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Ms. Michelle Arsenault
National Organic Standards Board
USDA-AMS-NOP
1400 Independence Ave. SW
Room 2648-S, Mail Stop 0268
Washington, DC 20250-0268

Re. CS: Hydroponics, Aeroponics, Aquaponics, and Containers

These comments to the National Organic Standards Board (NOSB) on its Spring 2017 agenda are submitted on behalf of Beyond Pesticides. Founded in 1981 as a national, grassroots, membership organization that represents community-based organizations and a range of people seeking to bridge the interests of consumers, farmers and farmworkers, Beyond Pesticides advances improved protections from pesticides and alternative pest management strategies that reduce or eliminate a reliance on pesticides. Our membership and network span the 50 states and the world.

Beyond Pesticides supports the view that hydroponic operations should not be considered eligible for organic certification. We also support most of the regulatory language suggested by the Crops Subcommittee (CS).

The reports of the Hydroponics Task Force (HTF) provide good evidence that hydroponics is not, and cannot be, organic. It may not be clear to all readers that the task force "report" is actually two reports under one cover –two reports written by subcommittees with very different viewpoints– the 2010 NOSB Recommendation Subcommittee (2010 SC) and the Hydroponic and Aquaponic Subcommittee (HASC). The former represents the viewpoint that organic production must be in the soil, and the second promotes certification of "organic" hydroponics. The confusion is heightened by a table near the end with columns labelled "NOSB 2010 Recommendation Summary" and "Task Force Analysis." Since the analysis in the second column is that of the HASC, not the entire HTF, it delivers a misleading impression that the whole HTF supports the certification of "bioponics" as organic. The NOP should never have allowed the document to be published in that format.

A range of issues critical to organic principles and standards, discussed below, must be considered when evaluating the compatibility of hydroponics or "bioponics" with certified organic.

Foundations of Organic Production

Historically, perhaps the most important principle of organic production is the "Law of Return," which together with the rule "Feed the soil, not the plant" and the promotion of biodiversity, provide the ecological basis for organic production.[1] Together these three principles describe a production system that mimics natural systems. The Law of Return says that we must return to the soil what we take from the soil. Non-crop organic matter is returned directly or through composting plant materials or manures. To the extent that the cash crop removes nutrients, they must be replaced by cover crops, crop rotation, or additions of off-site materials when necessary.

The dictum to "Feed the soil, not the plant" reminds us that the soil is a living superorganism that supports plant life as part of an ecological community. We do not feed soil organisms in isolation, to have them process nutrients for crop plants; we feed the soil to support a healthy soil ecology, which is the basis of terrestrial life.

Finally, biological diversity is important to the health of natural ecosystems and agroecosystems. Biodiversity promotes balance, which protects farms from outbreaks of damaging insects and disease. It supports the health of the soil through the progression of the seasons and stresses associated with weather and farming. It supports our health by offering a diversity of foods.

The report of the 2010 SC reminds us of these foundations, but also contrasts organic production and "conventional" agriculture. At the time of the passage of the Organic Foods Production Act, the organic community's characterization of soil as alive was viewed with amusement by the "conventional" agriculture experts, who saw soil as a structure for supporting plants while farmers poured on nutrients –and the poisons necessary to protect the plants growing outside of the protection of their ecological community. Interestingly, organic producers at that time compared conventional agriculture to hydroponics.

Conventional agriculture has now learned something about soil life –enough to promote some use of cover crops. On a parallel track, practitioners of hydroponics have learned the value of biology in their nutrient solutions. However, in both cases, the lessons have not been completely understood. This is made very clear from the attempts of the HASC to explain that "bioponics" (non-sterile hydroponics) depends on biological activity.

Yes, bioponics relies on biological activity in the nutrient solution to break down complex molecules and make them available to the plants. And yes, the nutrient solution in bioponics has an ecology –as all biological systems do. But the HASC repeatedly calls this a "soil ecology," although it is merely an artificial mimic of soil ecology and a reductionist approach to manipulating nature.

[1] See Sir Albert Howard. The Soil and Health: The Study of Organic Agriculture (1940), and An Agricultural Testament (1947).

