National Organic Standards Board
Crops Subcommittee Proposal
Hydroponics and Container-Growing Recommendations
August 29, 2017

Introduction

Over the past year the Crops Subcommittee has prepared—and received many public comments on—two discussion documents and a proposal covering the range of growing systems in which nutrient delivery to plants is water based, including aeroponics, hydroponics, aquaponics, and plants grown in containers. We have learned that the public is divided on these issues, as are members of the NOSB. Some think that organic certification should require plants be grown in soil that is connected to the earth's surface. Others think that organic certification should allow the growing of plants in pure nutrient solution, without the presence of any soil or compost. Others favor positions somewhere in between.

Accredited organic certification agencies have been permitted to certify hydroponic operations as organic by the National Organic Program (NOP), with some agencies certifying hydroponic operations and some choosing not to. The lack of consistency among certifying agencies and lack of standards for water-based nutrient-delivery growing systems has led to the need for the National Organic Standards Board to review this issue in a holistic way and recommend a path forward to the National Organic Program.

The purpose of this proposal is to delineate the range of growing systems, from soil to soilless, and make recommendations on a middle ground within that range, which we hope the NOSB and the organic community can support. To do that, we first summarize pertinent past discussions and legal considerations.

Background

The 1995 NOSB recommendation *Standards for Greenhouses* contains the statement:

> Hydroponic production in soilless media to be labeled organically produced shall be allowed if all provisions of the OFPA have been met.

This was before there was an NOP rule so the NOSB only had OFPA to guide them. Also, that statement indicated that an analysis had not been made of whether or not hydroponics met the provisions of OFPA. The brief dialogue at the 1995 meeting indicates that while some board members were supportive of hydroponics, others had concerns about soilless production:

> Kahn concluded his report by reading the hydroponics recommendation that would allow organic labeling for products from soilless media if all other National Program requirements are satisfied. Baker expressed his concerns about the philosophical problems associated with soilless production. Kahn noted that the recommendation only allows for the possibility of an organic hydroponics industry developing. Kahn recognized that hydroponics is a practice that is dependent on synthetic inputs and wants to open up dialogue with its proponents. Crossley moved and Weakley seconded a motion to accept lines 101-105 as a Board Final Recommendation. Friedman first offered a friendly amendment that was accepted to strike "other applicable" from the document. Vote: Unanimous aye.[1]

A revised proposed rule for the National Organic Program was published in March 2000 revising the initial

[1] NOSB Meeting Minutes - April 24-28, 1995. Orlando, Florida.

proposed rule published in December 1997. In the supplemental information, the following was stated:

> (13) We have amended the term, "system of organic farming and handling," to "system of organic production and handling" and retained the original definition in this proposal. The original definition was crafted to be consistent with the requirements of the Act. We have changed "farming" to "production" to provide a more encompassing term, which may come to include such diverse activities as hydroponics, green house production, and harvesting of aquatic animals. The purpose of the original definition was to describe practices and substances consistent with systems of organic farming and organic handling as required by the Act and to provide an explicit reference point for determining which practices and substances are most consistent with these systems. Several commenters suggested that the definition include the concepts, "agroecosystem health," "ecological harmony," and "biological diversity." Commenters also suggested including definitions for "organic agriculture," "organic farming," and "transition to organic." This definition is intended to clarify regulatory provisions in this proposal and is not intended as a broad philosophical statement. The terms "organic agriculture," "organic farming," and "transition to organic," are not used in this proposal and, therefore, are not defined[2]

The final rule for the National Organic Program was published in December 2000 (65 FR 80547). In the supplemental information, the following was stated:

> The proposed rule treated mined substances of high solubility as a single category of soil amendment and allowed their use where warranted by soil and crop tissue testing. Many commenters objected to the general allowance for this category of substances and were particularly disappointed that the NOSB annotations on two such materials, sodium (Chilean) nitrate and potassium chloride, were not included. Commenters cited the potential detrimental effects of these highly soluble and saline substances on soil quality and stated that several international organic certification programs severely prescribe or prohibit their use. One certifying agent recommended that natural substances of high solubility and salinity be handled comparably to similar synthetic materials such as liquid fish products and humic acids that appear on the National List, complete with their original NOSB annotations.
>
> At its June 2000 meeting, the NOSB recommended that the NOP delete general references to mined substances of high solubility from the final rule, and incorporate the NOSB's specific annotations for materials of this nature. We have adopted this recommendation by retaining a place for mined substances of high solubility in the soil fertility and crop nutrient management practice standard but restricting their use to the conditions established for the material as specified on the National List of prohibited natural substances. Under this approach, mined substances of high solubility are prohibited unless used in accordance with the annotation recommended by the NOSB and added by the Secretary to the National List.[3]

At the Spring 2002 Meeting the NOSB Crops Subcommittee brought forward a new proposal on hydroponics stating:

> Hydroponic production in soilless media shall be allowed if all other provisions of the Organic Food Production Act and NOP final rule have been met. However, the Crop Committee recommends that the principles of organic production as presented by the NOSB Board be met by any certified

[2] Federal Register Volume 65 Number 49. Page 13521. Docket Number: TMD-00-02-PR2, RIN 0581-AA40. National Organic Program Proposed Rule. Agricultural Marketing Service, USDA. March 13, 2000

[3] Federal Register Volume 65 Number 246. Page 80565. Docket Number: TMD-00-02-FR, RIN 0581-AA40. National Organic Program Final Rule. Agricultural Marketing Service, USDA. December 21, 2000

organic hydroponic system.

We recognize it will be a challenge for many hydroponic operations to meet some of the principles, that is, promoting biological cycles, recycling materials, minimizing use of non-reusable resources, et cetera. And we recommend that hydroponic operations that do not meet such principles be denied organic certification.

Discussion went on to note that this proposal followed recommendations made on greenhouse management, which allowed for waivers of certain NOP requirements. It was further noted that the intent of the proposal was to allow hydroponics if they meet all parts of OFPA/NOP other than soil requirements. Board members debated this motion and some questioned if exempting operations from soil was consistent with organic principles. Input was sought from the program if hydroponics were allowed under the NOP as currently written:

MR. BANDELE: Rick, maybe it would be helpful to get a clarification on, is hydroponics already covered?

MR. MATHEWS [NOP Program Manager]: The policy statement that is on the Web with regard to the scope of the National Organic Standards includes hydroponics.[2]

After input from the program, the board decided to table the matter stating:

Hydroponic -- based on a discussion yesterday, the crops committee will reconsider that it was pointed out by Rick that hydroponics is already covered as far as the existing rule is concerned. So what the crops committee will do is try to provide some -- a guidance document… to the hydroponic situation at a later date.[4]

At the October 2002 meeting there was some discussion of hydroponics being on the Crops agenda but no additional information.[5] At the May 2003 NOSB meeting a draft discussion document about hydroponic and soilless production techniques and questions was circulated and at the meeting the following statement was recorded in the minutes:

Draft guidance document regarding certification of hydroponics and other soil-less production systems. The draft will be forwarded to the strategic planning committee and NOP for feedback and to determine if further work on the document is a priority.[6]

The topic of hydroponics was next discussed at the October 2004 meeting. In the context of a draft NOP scope document, the policy sub-committee stated the following:

[In regards to the scope document] …the sixth area, which was mushrooms, apiculture and honey, greenhouse operations and greenhouse products, hydroponic agriculture; these are areas that the NOSB has had -- has addressed. These products from the April directive, the products may be certified to the existing NOP regulations which will be amended in future rulemaking to cover any unique production and handling requirements. NOSB has provided recommendations and the NOP is saying they'll publish at the earliest possible date through notice and comment rulemaking any additional standards needed for these commodities. So the Policy Development Committee recommends that the NOSB agree with the NOP for a position that mushrooms, apiculture and greenhouse operations can be certified organic and the products, as such, can be labeled as organic and carry the USDA Organic logo. We point out that the NOSB adopted the support of an April 25, 1995 greenhouse recommendation, a section entitled "Specialized Standards for Hydroponic Production in Soil-less Media" and that their recommendations stated, "Hydroponic production and

[4] NOSB Meeting Transcripts – May 6-8, 2002. Austin, Texas
[5] NOSB Meeting Minutes – October 19-20 2002. Washington DC
[6] NOSB Meeting Minutes – May 13-14 2003. Austin, Texas

> soil-less media to be labeled organically produced shall be allowed if all provisions of OFPA have been met." And though the issue has been discussed, the NOSB has not yet submitted a recommendation on hydroponic standards since a Final Rule was released, so we request that the Crops Committee place the item on its work plan and that rulemaking standards should not proceed until the NOSB has submitted a final recommendation.

Furthermore, during an exchange between Barbara Robinson (Agricultural Marketing Service Deputy Administrator) and a board member, the following was said:

> MR. BANDELE: I just have a kind of related question in terms of the -- just a point of clarification. Like something like hydroponics, which is -- can be covered by the rule but in which no guidance has yet been given, than at this point a USDA accredited certifier could certify an operation that's organic. Is that right?
>
> MS. ROBINSON: Yes. Yes. We believe that hydroponics are covered under the standards. They fall under the crop standards. But we recognize that, you know, there may be additional details that need to be added to the standards.[7]

Hydroponics was not discussed again until the August 2005 meeting and only to say there was no update[8]. At the November 2005 meeting hydroponics was discussed again with frustration being expressed over this being a work agenda item for multiple years with no progress. It was noted that hydroponic operations were being currently certified organic and the next steps would be to survey certifiers on how they were meeting the regulations.[9] At the April 2006 NOSB meeting the following update was given:

> Hydroponics is still on the list. Gather information and fact-finding on how and if hydroponics should have or could have standards, organic standards.

At the October 2006 meeting the NOSB discussed potential issues with hydroponics and OFPA around soilless production and aquatic plants. A survey of certifiers was proposed by the Crops Subcommittee.[10] In March 2007 the NOSB approved recommendations for aquaculture standards that included aquatic plants. As part of this recommendation the following definition was proposed:

> Aquatic plant. Any plant grown in an aquaculture facility, including microscopic or macroscopic algae, and excluding vascular aquatic plants such as watercress, rice, water hyacinth, and hydroponically produced vascular plant crops."

