National Organic Standards Board
Materials Subcommittee
2026 Research Priorities Proposal
Spring 2026

Executive Summary

INTRODUCTION

The National Organic Standards Board (NOSB) presents an annual list of research priorities for organic food and agriculture, a process originally established by the Board in 2012. The NOSB requests that integrated research be undertaken with consideration of the whole-farm system in multiple regions, recognizing the interplay of agroecology, the surrounding environment, and both native and farmed species of plants and animals.

As part of this year's process, the Livestock, Crops, and Handling Subcommittees have made an effort to categorize and differentiate highest priority topics from ongoing topics. In addition, stakeholder comments for the Fall 2025 meeting emphasized the need for research on topics that covered multiple sectors. In response to that, the NOSB is adding a new category called "Interdisciplinary", which incorporates those previously classed as "General."

BACKGROUND

The NOSB revisits the list of priorities each year. The list is made meaningful by input through the written and oral public comments shared with the Board, through the expertise of the Board itself, and through interactions throughout the year with those engaged in some dimension of the organic farm-to-fork continuum. When the NOSB has determined that a priority area has been sufficiently addressed, it is removed from the list. Priorities are also reviewed and updated each year to more accurately reflect the current need for new knowledge.

The NOSB encourages collaboration among laboratories, federal agencies, universities, foundations, organizations, business interests, organic farmers, and the broader organic community to address pressing issues in organic agriculture and processing/handling. We especially encourage university researchers to conduct non-intrusive studies on working organic farms.

The NOSB encourages integrated, whole-farm research into the areas described below.

Motion to accept the 2026 Research Priorities proposal
Motion by: Andrea Hatziyannis
Seconded by: Cat McCluskey
Yes: 5 No: 0 Abstain: 0 Recuse: 0 Absent: 0

SUMMARY LISTS (see following sections for expanded explanations)

INTERDISCIPLINARY RESEARCH PRIORITIES

1. Increasing access to organic foods
2. Barriers to transitioning to organic production
3. Whole farm ecosystem service assessments to determine the economic, social, and environmental impact of farming system choices
4. Research-based information on the economics of organic certification, and production as well as profitability of organic enterprises.
5. Information on the impact of organic enterprises on regional economies
6. Organic yield gaps and system-level productivity
7. Measuring and improving the effectiveness of research extension programs
8. Research-based information on farmer mental health and quality of life
9. Information on the availability, quality, and cost of farm labor
10. A comprehensive study of National List sanitizers used in all phases of organic production and handling.
11. Organic agroforestry and perennial-based systems.

CROPS

Top priorities for organic crop research

1. Assess the extent and impact of plastic use in organic crop production and identify ways organic producers can lead in reducing it and aligning with consumer concerns
2. Side-by-side trials of approved organic pesticide products, both synthetic and natural, and cultural methods, in multiple regions, with a request for collaboration with the IR4 project.
3. Develop alternatives to eliminate the use of Per- and Polyfluoroalkyl (PFAS) substances and implement remediation strategies to mitigate contaminated areas.
4. Assess the extent, economic impact and potential compensation mechanisms for GMO contamination and prohibited pesticide drift, such as from Dicamba, on organic crops.
5. Conduct whole farm ecosystem service assessments to determine the economic, social, and environmental impact of farming system choices.

Ongoing organic crop research topics -- Inputs

6. Develop NOP-compliant, biobased, biodegradable film mulches and hydromulches that control weeds, conserve moisture, and protect the soil. Include studies of decomposition rates, the effects of residues on soil biology, and the factors that affect the breakdown of biodegradable bio-based mulch film.
7. Impartial evaluation of microbial inoculants, soil conditioners, and other amendments and their contribution to soil health.
8. Holistic soil research to quantify soil biodiversity and activity.
9. The demand for organic nursery stock far exceeds the supply. Research is needed to identify the barriers to expanding supply.
10. Conduct a comprehensive review of the positive and negative impacts of copper products in pest management.
11. Increase the availability and supply of organic seeds by developing cultivars with improved performance. More breeding of cover crops is also needed. Also, conduct regional comparative trials to evaluate the performance and quality of organic varieties, seeds and planting stock.