Here is where a quote from the Omnivore's Dilemma (2006) by Michael Pollan can help give us some perspective on the importance of organic as envisioned by the pioneers of the practices and the drafter of the Organic Foods Production Act:

> To reduce such a vast biological complexity to NPK represented the scientific method at its reductionist worst. Complex qualities are reduced to simple quantities; biology gives way to chemistry. As [Sir Albert] Howard was not the first to point out, that method can only deal with one or two variables at a time. The problem is that once science has reduced a complex phenomenon to a couple of variables, however important they may be, the natural tendency is to overlook everything else, to assume that wat you can measure is all there is, or at least all that really matters. When we mistake what we can know for all there is to know, a healthy appreciation of one's ignorance in the face of a mystery like soil fertility gives way to the hubris that we can treat nature as a machine.

The ecological system of a hydroponic nutrient system is revealed in the HASC report to be more like a fermentation chamber –a means of processing plant nutrients– than the soil ecosystem of an organic farm. To see this, we can look at the three principles mentioned above.

The Law of Return. In a soil-based system, residues are returned to the soil by tillage, composting, or mulching. In a bioponics system, the residues may be composted, but none of the case studies describes how the residues are returned to the bioponic system, closing the loop. We note that the HASC identifies some inputs used in bioponics.[2] They include many agricultural products –animal-based compost, soy protein, molasses, bone meal, alfalfa meal, plant-based compost, hydrolyzed plant and animal protein, composted poultry manure, dairy manure, blood meal, cottonseed meal, and neem seed meal– and these are produced off-site, with no return to their production system. While most organic growers depend on some off-site inputs, most of the fertility in a soil-based system comes from practices that recycle organic matter produced on-site. The <u>cycling</u> of organic matter and on-site production of nutrients –as from nitrogen-fixing bacteria and microorganisms that make nutrients in native mineral soil fractions available to plants– is essential to organic production. The Law of Return is not about feeding plants, but about conserving the biodiversity of the soil-plant-animal ecological community.

Feed the soil, not the plant. The description of the bioponics system and case studies reveal how much bioponics relies on added plant nutrients. These nutrients may be made available through biological processes, but they are added to feed the plants, not the ecosystem. The case study of bioponic tomatoes in the Hydroponics Task Force Report, for example, says,

> After planting the seedlings in this growing media, it is necessary to add supplemental nutrition throughout the growing cycle (approximately one year). About once per week, solid and liquid nutrients are added to the growing media. Some fertilizer can be applied through the irrigation lines because they are soluble enough and will not clog the lines.

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[2] See table on p. 23 of HASC report.

> The use of soluble nitrogen fertilizers is limited because of their high costs, for instance for plant-based amino acids. As long as the sodium nitrate rule continues to apply, it will be used as a lower cost nitrogen source. Soluble organic-compliant inorganic minerals are also added through the irrigation system, such as potassium and magnesium sulfate.

Biodiversity. The definition of "organic production" in the organic regulations requires the conservation of biodiversity. As stated in the NOP Guidance on Natural Resources and Biodiversity Conservation (NOP 5020),

> The preamble to the final rule establishing the NOP explained, "[t]he use of 'conserve' [in the definition of organic production] establishes that the producer must *initiate practices to support biodiversity* ***and*** *avoid, to the extent practicable, any activities that would diminish it.* Compliance with the requirement to conserve biodiversity requires that a producer incorporate practices in his or her organic system plan that are beneficial to biodiversity on his or her operation." (76 FR 80563) [Emphasis added.]

Thus, it is not enough for a hydroponics producer to say it is <u>not diminishing</u> soil and plant biodiversity –the operation must take active steps to <u>support</u> biodiversity. On a soil-based organic farm, many practices support biodiversity –from crop rotations to interplanting to devoting space to hedgerows and other non-productive uses. Many of these practices can and should be used by farmers producing food in greenhouses. However, the case studies provided by the HASC are evidence that bioponics is a monocultural environment that does not support biodiversity.

Aquaponics. Aquaponics differs from bioponics in several respects. Animal wastes produced by the system are used to feed plants. There is more biodiversity because there are both plants and animals. However, the system is strongly dependent on fish feed coming from outside the system. As with bioponics, the Law of Return is violated for the production of the animal feed. If fish feed were produced on-site using recycled water and nutrients plants grown using fish waste, then we would be more inclined to see possibilities for organic aquaponics. There is also more possibility of a system with biodiversity and soil ecology, but that is not reflected in the case history presented.

