

**National Organic Standards Board
Livestock Subcommittee
Petitioned Material Proposal
Carbon Dioxide (CO₂) for Use in Aquatic Plant Production**

⁺February 3, 2014

Summary of Proposed Action:

Synthetic carbon dioxide is proposed to be added to the National List at 205.609. Section 205.609 will contain a list of synthetic substances allowed in organic aquatic plant production.

Carbon dioxide is an inorganic compound composed of one carbon atom and two oxygen atoms. In nature, carbon dioxide occurs as a gas and comprises 0.03% of the Earth's atmosphere. It is utilized by plants during photosynthesis and is produced by respiration by animals and plants. It is an important component of the carbon cycle and is also a well-known greenhouse gas.

The petition is for the use of carbon dioxide to grow algae within contained systems such as ponds and tanks. Petitioned use is for synthetic carbon dioxide due to the difficulty in buyers determining the source of CO₂. However there are naturally occurring sources of CO₂ available in some parts of the country.

CO₂ gas is used in the culture of aquatic plants as a production aid for alkalinity adjustment and maintaining pH at levels essential for rapid and healthy growth of the algae. Most, if not all, algae species are sensitive to pH levels. Carbon dioxide is used to maintain desired pH levels in water. The addition of CO₂ to water drives the pH value lower. Carbon dioxide is consumed by algae as cultures grow and can drive the pH level above the desired optimum. Since aquatic animals eliminate carbon dioxide as a metabolic product, the presence of aquatic animals in an algal culture reduces demand for carbon dioxide.

Carbon dioxide is available from natural sources and as a byproduct of various artificial sources. The most common operations from which commercially produced carbon dioxide is recovered are industrial plants which produce hydrogen or ammonia from natural gas, coal, or other hydrocarbon feedstock, and large-volume fermentation operations in which plant products are made into ethanol for human consumption, automotive fuel or industrial use. Breweries producing beer from various grain products are a traditional source. Corn-to-ethanol plants have been the most rapidly growing source of feed gas for CO₂ recovery.

Carbon dioxide is allowed for use under all international organic standards that were researched in an August 2006 technical report including Canadian, CODEX, EEC Council and IFOAM. However, it should be noted that at the time of that technical report, organic standards were not in place for organic aquatic plant production, and the allowed uses of carbon dioxide were for processing aids, pest control and terrestrial plant production.

While the petition is for synthetic carbon dioxide, the petitioner has made it clear that the reason for the request to include synthetic CO₂ is because of the variable availability around the country, rather than because synthetic is the only source.

Per the 1995 NOSB TAP review, CO₂ poses little risk to the environment and was unanimously determined to be consistent with a system of sustainable agriculture. At that time, the petitioned use was for addition to the National List at 205.605 for use in organic handling. The present petition is for use in aquatic plant production and therefore should be evaluated with different considerations. It could be argued that production methods that require continued external inputs may not be sustainable.

It should be noted that at the time of drafting this proposal there are no federal standards promulgated for aquatic plant or animal production and this proposal is based on NOSB recommendations of standards voted in 2007, 2008, and 2009.

Evaluation Criteria (see attached checklist for criteria in each category)

	Criteria Satisfied?		
1. Impact on Humans and Environment	X Yes	☐ No	☐ N/A
2. Essential & Availability Criteria	X Yes	☐ No	☐ N/A
3. Compatibility & Consistency	X Yes	☐ No	☐ N/A

Substance Fails Criteria Category: [] **Comments:**

Subcommittee Action & Vote, including classification proposal (state actual motion):

Classification Motion: Motion to classify Carbon Dioxide, CAS # 124-38-9, as synthetic

Motion by: Tracy Favre

Seconded by: Joe Dickson

Yes: 5 No: 0 Absent: 2 Abstain: 0 Recuse: 0

Listing Motion: Motion to list CO₂ at §205.609 with the following **annotation**: for use in contained systems such as tanks and ponds.

