



BEYOND PESTICIDES

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Ms. Michelle Arsenault
National Organic Standards Board
USDA-AMS-NOP
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Re. CS: Hydroponics, Aeroponics, Aquaponics, and Containers

These comments to the National Organic Standards Board (NOSB) on its Fall 2018 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. The NOSB should take a clear position in opposition to hydroponics and other non-soil-based methods in organic production, including containers.

The reports of the Hydroponics Task Force (HTF) provide evidence that hydroponics is not, and cannot, meet basic organic standards. 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 of the document with columns labeled "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. 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” chemical-intensive agriculture. At the time of the passage of the Organic Foods Production Act (OFPA), 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 synthetic nutrients –and the poisons that had become necessary to protect the plants growing without 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 and applied. 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 OFPA:

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 what 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 bioaponics system, the residues may be composted, but none of the case studies describes how the residues are returned to the bioaponic system, closing the loop. We note that the HASC identifies some inputs used in bioaponics.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 cycling 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 bioaponics system and case studies reveal how much bioaponics 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 bioaponic 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

² See table on p. 23 of HASC report.

through the irrigation lines because they are soluble enough and will not clog the lines. 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 not diminishing soil and plant biodiversity –the operation must take active steps to support 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.

Other Issues

Advocates of hydroponics/biaponics 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.

Furthermore, the water efficiency needs to be balanced against energy inefficiency. One study found that despite greater yield per unit area and better water use efficiency, lettuce grown hydroponically in a major lettuce production area of Arizona used 82 times as much energy per kilogram of lettuce as soil-based production.³ This is consistent with the statement of NOSB member Dave Mortensen during the recent NOSB webinar on hydroponics:

I also had an opportunity this winter to visit a hydroponics plant, and another concern I have is the extreme reliance on energy consumption. There had been an ice storm that knocked out power to this facility that I visited, and within 9 hours all of the plants and all of the fish had died due to the loss of power....and I found myself thinking this was about as far from an organic holistic system that I could imagine. I continue to be thinking of this from how the plants growing in these systems are responding, but also what is the energy footprint of the system.

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.⁴ Desired nutrients are generally more concentrated in organic vegetables, with

³ Barbosa, Guilherme Lages, Francisca Daiane Almeida Gadelha, Natalya Kublik, Alan Proctor, Lucas Reichelm, Emily Weissinger, Gregory M. Wohlleb, and Rolf U. Halden. "Comparison of land, water, and energy requirements of lettuce grown using hydroponic vs. conventional agricultural methods." *International journal of environmental research and public health* 12, no. 6 (2015): 6879-6891.

⁴ 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.

organic>conventional>hydroponic.⁵ To some extent, the nutrient levels of the produce can be manipulated with 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.⁶

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 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

⁵ 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., Guillard, 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.

⁶ 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.

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.

(d) A producer may manage crop nutrients and soil fertility 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 by applying:

(1) A crop nutrient or soil amendment included on the National List of synthetic substances allowed for use in organic crop production;

(2) A mined substance of low solubility;

(3) A mined substance of high solubility: *Provided, That, the substance is used in compliance with the conditions established on the National List of nonsynthetic materials prohibited for crop production;*

...

Beyond Pesticides comment: As pointed out in the background statement of the Crop Subcommittee proposal, the language above arose in response to public comment on a provision in the proposed rule that would have allowed the use of mined substances of high solubility when warranted by crop soil and tissue sampling. The intention of adding (2) and (3) above is to single out highly soluble nutrients and require that they be allowed only when conditions on the National List (such as those established for Chilean nitrate) could control their use. This is a requirement that is not met by hydroponic systems.

§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.

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.

Lighting

Regarding the use of artificial lighting, we agree with the Hydroponics Report (2010 SC):

- Greenhouses need to be more specifically defined as having transparent roofs and walls to permit the passage of sunlight. Controlled indoor environments without transparent roofs and walls can be used for transplant production but not for organic crops.
- Electric lighting may be used as a supplement to the sun, but not as a replacement for the sun when producing organic crops. Transplants can be produced with only electric lighting.

Recycling of Pots, Vegetative Matter, and Substrate

The recommendations adopted by the NOSB in 2010 should be followed:

Growing media shall be comprised of ingredients that allow for recycling and re-use as growing media within the operation, or alternatively, as a crop input outside the greenhouse. Growing media shall not be disposed of as waste, but should be recycled or reused whenever possible.

Use of Petroleum-Based Mulches that Are Applied, Left Down for Many Years, Covering Many Acres

The use of synthetic mulches should comply with the exemption in 205.206(c)(6): Plastic or other synthetic mulches: *Provided*, That, they are removed from the field at the end of the growing or harvest season.

What is soil?

The medium used in containers should be soil – it should result from the same soil-building practices as soil in a garden. We also concur with the Hydroponic Task Force definition:

Soil -- The upper layer of earth that may be dug or plowed and in which plants can grow. Soil consists of four important parts: mineral solids, water, air, and organic matter. Mineral solids are sand, silt, and clay and mainly consist of silicon, oxygen, aluminum, potassium, calcium, and magnesium. A typical agricultural soil has 1% to 6% organic matter. It is the interaction between the soil organisms in the organic matter that release the mineral nutrients from the soil minerals in plant available forms.

Conclusion

Beyond Pesticides opposes the organic certification of products grown by hydroponic, aeroponic, or aquaponic methods, or any other system in which the plants are not grown in the soil, in the ground. The NOSB should take a clear position in opposition to hydroponics and other non-soil-based methods in organic production, including containers.

Thank you for your consideration of these comments.

Sincerely,

A handwritten signature in cursive script, appearing to read "Terry Shistar".

Terry Shistar, Ph.D.
Board of Directors