Exceptions

Both reports discuss exceptions to organic production as a purely soil-based system. These exceptions prove the rule that organic production is soil-based. Sprouts are not required to be grown in soil because sprout production is a way of processing seeds, just as pickling is a way of processing vegetables. Transplants are not truly an exception because the crop is produced by plants grown in the soil. Mushrooms are not required to be grown in the soil because the mushrooms grown for food or medicinal uses are saprophytes that decompose organic matter. They are thus grown on ecologically-appropriate substrate –manure for *Agaricus bisporus* and wood for shitake (*Lentinula edodes*), hen of the woods (*Grifola frondosa*), reishi (*Ganoderma lucidum*), and others.

A Continuum of Greenhouse Production Methods

The discussion of greenhouse culture demonstrates that there is a continuum from in-ground production to hydroponic/bioponic production. As an example, we agree with the 2010 SC that microgreens are debatable as an exception –they are almost processed seeds and all of the nutrients can be provided by the compost medium. This is an area that needs more attention. If microgreens are to be treated the same as sprouts, then the seeds must be organic, and soluble fertilizers must not be allowed. We address containerized systems at the end of these comments.

Other Issues

Advocates of hydroponics/bioponics point to its greater water use efficiency as beneficial to the environment. However, many hydroponics operations are situated in deserts where in-ground cultivation of vegetables is impractical and water resources are scarce. In these situations, hydroponic growing operations may use limited water resources that are needed for other uses.

One factor leading consumers to purchase organic produce is its perceived greater nutrient value. Research supports that perception. On the other hand, research has shown that nitrate concentrations in leafy vegetables are significantly different for hydroponic, conventional, and in-ground organic systems, with hydroponic>conventional>organic.[3] Desired nutrients are generally more concentrated in organic vegetables, with organic>conventional>hydroponic.[4] To some extent the nutrient levels of the produce can be manipulated by manipulating the nutrient solution in hydroponics –once again reflecting the "feed the plant" philosophy inherent in hydroponics. While hydroponics may reduce stress on plants, some phytonutrients are produced by plants in response to stress.[5]

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[3] Guadagnin, S.G., Rath, S. and Reyes, F.G.R., 2005. Evaluation of the nitrate content in leaf vegetables produced through different agricultural systems. *Food additives and contaminants*, *22*(12), pp.1203-1208.

[4] Kimura, M. and Rodriguez-Amaya, D.B., 2003. Carotenoid composition of hydroponic leafy vegetables. *Journal of Agricultural and Food Chemistry*, *51*(9), pp.2603-2607. Virginia Worthington. *The Journal of Alternative and Complementary Medicine*. July 2004, 7(2): 161-173. doi:10.1089/107555301750164244. Caris-Veyrat, C., Amiot, M.J., Tyssandier, V., Grasselly, D., Buret, M., Mikolajczak, M., Guilland, J.C., Bouteloup-Demange, C. and Borel, P., 2004. Influence of organic versus conventional agricultural practice on the antioxidant microconstituent content of tomatoes and derived purees; consequences on antioxidant plasma status in humans. *Journal of agricultural and food chemistry*, *52*(21), pp.6503-6509. Toor, R.K., Savage, G.P. and Heeb, A., 2006. Influence of different types of fertilisers on the major antioxidant components of tomatoes. *Journal of Food Composition and Analysis*, *19*(1), pp.20-27.

[5] Kubota, C., Thomson, C.A., Wu, M. and Javanmardi, J., 2006. Controlled environments for production of value-added food crops with high phytochemical concentrations: lycopene in tomato as an example. *HortScience*, *41*(3), pp.522-525. Moreno, D.A., López-Berenguer, C., Martínez-Ballesta, M.C., Carvajal, M. and García-Viguera, C., 2008. Basis for the new challenges of growing broccoli for health in hydroponics. *Journal of the Science of Food and Agriculture*, *88*(8), pp.1472-1481.

Response to pro-hydroponics justifications for §205.203 and §205.205

§205.203 Soil fertility and crop nutrient management practice standard.

203(a) The producer must select and implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion.

Pro-hydroponics justification: "[T]he lack of tillage and extraction of nutrients from soil is also a way to improve or maintain soil."