12. Investigate the occurrence and fate of prohibited substances such as antibiotics, heavy metals, and pesticides in compost.
13. Investigate contaminated inputs from non-organic sources.
14. Investigate plasticizers and other additives to paper and their behavior in the environment.

Ongoing organic crop research topics -- Systems

15. Practices that reduce greenhouse gas emissions and that contribute to farming systems' resilience in the face of climate change.
16. Factors impacting organic crop nutrition, and comparison of organic and/conventional crop nutrient profiles.
17. Organic no-till and low-till practices for diverse climates, crops, and soil types.
18. Develop cover cropping practices that come closer to meeting the annual fertility demands of commonly grown organic crops.
19. More research, extension, and education are needed to fully understand the relationship between on-farm biodiversity and pathogen presence and abundance.
20. Strategies for the prevention, management, and control of problem insects, diseases, and weeds in the context of a changing climate, with an emphasis on predicting new pest problems and systems-based approaches.
21. Studies of the effects of long-term (2+ years) use of in-situ plastic weed barriers/landscape fabric on soils in greenhouse and container growing systems. This includes changes in nutrient levels and biodiversity above and below the soil level, as well as any needed remediation measures once the plastic has been removed.
22. Research-based information on corn and soybean trade deficits: assessment of imports and exports to determine the causal factors and viable solutions to unfavorable trade disparities; organic traceability and supply chain technology; market data and supply/demand transparency.

LIVESTOCK

Top priorities for organic livestock research

1. Elucidate the barriers to increased domestic organic pork and beef production and markets.
2. Develop balanced organic livestock rations incorporating high percentages of diverse, regionally adapted grain crops to complement corn and soybeans, creating more marketing opportunities for robust crop rotations.

Ongoing organic livestock research topics

3. Prevention and management of parasites in all livestock species across regions, including evaluation of natural parasiticides and methodologies such as nutritional programs, herbs, essential oils, homeopathic remedies, diatomaceous earth, pasture rotation, pasture species selections, mixed species grazing, and use of genetic within and between breeds.
4. Evaluate natural alternatives to DL-Methionine in a systems approach for organic poultry feed program.
5. Develop dairy programs that address climate change mitigation strategies while maintaining production capacity and maximizing effective forage rotations.
6. Alternatives to eliminate usage and remediation strategies to mitigate contaminated areas and water for Per- and Polyfluoroalkyl (PFAS) substances.\
7. Barriers to increased organic insect production.

FOOD HANDLING AND PROCESSING

Prioritized order within categories; categories not ordered by priority. See Expanded Explanation section for more detail, as applicable.

Improving methods and practices for organic handling and processing

1. Best practices for identifying potential vectors of heavy metal contamination in organic systems, including strategies for effective testing in soils, water, and processing facilities to support prevention measures.
2. Effect of various types of food packaging on organic products, including suitable alternatives to packaging that contain any of the following: phthalates, plasticizers, per- and polyfluoroalkyl substances (PFAS), BPA (Bisphenol-A), and antimicrobial nanoparticle surface coatings. Additionally, PFAS research should include testing for total organic fluorine as well as specific PFAS materials.
3. Evaluation of postharvest physiology of organic fruit and effective decay management practices to address unique post-harvest issues.
4. Environmental, economic, and health benefits of organic handling and processing for society, communities, businesses, and/or individuals.

Expanding market opportunities for organic products – e.g., consumer expectations, products based on rotational crops, etc.

