipping name

Not Dangerous Goods

Transport hazard class(es)
Packing group:Not Dangerous Goods
Environmental hazard:
Transport in bulk:
Special precautions for user:

SECTION 15 : Regulatory information

United States (USA)

SARA Section 311/312 (Specific toxic chemical listings):

None of the ingredients is listed

SARA Section 313 (Specific toxic chemical listings):

7783-20-2 Ammonium Sulfate

RCRA (hazardous waste code):

None of the ingredients is listed

TSCA (Toxic Substances Control Act):

All ingredients are listed.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act):

None of the ingredients is listed

Proposition 65 (California):

Chemicals known to cause cancer:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for females:

None of the ingredients is listed

Chemicals known to cause reproductive toxicity for males:

None of the ingredients is listed

Chemicals known to cause developmental toxicity:

None of the ingredients is listed

Canada

Canadian Domestic Substances List (DSL):

All ingredients are listed.

Canadian NPRI Ingredient Disclosure list (limit 0.1%):

None of the ingredients is listed

Canadian NPRI Ingredient Disclosure list (limit 1%):

None of the ingredients is listed

SECTION 16 : Other information

This product has been classified in accordance with hazard criteria of the Controlled Products Regulations and the SDS contains all the information required by the Controlled Products Regulations.Note:. The responsibility to provide a safe workplace remains with the user.The user should consider the health hazards and safety information contained herein as a guide and should take those precautions required in an individual operation to instruct employees and develop work practice procedures for a safe work environment.The information contained herein is, to the best of our knowledge and belief, accurate.However, since the conditions of handling and use are beyond our control, we make no guarantee of results, and assume no liability for damages incurred by the use of this material.It is the responsibility of the user to comply with all applicable laws and regulations applicable to this material.

GHS Full Text Phrases:

Abbreviations and acronyms:
IMDG: International Maritime Code for Dangerous Goods
PNEC: Predicted No-Effect Concentration (REACH)
CFR: Code of Federal Regulations (USA)
SARA: Superfund Amendments and Reauthorization Act (USA)
RCRA: Resource Conservation and Recovery Act (USA)
TSCA: Toxic Substances Control Act (USA)
NPRI: National Pollutant Release Inventory (Canada)
DOT: US Department of Transportation
IATA: International Air Transport Association
GHS: Globally Harmonized System of Classification and Labelling of Chemicals
ACGIH: American Conference of Governmental Industrial Hygienists
CAS: Chemical Abstracts Service (division of the American Chemical Society)
NFPA: National Fire Protection Association (USA)
HMIS: Hazardous Materials Identification System (USA)
WHMIS: Workplace Hazardous Materials Information System (Canada)
DNEL: Derived No-Effect Level (REACH)

Effective date : 12.28.2014
Last updated : 03.19.2015

PRAXAIR
Making our planet more productive™

Ammonia - US

Safety Data Sheet P-4562

This SDS conforms to U.S. Code of Federal Regulations 29 CFR 1910.1200, Hazard Communication.
Date of issue: 01/01/1981 Revision date: 08/28/2019 Supersedes: 03/23/2015

SECTION: 1. Product and company identification

1.1. Product identifier

Product form : Substance
Substance name : Ammonia - US
CAS-No. : 7664-41-7
Formula : NH3

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Industrial use; Use as directed.

1.3. Details of the supplier of the safety data sheet

Praxair, Inc.
10 Riverview Drive
Danbury, CT 06810-6268 - USA
T 1-800-772-9247 (1-800-PRAXAIR) - F 1-716-879-2146
www.praxair.com

1.4. Emergency telephone number

Emergency number : Onsite Emergency: 1-800-645-4633

CHEMTREC, 24hr/day 7days/week
— Within USA: 1-800-424-9300, Outside USA: 001-703-527-3887
(collect calls accepted, Contract 17729)

SECTION 2: Hazard identification

2.1. Classification of the substance or mixture

GHS US classification

Flam. Gas 2	H221
Press. Gas (Liq.)	H280
Acute Tox. 4 (Inhalation:gas)	H332
Skin Corr. 1B	H314
STOT SE 3	H335
Aquatic Acute 1	H400

2.2. Label elements

GHS US labeling

Hazard pictograms (GHS US) :


GHS04


GHS05


GHS07


GHS09

Signal word (GHS US) : Danger

Hazard statements (GHS US) : H221 - FLAMMABLE GAS
H280 - CONTAINS GAS UNDER PRESSURE; MAY EXPLODE IF HEATED
H314 - CAUSES SEVERE SKIN BURNS AND EYE DAMAGE
H332 - HARMFUL IF INHALED
H400 - VERY TOXIC TO AQUATIC LIFE
CGA-HG01 - MAY CAUSE FROSTBITE.
CGA-HG22 - CORROSIVE TO THE RESPIRATORY TRACT (This statement supercedes H335)

Precautionary statements (GHS US) : P202 - Do not handle until all safety precautions have been read and understood.
P210 - Keep away from Heat, Open flames, Sparks, Hot surfaces. - No smoking
P260 - Do not breathe gas
P262 - Do not get in eyes, on skin, or on clothing.
P280 - Wear protective gloves, protective clothing, eye protection, face protection.

P271+P403 - Use and store only outdoors or in a well-ventilated place.
P273 - Avoid release to the environment.
P377 - Leaking gas fire: Do not extinguish, unless leak can be stopped safely.
P381 - Eliminate all ignition sources if safe to do so.
P501 - Dispose of contents/container in accordance with container Supplier/owner instructions
P303, P361, P353, P363, P310 - IF ON SKIN OR (HAIR): Take off immediately all contaminated clothing. Rinse skin with water/shower. Immediately call a poison center or doctor/physician.
P304-P340-P312 - IF INHALED: remove victim to fresh air and keep at rest in a position comfortable for breathing.Call a POISON CENTER/doctor if you feel unwell.
P305, P351, P338, P310 - IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison center or doctor/physician.
P332+P313 - IF SKIN IRRITATION OCCURS: Get medical advice/attention.
CGA-PG05 - Use a back flow preventive device in the piping.
CGA-PG20+CGA-PG10 - Use only with equipment of compatible materials of construction and rated for cylinder pressure.
CGA-PG12 - Do not open valve until connected to equipment prepared for use.
CGA-PG06 - Close valve after each use and when empty.
CGA-PG02 - Protect from sunlight when ambient temperature exceeds 52°C (125°F).

2.3. Other hazards

Other hazards not contributing to the classification : Contact with liquid may cause cold burns/frostbite.

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/Information on ingredients

3.1. Substances

Name : Ammonia - US
CAS-No. : 7664-41-7

Name	Product identifier	%
Ammonia	(CAS-No.) 7664-41-7	99.5 - 100

3.2. Mixtures

Not applicable

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove to fresh air and keep at rest in a position comfortable for breathing. . If not breathing, give artificial respiration, with supplemental oxygen given by qualified personnel. If breathing is difficult, qualified personnel should give oxygen. Call a physician.

First-aid measures after skin contact : In case of contact, immediately flush affected areas with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before reuse. Discard contaminated shoes. The liquid may cause frostbite. For exposure to liquid, immediately warm frostbite area with warm water not to exceed 105°F (41°C). Water temperature should be tolerable to normal skin. Maintain skin warming for at least 15 minutes or until normal coloring and sensation have returned to the affected area. In case of massive exposure, remove clothing while showering with warm water. Seek medical evaluation and treatment as soon as possible.

First-aid measures after eye contact : Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Contact an ophthalmologist immediately. Get immediate medical attention.

First-aid measures after ingestion : Ingestion is not considered a potential route of exposure.

4.2. Most important symptoms and effects, both acute and delayed

No additional information available

4.3. Indication of any immediate medical attention and special treatment needed

Treat with corticosteroid spray as soon as possible after inhalation. Obtain medical assistance.

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Carbon dioxide, Dry chemical, Water spray or fog.

5.2. Special hazards arising from the substance or mixture

Reactivity : No reactivity hazard other than the effects described in sub-sections below.

5.3. Advice for firefighters

Firefighting instructions : Evacuate all personnel from the danger area. Use self-contained breathing apparatus (SCBA) and protective clothing. Immediately cool containers with water from maximum distance. Stop flow of gas if safe to do so, while continuing cooling water spray. Remove ignition sources if safe to do so. Remove containers from area of fire if safe to do so. On-site fire brigades must comply with OSHA 29 CFR 1910.156 and applicable standards under 29 CFR 1910 Subpart L—Fire Protection.

Protection during firefighting : **DANGER! Corrosive liquid and gas under pressure.**. Suffocation hazard by lack of oxygen.

Special protective equipment for fire fighters : Wear gas tight chemically protective clothing in combination with self contained breathing apparatus. Standard protective clothing and equipment (Self Contained Breathing Apparatus) for fire fighters.

Other information : Heat of fire can build pressure in cylinder and cause it to rupture. No part of a cylinder should be subjected to a temperature higher than 125ºF (52ºC). Cylinders are equipped with a pressure-relief device. (Exceptions may exist where authorized by DOT, in this case where cylinders contain less than 165 pounds of product.) If leaking or spilled product catches fire, do not extinguish flames. Flammable and toxic vapors may spread from leak and could explode if reignited. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an appropriate device. Reverse flow into cylinder may cause rupture. To protect persons from cylinder fragments and toxic fumes if a rupture occurs, totally evacuate the area if the fire cannot be brought under immediate control.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Evacuate personnel to a safe area. Appropriate self-contained breathing apparatus may be required. Approach suspected leak area with caution. Remove all sources of ignition. if safe to do so. Reverse flow into cylinder may cause rupture. Reduce gas with fog or fine water spray. Stop flow of product if safe to do so. Ventilate area or move container to a well-ventilated area. Flammable gas may spread from leak. Before entering the area, especially a confined area, check the atmosphere with an appropriate device.

6.1.1. For non-emergency personnel

No additional information available

6.1.2. For emergency responders

No additional information available

6.2. Environmental precautions

Prevent waste from contaminating the surrounding environment. Prevent soil and water pollution. Dispose of contents/container in accordance with local/regional/national/international regulations. Contact supplier for any special requirements.

6.3. Methods and material for containment and cleaning up

No additional information available

6.4. Reference to other sections

See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Do not breathe gas/vapor. Avoid all contact with skin, eyes, or clothing. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.

Keep away from heat, hot surfaces, sparks, open flames and other ignition sources. No smoking. Use only non-sparking tools. Use only explosion-proof equipment.

Wear leather safety gloves and safety shoes when handling cylinders. Protect cylinders from physical damage; do not drag, roll, slide or drop. While moving cylinder, always keep in place removable valve cover. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Never insert an object (e.g, wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Slowly open the valve. If the valve is hard to open, discontinue use and contact your supplier. Close the container valve after each use; keep closed even when empty. Never apply flame or localized heat directly to any part of the container. High temperatures may damage the container and could cause the pressure relief device to fail prematurely, venting the container contents. For other precautions in using this product, see section 16.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Store in a cool, well-ventilated place. Store and use with adequate ventilation. Store only where temperature will not exceed 125°F (52°C). Firmly secure containers upright to keep them from falling or being knocked over. Install valve protection cap, if provided, firmly in place by hand. Store full and empty containers separately. Use a first-in, first-out inventory system to prevent storing full containers for long periods.