Additionally, the following was proposed regarding aquaculture effluent:

> (2) Metabolic products of aquaculture species are not considered animal manure under §205.2 Terms Defined, Manure, and § 205.239 (c) Livestock Living Conditions.
>
> (3) Metabolic products of one species are recognized as organic resources for one or more other species in an aquaculture production system. The Organic System Plan of facilities producing aquatic animals must consider measures to recycle or biologically process metabolic products. Where feasible, the Organic System plan must include the polyculture of two or more different species grown in the same body of water, and the integration of additional species as water moves through the aquaculture facility or into adjoining discharge areas.
>
> (4) The feasibility of using water discharges and filtered metabolic products as nutrients for vascular plants in agricultural crops and constructed wetlands must be considered in Organic System Plans.

[7] NOSB Meeting Transcripts – October 12-14, 2004. Washington DC
[8] NOSB Meeting Transcripts – August 15-17 2005. Washington DC
[9] NOSB Meeting Transcripts – November 16-17 2005. Washington DC
[10] NOSB Meeting Transcripts – October 17-19 2006. Arlington, Virginia.

> The quantities of such discharges and filtered products applied shall not exceed the requirements of targeted plants in the receiving area, and shall not be discharged into unplanned areas. Vascular agriculture crops using nutrients from certified organic aquaculture operations may be certified organic if in compliance with other regulations in this Subpart.[11]

At the May 2009 board meeting the Crop Subcommittee brought forward a discussion document on hydroponic production systems. This document generated substantial public comment and board debate about the compatibility of hydroponics with organic principles.[12] At the November 2009 NOSB meeting, Barbara Robinson (Deputy Administrator Transportation and Marketing Programs USDA) talking in the context of Canadian Equivalence stated the following:

> I told Canada that although we do not specifically prohibit hydroponic production, that it was my understanding that we don't approve hydroponic what I referred to as crops in a bucket in this country.[13]

In 2009 a document titled *Soil-less Growing Systems Discussion Item* contains the following statement:

> In previous Crops Committee discussion documents, the question has been asked: 'Should container culture based growing media (typically utilized in greenhouse systems) that are predominately compost and compostable plant materials be considered 'soil'?'. As highlighted in earlier portions of this document, a foundational principle of organic farming is the practice of maintaining and nurturing soil health so as to foster the proliferation of the proper soil biology with their accompanying ecologies. Since all typical soil dwelling organisms, such as earthworms, insects, arachnids, protozoa, fungi, bacteria, and actinomycetes can thrive in a properly designed compost based growing media, producing the beneficial symbiotic ecological relationships found in soil, such growing media should be rightfully considered soil.

In 2010, the NOSB issued a recommendation entitled *Production Standards for Terrestrial Plants in Containers and Enclosures (Greenhouses).* The recommendation contained the following statements:

> Observing the framework of organic farming based on its foundation of sound management of soil biology and ecology, it becomes clear that systems of crop production that eliminate soil from the system, such as hydroponics or aeroponics, cannot be considered as examples of acceptable organic farming practices. Hydroponics...certainly cannot be classified as certified organic growing methods due to their exclusion of the soil-plant ecology intrinsic to organic farming systems and USDA/NOP regulations governing them.

And,

> Although the regulations do not specifically state 'soil only production', the exclusion of soil from organic production of normally terrestrial, vascular plants violates the intent of the regulations.

In the May 2014 Organic Integrity Quarterly the following was stated about hydroponic operations:

> Organic hydroponics is a method of growing plants using mineral nutrient solutions, in water, without soil. Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium, such as perlite, gravel, biochar, or coconut husk…Organic hydroponic production is allowed as long as the producer can demonstrate compliance with the USDA organic regulations…Accredited certifying agents are certifying organic hydroponic operations based on the

[11] NOSB Recommendation on Aquaculture Standards – March 29, 2007
[12] NOSB Meeting Transcripts - May 4-6, 2009. Washington DC
[13] NOSB Meeting Transcripts - November 3-5, 2009. Washington DC

> current organic regulations and the operation's Organic System Plan. In the future, the NOP may provide additional guidance regarding organic hydroponic production and how the regulations apply to such methods…The NOSB's 2010 recommendation included a provision for not allowing organic hydroponic production. The NOP continues to work on evaluating and implementing a backlog of older NOSB recommendations including the greenhouse recommendation.[14]

In 2015, the NOP established a Hydroponic and Aquaponic Task Force to further explore this issue and summarize their findings in order to provide additional information to guide the NOSB's deliberations on whether hydroponic and aquaponic production should be allowed under the current organic regulations, and if not, how the regulations could or should be changed. At the April 2015 NOSB meeting Miles McEvoy, Deputy Administrator of the NOP, stated the following about the 2010 recommendation:

> …in order for us to do something to not allow organic hydroponics, we would have to do a rule change, which is, as you know, quite challenging… So, in order to move this topic forward, we did not have enough information from the NOSB 2010 recommendation to do a proposed rulemaking to prohibit organic hydroponics. We need more information to be successful.[15]

The NOP Task Force report was completed in July 2016[16]. The Task Force was divided in their discussions and recommendations, so much so that the Task Force report was divided into two separate subcommittee reports, one named the "2010 NOSB Recommendation Subcommittee," which proposed that organic certification require that plants get all or most of their nutrition from soil or compost, and one named the "Hydroponic and Aquaponic Subcommittee," which favored allowing water-based nutrient delivery systems in organic certification. A third subcommittee of the Task Force explored options for labeling of hydroponic and container-based systems.

In consideration of the information presented in the Task Force report and from past NOSB recommendations, the Crops Subcommittee prepared a proposal for consideration by the full NOSB at the Fall 2016 NOSB meeting. The proposal included the following motion:

> Motion to allow bioponic[17] (including hydroponic, aeroponic, or aquaponic) as consistent with organic production under the provisions and recommendations to be developed by the NOSB in 2017.

The motion was worded "to allow bioponic" in order to require a 2/3 majority of the Board to overturn the previous NOSB recommendation (in 2010) that soilless production is not consistent with organic production. The Crops Subcommittee vote on the motion failed by a vote of two in favor and five opposed to allowing "bioponic."

At the Fall 2016 NOSB meeting, questions were raised about the wording of the motion. Particularly, it was noted that if the vote were to result in a failed motion, there would be no recommendation going forward from the NOSB to the NOP, making the vote meaningless. Therefore, the NOSB did not vote on the proposal

---

[14] Organic Integrity Quarterly, May 2014, page 13 "Organic Hydroponics"
[15] NOSB Meeting Transcripts – April 27-30, 2015. San Diego, California
[16] Hydroponic and Aquaponic Task Force Report, July 2016
[17] While "bioponics" was used in the Fall 2016 NOSB proposal, that term is not used in this proposal. Operations popularly referred to as "bioponic" fit within the definitions of hydroponics, aeroponics, aquaponics, and container growing used in this proposal.

but instead voted to send it back to the Crops Subcommittee for further work. However, the NOSB did pass the following resolution at the Fall 2016 meeting:

> The NOSB respects the efforts of the former NOSB that led to their 2010 recommendation on terrestrial plants in greenhouses. The NOSB recognizes that the foundation of organic agriculture is based upon a systems approach to producing food in the natural environment, which respects the complex dynamic interaction between soil, water, air, sunlight, plants and animals needed to produce a thriving agro-ecosystem.
>
> At the heart of the organic philosophy is the belief that our responsibilities of good stewardship go beyond production of healthy foods and include protection of natural resources, biodiversity and the ecosystem services upon which we all depend. We encourage future NOSB to consider this wider perspective as the board undertakes the challenges of assessing and defining innovations in agriculture that may be compatible in a system of organic production.
>
> In the case of the hydroponic/bioponic/aquaponic issue, it is the consensus[18] of the current members of the NOSB to prohibit hydroponic systems that have an entirely water based substrate. Although that was the original intent of the proposal before us today, the current proposal as structured does not achieve this objective.
>
> While the NOSB does not believe that the liquid substrate systems should be sold under the USDA organic label, these growers deserve the chance to promote their very commendable qualities and objectives in their own right.

For the Spring 2017 meeting, the Crops Subcommittee prepared a discussion document titled "Aeroponics/Hydroponics/Aquaponics," which solicited additional public input on these types of growing systems as well as container-based growing systems.

Relevant areas in the Rule

<u>Organic Foods Production Act of 1990 (OFPA)</u>

§6504. National standards for organic production

To be sold or labeled as an organically produced agricultural product under this chapter, an agricultural product shall—

> (1) have been produced and handled without the use of synthetic chemicals, except as otherwise provided in this chapter;
> (2) except as otherwise provided in this chapter and excluding livestock, not be produced on land to which any prohibited substances, including synthetic chemicals, have been applied during the 3 years immediately preceding the harvest of the agricultural products; and

[18] Because two members of the NOSB did not support this resolution, the resolution was amended to substitute the word "majority" for "consensus." However, it wasn't recognized until later that that word change confused the sentence syntax. It should also be noted that the two NOSB members who did not support the resolution went on record as being opposed because they did not think the resolution was strong enough, but they too were opposed to "hydroponic systems that have an entirely water-based substrate."

(3) be produced and handled in compliance with an organic plan agreed to by the producer and handler of such product and the certifying agent.

§6512. Other production and handling practices

If a production or handling practice is not prohibited or otherwise restricted under this chapter, such practice shall be permitted unless it is determined that such practice would be inconsistent with the applicable organic certification program.

§6513. Organic plan

... (b) Crop production farm plan

(1) Soil fertility

An organic plan shall contain provisions designed to foster soil fertility, primarily through the management of the organic content of the soil through proper tillage, crop rotation, and manuring. ...

.... (g) Limitation on content of plan

An organic plan shall not include any production or handling practices that are inconsistent with this chapter.

USDA Organic Regulations

§205.2 Terms defined.

Crop rotation. The practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown repeatedly without interruption on the same field. Perennial cropping systems employ means such as alley cropping, intercropping, and hedgerows to introduce biological diversity in lieu of crop rotation.