5. Evaluation of the essentiality of § 205.605(a), § 205.605(b), and § 205.606 substances and the suitability of organic alternatives (i.e., including commercial availability) in applicable food formulations via laboratory testing, sensory evaluation, and/or market analysis.
6. Alternatives to conventional celery powder for curing organic meat.
7. Consumer food product development research for crops integral to organic farming systems (e.g., rotational crops).
8. Multi-product stream crops with potential for use in organic products, including organic produce items with strong pigment levels that could be sold for direct consumption and processed into organic colors.
9. Opportunities and barriers to organic alcohol production from rotational crops
10. Phosphates used in processed foods

Complete (or full) materials review

11. Research on the creation of an overarching ancillary ingredient review process for materials used in processing and handling vs reviewing ancillaries as part of the petition or sunset review process, including cost/benefit of each process.

MATERIALS/GMO

1. Fate of Genetically Engineered Plant Material in Compost
2. Integrity of Breeding Lines and Ways to Mitigate Small Amounts of Unwanted Genetic Material
3. Assess the Genetic Integrity of Organic Crops At-Risk
4. Prevention of GMO Crop Contamination: Evaluation of effectiveness
5. Testing for Fraud: Developing and implementing new technologies and practices
6. Improving our understanding of the (1) potential threats and (2) costs to the organic sector that result from the use of excluded methods

EXPANDED EXPLANATIONS

INTERDISCIPLINARY RESEARCH PRIORITIES

1. **Increasing Access to Organic Foods**
   What factors influence access to organically produced foods? Individual-based studies are needed to assess the constraints to accessing organic food. Research should be funded that builds on an understanding of constraints by asking what community, market, and policy-based incentives would enhance access to organic foods.

2. **Barriers to Transitioning to Organic Production**
   What are the specific production barriers and/or yield barriers that farmers face during the three-year transition period to organic production? Statistical analysis of what to expect economically during the transition is needed to help transitioning growers prepare and successfully complete the transition process.

3. **Whole farm ecosystem service assessments to determine the economic, social, and environmental impact of farming system choices**
   This can include the full spectrum of crop, livestock, and integrated systems as well as soilless systems.

4. **Research-based information on the economics of organic certification, and production as well as profitability of organic enterprises**.
   Production budgets and profitability analyses can be broken down for specific sectors, farm scales, and crops. Some are well-studied, and literature reviews could be worthwhile. Conditions and conclusions vary over time as relative prices change. How important is the perception of integrity or its lack in the market? Farmers will benefit from this information.

5. **Information on the impact of organic enterprises on regional economies**
   Ground-breaking studies have been done in this area and need to be expanded and followed up.

6. **Organic yield gaps and system-level productivity**
   These studies have been done for specific crops and regions. More needs to be done on diversified farm operations, including those with both crops and livestock.

7. **Measuring and improving the effectiveness of research extension programs**
   How to ensure that results from these Research Priorities are fully shared with farmers and other organic stakeholders? The Extension system appears to be losing funding and is unable to reach many organic farmers. Alternative information outlets may be biased or oriented toward product sales. Farmer-to-farmer networks need to be studied and optimized as well. Organic farming is under multiple threats, and the entire organic community needs accurate and timely information.

8. **Research-based information on farmer mental health and quality of life**
   Much research has been done on farming stresses and their effects on mental health. More needs to be done, and results circulated to farmers and farm service providers.

9. **Information on the availability, quality, and cost of farm labor**
   The availability and quality of farm labor is in flux. Farmers and lawmakers need to fully understand the situation.