OTHER PRECAUTIONS FOR HANDLING, STORAGE, AND USE: When handling product under pressure, use piping and equipment adequately designed to withstand the pressures to be encountered. Never work on a pressurized system. Use a back flow preventive device in the piping. Gases can cause rapid suffocation because of oxygen deficiency; store and use with adequate ventilation. If a leak occurs, close the container valve and blow down the system in a safe and environmentally correct manner in compliance with all international, federal/national, state/provincial, and local laws; then repair the leak. Never place a container where it may become part of an electrical circuit.

7.3. Specific end use(s)

None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Ammonia - US (7664-41-7)		
ACGIH	ACGIH TLV-TWA (ppm)	25 ppm
ACGIH	ACGIH TLV-STEL (ppm)	35 ppm
USA OSHA	OSHA PEL (TWA) (mg/m^3)	35 mg/m^3
USA OSHA	OSHA PEL (TWA) (ppm)	50 ppm
USA IDLH	US IDLH (ppm)	300 ppm

Ammonia (7664-41-7)		
ACGIH	ACGIH TLV-TWA (ppm)	25 ppm
ACGIH	ACGIH TLV-STEL (ppm)	35 ppm
USA OSHA	OSHA PEL (TWA) (mg/m^3)	35 mg/m^3
USA OSHA	OSHA PEL (TWA) (ppm)	50 ppm

8.2. Exposure controls

Appropriate engineering controls : USE ONLY IN A CLOSED SYSTEM. An explosion-proof, corrosion-resistant, forced-draft fume hood is preferred.

Eye protection	: Wear safety glasses when handling cylinders; vapor-proof goggles and a face shield during cylinder changeout or whenever contact with product is possible. Select eye protection in accordance with OSHA 29 CFR 1910.133.
Skin and body protection	: Wear metatarsal shoes and work gloves for cylinder handling, and protective clothing where needed. Wear appropriate chemical gloves during cylinder changeout or wherever contact with product is possible. Select per OSHA 29 CFR 1910.132, 1910.136, and 1910.138.
Respiratory protection	: When workplace conditions warrant respirator use, follow a respiratory protection program that meets OSHA 29 CFR 1910.134, ANSI Z88.2, or MSHA 30 CFR 72.710 (where applicable). Use an air-supplied or air-purifying cartridge if the action level is exceeded. Ensure that the respirator has the appropriate protection factor for the exposure level. If cartridge type respirators are used, the cartridge must be appropriate for the chemical exposure. For emergencies or instances with unknown exposure levels, use a self-contained breathing apparatus (SCBA).
Thermal hazard protection	: Wear cold insulating gloves when transfilling or breaking transfer connections.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	: Gas
Appearance	: Colorless gas. Liquid under pressure.
Molecular mass	: 17 g/mol
Color	: Colorless.
Odor	: Ammoniacal.
Odor threshold	: No data available
pH	: Not applicable.
Relative evaporation rate (butyl acetate=1)	: No data available
Relative evaporation rate (ether=1)	: Not applicable.
Melting point	: -77.7 °C
Freezing point	: No data available
Boiling point	: -33.4 °C
Flash point	: No data available
Critical temperature	: 132.4 °C
Auto-ignition temperature	: 650 °C
Decomposition temperature	: No data available
Flammability (solid, gas)	: ≥ 16 vol % 25
Vapor pressure	: 860 kPa
Critical pressure	: 11350 kPa
Relative vapor density at 20 °C	: No data available
Relative density	: 0.7
Density	: 0.682 g/cm^3 (at -33 °C)
Relative gas density	: 0.6
Solubility	: Water: 517000 mg/l
Log Pow	: Not applicable.
Log Kow	: Not applicable.
Viscosity, kinematic	: Not applicable.
Viscosity, dynamic	: Not applicable.
Explosive properties	: Not applicable.
Oxidizing properties	: None.
Explosion limits	: No data available

9.2. Other information

Gas group	: Press. Gas (Liq.)
Additional information	: None.

SECTION 10: Stability and reactivity

10.1. Reactivity

No reactivity hazard other than the effects described in sub-sections below.

10.2. Chemical stability

Stable under normal conditions.

10.3. Possibility of hazardous reactions

May occur.

10.4. Conditions to avoid

Avoid prolonged exposure to air or moisture. Avoid moisture in installation systems.

10.5. Incompatible materials

Gold, silver, mercury, Oxidizing agents, Halogens, Halogenated compounds, Acids, Copper, Zinc, Copper/Zinc alloys (Brass), Chlorates.

10.6. Hazardous decomposition products

Hydrogen may be formed at temperatures above 1544°F (840°C).

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Inhalation:gas: HARMFUL IF INHALED.

Ammonia - US (\f)7664-41-7	
LC50 inhalation rat (ppm)	7338 ppm/1h
ATE US (gases)	3669 ppmV/4h

Ammonia (7664-41-7)	
LC50 inhalation rat (ppm)	7338 ppm/1h
ATE US (gases)	3669 ppmV/4h

Skin corrosion/irritation : CAUSES SEVERE SKIN BURNS AND EYE DAMAGE.
pH: Not applicable.
Serious eye damage/irritation : Not classified
pH: Not applicable.
Respiratory or skin sensitization : Not classified
Germ cell mutagenicity : Not classified
Carcinogenicity : Not classified
Reproductive toxicity : Not classified
Specific target organ toxicity – single exposure : MAY CAUSE RESPIRATORY IRRITATION.
Specific target organ toxicity – repeated exposure : Not classified
Aspiration hazard : Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : VERY TOXIC TO AQUATIC LIFE. No ecological damage caused by this product.

Ammonia - US (7664-41-7)	
LC50 fish 1	0.44 mg/l (Exposure time: 96 h - Species: Cyprinus carpio)
EC50 Daphnia 1	25.4 mg/l (Exposure time: 48 h - Species: Daphnia magna)
LC50 fish 2	2.43 mg/l (Exposure time: 96 h - Species: Lepomis macrochirus)

Ammonia (7664-41-7)	
LC50 fish 1	0.44 mg/l (Exposure time: 96 h - Species: Cyprinus carpio)
EC50 Daphnia 1	25.4 mg/l (Exposure time: 48 h - Species: Daphnia magna)

Ammonia (7664-41-7)	
LC50 fish 2	2.43 mg/l (Exposure time: 96 h - Species: Lepomis macrochirus)

12.2. Persistence and degradability

Ammonia - US (7664-41-7)	
Persistence and degradability	The substance is biodegradable. Unlikely to persist.

Ammonia (7664-41-7)	
Persistence and degradability	The substance is biodegradable. Unlikely to persist.

12.3. Bioaccumulative potential

Ammonia - US (7664-41-7)	
Log Pow	Not applicable.
Log Kow	Not applicable.
Bioaccumulative potential	Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

Ammonia (7664-41-7)	
Log Pow	Not applicable.
Log Kow	Not applicable.
Bioaccumulative potential	Not expected to bioaccumulate due to the low log Kow (log Kow < 4). Refer to section 9.

12.4. Mobility in soil

Ammonia - US (7664-41-7)	
Mobility in soil	No data available.
Ecology - soil	Because of its high volatility, the product is unlikely to cause ground or water pollution.

Ammonia (7664-41-7)	
Mobility in soil	No data available.
Ecology - soil	Because of its high volatility, the product is unlikely to cause ground or water pollution.

12.5. Other adverse effects

Other adverse effects : May cause pH changes in aqueous ecological systems.
Effect on ozone layer : None.
Effect on the global warming : No known effects from this product.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Product/Packaging disposal recommendations : Do not attempt to dispose of residual or unused quantities. Return container to supplier.

SECTION 14: Transport information

In accordance with DOT
Transport document description : UN1005 Ammonia, anhydrous, 2.2
UN-No.(DOT) : UN1005
Proper Shipping Name (DOT) : Ammonia, anhydrous
Class (DOT) : 2.2 - Class 2.2 - Non-flammable compressed gas 49 CFR 173.115
Hazard labels (DOT) : 2.2 - Non-flammable gas

DOT Symbols : D - Proper shipping name for domestic use only, or to and from Canada

DOT Special Provisions (49 CFR 172.102)	: 13 - The words Inhalation Hazard shall be entered on each shipping paper in association with the shipping description, shall be marked on each non-bulk package in association with the proper shipping name and identification number, and shall be marked on two opposing sides of each bulk package. Size of marking on bulk package must conform to 172.302(b) of this subchapter. The requirements of 172.203(m) and 172.505 of this subchapter do not apply. T50 - When portable tank instruction T50 is referenced in Column (7) of the 172.101 Table, the applicable liquefied compressed gases are authorized to be transported in portable tanks in accordance with the requirements of 173.313 of this subchapter.
Marine pollutant	: Yes 

Additional information

Emergency Response Guide (ERG) Number	: 125 (UN1005);154 (UN2672)
Other information	: No supplementary information available.
Special transport precautions	: Avoid transport on vehicles where the load space is not separated from the driver's compartment. Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers: - Ensure there is adequate ventilation. - Ensure that containers are firmly secured. - Ensure cylinder valve is closed and not leaking. - Ensure valve outlet cap nut or plug (where provided) is correctly fitted. - Ensure valve protection device (where provided) is correctly fitted.

Transport by sea

UN-No. (IMDG)	: 1005
Proper Shipping Name (IMDG)	: AMMONIA, ANHYDROUS
Class (IMDG)	: 2 - Gases
Division (IMDG)	: 2.3 - Toxic gases
MFAG-No	: 125

Air transport

UN-No. (IATA)	: 1005
Proper Shipping Name (IATA)	: Ammonia, anhydrous
Class (IATA)	: 2.3 - Gases : toxic
Subsidiary risk (IATA)	: (8)
Civil Aeronautics Law	: Gases under pressure/Gases toxic under pressure

SECTION 15: Regulatory information

15.1. US Federal regulations

Ammonia - US (7664-41-7)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Listed on the United States SARA Section 302 Subject to reporting requirements of United States SARA Section 313	
CERCLA RQ	100 lb
SARA Section 302 Threshold Planning Quantity (TPQ)	500 lb
SARA Section 313 - Emission Reporting	1 % (includes anhydrous Ammonia and aqueous Ammonia from water dissociable Ammonium salts and other sources, 10% of total aqueous Ammonia is reportable under this listing)

Chemical(s) subject to the reporting requirements of Section 313 or Title III of the Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.