Field. An area of land identified as a discrete unit within a production operation.

Organic production. A production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity.

§ 205.200 General.

The producer or handler of a production or handling operation intending to sell, label, or represent agricultural products as “100 percent organic,” “organic,” or “made with organic (specified ingredients or food group(s))” must comply with the applicable provisions of this subpart. Production practices implemented in accordance with this subpart must maintain or improve the natural resources of the operation, including soil and water quality.

§205.202 Land requirements.

Any field or farm parcel from which harvested crops are intended to be sold, labeled, or represented as “organic,” must: (a) Have been managed in accordance with the provisions of §205.203 through 205.206;

§ 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.

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

(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....

§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;

Discussion

This discussion section provides background information in support of the voting motions that follow. Arguments in favor of allowing hydroponic systems to be certified organic are in a minority view at the end of this document.

The role of the NOSB centers on making recommendations that underpin the integrity of the USDA organic label. Consumers entrust the NOSB with the important role of critically assessing what constitutes organic production and processing. The NOSB understands that many production systems and brand labeling exist outside of the organic label; however, our role is as gatekeepers of the organic label. As such, it is our responsibility to recommend production practices that uphold the integrity of the USDA organic seal, that are built on the primacy of soil stewardship, that are managed to emulate ecological processes of productive ecosystems, that support and enhance biodiversity, and that minimize to the extent possible the downside effects of farming while at the same time producing safe, nutritious, and tasty foods.

The organic designation, with its roots in the teachings of Sir Albert Howard, is based on soil. This fact is evident throughout the *Organic Foods Production Act* (OFPA). Section 6513 of the Organic Plan under the Crop Production section begins with Soil Fertility, detailing the critical role that managing organic matter plays in the plan, then finishes (section (G)) stating "an organic plan shall not include any production or handling practices that are inconsistent with this chapter". There are a number of other reasons not to include hydroponic agriculture within the organic designation.

Field-grown plants are physiologically different from hydroponically grown plants for a number of reasons. Hydroponic, greenhouse plants are not stressed the way field-grown plants are. Secondary plant metabolites, for example, frequently increase in concentration in stressed plants.[19] Secondary plant metabolites have also been found to be higher in organic crops than conventional, in soil-based systems.[20]

[19] Ramakrishna, A. and Ravishandar, G.A., 2011. Influence of abiotic stress factors on secondary metabolites in plants. Plant Signal Behav. 2011 Nov 1; 6(11): 1720–173.
[20] Benbrook, C.M., 2005. Elevating antioxidant levels in food through organic farming and food processing. An Organic Center State of Science Review. https://www.organic-center.org/reportfiles/Antioxidant_SSR.pdf

Field-grown plants will also be symbiotic with sets of microbial communities that are distinct from those found in hydroponically grown plants, and there are many consequences of this. The endophytic fungi living in stems and leaves will also be very different in hydroponic container-grown and field-grown plants. These fungi influence a number of physiological variables including secondary metabolism, with consequences for flavor and nutrition.

In addition to bypassing naturally occurring, co-evolved relationships between plant roots and the many functional trait types of rhizospheric organisms, nutrient bathing is an unbuffered system. For example, nutrient solutions contain high concentrations of nitrate, which plants can accumulate beyond their requirement, storing excess nitrate in leaf (and root) vacuoles. This is particularly problematic for some species like spinach and chard. Nitrate is toxic in food, has been linked to stomach cancer, and can kill livestock. Meta-analyses have shown that organically produced produce has lower nitrate levels than conventionally grown produce, an example of a clearly documented health benefit of organic production. Nitrogen regimes in organic systems are slow release, making them more synchronized with plant demand, which is better for the environment (less leaching and volatilization) as well as better for consumers. The problem with solution culture in this context is that N and P regimes are orders of magnitude more concentrated than those found in soil solution which is naturally highly buffered (meaning only a fraction of the nutrients that exist in the soil are available at any one time). Nutrient solutions are unbuffered, so high N and P concentrations are needed, which could result in unnatural and (in the case of N) problematic mineral nutrient accumulation. High P regimes will also reduce phytoavailability of Fe and Zn, two nutrients deficient in many human diets.

An added concern about the difference between a buffered soil--where nutrients are built up over a long period of time with the bulk of the mineral nutrition coming from manure, crop rotation, cover cropping, compost, and nutrient capture from rainwater--is that for a number of hydroponic systems, the principle source of fertility comes from highly soluble sources such as hydrolyzed soybean meal. Today, approximately 95% of the soybeans grown in the U.S. are genetically modified, using molecular methods prohibited by the NOP. The engineered trait used in GM soybean has brought about a dramatic rise in herbicide use on the backs of the so-called *transgene facilitated herbicide treadmill* (Mortensen et al. 2012).[21] Hydroponic growers who use hydrolyzed soybean meal have indicated that they source it from Europe, to avoid GMO soybean meal. Are the environmental costs of importing this nutrient factored into the claimed environmental benefits of hydroponic production?

In a 2015 paper purporting to be “the first quantitative comparison of conventional and hydroponic produce production” (Barbosa et al. 2015),[22] the authors compared the yield, water use efficiency, and energy use efficiency of the two production systems. The paper contained some misleading assumptions about the yield of the two systems. Specifically, the paper concludes that lettuce yield would be 11 times higher in the hydroponic production system. Only at the end of the paper is it clarified that the analysis is built on the assumption that lettuce is grown year round in the hydroponic system while “warm season crops” would be grown in the field, and the analysis only compared lettuce production and not those additional warm season crops. In effect, the paper far understates the yield of the “conventional, soil grown” crops. However, the energy required to produce the crops compared across the hydroponic and soil grown systems is revealing. The paper concludes that the pumps, heating and cooling, filtration, lighting

[21] Mortensen, D.A., Egan, J.F., Maxwell, B.D., Ryan, M.R., and R.G. Smith, 2012. Navigating a critical juncture for sustainable weed management. Bioscience Volume 62:1. pp75-84.
[22] Barbosa, G.L., Gadelha, F.D., Kublik, N., Proctor, A. Reichelm, L. Weissinger, E. Wohlleb, G.M. and R.U. Halden, 2015. Comparison of land, water, and energy requirements of lettuce grown using hydroponic vs. conventional agricultural methods. Int. J. Environ. Res. Public Health **2015**, 12(6), 6879-6891

etc. would result in an approximately 100-fold increase in energy use per unit of lettuce produced. By the author's own admission, energy analyses of this kind are surprisingly rare.

In a study of indoor *Cannabis* production, Mills (2012)[23] found that energy consumption for this practice in the United States is 1% of national electricity use, or $6 billion each year. One average kilogram of final product was associated with 4600 kg of carbon dioxide emissions to the atmosphere, or that of 3 million average U.S. cars when aggregated across all national production. The paper goes on to state, "the unchecked growth of electricity demand in this sector confounds energy forecasts and obscures savings from energy efficiency programs and policies".

In addition to these systems being energy inefficient, they lack resiliency. During a recent visit to an aquaponics facility in the northeastern U.S., one NOSB member observed staff replanting lettuce and other greens and awaiting a shipment of new fish. An ice storm had moved through the region and knocked power out for nine hours. During that time, the daytime heat load, coupled with the lack of nutrient delivery and oxygenation of the roots of the plants and fish tanks, resulted in most of the lettuce dying and all of the fish dying. In terms of systems resilience, this aquaponics system with its high dependence on electricity, predisposed the system to be very brittle. A system built on a high degree of external energy use is not in keeping with the spirit of the organic label.

Hydroponic proponents argue that as many bacteria and fungi are found in hydroponics as are found in soil-based systems. However, they are not able to cite data to indicate that hydroponic systems have the ecological complexity of soil-based systems. How soils are managed does affect microbial diversity. In a comparison of organic and conventional soil-based systems, it was found that the "Organically managed system increased taxonomic and phylogenetic richness, diversity and heterogeneity of the soil microbiota when compared with conventional farming system."[24]

It is not surprising that hydroponic systems would have high numbers of decomposing microorganisms when labile feedstocks like hydrolyzed soybean or fish meal are fed into the system. Populations of microorganisms will multiply quickly when given such an easily degraded food source. However, those should not be considered equivalent to the diverse populations of microorganisms present in a soil-based rhizosphere.

Natural soils are generally 95% or more mineral matter by weight. Soil mineral particles (clay, silt, and sand) are intimately intertwined and complexed with soil organic matter. This mineral/organic matter soil system provides habitat and food sources for a great diversity of soil microorganisms and creates pore spaces in soils for storing water and for air exchange with the atmosphere. The clay/humus complexes also serve a primary function of holding soil nutrients in reserve for plant uptake.

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. Crop rotations and cover crops are also important to create and maintain healthy soils, which contribute to healthy plants. It is this complex soil system that pioneer organic farmers learned to work with and optimize, in contrast to the prevalent industrial, input-based model of agriculture, which they rejected. Early organic certification standards reflected this system and required on-farm practices and use of materials that fostered soil health by means of managing crop residue, using livestock manures, composting, cover cropping, and adding natural

[23] E. Mills, 2012. The carbon footprint of indoor cannabis production. Energy Policy 46 (2012) 58–67.
[24] Lupatini, M., Korthals, G.W., de Hollander, M., Janssens, T.K.S., and Kuramae, E.E., 2016. Soil microbiome is more heterogeneous in organic than conventional farming system. Front Microbiol. 2016; 7: 2064.

rock powders (Task Force report p. 14). For these reasons, many organic producers reject hydroponic systems that are input-based rather than soil-based.

Loss of arable land and the need to feed a growing world population are cited by pro-hydroponic advocates. However, organic agriculture, with its focus on soil building and protection or enhancement of natural resources, offers the opportunity to continually improve soil productivity and the natural resource base while producing crops, as well as to transform land which has been degraded by poor farming practices or is of low productive capability into sustainable farming systems. Moreover, productivity *per se* is not a measure of the legitimacy of organic agriculture. Maintenance and improvement of the natural resources of the operation are also mandated under the organic regulation. On soil-based organic farms, the production of food and fiber is accomplished in concert with improving habitat for wildlife of all types including pollinators, mammals, amphibians, and soil microbes. Increased soil organic matter, cover crops, rotations, contour strips, reduced tillage, and other activities continually improve soil 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.