10. **A comprehensive study of National List sanitizers used in all phases of organic production and handling.**
    Holistic studies are needed on all phases of sanitizer use in organic food production, processing, and distribution, including disinfection of irrigation, maple, and dairy lines; dairy bulk tanks and trucks; post-harvest treatments; processing equipment and packing lines, etc. Suggested topics:
    - Effective alternatives to current sanitizers. Effectiveness of sanitizers includes both reduction of pathogenic organisms and reduction of post-harvest spoilage.
    - effects on occupational and consumer human health and the environment
    - optimizing rotational use strategies for various situations and purposes
    - Collaboration among researchers, agencies that regulate sanitizers and food safety, and NOP with the goal of developing an alternative process for evaluating sanitizers and sanitation practices for use by organic operations
    - Is there a measurable transfer of sanitizer residue to organic food following the sanitization of food contact surfaces? If residues are not found, is it even necessary for the National List to regulate surface/environmental sanitizers? (Residue studies should not be limited to only National List materials but should also include sanitizers such as quaternary ammonia compounds.)
    - What amount of sanitizer/disinfectant remains on or in various organic products after a processing or packing step that includes direct treatment with a sanitizer such as immersion in a water bath treated with a sanitizer?
    - Could the development of robust, post-harvest handling standards better identify which sanitation, disinfectants, or treatment practices impact organic integrity? Could expanded handling standards assist in regulating and enforcing the use of sanitizers instead of, or in addition to, the National List?
    - Could restructuring the National List to separate sanitizers from ingredients and processing aids create a pathway to development of an alternative set of evaluation criteria for sanitizers?
    - What would the impact on handlers and processors be if any specific sanitizers were removed from the National List?

11. **Organic agroforestry and perennial-based systems**.
    There has been a dearth of research into the organic establishment and management of agroforestry, permaculture, and woody perennial conservation buffers. These systems offer multiple ecosystem benefits including enhanced soil health and organic matter, improved nutrient cycling and reduced input needs, improved water quality, increased biodiversity, and improved microclimate for crops and livestock. In addition, woody perennial buffer plantings can protect organic crops from pesticide and GMO pollen drift from neighboring non-organic farms. These benefits need to be quantified and optimized.

CROPS

Top priorities for organic crop research

1. **The extent and impact of plastic use in organic crop production**

Both consumers and producers are concerned about the use of plastics in organic agriculture. The Crops Subcommittee is requesting research and information on the following:

- Statistics on current use (acreage and quantity) of crop production plastics, including mulches, drip tape, containers, row covers, tarps, high tunnels, greenhouses, etc.
- What is the turnover and fate of these plastics? This information is needed for the U.S. and major production areas such as Mexico, Spain, Chile, Holland, Canada, etc.
- What are the effects of breakdown products, airborne releases, and microplastics on soil organisms and crop plants? What is the fitness cost to beneficial microbial/fungal communities due to the presence of plastics, resins, and other breakdown substances in soil and compost?
- What are the economics of alternatives?
- If approved biodegradable biobased mulch films are developed, how many organic farmers would switch to them, and what would impact overall plastic usage?
- Can longer-term mulches, such as landscape fabric, reduce overall plastic use if allowed to remain in place over several years?
- What are the best first steps to reduce plastic use in organic production?

2. **Efficacy Comparisons of Inputs and Practices for Organic Production**

   Organic farmers need to have information from side-by-side trials between allowed and petitioned synthetic inputs versus non-synthetic alternative inputs or practices. During its five-year review of sunset materials on the National List and in the evaluation of newly petitioned materials, the NOSB often lacks sufficient information of the effectiveness of these materials as compared with other synthetics on the National List, natural materials, and cultural methods. Side-by-side trials with approved organic inputs, both synthetic and natural, and cultural methods to evaluate efficacy would strengthen the review process and provide growers with valuable information in pest and disease management decisions.

   The NOSB specifically requests collaboration with the Minor Crop Pest Management Program Interregional Research Project #4 (IR4) to include materials on the National List in their product trials. Such studies would help inform the NOSB review process of sunset materials and to determine if materials are sufficiently effective for their intended purpose, particularly when weighed against the natural and cultural alternatives. It should be noted that growers commonly rely on a mix of cultural practices and both non-synthetic materials and materials from the National List to produce crops of marketable quality and sufficient yield for profitability; it is understood that such studies would serve as a starting point and would form part of the comprehensive material review process.