Ammonia	CAS-No. 7664-41-7	99.5 - 100%

Ammonia (7664-41-7)	
Listed on the United States TSCA (Toxic Substances Control Act) inventory Listed on the United States SARA Section 302 Subject to reporting requirements of United States SARA Section 313	
CERCLA RQ	100 lb
SARA Section 302 Threshold Planning Quantity (TPQ)	500 lb
SARA Section 311/312 Hazard Classes	Immediate (acute) health hazard Delayed (chronic) health hazard Sudden release of pressure hazard Fire hazard
SARA Section 313 - Emission Reporting	1 % (includes anhydrous Ammonia and aqueous Ammonia from water dissociable Ammonium salts and other sources, 10% of total aqueous Ammonia is reportable under this listing)

15.2. International regulations

CANADA

Ammonia - US (7664-41-7)
Listed on the Canadian DSL (Domestic Substances List)

Ammonia (7664-41-7)
Listed on the Canadian DSL (Domestic Substances List)

EU-Regulations

Ammonia - US (7664-41-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

Ammonia (7664-41-7)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)

15.2.2. National regulations

Ammonia - US (7664-41-7)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Japanese ISHL (Industrial Safety and Health Law) Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Japanese Poisonous and Deleterious Substances Control Law Listed on the Canadian IDL (Ingredient Disclosure List) Listed on INSQ (Mexican National Inventory of Chemical Substances) Listed on the TCSI (Taiwan Chemical Substance Inventory)

Ammonia (7664-41-7)
Listed on the AICS (Australian Inventory of Chemical Substances) Listed on IECSC (Inventory of Existing Chemical Substances Produced or Imported in China) Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory Listed on the Japanese ISHL (Industrial Safety and Health Law) Listed on the Korean ECL (Existing Chemicals List) Listed on NZIoC (New Zealand Inventory of Chemicals) Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances) Japanese Poisonous and Deleterious Substances Control Law Listed on the Canadian IDL (Ingredient Disclosure List) Listed on INSQ (Mexican National Inventory of Chemical Substances) Listed on the TCSI (Taiwan Chemical Substance Inventory)

15.3. US State regulations

Ammonia - US(7664-41-7)	
U.S. - California - Proposition 65 - Carcinogens List	No
U.S. - California - Proposition 65 - Developmental Toxicity	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Female	No
U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No
State or local regulations	U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List U.S. - Pennsylvania - RTK (Right to Know) List

California Proposition 65 - This product does not contain any substances known to the state of California to cause cancer, developmental and/or reproductive harm

Ammonia (7664-41-7)

U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No significant risk level (NSRL)
No	No	No	No	

Ammonia (7664-41-7)

U.S. - Massachusetts - Right To Know List
U.S. - New Jersey - Right to Know Hazardous Substance List
U.S. - Pennsylvania - RTK (Right to Know) - Environmental Hazard List
U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Other information : When you mix two or more chemicals, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Before using any plastics, confirm their compatibility with this product.

Praxair asks users of this product to study this SDS and become aware of the product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this SDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Safety Data Sheet. Since the use of this information and the conditions of use are not within the control of Praxair, Inc, it is the user's obligation to determine the conditions of safe use of the product.

Praxair SDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current SDSs for these products, contact your Praxair sales representative, local distributor, or supplier, or download from www.praxair.com. If you have questions regarding Praxair SDSs, would like the document number and date of the latest SDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (Phone: 1-800-PRAXAIR/1-800-772-9247; Address: Praxair Call Center, Praxair, Inc, P.O. Box 44, Tonawanda, NY 14151-0044).

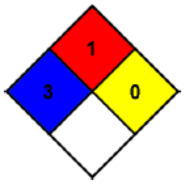
PRAXAIR and the Flowing Airstream design are trademarks or registered trademarks of Praxair Technology, Inc. in the United States and/or other countries.

Revision date : 08/28/2019

NFPA health hazard : 3 - Materials that, under emergency conditions, can cause serious or permanent injury.

NFPA fire hazard : 1 - Materials that must be preheated before ignition can occur.

NFPA instability : 0 - Material that in themselves are normally stable, even under fire conditions.



Appendix H

SUPPORTING POSITION FOR AMMONIA EXTRACT PRESENTED AT CCOF BOARD MEETING FEB 18, 2020

Novel NH_3 Products

Concentrated High Nitrogen
Liquid Fertilizers

Outline

OVERVIEW

PRINCIPLES

IMPACT

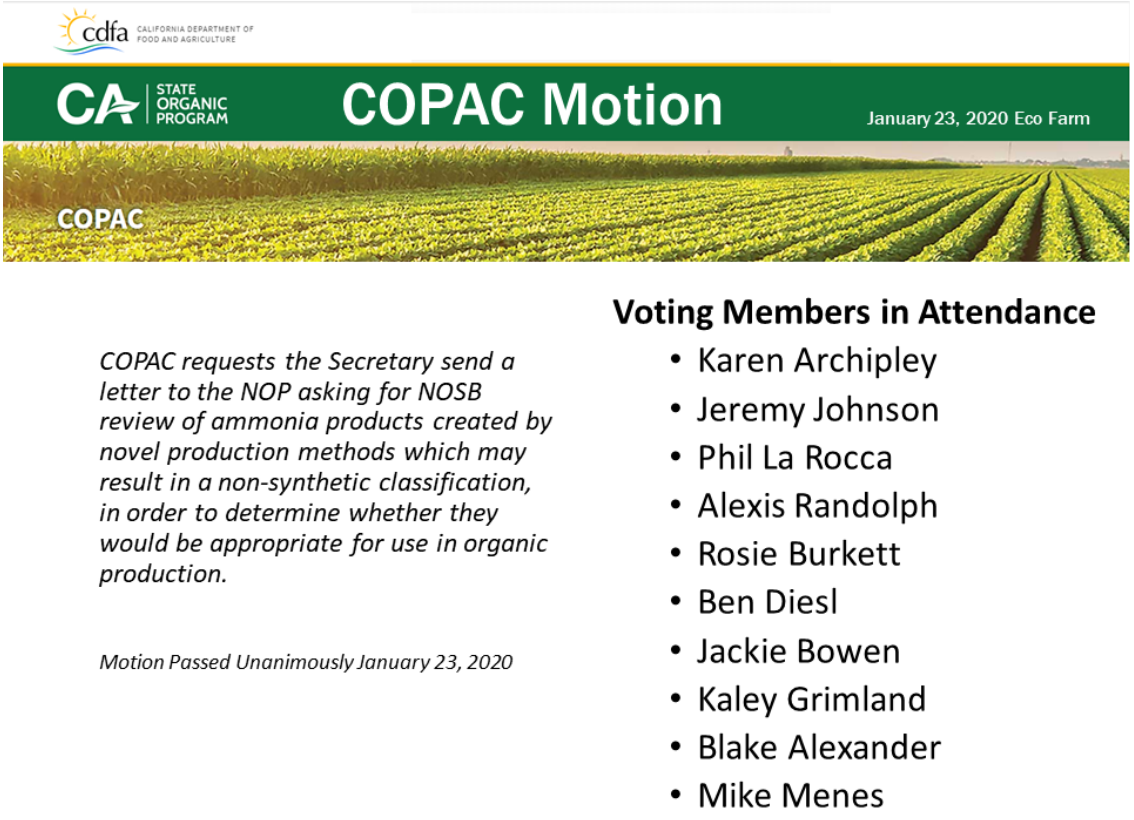
FRAUD

FUTURE

Novel NH_3 Products

- New Category of Input
- Multiple applications from several firms
- Liquid >2% ammoniacal nitrogen (most 5-7%)
- Biological sources
- Purified/separated from other materials
- Concentrated
- Packaged (bottled)

https://www.cdfa.ca.gov/is/ffldrs/fertilizer_OIM.html



cdfa CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

CA STATE ORGANIC PROGRAM

COPAC Motion

January 23, 2020 Eco Farm

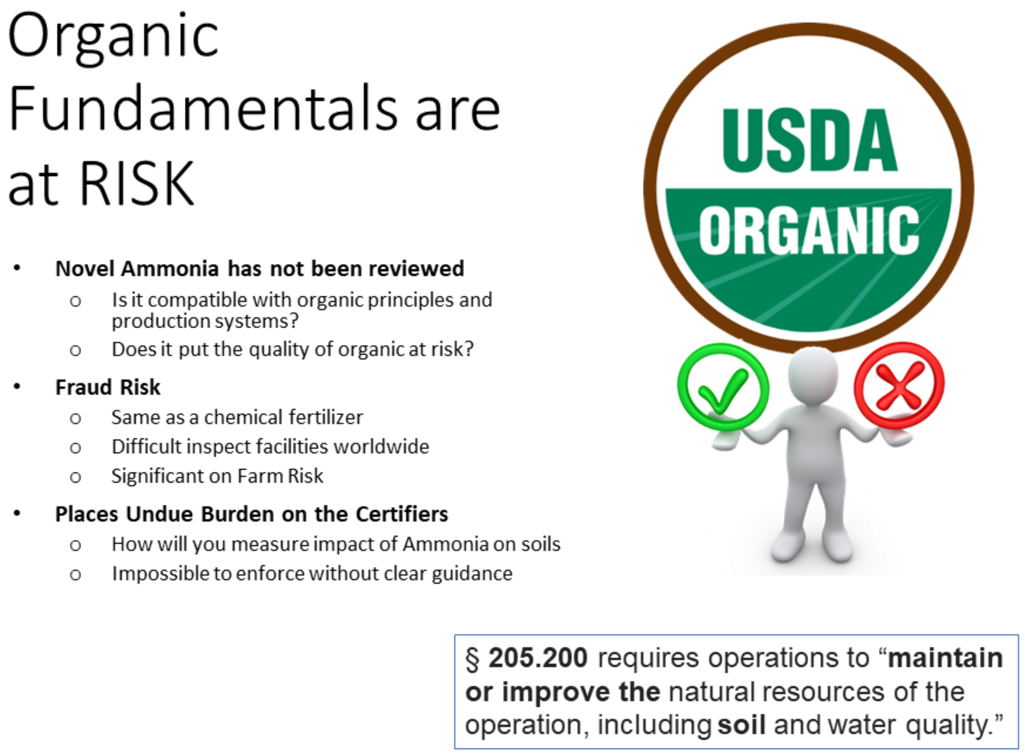
COPAC

COPAC requests the Secretary send a letter to the NOP asking for NOSB review of ammonia products created by novel production methods which may result in a non-synthetic classification, in order to determine whether they would be appropriate for use in organic production.

Motion Passed Unanimously January 23, 2020

Voting Members in Attendance

- Karen Archipley
- Jeremy Johnson
- Phil La Rocca
- Alexis Randolph
- Rosie Burkett
- Ben Diesl
- Jackie Bowen
- Kaley Grimland
- Blake Alexander
- Mike Menes



Organic Fundamentals are at RISK

- **Novel Ammonia has not been reviewed**
  - Is it compatible with organic principles and production systems?
  - Does it put the quality of organic at risk?
- **Fraud Risk**
  - Same as a chemical fertilizer
  - Difficult inspect facilities worldwide
  - Significant on Farm Risk
- **Places Undue Burden on the Certifiers**
  - How will you measure impact of Ammonia on soils
  - Impossible to enforce without clear guidance

§ **205.200** requires operations to "**maintain or improve the** natural resources of the operation, including **soil** and water quality."