Hydroponic production is highly dependent on continuous use of fertilizer inputs to the production system, rather than relying on a productive soil and natural recycling of nutrients through decaying organic matter to regenerate the fertility needs of the crop. The "input substitution" approach used in hydroponics has long been considered incompatible with a system of organic agriculture. Some of the major fertility inputs used in hydroponic production are transported long distances to the hydroponic production site, negating the purported environmental benefits of hydroponic production.

Specific language from OFPA and the Organic Rule that justify disqualifying soilless production from organic certification includes the following:

- §6513 Organic Plan: "An organic plan shall contain provisions designed to foster soil fertility, primarily through the management of the organic content of the soil through proper tillage, crop rotation, and manuring…An organic plan shall not include any production or handling practices that are inconsistent with this chapter."
- § 205.200 General: "Production practices implemented in accordance with this subpart must maintain or improve the natural resources of the operation, including soil and water quality."
- § 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."
    - (b) "The producer must manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials."
    - (c) "The producer must manage plant and animal materials to maintain or improve soil organic matter content…"

Aeroponic, hydroponic, and aquaponic production systems can be productive cropping systems, which can be appropriate and well adapted to specific situations. However, that does not mean those systems are compatible with the principles of organic production or should quality them for organic certification.

Public Comments from Previous Proposal and Discussion Documents

Numerous comments were received from the public in response to the Hydroponics Task Force report and the NOSB Crops Subcommittee proposal and two discussion documents on hydroponics and container growing over the past year.

Those in favor of allowing hydroponics to carry the organic label in the marketplace discussed the efficient use of water and nutrients as important considerations. They also stated that there were fewer disease and pest problems in their controlled-environment production systems, leading to lower use of organically approved pesticides. Soil and water were considered by them to be equally acceptable as a medium to deliver nutrients to plant roots. Food safety, worker health, providing food to urban food deserts, or aiding inexperienced or small-scale growers were also cited as benefits of hydroponics. Hydroponic growers were also concerned that if hydroponics were no longer allowed, current hydroponic growers would lose their organic market.

Those against allowing hydroponics to carry the organic label in the marketplace discussed the foundational principles of organic as originating with care and improvement of the soil and the overall ecosystem. Longer-term improvements such as the use of nitrogen-fixing crops, cover crops for improved organic matter, and an overall regenerative system that protects water and wildlife as well as supporting biodiversity, were also noted in numerous comments. The OFPA and organic regulations were cited, illustrating where soil- and ecosystem-based production systems are in the basic description of certified organic production. Many agreed hydroponics can be an innovative system of production, but did not agree that it met the letter or spirit of the organic law or regulations. Organic growers using soil in greenhouses contended that it is the greenhouse environment, not hydroponics, that allows for lower pesticide use, improved food safety, worker health, and providing food to urban food deserts.

Rationale for Proposed Recommendations on Aeroponics, Hydroponics, Aquaponics, and Container Growing

At the first meeting of the Hydroponic/Aquaponic Task Force in January 2016, the NOP presented information about potential gaps and inconsistencies in the past NOSB recommendations, both for hydroponics and for greenhouse growing systems in general. The NOP presentation included the following statement, "Further analysis and clarification is necessary because regardless of what position the NOSB ultimately takes on the issue of hydroponics and aquaponics, the NOP will likely need to undertake rulemaking. Rulemaking requires a comprehensive recommendation from the NOSB that addresses grey areas left by past recommendations."

The grey areas and gaps include the following (paraphrased from original):

- A clear explanation of the basis for each recommendation made.
- Acknowledging the continuum of production methods from field/soil to hydroponic and the role of compost or other biological growing media. Recommendations on each type of production and reasons for allowing or prohibiting.
- Guidelines are needed on exactly how different production types comply with provisions in regulations for soil fertility, rotation, and cover cropping.
- Definitions of vague terms including container, hydroponics, soil-less media, "compost-based", and soil ecology.
- How are OFPA and the NOP rule able to be consistent on other soilless production such as mushrooms, sprouts, aquatic plants and greenhouse in-ground systems?
- What is the justification for requiring soil (as opposed to cycling of resources, promoting ecological balance, and conserving biodiversity) but making an exception for cover crops, crop rotation, etc. when soil is not explicitly required in the regulations, but crop rotation is a MUST?
- Aquaponic systems are not specifically addressed in previous NOSB recommendations.

The lengthy report from the Task Force contains much more background information; too extensive to cover here. Selected portions are referenced throughout this proposal.

For clarity, terms used in this proposal, as well as some of the most common definitions taken from the NOSB 2010 Recommendation and the Task Force Report are appended in a glossary, amended for this discussion.

1. Consistency with mushrooms, aquatic plants, seedlings, and other "soilless" culture.
The 2010 Subcommittee of the Task Force report points out the following,

> From this subcommittee's perspective, the recommendation could be bettered, and more easily accepted by the NOP, if it explained how each of these exceptions to the premise that crops be grown in soil; 1) are linked to soil, or 2) are not naturally living or growing in soil so there is no reason for farming them in soil. Furthermore, how each meets the Principles of Organic Production and Handling (NOSB, 2001) should be made clear.

They continue by pointing out that sprouts and wild harvest aquatic plants are addressed in the current organic regulations, and the Preamble to the final rule specifically states that additional standards would be needed for mushrooms and greenhouses.

The Crops Subcommittee concurs with this analysis. Sprouting seeds is similar to a processing step for an organic product. Therefore the ingredient (seeds) must be certified organic. There are no inputs to the seeds to make them grow besides water, an exempt handling ingredient. The essential elements otherwise needed for plants to complete their lifecycle are not added because all the nutrition they need to the point of harvest is provided by the seed.

The 2010 NOSB recommendation *Production Standards for Terrestrial Plants in Containers and Enclosures (Greenhouses)* includes the statement "naturally aquatic plant species and non-vascular plant species such as mushrooms come from different (non-soil) ecological niches and would be handled separately. Sprouts (the sprouted radicle and hypocotyl of seeds) are produced without soil by design and are not subject to this recommendation."

Wild Aquatic plants are covered under the wild crop section of the rules, and the preamble specifically points out that the term "site" was used to replace "from land" in the proposed rule. This clarifies that wild aquatic plant certification was intended. However, there is now a large amount of aquatic plant farming occurring that would not be considered wild, and this is not covered in the current rules.

Seedlings, or transplants, are also specifically mentioned in the organic rules and must be certified organically grown but are considered acceptable if raised in soil-less media. These are future crops that will spend most of their time growing in soil, and the time to produce the transplant is short compared to the time spent in the ground.

Mushrooms are fungi, not plants, and that justifies that they don't have a direct link to soil. They are more similar to yeasts and microorganisms that may be grown on substrate that does not depend on minerals from soil. The parameters of their production may eventually need additional rulemaking, but so far many mushrooms are able to be certified organic under the existing rules.

2. Land Considerations and Natural Resources
Regardless of where the container production is occurring, the land underneath the containers and the surrounding environment must be considered. The land underneath an outdoor operation must comply with the same provisions of the rule regarding land history and transition as other land. It must also be maintained or improved with respect to avoiding contamination. Land that has a building on top of it with an impermeable floor must comply with whatever practices are adopted for greenhouse or enclosure production.

The 2010 Subcommittee of the Task Force asked the NOSB to consider limiting the use of land where crops could be grown in the soil from being converted to container production. It also suggested limiting the conversion of non-organic container plants to organic by re-potting them in organic growing media.

Natural resource conservation includes the resources of soil, water, and wildlife. This must be addressed in an Organic System plan for a container growing system. This includes maintaining the condition of land underneath the container production, fate of any water or nutrient run-off from container production, and any positive actions taken to encourage biodiversity, such as installing hedgerows, planting insectary plants amongst the containerized crop plants, and other similar techniques.

3. Rotation
The 2010 NOSB recommendation noted that the intent of the rotation and cover cropping clauses in the rule could be met by similar practices with the same functions or goals as the crop rotation that are applicable to the operation. Such techniques might include mulching, replacing growing media (thus replenishing the soil system), planting hedgerows, adding microbial inoculants to stimulate existing populations, and recycling and composting used growing media. It was noted by the 2010 Recommendation Subcommittee of the Task Force that the crop rotation requirement is already not enforced by some certifiers on greenhouse crops grown in soil and on perennial crops with limited water.

Similarly, Canadian standards 7.5.12 states:

> Soil regeneration and recycling procedures shall be practiced. The following alternatives to crop rotation are permitted: grafting of plants onto disease-resistant rootstock, freezing the soil in winter, regeneration by incorporating biodegradable plant mulch (for example, straw or hay), and partial or complete replacement of greenhouse soil or container soil, provided it is re-used outside the greenhouse for another crop.

4. Containers & Growing Media
The 2010 NOSB recommendation on Terrestrial Plants in Containers does partially address production in containers. It specifies that the substrate in the container be based on compost and reiterates the previous NOSB opinion that compost was equivalent to soil.

The weakness of the 2010 recommendation was that it didn't quantify "compost-based", nor did it specify upper or lower limits for the volume of soil or compost in a container to achieve a level of biological activity comparable to that found in soil. There was also no consideration of whether non-synthetic, carbon-based materials such as coir or peat moss could serve the same functions as soil in a container.

The statement from OFPA that fertility come "primarily through the management of the organic content of the soil" has been interpreted to mean that soluble fertilizers should not be the primary source of nutrients but only a supplement to an overall program focused on crop rotations, cover crops, and amending with compost or manure. This is reflected consistently throughout NOSB recommendations from the past, from

limitations on sodium nitrate or potassium chloride, to many rejected petitions centered on adding soluble forms of nutrients to the National List.