Beyond Pesticides comment: This argument would seem to justify as organic any land use –such as putting in a parking lot— that does not grow plants in the soil. Organic no-till is an example of a practice that foregoes most tillage and improves the physical, chemical, and biological condition of the soil and minimizes soil erosion. Covering the soil with an impervious structure –whether it is a parking lot or a greenhouse— does not improve the soil, and –as pointed out by opponents of hydroponics cited in the discussion document— erecting a structure may contribute to soil erosion by providing less soil surface for infiltration of rain.

203(b) The producer must manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials.

Pro-hydroponics justification: "[C]rop nutrient management and growing media fertility can be maintained without contributing to contamination by allowing proliferation of active biology which is equivalent to rotation, or cover crops."

Beyond Pesticides comment: Crop rotation, cover crops, and the addition of plant and animal materials to the soil produce many benefits. Among those benefits is the provision of plant nutrients and soil fertility. However, these practices are not solely based on crop productivity. They are required in organic production because organic production is designed to have positive impacts on ecosystems. As stated at the very beginning of the *NOSB Principles of Organic Production and Handling*, adopted October 17, 2001, "Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity." The practices specified in this regulation contribute to benefits on and off the farm –for example, carbon sequestration–that go far beyond avoiding contamination.

203(c) The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances....

Pro-hydroponics justification: "[C]ontamination is avoided by growing in a controlled system and having compliant practices in place for discharges."

Beyond Pesticides comment: By focusing on the word "contamination," this statement ignores the essence of the regulatory requirement –to "manage plant and animal materials to maintain or improve soil organic matter content" – which is something that hydroponic systems do not do.

§205.205 Crop rotation practice standard.

The producer must implement a crop rotation including but not limited to sod, cover crops, green manure crops, and catch crops that provide the following functions that are applicable to the operation:

(a) Maintain or improve soil organic matter content;

(b) Provide for pest management in annual and perennial crops; …

Pro-hydroponics justification: "[R]otation is accomplished by renewal of growing media at the end of each crop cycle or as appropriate for each crop." As bioponic (hydroponic) systems do not impact the soil organic matter below the system as would an in-ground crop, it is expected that the requirement of rotations and cover crops to maintain or improve such surrounding soil organic matter would be inapplicable to bioponic (hydroponic) production." (Task Force report, p. 149)."

Beyond Pesticides comment: Again, the promoters of hydroponics ignore the core of the regulatory requirement and demonstrate a lack of understanding of organic principles. Renewal of growing media at the end of each crop cycle does not "implement a crop rotation, including, but not limited to, sod, cover crops, green manure crops, and catch crops." To claim an exemption from this requirement because "bioponic (hydroponic) systems do not impact the soil organic matter below the system as would an in-ground crop" demonstrates a fundamental lack of understanding of organic production, which has been defined by the NOSB (in the statement of principles quoted above) as "an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity."

Comments on arguments against hydroponics

We generally agree with the arguments presented against hydroponics, but would supplement them with the following.

"The maintenance and regeneration of this complex, living soil system is a biological process that requires continual recycling of organic materials within the soil system. . . . For this reason, many organic producers reject hydroponic systems that are input-based rather than soil-based. Also, when hydroponic operations pave over soil with cement or gravel, soil and natural resource conservation can be compromised."

It is not just "many organic producers" who reject input-based systems. The first *Principle of Organic Production and Handling* adopted by the NOSB states,

> 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.

"Increased soil organic matter, cover crops, rotations, contour strips, reduced tillage and other activities continually improve the soil's structure and lessen erosion, which negatively affects water and soil quality. This integration of working lands with ecosystem stewardship is a foundational principle of organic agriculture."

In addition to the advantages cited here, we add carbon sequestration, which is important to mitigating the problems caused by global climate change.

"The 'input substitution' approach of hydroponics has long been considered incompatible with a system of organic agriculture."

Again, we refer to the above quotation from the *NOSB Principles of Organic Production and Handling* to support the importance of this assertion.

Suggested regulatory language

We generally support the suggestions of the Crops Subcommittee, but see below regarding "recalcitrant."