History of Ammonia Fraud in Organic Fertilizers

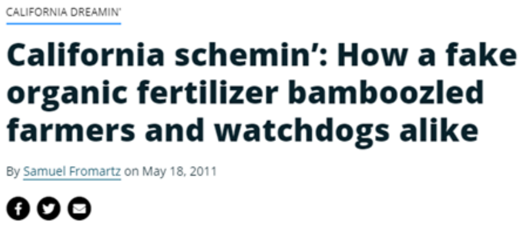
Los Angeles Times

BUSINESS

Organic fertilizer maker accused of using synthetic chemicals

By P.J. HUFFSTUTTER, LOS ANGELES TIMES MARCH 11, 2011 | 12 AM

ADVERTISEMENT



CALIFORNIA DREAMIN'

California schemin': How a fake organic fertilizer bamboozled farmers and watchdogs alike

By Samuel Fromartz on May 18, 2011

The Packer

Organic fertilizer fraud nets 6.5-year prison term

The Packer

November 20, 2012 05:28 PM

6-2-0

This product is sold as a commercial liquid fertilizer, designed to provide growers with a uniform, stable and easy-to-apply fish-based nutrients for either foliar or soil fertility use. This product complies with Organic Certification standards and can be used by Certified Organic Growers.

Compatibility: Agrolizer™ may be used with any common use fertilizers. Jar test if unsure about compatibility. Contact the manufacture if in doubt. Do not dilute with water or fertilizers until ready for use. Do not add microbes to stored product

AgroMar Inc. makes no warranty of merchantability, fitness for any purpose or otherwise, express or implied, concerning this product or its uses which extend beyond the use of the product under normal conditions in accordance with the statements made on this label.

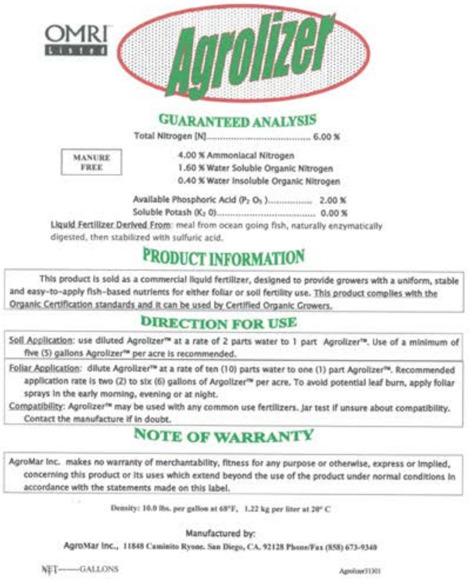
Handling: Follow appropriate general safety procedures. In case of accidental exposure, flush with plenty of water. Refer to Material Safety Data Sheet (MSDS) for additional information.

SHAKE, STIR OR AGITATE BEFORE USE.

Density: 10.2 lbs. /gal. at 68°F, 1.22 kg/ liter at 20° C

Manufactured by:
AgroMar Inc.,
11848 Caminito Ryone, San Diego, CA, 92128
Phone/Fax (858) 673-9340

Net Contents__ BULK _



GUARANTEED ANALYSIS

Total Nitrogen [N].. 6.00 %

MANURE FREE

4.00 % Ammoniacal Nitrogen
1.60 % Water Soluble Organic Nitrogen
0.40 % Water Insoluble Organic Nitrogen

Available Phosphoric Acid (P_2O_5)................ 2.00 %
Soluble Potash (K_2O).. 0.00 %

Liquid Fertilizer Derived From: meal from ocean going fish, naturally enzymatically digested, then stabilized with sulfuric acid.

PRODUCT INFORMATION

This product is sold as a commercial liquid fertilizer, designed to provide growers with a uniform, stable and easy-to-apply fish-based nutrients for either foliar or soil fertility use. This product complies with the Organic Certification standards and it can be used by Certified Organic Growers.

DIRECTION FOR USE

Soil Application: use diluted Agrolizer™ at a rate of 2 parts water to 1 part Agrolizer™. Use of a minimum of five (5) gallons Agrolizer™ per acre is recommended.

Foliar Application: dilute Agrolizer™ at a rate of ten (10) parts water to one (1) part Agrolizer™. Recommended application rate is two (2) to six (6) gallons of Argolizer™ per acre. To avoid potential leaf burn, apply foliar sprays in the early morning, evening or at night.

Compatibility: Agrolizer™ may be used with any common use fertilizers. Jar test if unsure about compatibility. Contact the manufacture if in doubt.

NOTE OF WARRANTY

AgroMar Inc. makes no warranty of merchantability, fitness for any purpose or otherwise, express or implied, concerning this product or its uses which extend beyond the use of the product under normal conditions in accordance with the statements made on this label.

Density: 10.0 lbs. per gallon at 68°F, 1.22 kg per liter at 20° C

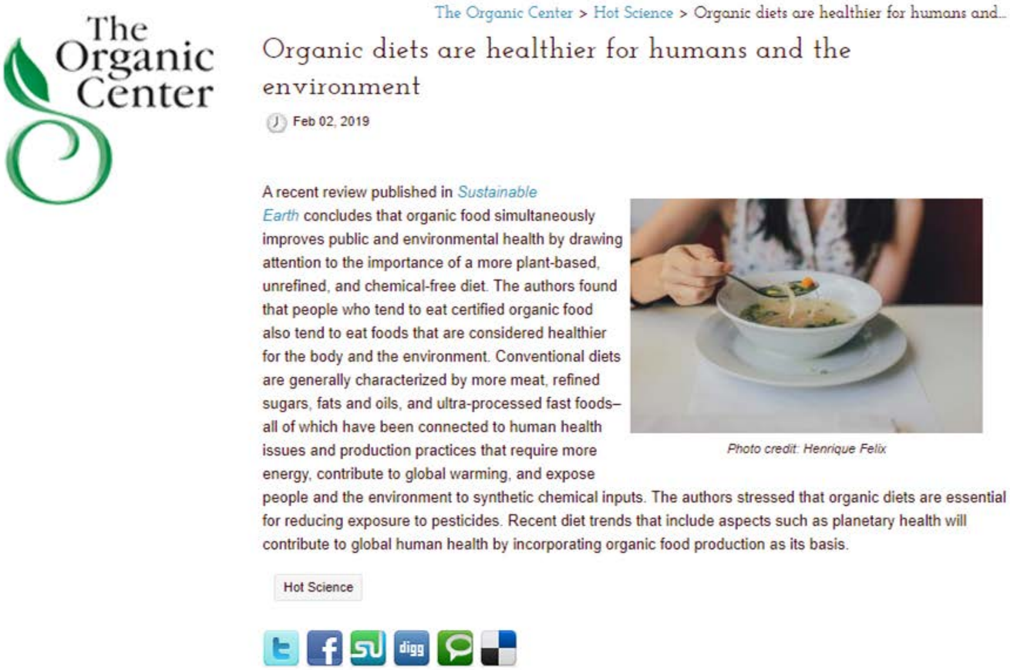
Manufactured by:
AgroMar Inc., 11848 Caminito Ryone, San Diego, CA. 92128 Phone/Fax (858) 673-9340

NET——GALLONS

Agrolizer31301

Risk of Fraud

- Domestic and International
- Supply Chain
- Difficult to Enforce
- Documentation
- Method of Detection
- Small % in formulation (keep above X limit)



The Organic Center > Hot Science > Organic diets are healthier for humans and...

Organic diets are healthier for humans and the environment

Feb 02, 2019

A recent review published in *Sustainable Earth* concludes that organic food simultaneously improves public and environmental health by drawing attention to the importance of a more plant-based, unrefined, and chemical-free diet. The authors found that people who tend to eat certified organic food also tend to eat foods that are considered healthier for the body and the environment. Conventional diets are generally characterized by more meat, refined sugars, fats and oils, and ultra-processed fast foods–all of which have been connected to human health issues and production practices that require more energy, contribute to global warming, and expose people and the environment to synthetic chemical inputs. The authors stressed that organic diets are essential for reducing exposure to pesticides. Recent diet trends that include aspects such as planetary health will contribute to global human health by incorporating organic food production as its basis.

Photo credit: Henrique Felix

Hot Science

Lack of Carbon

- Complex mixture of nutrients
- High in carbon (~20-35% carbon)
- Vital for promoting microbial activity
- Vital for promoting soil health

Lack of Life – microbial activity

- Generally all organic fertilizers have viable microbes
- Inoculate soils with diverse microbes
- Improve soil health
- Improve soil functionality
- Improve soil structure

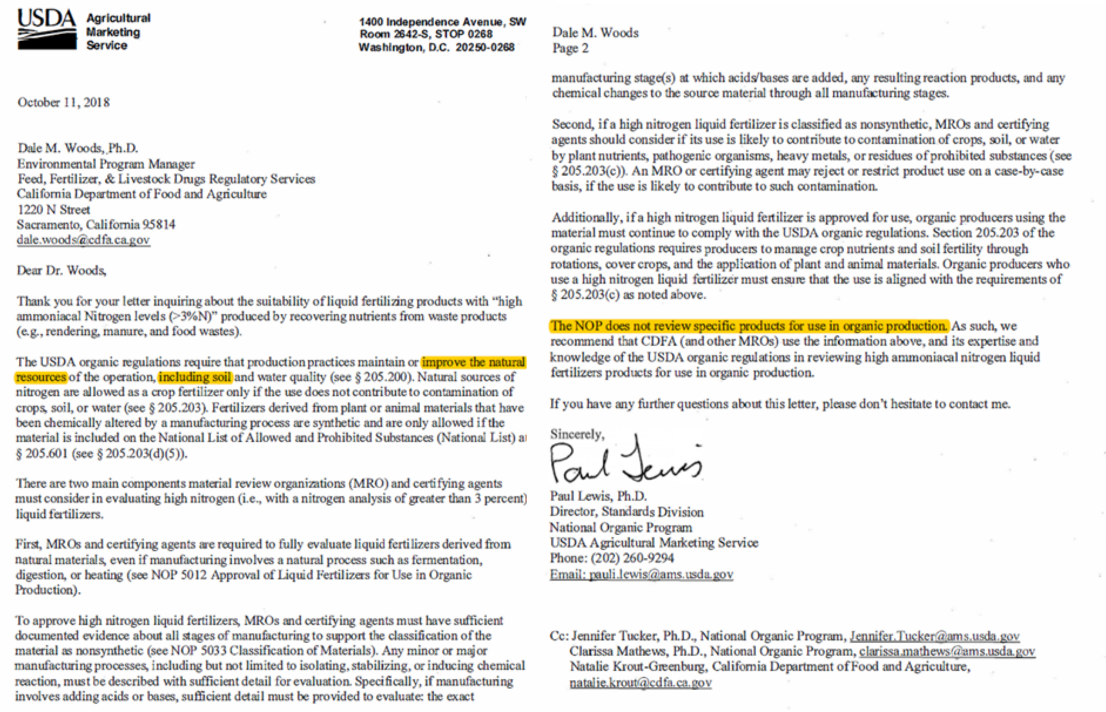
Lack of Nutrients

- Nutrients tied up in complex bio-molecules
- Decomposed through microbial activity
- Microbial activity aided by nutrients
- Organic fertilizers are sources soil microbe food sources
- Ammonia fertilizers do not have this

Current Status

- All MROs are reviewing and approving Novel NH_3 Products
- Response from NOP
- New Category has not been reviewed by NOSB
- Unclear guidance for MRO or ACA
- MRO outreach to ACA
- Certifier's Undue Burden

“The NOP does not review specific products for use in organic production.”