In order to specify an appropriate size of container or characteristics of the growing media that are appropriate for organic production, there needs to be a comparison of the characteristics of container system versus the soil system. The 2010 Recommendation Subcommittee of the Task Force uses bulk density as point of comparison to assess important distinctions between the two systems. Mineral soils have a bulk density of about 1.3 grams per cubic centimeter, while non-organic peat or coir-based media are only 0.13 gm/cubic cm, one tenth as much. With compost or other high organic matter media, the bulk density increases and so will the nutrient-supplying capacity.

A raised bed that has a liner between it and the ground is considered a container, regardless of the depth of the growing media. However, containers as referred to in this discussion are limited to those containing a solid substrate only[25].

By making the containers large enough, the nutrients in the organic matter fraction will be able to supply the majority of the nutrition for the plant. What is large enough, and how can it be explained in a way that is appropriate for different plants? The 2010 Recommendation Subcommittee of the Task Force cites the work of Dr. Martine Dorais of Laval University and the Agassiz Research and Development Centre. At a volume of 100 to 180 liters of soil per m^2, she has demonstrated that no liquid feeding is necessary, and fertility can be provided by the biological activity of the growing medium in the beds.

Both Canada and Sweden permit container growing while requiring minimum soil volumes based on growing area (although proposed new EU rules would prohibit container growing in the future). Canada requires a minimum soil volume of 70 liters[26] per m^2 of growing area. For staked crops like tomatoes and peppers, they require at least 10% compost at the start of production, and containers must be at least 30 cm (12 inches) high. They state, 7.5.4:

> Soil used in a container system, with the exception of transplants, shall provide nutrients to plants continuously. The soil (growth media) shall contain a mineral fraction (sand, silt or clay) and an organic fraction; it shall support life and ecosystem diversity.

The Canadian standards do not specify an amount of compost or soil for other crops such as lettuce or blueberries. They do not account for breakdown and settling of soil volume. It is unclear how certifiers can measure the soil volume, and the term "growing area" is not well defined.

In Sweden, at least 30 liters of soil per m^2 are required for annual crops with long seasons and 0.2 liters per pot for other plants, such as herbs, lettuce, and strawberries. However, as mentioned above, proposed new EU rules would prohibit container growing in Sweden.

The 2010 Recommendation Subcommittee of the Task Force report states, "Transplant and container growing methods would have more clarity if container growing media had a defined initial and temporal water and nutrient holding capacity and biology carrying capacity." It is possible to have a compost- or soil-

[25] Container troughs in which water is recirculated are considered hydroponic. Similarly, container systems with troughs under the pots that collect, filter, and recirculate the water after adding additional liquid nutrients are considered hydroponic unless they meet the container standard in the Container Production Systems motion below**.**

[26] For reference a 5-gallon pot holds 25 liters and a 10-gallon pot holds 40 liters.

based growing media with adequate aeration and water holding capacity that can provide enough fertility for production of annual plant crops or a season in the growth of perennial plants.

The 2010 Recommendation Subcommittee of the Task Force proposed that organic growing media must have a minimum of 20% compost.

5. Nutrition

The 2010 Recommendation Subcommittee of the Task Force Report states, "The key distinction between organic fertility management and conventional fertility management is that under organic management the source of the bulk of the crop nutrients are from the biological activity of decomposing complex organic molecules (compost, manures, seed meals, etc.) and the mineral fractions." Soil is important due to the interactions of the physical, chemical, and biological properties together.

While hydroponic systems can be efficient in nutrient recycling and water conservation, they do not have the complex interactions found in an organic soil-based system. The backbone of organic production is the complex interactions between soils, plants, animals (from tiny insects to large herbivores and carnivores), and humans.

It would seem logical to assess the continuum between grown in the ground and fully liquid-based systems by determining where the plant nutrition is coming from. If the nutrients are primarily coming from soil or compost and solid amendments, then they would be considered equivalent to in-ground production whereas a container production system that relies primarily on liquid fertilizers would not be within the requirement for soil-based systems.

The NOSB recognizes that some soils contain very little inherent fertility and crops are being grown and certified organic which rely in large part on liquid fertilizers. While that is an area that the NOSB and NOP should examine to see if higher standards should be set to improve the inherent fertility of those soils over time, that is outside the scope of this attempt to set standards for crops grown in containers. Container producers have more flexibility to create a minimum level of fertility in the container substrate mix before beginning production, compared to producers growing in the ground.

The 2010 Recommendation Subcommittee of the NOP Hydroponics Task Force proposed to “Limit organic certification to what is grown in the ground, with the exceptions of transplants, ornamental, and herbs.” That subcommittee further proposed that if organic certification were to include crops grown in containers, there should be a “limitation of no more than 50% of the required fertility being added after planting, and no more than 20% to be added as a liquid fertilizer after planting. For perennials these limitations should be on an annual basis.

“The British Soil Association specifies that at least 51% of the nutrition for the crop must come from the soil at the time of planting” (Task Force Report p. 54). That applies to crops grown in the ground. Other standards for greenhouses limit liquid nutrients to 25% of the total nutrients supplied. A recent revision to the Canadian standards[27] also proposes limits on liquid fertilizers by stating that for small soil volumes, 70% of the nitrogen and phosphorus must be supplied by solid organic soil amendments that require an active soil ecosystem.

The suggestion of the 2010 Recommendation Subcommittee of the Task Force that liquid nutrients be limited to 20% of the total nutrients supplied is consistent with the current annotation for the use of the

[27] 2016 amended draft of Canada Organic Standards, pp 44-45: General Principles and Management Standards

highly soluble Chilean nitrate, which is listed at 205.602: “Sodium nitrate (is prohibited)—unless use is restricted to no more than 20% of the crop’s total nitrogen requirement.”

The policy on Chilean nitrate sets a precedent for the use of highly soluble inputs. How that policy came about is worth exploring here because it illustrates how the principles of organic agriculture influenced that policy.

As mentioned above, in the Preamble to the Final Rule of the NOP of December 21, 2000, the Proposed Organic Rule of 1997 had allowed the use of mined substances of high solubility (e.g., Chilean nitrate). The Preamble to the Final Rule goes on to say “Many commenters objected to the general allowance for this category of substances.” Therefore, the Final Rule included the June 2000 recommendation of the NOSB, which is the annotation at §205.602 that sodium nitrate be “restricted to no more than 20% of the crop’s total nitrogen requirement.”

In April 2000, the NOSB recommended complete prohibition of sodium nitrate. The NOP has yet to fulfill that recommendation but issued a policy memo in September 2011[28] that states:

> Organic producers must meet the requirements of 7 CFR 205.200 which states that production practices must maintain or improve the natural resources of the operation, including soil and water quality. Under 7 CFR 205.203(b), producers must manage crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal nutrients. Organic producers who use sodium nitrate need to ensure that the use of sodium nitrate is aligned with the requirements of 7 CFR 205.203(b).

The principle of limiting soluble Chilean nitrate to 20% of a crop’s nitrogen requirement in order to remain aligned with the soil fertility requirements of the organic standards is consistent with a principle of limiting soluble fertility sources to 20% of a crop’s needs in container production systems.

A requirement that would limit liquid feeding of crops is complicated by the number of essential elements needed by crops, and that some micronutrients may need higher percentages of supplemental feeding than macronutrients like nitrogen. Nitrogen is generally the most dynamic crop nutrient in the soil/substrate, and managing nitrogen in accord with organic principles will likely ensure that all nutrients are managed well. Also, limiting the requirement to just one indicator element (nitrogen) makes monitoring for compliance much easier.

Chilean nitrate is generally about 16-0-0 (16% nitrogen). Hydrolyzed soybean meal (which is commonly used as a nitrogen source in hydroponic container systems) is also sold as 16-0-0 (16% nitrogen), and like Chilean nitrate, is completely water-soluble. Limiting use of soluble nitrogen feeding to 20% of crops’ needs will help ensure that container growing is aligned with the requirements of 7 CFR 205.203(b), as outlined in the quote from the NOP above.

Hydroponics proponents claim that the mineralization of nutrients into forms that plants can take up can be performed by microbial digestion in a hydroponics system with carbon-based substrate, and that the microbial population and dynamics are equivalent to a "diverse soil ecology". The Crops Subcommittee questions those statements because simple, labile nutrient sources are used in container systems, and no definitive data has been provided to back up the claim that microbial dynamics are equivalent to a diverse soil ecology. Saying that "soil biology" can happen without soil is not substantiated by definition or data.

[28] https://www.ams.usda.gov/sites/default/files/media/NOP-Notice-12-1-SodiumNitrate.pdf

6. Other issues
The Task Force report included discussion about other issues related to indoor production. In a separate discussion document to be presented at the Fall 2017 meeting in Jacksonville, the Crops Subcommittee discusses three of those issues: use of artificial light; use of synthetic mulches; and disposal of crops, substrates, and containers at the end of the crops' production cycle. The Crops Subcommittee seeks input from the organic community on those issues.

Some have expressed concern that if hydroponic and aquaponic production are prohibited from organic certification, it would be a hardship for those hydroponic and aquaponic operations currently certified. Certainly, some currently certified operations would lose certification, but the numbers would be quite small relative to the total number of operations certified through the NOP.

At the April 2016 meeting of the NOSB, Deputy Administrator Miles McEvoy, presented the results[29] of a 2016 survey to certifying agents regarding the certification of hydroponic, aquaponic, and container-based systems. Of the 80 accredited certifying agents worldwide at the time of the survey, 17 certified hydroponic and aquaponic operations. Stated as a percentage, 21% of certified agents are certifying these operations. Similarly, of the approximately 31,000 certified organic operations, 30 (or less than 0.1% of all certified organic operations) were certified organic hydroponic. There were 22 certified organic aquaponic operations, or 0.07% of all certified organic operations. Finally, there were 69 certified organic container-based operations, or 0.2% of all certified organic operations. As is clear from these figures, certified organic hydroponic, aquaponic, and container-based systems constitute an extreme minority of all certified organic operations, or less than 0.4% when combined.

Regarding the location within the organic standards where aeroponics, aquaponics, and hydroponics could be addressed, if any of the motions below to remove organic certification from a specific method of production are passed by the NOSB, the National Organic Program could add those prohibitions to 205.105, as well as adding the definitions of the various methods to 205.2 Terms Defined.