- **205.2 Terms defined. Add:**
    - **Aeroponics:** A variation of hydroponics in which plant roots are suspended in air and misted with nutrient solution.
    - **Hydroponics:** The production of normally terrestrial, vascular plants in nutrient-rich solutions, or in a medium of inert or biologically recalcitrant solid materials to which a nutrient solution is added.
    - **Aquaponics:** A recirculating hydroponic system in which plants are grown in nutrients originating from aquatic animal wastewater, which may include the use of bacteria to improve availability of these nutrients to the plants. The plants improve the water quality by using the nutrients, and the water is then recirculated back to the aquatic animals.

- **§205.105 Allowed and prohibited substances, methods, and ingredients in organic production and handling.**
    - **Add (h) Aeroponics.**
    - **Add (i) Hydroponics.**
    - **Add (j) Aquaponics.**

Discussion questions regarding hydroponics

1) The soil science term "recalcitrant" is used in the definition of hydroponics to identify substrates that are used in some hydroponic systems that are not completely "inert" but do not contribute substantive plant nutrition. Is this term and the intent of including it in the definition understood by the organic community, and should it be included in the definition?

Although we are in agreement with the sense of the definition –in including substrates that are not completely inert but do not contribute substantive plant nutrition– we caution that using a term from soil science that refers to components of natural soils may prove to be misleading. Therefore, we suggest that the definition be revised:

> Hydroponics: The production of normally terrestrial, vascular plants in nutrient-rich solutions, or in a medium of inert or ~~biologically recalcitrant~~ solid materials **that are resistant to decomposition**, to which a nutrient solution is added.

2) Please provide feedback on the definitions of aeroponics, hydroponics, and aquaponics used in this proposal.

With the exception noted above, we support the definitions.

3) Some stakeholders have proposed an option of alternative labeling under OFPA for organic hydroponics. Please address opportunities or weakness to this suggestion.

We support alternative labeling, as long as it does not use the word "organic." OFPA and the NOP do not provide the proper framework for such a label. However, a label could be developed under USDA's Process Verified Program.

4) Some proponents of hydroponics have stated that some commercial organic in-ground farmers may rely on liquid fertility inputs for most of their fertility needs. Please provide information to either support or refute this statement. Should that issue be addressed in the future?

Discussions of the essentiality of some inputs –such as corn steep liquor and sodium nitrate– lead us to believe that the statement is true. If so, such farmers should not be certified organic –because of the same principle we have cited several times above, defining organic production.

Containers

The term "container" is very broad, encompassing pots in various sizes and shapes, as well as beds that are not in direct continuous contact with the earth –such as rooftop gardens, or gardens in areas where an impervious layer protects plants from contaminated earth beneath. We support eligibility for organic certification of containers where the soil is managed organically. As discussed above, managing the soil organically involves many things –most could not be done in pots or most other containers, but would be possible in large beds. In particular, the following regulations must be followed to the letter.

§205.203 Soil fertility and crop nutrient management practice standard.

(a) The producer must select and implement tillage and cultivation practices that maintain or improve the physical, chemical, and biological condition of soil and minimize soil erosion.

To meet this requirement, the producer must adopt practices that are essentially the same as those that might be used in established beds in an organic garden.

(b) The producer must manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials.

This requirement should be taken literally.

(c) The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances....

In any container, including large beds, there is a danger of building up heavy metals and other substances –including water– because of the lack of connection with the subsoil. Special care needs to be devoted to managing runoff in extreme rainfall and to monitoring concentrations of heavy metals.

§205.205 Crop rotation practice standard.

The producer must implement a crop rotation including but not limited to sod, cover crops, green manure crops, and catch crops that provide the following functions that are applicable to the operation:

(a) Maintain or improve soil organic matter content;

(b) Provide for pest management in annual and perennial crops; …

Again, these are requirements that should be applied literally to containerized systems.

Biodiversity conservation

In addition, containerized systems must implement practices to preserve and build biodiversity. This includes plantings as part of crop rotations that support pollinators and other insects. It also includes management of non-crop areas to conserve biodiversity.

Conclusion

Beyond Pesticides opposes the organic certification of products grown by hydroponic, aeroponic, or aquaponic methods. Containerized culture may be eligible for organic certification under limited circumstances in which organic soil-building and other practices are used.

Thank you for your consideration of these comments.

Sincerely,

Terry Shistar, Ph.D.
Board of Directors