USDA Agricultural Marketing Service

1400 Independence Avenue, SW
Room 2642-S, STOP 0268
Washington, D.C. 20250-0268

October 11, 2018

Dale M. Woods, Ph.D.
Environmental Program Manager
Feed, Fertilizer, & Livestock Drugs Regulatory Services
California Department of Food and Agriculture
1220 N Street
Sacramento, California 95814
dale.woods@cdfa.ca.gov

Dear Dr. Woods,

Thank you for your letter inquiring about the suitability of liquid fertilizing products with “high ammoniacal Nitrogen levels (>3%N)” produced by recovering nutrients from waste products (e.g., rendering, manure, and food wastes).

The USDA organic regulations require that production practices maintain or improve the natural resources of the operation, including soil and water quality (see § 205.200). Natural sources of nitrogen are allowed as a crop fertilizer only if the use does not contribute to contamination of crops, soil, or water (see § 205.203). Fertilizers derived from plant or animal materials that have been chemically altered by a manufacturing process are synthetic and are only allowed if the material is included on the National List of Allowed and Prohibited Substances (National List) a § 205.601 (see § 205.203(d)(5)).

There are two main components material review organizations (MRO) and certifying agents must consider in evaluating high nitrogen (i.e., with a nitrogen analysis of greater than 3 percent) liquid fertilizers.

First, MROs and certifying agents are required to fully evaluate liquid fertilizers derived from natural materials, even if manufacturing involves a natural process such as fermentation, digestion, or heating (see NOP 5012 Approval of Liquid Fertilizers for Use in Organic Production).

To approve high nitrogen liquid fertilizers, MROs and certifying agents must have sufficient documented evidence about all stages of manufacturing to support the classification of the material as nonsynthetic (see NOP 5033 Classification of Materials). Any minor or major manufacturing processes, including but not limited to isolating, stabilizing, or inducing chemical reaction, must be described with sufficient detail for evaluation. Specifically, if manufacturing involves adding acids or bases, sufficient detail must be provided to evaluate: the exact

Dale M. Woods
Page 2

manufacturing stage(s) at which acids/bases are added, any resulting reaction products, and any chemical changes to the source material through all manufacturing stages.

Second, if a high nitrogen liquid fertilizer is classified as nonsynthetic, MROs and certifying agents should consider if its use is likely to contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances (see § 205.203(c)). An MRO or certifying agent may reject or restrict product use on a case-by-case basis, if the use is likely to contribute to such contamination.

Additionally, if a high nitrogen liquid fertilizer is approved for use, organic producers using the material must continue to comply with the USDA organic regulations. Section 205.203 of the organic regulations requires producers to manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials. Organic producers who use a high nitrogen liquid fertilizer must ensure that the use is aligned with the requirements of § 205.203(c) as noted above.

The NOP does not review specific products for use in organic production. As such, we recommend that CDFA (and other MROs) use the information above, and its expertise and knowledge of the USDA organic regulations in reviewing high ammoniacal nitrogen liquid fertilizers products for use in organic production.

If you have any further questions about this letter, please don't hesitate to contact me.

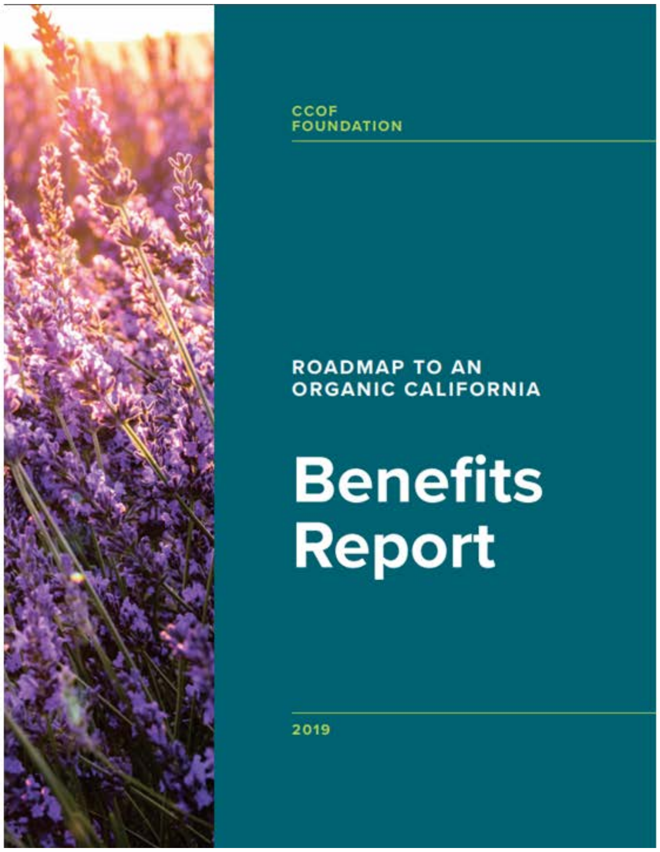
Sincerely,
Paul Lewis

Paul Lewis, Ph.D.
Director, Standards Division
National Organic Program
USDA Agricultural Marketing Service
Phone: (202) 260-9294
Email: pauli.lewis@ams.usda.gov

Cc: Jennifer Tucker, Ph.D., National Organic Program, Jennifer.Tucker@ams.usda.gov
Clarissa Mathews, Ph.D., National Organic Program, clarissa.mathews@ams.usda.gov
Natalie Krout-Greenburg, California Department of Food and Agriculture,
natalie.krout@cdfa.ca.gov

NOP Response Takeaways

- Restated the regulations that were already available
- Did not take a position on the material (and they shouldn’t)
- Was interpreted by some that it novel ammonia was acceptable by the NOP
- Does not mean that MROs should take a position
- Does not mean that ACAs should interpret an input
- Failed to mention the role of the NOSB for this **New Category**
- This is the only guidance for MRO and ACA on how to evaluate this new category

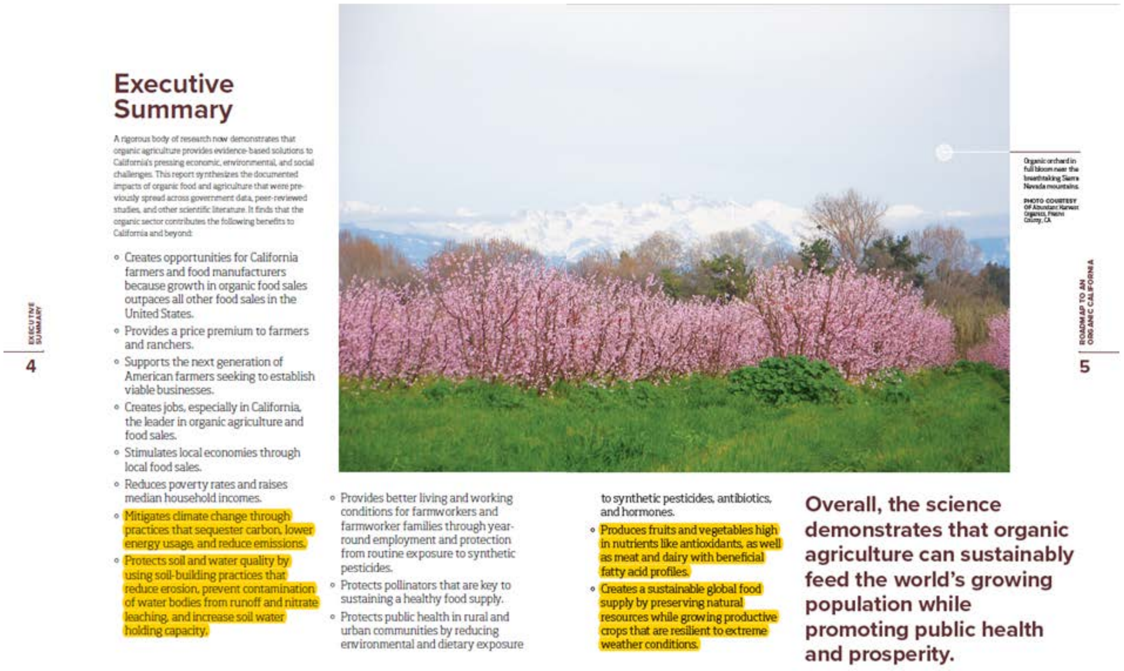


CCOF
FOUNDATION

ROADMAP TO AN
ORGANIC CALIFORNIA

Benefits Report

2019



Executive Summary

A rigorous body of research now demonstrates that organic agriculture provides evidence-based solutions to California's pressing economic, environmental, and social challenges. This report synthesizes the documented impacts of organic food and agriculture that were previously spread across government data, peer-reviewed studies, and other scientific literature. It finds that the organic sector contributes the following benefits to California and beyond:

- Creates opportunities for California farmers and food manufacturers because growth in organic food sales outpaces all other food sales in the United States.
- Provides a price premium to farmers and ranchers.
- Supports the next generation of American farmers seeking to establish viable businesses.
- Creates jobs, especially in California, the leader in organic agriculture and food sales.
- Stimulates local economies through local food sales.
- Reduces poverty rates and raises median household incomes.
- Mitigates climate change through practices that sequester carbon, lower energy usage, and reduce emissions.
- Protects soil and water quality by using soil-building practices that reduce erosion, prevent contamination of water bodies from runoff and nitrate leaching, and increase soil water holding capacity.
- Provides better living and working conditions for farmworkers and farmworker families through year-round employment and protection from routine exposure to synthetic pesticides.
- Protects pollinators that are key to sustaining a healthy food supply.
- Protects public health in rural and urban communities by reducing environmental and dietary exposure to synthetic pesticides, antibiotics, and hormones.
- Produces fruits and vegetables high in nutrients like antioxidants, as well as meat and dairy with beneficial fatty acid profiles.
- Creates a sustainable global food supply by preserving natural resources while growing productive crops that are resilient to extreme weather conditions.

Overall, the science demonstrates that organic agriculture can sustainably feed the world's growing population while promoting public health and prosperity.

Organic orchard in full bloom near the breathtaking Sierra Nevada mountains.