An example would be:
205.105 To be sold or labeled as "100% organic", "organic", or "made with organic (specified ingredients or food groups)", the product must be produced and handled without the use of:
(h) aeroponics
(i) aquaponics
(j) hydroponics

Crops Subcommittee Proposed Recommendations:

<u>Aeroponics</u>
Discussion: Aeroponics systems do not require soil or a root-zone medium. The roots are intentionally suspended in midair, in part to expose them to more atmospheric oxygen to aid plant growth. The roots are regularly sprayed with water that contains water-soluble nutrients.

The Crops Subcommittee is opposed to allowing aeroponic production systems to be certified organic because they do not meet the requirements of OFPA or the Organic Rule.

Subcommittee vote:
Motion to prohibit aeroponic production systems from organic certification.
Motion by: Emily Oakley

[29] https://www.ams.usda.gov/sites/default/files/media/McEvoy%20NOSB%20April%202016.pdf

Seconded by: Harriet Behar
Yes: 8 No: 0 Abstain: 1 Absent: 0 Recuse: 0

Aquaponics

Discussion: Aquaponic production is a form of hydroponics in which plants get some or all of their nutrients delivered in liquid form from fish waste. Aquaponics is defined here as "A recirculating hydroponic system in which plants are grown in nutrients originating from aquatic animal waste water, 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."

The NOP has strict standards for handling animal manure in terrestrial organic production, but no such standards exist to ensure the safety of plant foods produced in the fecal waste of aquatic vertebrates. Also, the NOP has not yet issued standards for organic aquaculture production, upon which aquaponic plant production would be dependent.

The Crops Subcommittee is opposed to allowing aquaponic production systems to be certified organic at this time. If aquaculture standards are issued in the future, and concerns about food safety are resolved, aquaponics could be reconsidered.

Subcommittee vote:

Motion to prohibit aquaponic production systems from organic certification.
Motion by: Harriet Behar
Seconded by: Jesse Buie
Yes: 7 No: 2 Abstain: 0 Absent: 0 Recuse: 0

Hydroponics and Container Growing

Discussion: The word "hydroponics" comes from two Greek words: hydro, meaning water; and ponos, meaning labor. In popular use of the term, hydroponics means growing plants by providing the plants' nutrition in liquid form. The Merriam-Webster Dictionary definition of hydroponics is "the growing of plants in nutrient solutions with or without an inert medium (such as soil) to provide mechanical support."

Proponents of allowing hydroponic production to qualify as certified organic have created confusion in the hydroponics discussion by attempting to redefine some forms of hydroponic production as "container growing." That creates confusion because, in fact, all hydroponic production is done in containers, and as noted above, hydroponics has traditionally been defined by the use of nutrient solutions to feed plants, not by the particular type of rooting medium used.

In particular, hydroponic producers who want to be certified organic claim that if plants are grown in certain rooting media, the growing system is no longer hydroponic, even if all, or virtually all, of the plants' nutrition is provided as a liquid feed. That belies both common usage and dictionary definitions of "hydroponics."

A common rooting medium that is used in hydroponic container production is coconut coir. One of the advantages of coir as a growing medium is that coir is resistant to microbial decomposition, so it will maintain its structure and water-holding capacity in the container longer than some other rooting materials. Hydroponic advocates argue that coir is not inert. However, the NOP, in the May 2014 Organic Integrity Quarterly (cited above), included "coconut husk" in a list of examples of an "inert medium."

In a research paper investigating decomposition rates of coir, Prabhu and Thomas[30] point out "Coir pith with high C:N ratio (about 100:1), lignin and polyphenol contents is highly resistant to easy decomposition…Lignin prevents the easy decomposition and mineralization of coir pith…making it a recalcitrant biopolymer."

Coir is a good rooting medium for hydroponic production because it has high air- and water-holding capacity and because it is recalcitrant. Coir pith also has a cation exchange capacity of 20-30 meq/100g (Ravindranath)[31]. However, "As a nutrient source, coir pith has not much value" (Prabhu and Thomas). The nitrogen content of coir pith ranges from 0.26% (Ravindranath) to 0.57% (Bethke)[32]. Given the C:N ratio of 100:1 for coir pith, the small amount of nitrogen in coir will not serve as a nitrogen source for growing plants, which means that in a hydroponic system using coir as the rooting medium, all of the plants' nitrogen needs will have to be supplied by liquid feeding.

It is interesting to note that the Merriam-Webster definition of hydroponics noted above parenthetically equates soil to an inert medium in a system in which plants' nutrient needs are being fulfilled through liquid feeding. Of course, we know that in a soil-based cropping system--in which the plants' nutrient needs are being supplied by the soil--the soil is not inert, but dynamically supplies and cycles nutrients. However, any rooting medium—including soil—will not serve as an adequate or long-term source of fertility to grow plants unless it is managed to do so.

The majority of the Crops Subcommittee believes that providing most of a plant's nutritional needs through liquid feeding in a container should be defined as hydroponics, regardless of the rooting medium used. The Crops Subcommittee further supports the suggestion of the 2010 Recommendation Subcommittee of the NOP Hydroponics Task Force, which stated that there should be a "limitation of no more than 50% of the required fertility being added after planting, and no more than 20% to be added as a liquid fertilizer after planting." In order to make monitoring simpler, and because nitrogen can serve as an indicator nutrient to demonstrate the nutrient-supplying power of a soil/compost system, the Crops Subcommittee proposes that this fertility requirement of container systems apply to nitrogen only.

The majority of the Crops Subcommittee believes that this standard is sufficient to ensure that crops grown in containers are not merely being fed hydroponically but have an active soil biology and ecology that can supply nutrients to the crops. This is in keeping with the 2010 NOSB recommendation, which states:

> "Observing the framework of organic farming based on its foundation of sound management of soil biology and ecology, it becomes clear that systems of crop production that eliminate soil from the system, such as hydroponics or aeroponics, cannot be considered as examples of acceptable organic farming practices. Hydroponics...certainly cannot be classified as certified organic growing methods due to their exclusion of the soil-plant ecology intrinsic to organic farming systems and USDA/NOP regulations governing them."

Universities and crop consultants who advise hydroponic growers can provide tables of the nitrogen requirement (or nitrogen removal) of crops, which can be used to calculate the 20% and 50% limits on liquid feeding of nitrogen. For example, Knotts Handbook for Vegetable Growers indicates that a 30-ton

[30] Prabhu, S.R. and G.V. Thomas, 2002. Biological conversion of coir pith into a value-added organic resource and its application in Agri-Horticulture: Current status, prospects and perspective.
[31] Ravindranath, Chief editor, Coir Pith Wealth from Waste, a Reference. 2016. Coir Board, Ministry of MS&ME, Govt. of India.
[32] Bethke, C.L., 2008. Nutritional properties of agrocoir. Horticultural Soils and Nutrition Consulting 77 Granite Road Williamston, Michigan 48895.

tomato yield will require 180 lb/acre of nitrogen.[33] The crop consulting firm Yara estimates (online)[34] that the nitrogen requirement (removal) of tomatoes is 5 to 5.3 lbs of nitrogen per ton of yield. A grower would need to use a nitrogen requirement value appropriate for the region, growing conditions, and expected yield of the operation. Similar calculations are already commonly used to determine the 20% limit for Chilean nitrate allowed in organic crop production.

Subcommittee vote, container production:
Motion that for container production to be certified organic, a limit of 20% of the plants' nitrogen requirement can be supplied by liquid feeding, and a limit of 50% of the plants' nitrogen requirement can be added to the container after the crop has been planted. For perennials, the nitrogen feeding limit is calculated on an annual basis. Transplants, ornamentals, herbs, sprouts, fodder, and aquatic plants are exempted from these requirements.

Motion by: Francis Thicke
Seconded by: Steve Ela
Yes: 6 No: 3 Abstain: 0 Absent: 0 Recuse: 0

Subcommittee vote, hydroponics:
Motion that any container production system that does not meet the standard of a limit of 20% of the plants' nitrogen requirement being supplied by liquid feeding, and a limit of 50% of the plants' nitrogen requirement being added to the container after the crop has been planted is defined as hydroponic and should not be allowed to be certified organic. For perennials, the nitrogen feeding limit is calculated on an annual basis. Transplants, ornamentals, herbs, sprouts, fodder, and aquatic plants are exempted from these requirements.

Motion by: Jesse Buie
Seconded by: Dave Mortensen
Yes: 6 No: 3 Abstain: 0 Absent: 0 Recuse: 0

****

Glossary of terms

Aeroponics: A variation of hydroponic plant production in which plant roots are suspended in air and misted with nutrient solution.

Aquaponics: A recirculating hydroponic plant production system in which plants are grown in nutrients originating from aquatic animal waste water, 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.

Recalcitrant: Resistant to microbial attack.

Container: Any vessel and associated equipment used to house growing media and the complete root structure of terrestrial plants and to prevent the roots from contacting the soil or surface beneath the

[33] Maynard, D.N. and G.J. Hochmuth. Knotts Handbook for Vegetable Growers, 5th ed., 2007. John Wiley and Sons Inc., Hoboken, New Jersey.
[34] http://www.yara.us/agriculture/crops/tomato/key-facts/nutritional-summary/

vessel, such as, but not limited to, pots, troughs, plastic bags, floor mats, etc.

Greenhouse: Permanent enclosed structure that allows for an actively controlled environment used to grow crops, annual seedlings or planting stock.

Growing media: Material which provides sufficient support for the plant root system and enables the plant to extract water and nutrients. Used interchangeably with the term "substrate".

Hydroponics (for the purposes of this proposal): Any container production system that does not meet the standard of a limit of 20% of the plants' nitrogen requirement being supplied by liquid feeding, and a limit of 50% of the plants' nitrogen requirement being added to the container after the crop has been planted.