3. **Per- and Polyfluoroalkyl (PFAS): Alternatives to eliminate usage and remediation strategies to mitigate contaminated areas.**

   Background: There is a need for increased research examining PFAS substances. PFAS is a broad term that contains thousands of chemicals used in consumer, commercial, and industrial products. There is evidence that PFAS substances, also known as “forever chemicals,” contaminate farmland, water, food, consumer goods, and more. PFAS substances can negatively

impact human health and animal health in direct and indirect ways over time. Many researchers and scientists are looking into matters related to PFAS substances.
The NOSB is requesting additional research on the following:

- To find safe and eco-friendly alternatives so PFAS substances can be eliminated in the production of consumer, commercial, and industrial products to prevent any future contamination.
- To quantify the impact of PFAS substances on the environment, including agricultural land and water, and human and animal health.
- To utilize tools to identify, measure, and remediate PFAS contamination that has already occurred in the environment and on organic and non-organic farmland. Explore measuring total organic chlorine to ensure that all PFAS variants are captured.
- To identify viable programs for addressing the financial and emotional costs of land that must be removed from production due to PFAS contamination.

4. **Assessing the economic impact of GMO contamination on organic crops**
Background: Genetically engineered crops and organic crops can exist in adjacent fields. There are many risks, including cross-pollination, that are mitigated as best as possible by the growers involved, but much to the expense of the organic producer. Organic growers use borders, at a minimum of thirty feet, off-set planting timeframes to avoid cross-pollination (causing organic crops to be planted sometimes at undesirable times) and change cropping rotations, all to mitigate risk. In addition, dicamba drift from sources further away can damage crops.
Research is needed on the following:
    - The total cost of GMO contamination on organic farms for the full range of crops with GMO varieties (including lesser-studied crops like apples, canola, summer squash, sweet corn, etc.). This would include recommended buffer requirements, recommended planting delays windows, testing costs, a variety of pollen receptivity restrictions, loss of sales, etc.
    - Are USDA coexistence provisions adequate?
    - Drifting chemicals can be considered “chemical trespassing.” Could pollen contamination be considered trespassing as well? Are there avenues for compensation for organic crops damaged or with reduced sale value due to contamination from other farms?

5. **Ecosystem service provisioning and biodiversity of organic systems**
How do organic systems impact ecosystem service provisioning, both on-farm and off-farm through the materials and inputs sourced and used for production? For example, life-cycle analysis of environmental costs and benefits of inputs used for organic production, such as manure, seaweed, and fish-based soil amendments, would be beneficial. Additionally, what is the impact of diversified and agroecologically designed organic farming systems on biodiversity and ecosystem services within the farm and in its surroundings? Can farm-mapping be performed to quantify the impact of the location of a farm (in a broader landscape) and the arrangement of fields and non-crop habitats to enhance biodiversity and ecosystem service provisioning?

Ongoing organic crop research topics -- Inputs

6. **Biodegradable Bio-based Mulch Film--develop NOP-compliant, biobased, biodegradable film**

mulches and hydromulches that control weeds, conserve moisture, optimize temperatures, and protect the soil.
More studies are needed addressing the following bullets. Data from Europe, where BBMF mulches are allowed for organic production, may be particularly useful.

- How rapidly do these mulches fully decompose, to what extent do cropping system, soil type, and climate mediate decomposition rates, and does the percentage of the polymers in the mulch film affect the decomposition rate?
- Are there metabolites or breakdown products of these mulches that do not fully decompose?
- Do any of these mulches fully decompose?
- Do breakdown byproducts influence the community ecology and ecosystem function of soils, plants, and the livestock that graze on crops grown in these soils?
- As fragments degrade, do they pose a problem to terrestrial and aquatic wildlife? What are the environmental fates of micro- and nano-plastic fragments resulting from biodegradable mulch film degradation, and what hazards do they present to organisms that they interact with on the way to that fate?
- Do the residues of these films accumulate after repeated use?
- Are the testing protocols in place to ensure decomposition standards?
- Are there ways that paper mulches can be improved for commercial use?