PHOTO COURTESY OF Abundant Harvest Organics, Fresno County, CA

This WILL shape the future

CONCLUSION

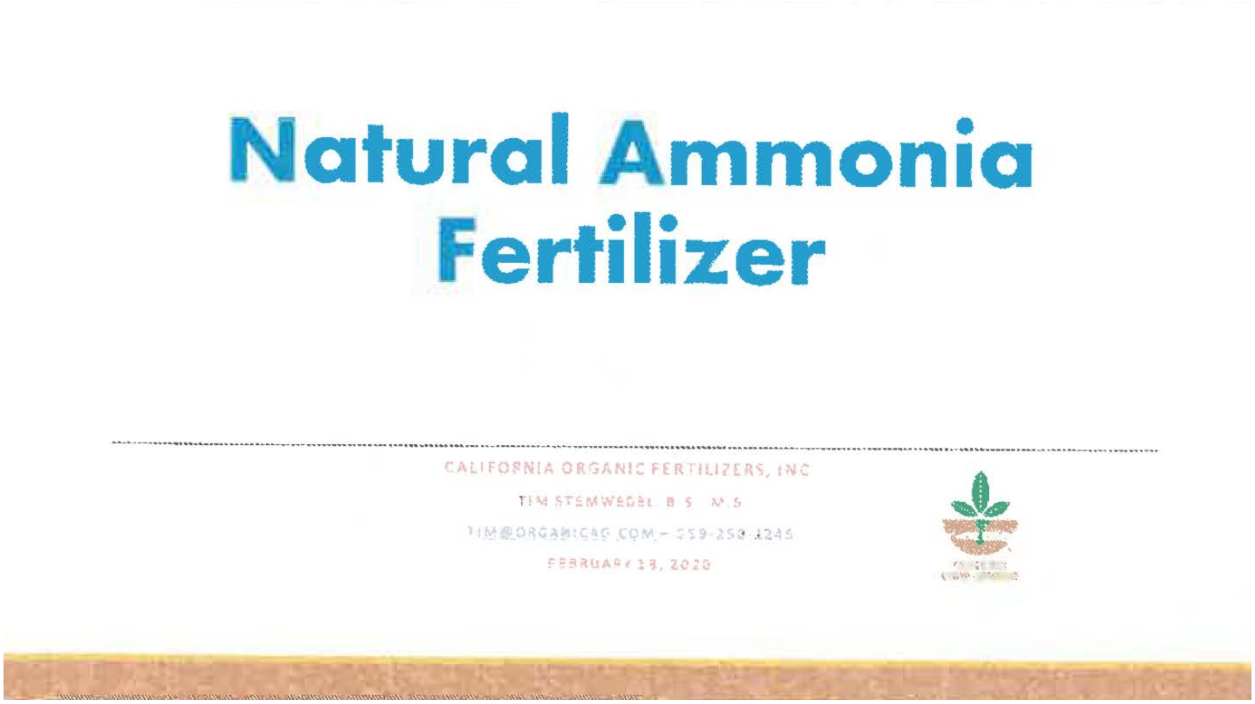
Does Novel NH_3 Products fulfill CCOF Goals?

- **Mitigates climate change** through practices that **sequester carbon**, lower energy usage and reduce emissions.
- **Protects soil** and water quality by using **soil-building practices** that reduce erosion, prevent contamination of water bodies from runoff and nitrate leaching, and increase soil water holding capacity.
- **Produces** fruits and vegetables **high in nutrients** like antioxidants, as well as meat and dairy with beneficial fatty acid profiles.
- Creates a sustainable global food supply by preserving natural resources while growing productive crops that are resilient to extreme weather conditions.

Take Action Now to Prevent Chemicals destroying Organic

Appendix I

CONTRASTING POSITION FOR AMMONIA EXTRACT PRESENTED AT CCOF BOARD MEETING FEB 18, 2020



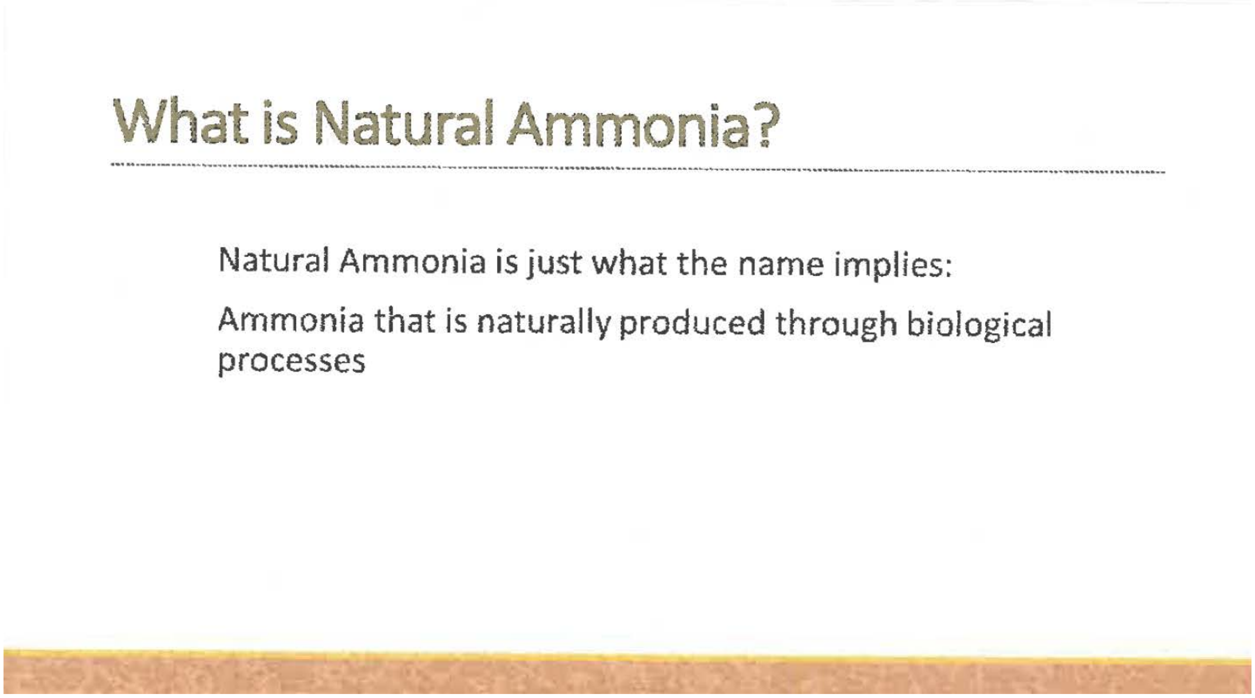
Natural Ammonia Fertilizer

CALIFORNIA ORGANIC FERTILIZERS, INC

TIM STEMWEDEL, B.S., M.S

TIM@ORGANICAG.COM – 559-253-1245

FEBRUARY 18, 2020



What is Natural Ammonia?

Natural Ammonia is just what the name implies:

Ammonia that is naturally produced through biological processes

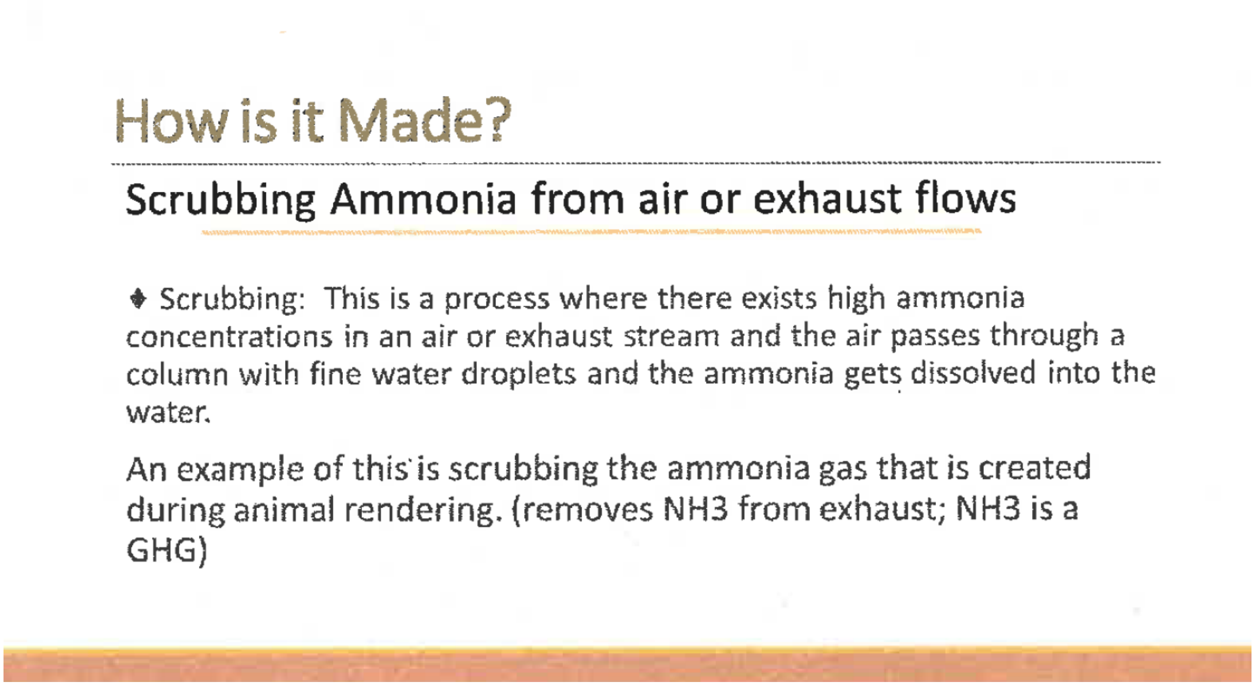
Is it Different than a Chemical Ammonia?

- Chemical ammonia is produced using the Haber-Bosch process that uses natural gas, air and catalysts at high temperature and pressure
- Natural Ammonia is produced by microbes feeding on nitrogen containing proteins. COFI uses a fermentation system similar to wine or alcohol fermentation. The original microbes were sourced from fresh dairy manure.

Is it Different than a Chemical Ammonia?

- Chemical ammonia has a very low Nitrogen Isotope N15/N14 since the nitrogen was fixed from air which is 99.6% N14.
- Natural Ammonia has a high Nitrogen Isotope N15 level

  COFI testing at the University of California shows as high as 20% N15 isotope demonstrating that the materials are quite different and may be tested for nitrogen isotope levels to combat fraud.