Motion by: Tracy Favre

Seconded by: Calvin Walker

Yes: 4 No: 1 Absent: 2 Abstain: 0 Recuse: 0

Basis for annotation: ☒ To meet criteria above ☐ Other regulatory criteria ☐ Citation
Notes:

Minority Opinion: see end of document

Approved by Tracy Favre, Subcommittee Chair, to transmit to NOSB February 3, 2014

NOSB Evaluation Criteria for Substances Added To the National List: Crops

Category 1. Adverse impacts on humans or the environment? Carbon Dioxide for use in Aquatic Plant Production

Question	Yes	No	N/A	Comments/Documentation (TAP; petition; regulatory agency; other)
1. Is there a probability of environmental contamination during use or misuse? [§6518(m)(3)]		X		Carbon dioxide can be classified as either synthetic or non-synthetic depending upon source, and is a naturally occurring component of air. High concentrations can lower the pH of water, which could adversely affect the environment. However, good management practices would mitigate this possibility. (Petition 2012).
2. Is there a probability of environmental contamination during, manufacture or disposal? [§6518(m)(3)]	X.			Production of carbon dioxide is a by-product of processes that have adverse effects on the environment. However, because CO ₂ is a by-product of these processes, these affects would occur regardless of CO ₂ production. (Aug 2006 TR, lines 296-299).
3. Are there any adverse impacts on biodiversity? (§205.200)		X		Under good management practice carbon dioxide for use in aquatic plant production is self-limiting, as too much CO ₂ decreases plant production and lowers water pH. (Petition, 2012) So impacts to biodiversity are unlikely.
4. Does the substance contain inerts classified by EPA as 'inerts of toxicological concern'? [§6517 (c)(1)(B)(ii)]		X		CO ₂ can exist in gaseous, liquid or solid forms but does not contain inerts. All manufacturing processes require purification (Aug 2006 TR, lines 188-189)
5. Is there potential for detrimental chemical interaction with other materials used in organic farming systems? [§6518(m)(1)]		X		High concentrations of CO ₂ will decrease water pH and make some nutrients bio-unavailable, but under normal good management practices, it is unlikely there would be detrimental chemical interactions. (Petitioner) See #3 above regarding self-limiting.
6. Is there a toxic or other adverse action of the material or its breakdown products? [§6518(m)(2)]		X		CO ₂ can be long-lived in the environment and therefore could contribute to climate change but otherwise poses no adverse action upon breakdown.
7. Is there persistence or concentration of the material or breakdown products in the environment? [§6518(m)(2)]	X			Carbon dioxide is a greenhouse gas (Aug 2006 TR, line 299), however, under proper management for aquatic plant production, CO ₂ would be metabolized by aquatic plants. (Petitioner)

8. Would the use of the substance be harmful to human health or the environment? [§6517 (c)(1)(A)(i); §6517 (c)(2)(A)(i); §6518(m)(4)]		X		At levels proposed for use by the petitioner, under normal good management practice, there is no demonstration of harmful effects to human health or the environment. In high concentrations in closed systems, there is a possibility of atmospheres dangerous for humans, but good management practices are likely to mitigate this possibility. Up to .05% is considered not harmful to humans. However, higher concentrations can be harmful. (Aug 2006 TR, lines 306-307) No evidence was found indicating that carbon dioxide leaves residues on food. (Aug 2006 TR, lines 354-356). Carbon dioxide is on the list of FDA confirmed GRAS substances. (Aug 2006 TR, lines 348-349)
9. Are there adverse biological and chemical interactions in the agro-ecosystem? [§6518(m)(5)]		X		On the contrary, good management of CO ₂ levels leads to increased plant production and biodiversity. Only at high concentrations could CO ₂ potentially have a negative impact. (Petitioner)
10. Are there detrimental physiological effects on soil organisms, crops, or livestock? [§6518(m)(5)]		X		See comment above.