Nutrient solution: Growing solution used in traditional hydroponic production that is commonly composed of immediately plant-available soluble mineral salts in water

Soil: The unconsolidated mineral or organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. (ii) The unconsolidated mineral or organic matter on the surface of the earth that has been subjected to and shows effects of genetic and environmental factors of: climate (including water and temperature effects), and macro- and microorganisms, conditioned by relief, acting on parent material over a period of time. A product-soil differs from the material from which it is derived in many physical, chemical, biological, and morphological properties and characteristics (Soil Science Society of America Glossary).

Minority View:

Summary of Pro-Hydroponic Arguments

As is pointed out in the Aquaponics/Hydroponics Subcommittee of the Task Force report and in public comments received over the past year, hydroponics has a long history in agriculture from societies that worked with limited resources in changing conditions. Hydroponics is an innovative system that results in efficient water and nutrient use. This efficient use of water allows for conservation of vital water resources which have been scarce recently due to climate change and recent droughts. Due to its controlled environment, hydroponic operations—like other greenhouse operations—have been able to lessen the use of pesticides, and operators have been able to develop systems that rely on organically approved inputs for crop nutrition and health.

Hydroponics can be an appropriate way to address challenges in farming as a whole, such as drought, food safety, limited access to arable land and production of food in urban areas or on un-arable land. Hydroponics operations are quite diverse and can be stand-alone operations or part of a larger in-ground farming operation. Critics contend that hydroponics are reliant on off-site nutrients and while the site specific conditions will dictate the level and type of nutrient cycling that occurs, proponents would argue the same is true for most organic in-ground farmers as well, including reliance on off farm manure. Practitioners have developed systems that are integrated, use only materials on the National List, and incorporate microbial action to provide plant health and nutrition. The introduction of fish to create an aquaponic system can address production of a protein source and integrate *in situ* fertilizer production with an integrated system.

Hydroponic proponents argue that as much bacteria and fungi are found in hydroponics as is found in soil-based systems. They cite studies that look at the microbiology in hydroponics systems and find about 10,000,000 bacteria per milliliter of nutrient solution[35] [36]. Soil microbiology varies quite a bit, but compost consistently comes in at 100,000 to 1,000,000,000 colony forming units - or cfu- a measure of the viable bacterial and fungal cells - per milliliter of dry compost[37] [38] [39]. These systems are also rich in fungi-- a study that looked at both fungi and bacteria in hydroponic systems found 1,000,000 cfu/ml bacteria and 10 to 1000 fungi cfu/ml in the system[40]. They supply research that shows suppression of plant disease by root flora and other microflora in hydroponics. A review of these studies in 2011 found suppressive flora in rockwool, NFT, peat, and other hydroponic methods[41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51]. It should be noted that

---

[35] Berkelmann, B., W. Wohanka, and G. A. Wolf. 1994. Characterization of the bacterial flora in circulating nutrient solutions of a hydroponic system in rockwool. Acta Hortic. 361:372–381.

[36] Waechter-Kristensen, B., S. Caspersen, S. Adalsteinsson, P. Sundin, and P. Jensén. 1999. Organic compounds and micro-organisms in closed, hydroponic culture: Occurrence and effects on plant growth and mineral nutrition. Acta Hortic. 481:197–204.

[37] Bess, V. 2008. Evaluating Microbiology Of Compost 83–85.

[38] Chandna, P., L. Nain, S. Singh, and R. C. Kuhad. 2013. Assessment of bacterial diversity during composting of agricultural byproducts. BMC Microbiol. 13:99.

[39] Hassen, A., K. Belguith, N. Jedidi, A. Cherif, M. Cherif, and A. Boudabous. 2001. Microbial characterization during composting of municipal solid waste. Bioresour. Technol. 80:217–225.

[40] Berkelmann, B., W. Wohanka, and G. A. Wolf. 1994. Characterization of the bacterial flora in circulating nutrient solutions of a hydroponic system in rockwool. Acta Hortic. 361:372–381.

[41] . Clematis, F., A. Minuto, M. L. Gullino, and A. Garibaldi. 2009. Suppressiveness to Fusarium oxysporum f. sp. radicis lycopersici in re-used perlite and perlite-peat substrates in soilless tomatoes. Biol. Control. Elsevier Inc. 48:108–114.

[42] Folman, L. B., J. Postma, and J. a. Veen. 2001. Ecophysiological characterization of rhizosphere bacterial communities at different root locations and plant developmental stages of cucumber grown on rockwool. Microb. Ecol. 42:586–597.

[43] Minuto, A., F. Clematis, M. L. Gullino, and A. Garibaldi. Induced suppressiveness toFusarium oxysporum f.sp.radicis lycopersici in rockwool substrate used in closed soilless systems. Phytoparasitica 35:77–85.

[44] Muslim, A., H. Horinouchi, and M. Hyakumachi. 2003. Control of fusarium crown and root rot of tomato with hypovirulent binucleate Rhizodonia in soil and rock wool systems. Plant Dis. 87:739–747.

[45] Postma, J., M. J. Willemsen-de Klein, and J. D. van Elsas. 2000. Effect of the Indigenous Microflora on the Development of Root and Crown Rot Caused by Pythium aphanidermatum in Cucumber Grown on Rockwool. Phytopathology 90:125–33.

[46] Postma, J. 2004. Suppressiveness of root pathogens in closed cultivation systems. Acta Hortic. 644:503–510.

[47] Postma, J., B. P. J. Geraats, R. Pastoor, and J. D. van Elsas. 2005. Characterization of the Microbial Community Involved in the Suppression of Pythium aphanidermatum in Cucumber Grown on Rockwool. Phytopathology 95:808–818.

[48] Tu, J. C. ., A. P. . Papadopoulos, X. Hao, and J. Zheng. 1999. The relationship of Pythium root rot and rhizosphere microorganisms in a closed circulating and an open system in rockwool culture of tomato. Acta Hortic. 481:577–583.

[49] Vallance, J., F. Déniel, G. Floch, L. Guérin-Dubrana, D. Blancard, and P. Rey. 2011. Pathogenic and beneficial microorganisms in soilless cultures. Agron. Sustain. Dev. 31:191–203.

[50] . van Os, E. A., and J. Postma. 2000. Prevention of root diseases in closed soilless growing systems by microbial optimisation and slow sand filtration. Acta Hortic. 532:97–102.

[51] Zhang, W., and J. C. Tu. 2000. Effect of ultraviolet disinfection of hydroponic solutions on Pythium root rot and non-target bacteria. Eur. J. Plant Pathol. 106:415–421

compared to soil, there have been many less studies on suppressive flora in hydroponics. The fact that of these few studies, so many have found strong evidence of suppressive flora in hydroponics is important.

While there has been ambiguity over the years on the position of the NOSB related to organic hydroponic production, the NOP has noted in 2002, 2004, 2009, 2014 and 2016 that organic hydroponic production is allowed as long as the producer can demonstrate compliance with the USDA organic regulations However, an NOP publication (the Organic Integrity Quarterly of May 2014) did state that there may be additional guidance issued in the future for these methods. The allowance of hydroponic certification without organic hydroponic production standards has led to inconsistent approval by certifiers.

The hydroponic proponents of the Task Force contended that advantages of hydroponic systems included water conservation, food safety, disease suppression, nutrient conservation and retention, and soil conservation (because of not using any soil and use of land unsuitable for cultivation). They argued that these production systems abide by the definition of organic production: A production system that is managed in accordance with the Act and regulations in this part to respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity. Additionally, proponents contend they comply with applicable areas of the rule, including writing and implementing an Organic System Plan, keeping records, preserving and cycling natural resources, and using compliant inputs. Precedence for exemptions for non-applicable areas of the standards has already been set by NOSB recommendations on greenhouse production, mushroom production, aquaculture production and others.

Organic production systems

The justifications for how hydroponic systems comply with §205.203 (soil fertility and crop nutrients) and §205.205 (crop rotation) have been given as follows (see rule wording above):

- §205.203 (a) – Depends on the site specific conditions but generally, if the system interacts with soil these requirements apply as they would to in-ground farms. If production is soil-less then the non-use of soil maintains the site's soil. Operations are still responsible for not degrading soil.
- §205.203 (b), (c) and 205.205 – In lieu of crop rotation and cover cropping, soil regeneration and recycling practices are implemented and documented in order to demonstrate that the required functions/goals of crop rotation and cover cropping listed in 205.205 (a, b, c, d) have been achieved through these alternate practices, as applicable to the operation. Specifically, by maintaining or improving organic matter content, providing for pest management in crops, managing deficient or excess plant nutrients, and by providing erosion control. Exemptions for crop rotation and cover cropping have been recommended by the NOSB in the past for specific types of operations like greenhouses.

Minority Discussion

This minority view is a byproduct of numerous hours of debate, research, and contemplation about the diversity of the organic community. The industry is comprised of a variety of producers, processors, certifiers, retailers and consumers that all have evolved to define what compliant organic production systems look like under current NOP regulation. During many rounds of public comment, the NOSB has listened to the community and their opinions on the applicability and legality of hydroponic, aeroponic and aquaponic systems under the organic label. As with all complex issues, there are various viewpoints

regarding the meaning and interpretation of the organic regulation. The minority position celebrates this diversity and respects all shareholders' interpretations.

There are some who believe that proper soil management following principles outlined in the standards are foundational to what organic certification should mean. Many founding farmers of the organic movement shared this perspective as they pioneered new methods of agricultural production as an alternative to conventional production. We agree that soil is historically linked with organic production and should be as well in its future – we are pro soil. However, we do not view this as a mutually exclusive decision – being pro soil does not mean there is not a home for other production methods that "respond to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity."

Members of the organic community were drawn to organic foods and production for various reasons, including but not limited to: Environmental impacts of agriculture, resource conservation, avoidance of highly toxic synthetic pesticides and fertilizers, believed health benefits, local agriculture, etc. Some of these aspects were included in the law and regulations, while others were left out. Most members of the organic community are motivated by these concerns and more, each to varying degrees. Each of these concerns have tradeoffs which need to be balanced. Determining where this balance lies has unfortunately confounded the NOSB since its inception in 1995.