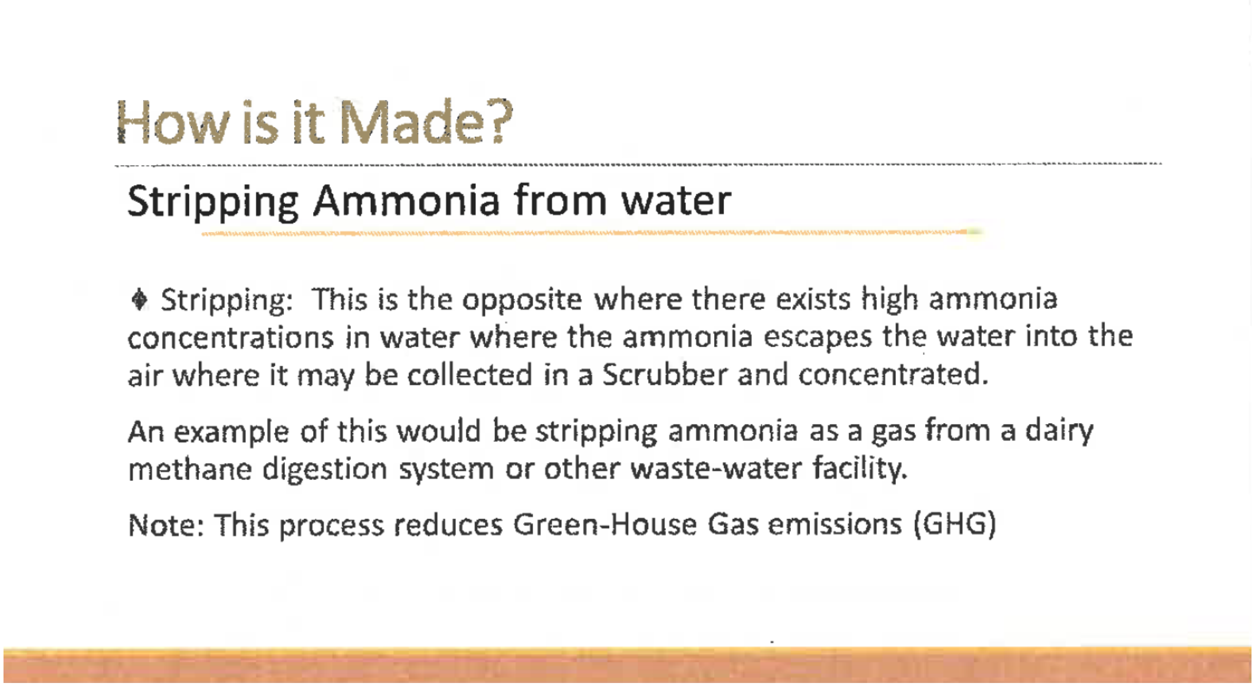


How is it Made?

Scrubbing Ammonia from air or exhaust flows

◆ Scrubbing: This is a process where there exists high ammonia concentrations in an air or exhaust stream and the air passes through a column with fine water droplets and the ammonia gets dissolved into the water.

An example of this is scrubbing the ammonia gas that is created during animal rendering. (removes NH3 from exhaust; NH3 is a GHG)



How is it Made?

Stripping Ammonia from water

◆ Stripping: This is the opposite where there exists high ammonia concentrations in water where the ammonia escapes the water into the air where it may be collected in a Scrubber and concentrated.

An example of this would be stripping ammonia as a gas from a dairy methane digestion system or other waste-water facility.

Note: This process reduces Green-House Gas emissions (GHG)

How is it Made?

COFI's System – Step One

◆ **Fermentation**

Protein containing materials such as meat meal, corn steep, fish waste are fermented with ammonia producing microbes until the protein has been converted to ammonia by the microbes.

How is it Made?

COFI's System – Step Two

◆ **Distillation**

The ammonia containing liquid is distilled very much like alcohol is distilled. Instead of alcohol being turned into a gas and then condensed to liquid it is Ammonia that is being turned to gas and then condensed into a high concentrated ammonia solution. None of the fermentation liquid is present in the final product.

Ammonia is similar to alcohol in its chemical properties and is susceptible to extraction from water using temperature.

How is it Made?

COFI's System – Step Two

- **Distillation**

  The ammonia containing liquid is distilled very much like alcohol is distilled. Instead of alcohol being turned into a gas and then condensed to liquid it is Ammonia that is being turned to gas and then condensed into a high concentrated ammonia solution. None of the fermentation liquid is present in the final product.

  Ammonia is similar to alcohol in its chemical properties and is susceptible to extraction from water using temperature.

OIM Review

CDFA

- CDFA is a recognized MRO for the NOP
- CDFA received guidance from the NOP regarding natural ammonia products. The NOP instructed them to confirm that the production and final products met NOP standards.
- CDFA does thorough reviews and conducts on-site inspections to confirm that the process and materials meet NOP rules on an ongoing basis. No other MRO does this.

Benefits of Natural Ammonia

Eco-system Impact

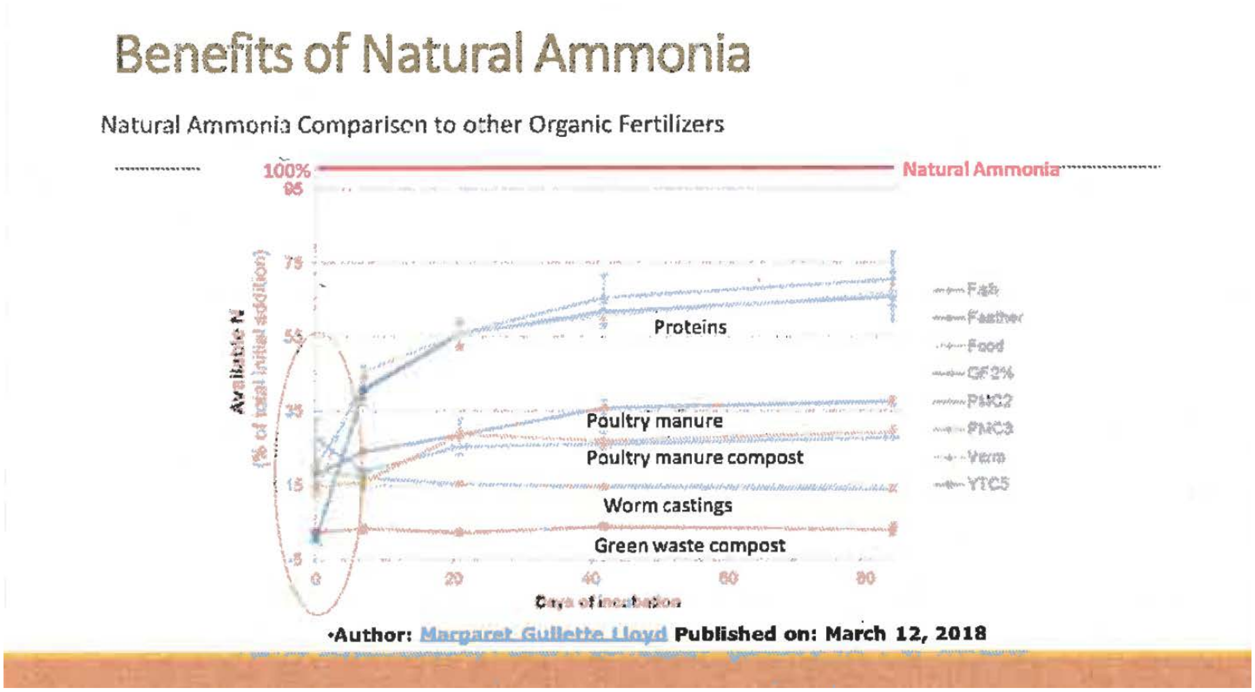
100% Plant Available Nitrogen

- Most efficient organic form of nitrogen available
- This will reduce the total amount of nitrogen a grower needs to apply.
- Reduces the amount of left-over nitrogen that is susceptible to run-off or leaching into the groundwater.
- Purity of NA Reduces the amount of non-nutrient materials added to the soil many other fertilizers contain that are potentially harmful by-products.

Product Comparisons

Standard Organic Fertilizers

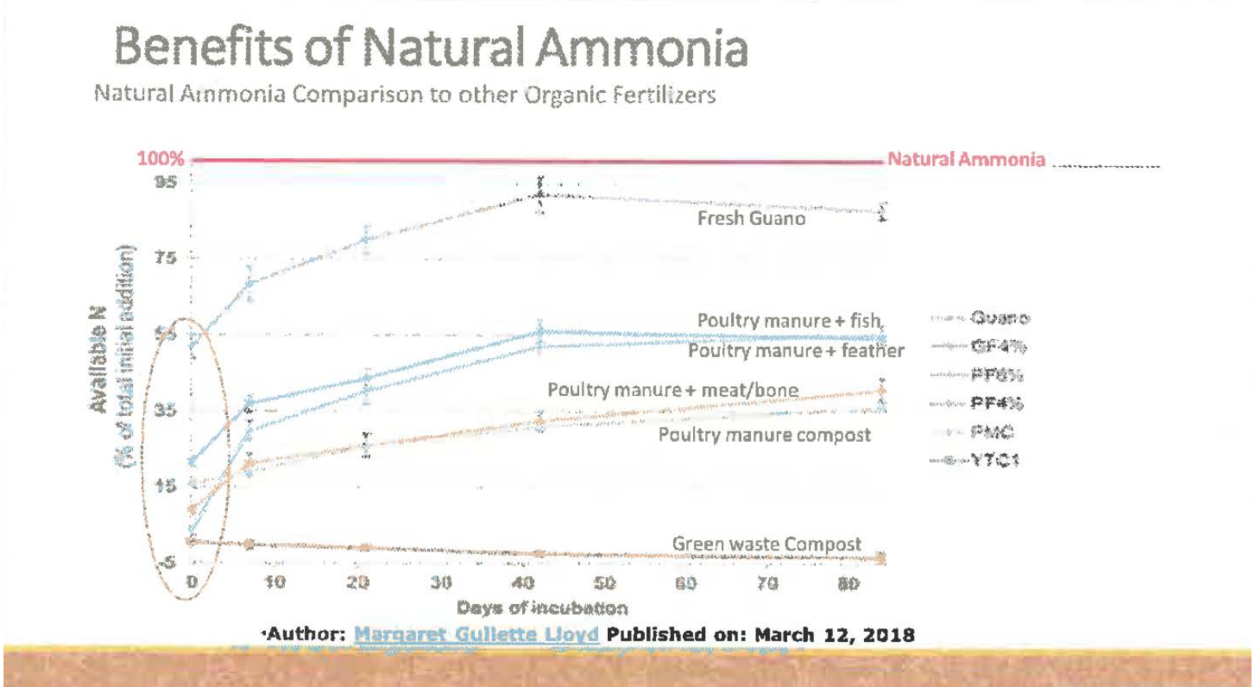
- Contain very diverse levels of PAN over growing season.
- Contain variable PAN release rates
- Contain variable levels of immediately available PAN
- The Immediately available PAN present is normally Ammonia. As high as 50% of Total N



Benefits of Natural Ammonia

Natural Ammonia Comparison to other Organic Fertilizers

•**Author:** Margaret Gullette Lloyd **Published on: March 12, 2018**



Benefits of Natural Ammonia

Natural Ammonia Comparison to other Organic Fertilizers

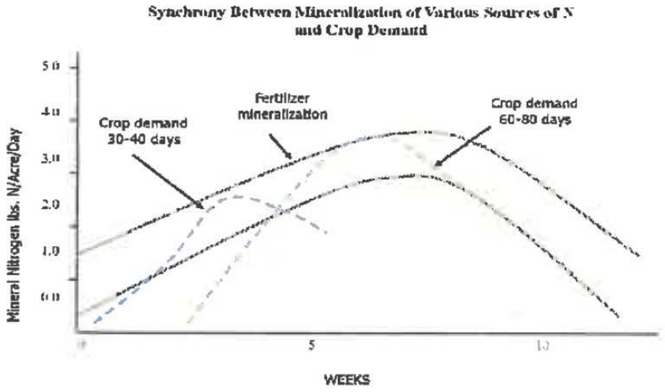
•**Author:** Margaret Gullette Lloyd **Published on: March 12, 2018**