Category 2. Is the Substance Essential for Organic Production? Carbon Dioxide for Use in Aquatic Plant Production

Question	Yes	No	N/A	Comments/Documentation (TAP; petition; regulatory agency; other)
1. Is the substance agricultural? [§6502(1)]		X		Carbon dioxide is an inorganic compound composed of one carbon atom and two oxygen atoms. In nature, carbon dioxide occurs as a gas and comprises 0.03% of the Earth's atmosphere. It is utilized by plants during photosynthesis and is produced by respiration by animals and plants. It is an important component of the carbon cycle and is also a well known greenhouse gas. (Aug 2006 TR, lines 17-21) Petitioned use is for synthetic Carbon Dioxide due to the difficulty in buyers determining the source of CO ₂ . However, while non-agricultural, there are naturally occurring sources of CO ₂ available in some parts of the country. (Aug 2006 TR, lines 240-252)

2. Is the substance formulated or manufactured by a chemical process? [§6502(21)]	X			There are numerous methods by which CO ₂ can be produced, including fermentation and as a by-product of oil and gas production. (Aug 2006 TR, lines 226-229)
3. Is the substance formulated or manufactured by a process that chemically changes a substance extracted from naturally occurring plant, animal, or mineral sources? [§6502(21)]	X			In some cases, CO ₂ production is a result of manufacturing processes, such as ethanol or oil and gas refining processes. (Aug 2006 TR, lines 178-201)
4. Is the substance created by naturally occurring biological processes? [§6502(21)]	X			CO ₂ can result from metabolic process of plants and animals and from some fermentation processes. (Aug 2006 TR, lines 203-207, 234-238)
5. Is there a natural source of the substance? [§ 205.600(b)(1)]	X			Naturally occurring CO ₂ does exist in deposits located in Mississippi, Colorado, and New Mexico, Utah, Wyoming and Washington, but transport of pressurized gas over long distances is not advised, and therefore may not be available in some parts of the country. (Aug 2006 TR, lines 178-201)
6. Is there an organic substitute? [§205.600(b)(1)]		X		Citric acid can be used in soil based operations but for aquatic environments, there is no known substitute. (Petitioner)
7. Is there a wholly natural substitute product? [§6517(c)(1)(A)(ii)]	X			Naturally occurring as a result of biological processes of animals, additionally natural sources of CO ₂ are available on a regional basis. (Petitioner)
8. Are there any alternative substances? [§6518(m)(6)]		X		There are no known substitutes. While there are non-synthetic forms of carbonate such as sodium bicarbonate and sodium carbonate that can lower pH values in water, these substances do not lower pH to values below 8.5 that are necessary for most species of algae. For aquatic plant production, CO ₂ is essential for proper plant health and productivity. When aquatic plant production is paired with animal production, the requirement for additional CO ₂ is reduced. (Petitioner)
9. Are there other practices that would make the substance unnecessary? [§6518(m)(6)]		X		See comment #8 above, however it is difficult to properly maintain water pH in aquatic plant production without the use of CO ₂ . Alkalinity and pH control is essential in the culture of aquatic systems. All, or virtually all, aquatic plants require carbon dioxide for healthy and rapid growth. There are no substitute substances, nor are there alternative culture methods. (Petitioner)

NOSB Evaluation Criteria for Substances Added To the National List Crops

Category 3. Is the substance compatible with organic production practices? Carbon Dioxide for Use in Aquatic Plant Production

Question	Yes	No	N/A	Comments/Documentation (TAP; petition; regulatory agency; other)
1. Is the substance consistent with organic farming and handling? [§6517(c)(1)(A)(iii); 6517(c)(2)(A)(ii)]	X			Per a 2005 TAP review, CO ₂ is consistent with organic farming and handling. CO ₂ is already listed on the National List for use in organic handling at 205.605. Carbon dioxide is allowed for use under all international organic standards that were researched including Canadian, CODEX, EEC Council and IFOAM. However, it should be noted that at the time of the technical report, organic standards were not in place for organic aquatic plant production, and the allowed uses of carbon dioxide were for processing aids, pest control and terrestrial plant production (Aug 2006 TR, lines 127-171)
2. Is the substance compatible with a system of sustainable agriculture? [§6518(m)(7)]	X	X		Per the 1995 NOSB TAP review, CO ₂ poses little risk to the environment and was unanimously determined to be consistent with a system of sustainable agriculture. At that time, the petitioned use for or addition to the National List at 205.605(b) for use in organic handling. The present petition is for use in aquatic plant production and therefore should be evaluated with different considerations. While the petition is for synthetic Carbon Dioxide, the petitioner has made it clear that the reason for the request to include synthetic CO ₂ is because of the variable availability around the country, rather than because synthetic is the only source. It could be argued that production methods that require continued external inputs may not be sustainable.
3. If used in livestock feed or pet food, Is the nutritional quality of the food maintained with the substance? [§205.600(b)(3)]			X	
4. If used in livestock feed or pet food, Is the primary use as a preservative? [§205.600(b)(4)]			X	