The 1995 NOSB recommendation *Standards for Greenhouses* contains the statement, "Hydroponic production in soilless media to be labeled organically produced shall be allowed if all provisions of the OFPA have been met." That statement indicated that an analysis had not been made of whether hydroponics met the provisions of OFPA. The brief dialogue at the meeting made it clear that while some board members were supportive of hydroponics, others had concerns about soilless production.

In March 2000, a revised proposed rule for the National Organic Program was published, revising the initial proposed rule published in December 1997. In the supplemental information, the following was stated:

> We have amended the term, "system of organic farming and handling," to "system of organic production and handling" and retained the original definition in this proposal. The original definition was crafted to be consistent with the requirements of the Act. We have changed "farming" to "production" to provide a more encompassing term, which may come to include such diverse activities as hydroponics, green house production, and harvesting of aquatic animals. The purpose of the original definition was to describe practices and substances consistent with systems of organic farming and organic handling as required by the Act and to provide an explicit reference point for determining which practices and substances are most consistent with these systems.[52]

In an 1807 communication from Thomas Jefferson to William H. Cabbell as to statutory interpretation, Thomas Jefferson stated,

> *"In the construction of a law, even in judiciary cases of meum et tuum, where the opposite parties have a right and counter right in the very words of the law, the Judge considers the intention of the lawgiver as his true guide, and gives to all the parts and expressions of the law, that meaning which will effect, instead of defeating, its intention. But in laws merely executive, where no private right stands in the way, and the public object is in the interest of all, a much freer scope of construction, in favor of the intention of the law, ought to be taken, and ingenuity ever should be exercised in devising constructions which may save to the public the benefit of the law. Its intention is the important thing:*

[52] Federal Register Volume 65 Number 49. Page 13521. Docket Number: TMD-00-02-PR2, RIN 0581-AA40. National Organic Program Proposed Rule. Agricultural Marketing Service, USDA. March 13, 2000

the means of attaining it quite subordinate." –Thomas Jefferson to William H. Cabbell, 1807.

The minority view does find some common ground with the majority proposal; however, we find it strays too far from the original intent of the previous NOSB recommendations. It is not consistent with previous Board decisions, nor its intent when crafting its recommendations. It would be difficult for the NOP to implement without additional justification.

The minority view holds that the 2010 NOSB recommendation entitled *Production Standards for Terrestrial Plants in Containers and Enclosures (Greenhouses)* was generally complete in regards to addressing compliant characteristics of organic systems under the NOP regulation. However, as was discussed previously in the introduction and background section, the NOP returned to the NOSB following the 2016 Task Force report, asking for additional clarity regarding the 2010 NOSB hydroponics recommendation because the NOP felt the 2010 recommendation left too many aspects of compliant organic production systems open for interpretation. As such, the minority position below is an edited and redlined version of the 2010 NOSB recommendation intended to provide further clarity requested by the NOP.

The minority view notes that the 2010 recommendation allowed compost to be utilized in place of soil because it deemed it equivalent to soil. The foundation of this equivalency was stated as follows:

> The foundational principle of organic farming is the practice of maintaining and nurturing soil health so as to foster the proliferation of the proper soil biology with their accompanying ecologies. Since all typical soil dwelling organisms, such as earthworms, protozoa, fungi, bacteria, actinomycetes, etc. can thrive in a properly designed compost based growing media, producing the beneficial symbiotic ecological relationships found in soil, such growing media should be rightfully considered soil.

As such, the minority view extends that if production systems, utilizing organically approved production techniques on majority carbon based substrate, can foster the proliferation of proper soil biology within their accompanying ecologies as evidenced by the presence of typical soil dwelling organisms, such as earthworms, protozoa, fungi, bacteria, actinomycetes then they should be eligible for organic certification. Therefore, we propose working on a production standard that requires verification of the presence of four trophic levels. We understand this concept is new and has not been reviewed or commented on by the organic community or industry. We welcome feedback from the community and industry on this concept, definition and feasibility.

The minority view is based upon the beliefs that organic production should enforce responsible stewardship practices, address sustainability and conservation of resources (e.g. land, water, on-farm inputs, energy, biodiversity), and allow for novel developments in organic food production systems that assist in providing greater access of organic food to consumers.

The minority is not supportive of taking either proposal (major or minority) through to a vote at the Fall 2017 NOSB meeting. Given the division of the community reflected in the division of the board, all stakeholders need to come to terms that a greater compromise will be necessary to make progress on this issue. The minority view finds merit in a discussion on hydroponic/soilless production standards and mandatory additional labeling with the organic label/claim. This concept has not been fully explored.

The minority view believes these proposed revisions to the 2010 recommendation require further refinement and as noted earlier we request additional feedback from the public on these proposed revisions.

Proposal – based on 2010 NOSB Recommendation

§ 205.2 Terms Defined

Greenhouse- Permanent enclosed structure that allows for an actively controlled environment used to grow organic crops, annual seedlings or planting stock used in organic production.

Hydroponics- The production of normally terrestrial, vascular plants in nutrient rich solutions or in an inert, porous, solid matrix bathed in nutrient rich solutions. Sprouts and fodder are considered a processed material and are not considered hydroponic.

Aeroponics- A variation of hydroponics in which plant roots are suspended in air and misted with nutrient solution.

Containers- Any vessel and associated equipment used to house growing media and the complete root structure of terrestrial plants and to prevent the roots from contacting the soil or surface beneath the vessel, such as, but not limited to, pots, troughs, plastic bags, floor mats. etc.

~~*Growing media*- Material which contains sufficient organic matter capable of supporting the plant root system and a natural and diverse soil ecology.~~

Container Production- The production of normally terrestrial, vascular plants in containers. Can be certified organic if production requirements of section of 205.209 are met.

Trophic levels: The hierarchical levels of organisms within an ecosystem; each level consisting of organisms that share the same function and food source in the food chain of a defined ecosystem.

§ 205.105 Allowed and prohibited substances, methods, and ingredients in organic production and handling. To be sold or labeled as "100 percent organic," "organic," or "made with organic (specified ingredients or food group(s))," the product must be produced and handled without the use of**:**

(h) Aeroponics and Hydroponics.

§ 205.209 Terrestrial Plants in Containers and Enclosures ~~(Greenhouses)~~

(a) Container and enclosure (such as a greenhouse) operations must meet all applicable requirements of subparts B (205.105) and C (205.200 – 205.206) except that:

(1) The producer operating a container or enclosure operation ~~greenhouse~~ with crops grown in containers using a growing media that does not include soil from the production site is exempt from requirements of 205.202(b)~~, 205.203(a).~~

(2) The producer operating with crops grown in containers shall comply with the applicable section of 205.203(a) based on site specific conditions.

(3) In addition, the ~~growing~~ container based producer is exempt from the crop rotation and cover cropping requirements in section 205.203(b) and 205.205. In lieu of crop rotation and cover cropping, soil regeneration and recycling practices shall be implemented and documented for the Accredited Certification Agent in order to demonstrate that the required functions/goals of crop rotation and cover cropping listed in 205.205(a, b, c, d) have been achieved through these alternate practices, as applicable to the operation. Specifically:

(i) Maintain or improve soil organic matter content (a)- Examples include, but are not limited to, recycling and re-use of growing media, addition of compost and other compostable materials, earthworm replenishment, microbial re-inoculation, etc.

(ii) Provide for pest management in crops (b)- Examples include, but are not limited to: Soil borne damping-off control through various low temperature heating methods; Soil inoculation using disease suppressant bacteria and fungi.

(iii) Manage deficient or excess plant nutrients (c)- Examples include, but are not limited to: Recycle excess plant nutrients contained in drain water from media containers, avoiding so called drain-to-waste systems. Recycled nutrients must be re-used in the greenhouse, or alternatively, on a growing crop outside the facility.

(iv) Provide erosion control (d)- Examples include, but are not limited to: Though erosion is not generally applicable to greenhouse production, recycling of drain water prevents off-site movement of nutrients, a common consequence of typical field erosion.

(4) The Container Organic System Plan must address how meets the requirements to conserve biodiversity and maintain or improve natural resources of the site-specific operations. The Organic System Plan should include the entire production site (containers and non-containers as applicable) as well as the surrounding environment.

(b) Growing media requirements:

(1) ~~ingredients~~ Inputs shall be verified by Accredited Certifying Agent and shall not include as ingredients any prohibited materials.

(2) 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.

(3) Growing media shall not be disposed of as waste, but should be recycled or reused whenever possible.

(4) Growing media shall contain sufficient organic matter capable of supporting natural and diverse soil ecology as evidenced by supporting four trophic levels. ~~For this reason, hydroponic and aeroponic systems are prohibited.Growing media used to produce crop transplants should also be capable of supporting a natural and diverse soil ecology.~~

(5) Growing media shall be a minimum of 50% carbon based material.

(c) Producers may use full-spectrum light sources.

(d) Plants and soil shall not be in direct contact with, or indirect contact with condensates from, wood treated with prohibited materials that are used for greenhouse structures or frames of raised beds.

(e) Producers must recycle or reuse containers at end of life.

~~(f) To comply with the provisions of 205.201(a)(5) to prevent commingling and contamination, organic and non-organic crops can be grown within the same structure only if the following conditions are met:~~

~~(1) An impermeable wall shall separate organic and non-organic production sites if prohibited materials are applied to the non-organic crop to ensure that cross contamination does not occur.~~

~~(2) The ventilation systems must ensure that prohibited materials cannot drift, or be otherwise conveyed to the organic~~

~~(3) Separate watering systems must be established if prohibited fertilizers and/or pesticides are injected within the watering system.~~

~~(4) Producers must ensure that no contamination occurs to the organic crop through cross-pollination with crops produced through genetic engineering~~

~~(5) Soil mixing machines and other equipment used for non-organic crop production must be thoroughly cleaned prior to use in organic production.~~

~~(6) Adequate physical facilities, as determined by the certifying agent, shall separate organic and non-organic crops and production materials in storage, production or holding areas.~~

~~(7) Organic and non-organic crops and production areas must be conspicuously labeled.~~

Approved by Francis Thicke, Subcommittee Chair, to transmit to NOSB, August 29, 2017