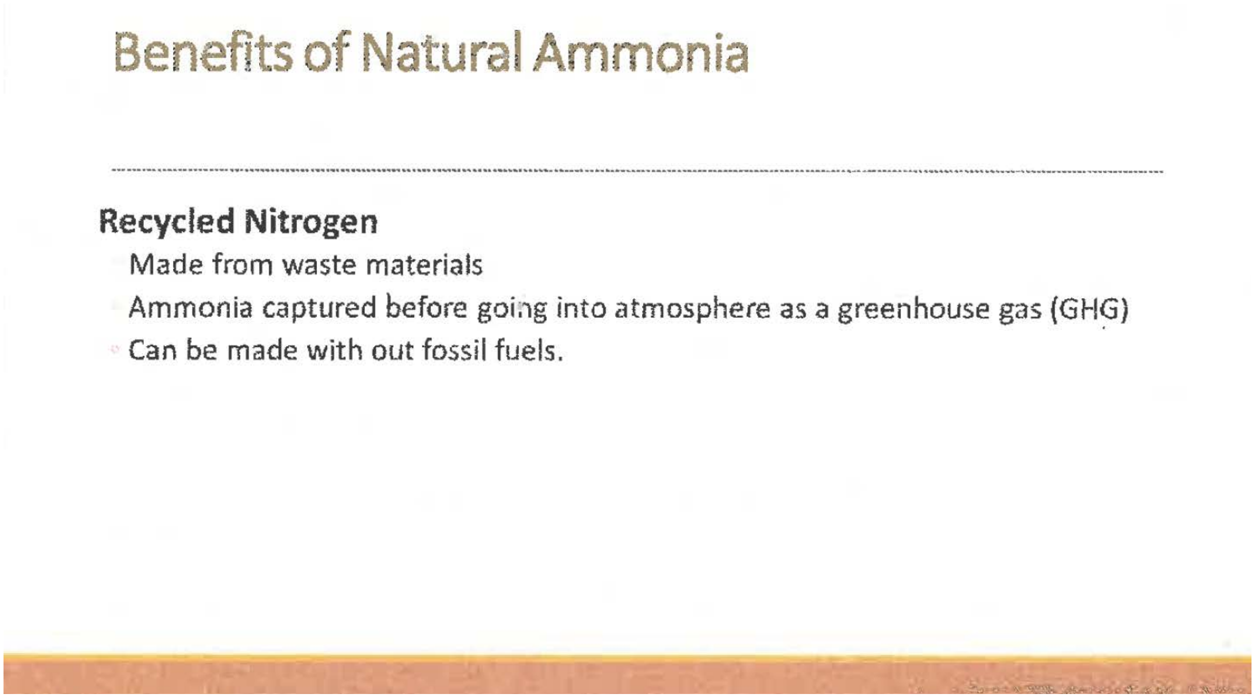
Benefits of Natural Ammonia

Use of Natural Ammonia

- Natural ammonia liquids are clear and clean and flow through irrigation systems easily.
- 100% PAN allows growers to make up for nitrogen deficiency during the growing season thereby increasing crop quality and yields.
- NA is best used to provide extra nitrogen immediately to a crop when the demand for nitrogen by the crop is greater than what the soil can supply. (improve quality and yields)
- NA is not meant to replace other inputs. It is a tool to be used to augment a balanced soil health program and to help minimize over-application of nitrogen.

Benefits of Natural Ammonia

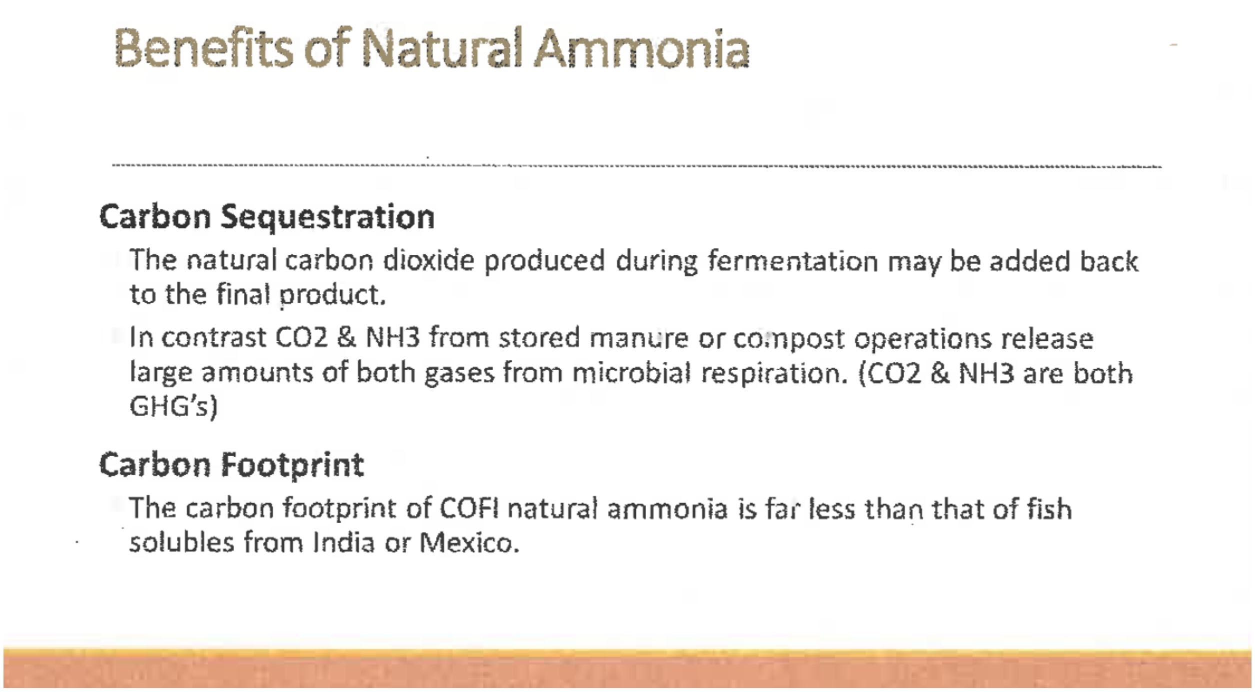




Benefits of Natural Ammonia

Recycled Nitrogen

- Made from waste materials
- Ammonia captured before going into atmosphere as a greenhouse gas (GHG)
- Can be made with out fossil fuels.



Benefits of Natural Ammonia

Carbon Sequestration

- The natural carbon dioxide produced during fermentation may be added back to the final product.
- In contrast CO2 & NH3 from stored manure or compost operations release large amounts of both gases from microbial respiration. (CO2 & NH3 are both GHG's)

Carbon Footprint

- The carbon footprint of COFI natural ammonia is far less than that of fish solubles from India or Mexico.

Benefits of Natural Ammonia

GMO

- These products are GMO free

Social Equity (California Organic Fertilizers)

- COFI's Natural Ammonia product is made in the USA in Hanford, CA.
- All COFI employees are full-time employees with benefits including 100% company paid Gold Level health care, vacation, sick leave, 401K etc.

Benefits of Natural Ammonia

Food Safety

- Natural ammonia is 100% free of pathogens and is not susceptible to contamination by pathogens

Product Quality

- COFI's Natural Ammonia product is made in the USA in Hanford, CA, at COFI's facility where all aspects of production are controlled by COFI and inspected by CDFA.

Other Issues

Environmental Concerns

- Natural Ammonia is a product.
- How it is used determines if there is a potential for environmental damage.
- This is the same for any product.

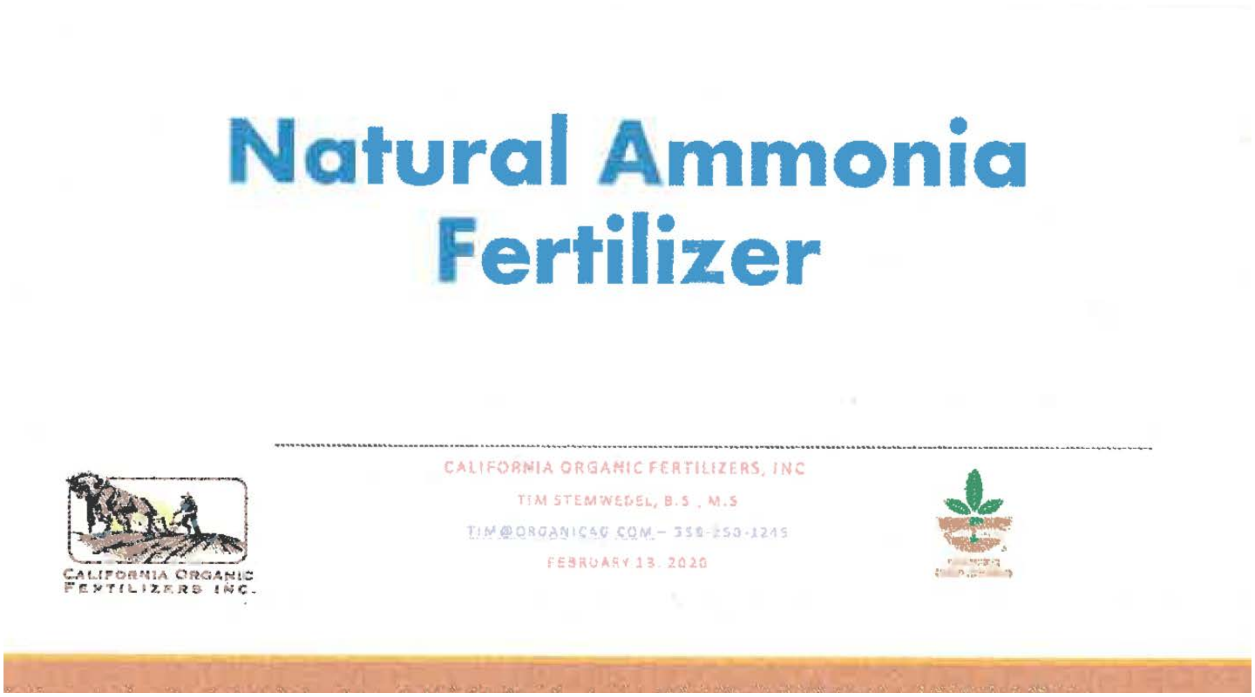
Other Issues

Negative impact on Soil & Environment

- COFI Natural Ammonia is 100% ammonia produced by a distillation process and contains extremely low levels of other minerals.
- In contrast to other products, that contain high salts, antibiotics, aluminum and other contaminants, Natural Ammonia is a hero!

Affect on nutrition of organically produced products

Nitrogen is essential for quality crop production. Ammonia and nitrate are the two main forms of nitrogen used by crops. It is unfathomable to imagine how a clean natural ammonia fertilizer could reduce nutritional value of organic products as compared to other inputs.



Natural Ammonia Fertilizer

CALIFORNIA ORGANIC FERTILIZERS INC.

CALIFORNIA ORGANIC FERTILIZERS, INC

TIM STEMWEDEL, B.S , M.S

TIM@ORGANICAG.COM – 559-250-1245

FEBRUARY 13, 2020