5. If used in livestock feed or pet food, Is the primary use to recreate or improve flavors, colors, textures, or nutritive value lost in processing (except when required by law)? [§205.600(b)(4)]			X	
6. Is the substance used in production, and does it contain an active synthetic ingredient in the following categories: [§6517(c)(1)(B)(i); copper and sulfur compounds		X		
toxins derived from bacteria		X		
pheromones, soaps, horticultural oils, fish emulsions, treated seed, vitamins and minerals		X		
livestock parasiticides and medicines		X		
production aids including netting, tree wraps and seals, insect traps, sticky barriers, row covers, and equipment cleansers		X		

Minority Opinion - Carbon Dioxide for Use in Aquatic Plant Production February 23, 2014

A minority of the subcommittee suggests that it is appropriate to adopt an annotation for carbon dioxide in aquaculture, with a justification explaining the that the specific time frame of five (5) years for an expiration date allows the Board to monitor the use of the material, incentivize alternatives, update its scientific and essentiality review, and vote on the continuation of use pending the receipt of a petition requesting that use be continued.

Support for the annotation is based on the following justification: Since this petition is being considered in the absence of regulations defining acceptable practices in organic aquaculture, essentiality in particular cannot be judged at this time. Therefore, the NOSB needs to reconsider the approval in five (5) years at the least. Current consideration of the material has raised issues relating to health or environmental impacts; alternatives derived from natural sources; and compatibility with organic and sustainable agriculture.. The review in five (5) years provides an opportunity for the Board to reevaluate and vote for the continued or modified use of the material under the same standard of review that is used to approve the material initially.

The NOSB Principles of Organic Production and Handling (adopted October 17, 2001) begin:

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.

To provide a major component necessary for aquatic plant growth in the form of a synthetic chemical is inconsistent with organic principles.

The Crops Subcommittee received information that indicates that additions of synthetic carbon dioxide are not essential. An NOP survey of certifiers who certify organic aquatic plant production found that very few inputs were used. Sometimes natural alkali, carbon dioxide, and sodium bicarbonate were used. Integrated systems¹ control pH and alkalinity, as well as other parameters, by balancing the organic components of the system.

While carbon dioxide may not seem very hazardous, the atmospheric concentration has reached the all-time high of 400ppm, elevating to extreme levels the threat of global climate change. Organic production may not be a large contributor, but the use of synthetic carbon dioxide, which is not captured, as opposed to using carbon dioxide produced by animals in the system, does contribute to the problem.

Finally, lacking an organic aquaculture policy for plant production introduces a further difficulty in creating the parameters necessary to establish systems that are compatible with the Organic Foods Production Act and resulting organic methods. Evaluating the use patterns of synthetic materials permitted on the National List outside of a defined policy on whole aquaculture systems for plants and animals runs contrary to organic process and practice because the use of a synthetic material must be evaluated relative to a practice norm in which no synthetics are added.

The petitioner has indicated that carbon dioxide for use in organic production of aquatic plants would be used only in closed systems. We believe that use of this substance in closed systems with no discharge to natural water bodies is vital to be added to the motion for the carbon dioxide proposed recommendation.

¹ See, for example, Siew-Moi Phang, 1992. **Role of algae in livestock-fish integrated farming systems. Proceedings of the FAO/IPT Workshop on Integrated Livestock-Fish Production Systems, 16–20 December 1991, Institute of Advanced Studies, University of Malaya, Kuala Lumpur, Malaysia.**