7. **Evaluation of Microbial Inoculants, Soil Conditioners, and Other Amendments**
Vendors of organic amendments now offer a large and growing array of microbial inoculants, organic soil conditioners, and other materials claimed to improve soil health, crop vigor and quality, and combat weeds, pests, and diseases. There is an urgent need for impartial evaluation of these materials to help producers decide which products to use and to avoid unnecessary expenditures on products that are unlikely to yield benefits.

8. **Holistic Soil Research to Quantify Soil Biology**
Organic farmers are presented with many alternative ways of assessing the health of their soil and its biological components. Which assessments give the most accurate and useful information to help farmers best manage soil over the short and long term?

9. **Identify Barriers and Develop Protocols for Organic Nursery Stock Production**
The demand for organic nursery stock far exceeds the supply. Research is needed to identify the barriers to expanding this market, then develop and assess organic methods for meeting the growing demand for organically grown nursery stock. Research centered on the development of practical organic methods for the nursery industry to implement is needed, including:
    - Disease and insect control materials that are allowed under organic standards and may be accepted under specific phytosanitary regulatory requirements.
    - New materials for controlling pests addressed by phytosanitary rules that show promise of compatibility with National List review criteria.
    - Alternative protocols for phytosanitary certification of nursery stock that are based on outcomes (such as testing or inspection) rather than requirements for use of synthetic materials during production.
    - Evaluate the use of mycorrhizal inoculants in nursery production

10. **Comprehensive Review of Copper**

Systems research that identifies disease-resistant material and biological controls that can reduce the use of copper-based compounds where possible is needed. Use of copper has documented negative effects on human and ecosystem health. Continued strong efforts need to be made to reduce the reliance on copper in organic production.

- Develop alternative formulations of materials containing copper so that the amount of elemental copper is reduced.
- Develop biological agents that work on diseases that copper is now used on.
- Research on tadpole shrimp and algae control in rice, and whether sodium carbonate peroxyhydrate or other materials are suitable copper alternatives in an aquatic environment.
- Research on movement and fate of applied copper in aquatic and field environments.
- Establish available and total copper threshold levels above, and identify which soil organisms are harmed, for different regions and soil types.
- Breeding plants that are resistant to the diseases that copper influences.

11. **Increase the availability and supply of organic seeds by developing cultivars with improved performance. More breeding of cover crops is also needed. Also, conduct regional comparative trials to evaluate the performance and quality of organic varieties, seeds and planting stock.**
Investigate barriers to production and adoption of organic seed. Identify specific gaps and suggest solutions. In addition, rigorous, unbiased trials are needed to compare performance of different sources of organic and conventional varieties. These can reflect a range of common organic production practices, such as high or low nitrogen status or with and without plastic mulch.

12. **Research on the fate of prohibited substances in compost – antibiotics, heavy metals, pesticides, etc.**
Can composting reduce or eliminate some undesired contaminants? Are some recalcitrant? Research is needed on the fate of what may be unavoidable contaminants in compost feedstocks.

13. **Investigate contaminated inputs from non-organic sources**
In addition to PFAS and GMO drift, there are many other sources of contamination that can negatively impact organic farms and crops. Examples would be contaminants in manures and other fertilizers, irrigation water, etc. Research to identify these and whether they are avoidable needs to be ongoing.

14. **Investigate plasticizers and other additives to paper and their behavior in the environment.**
Modern paper may contain many additives. The extent of these materials and their behavior in compost, the soil, and the environment needs to be studied.

Ongoing organic crop research topics -- Systems

15. **Climate Change (Reducing Greenhouse Emissions and Sequestering Carbon)**
A growing body of research demonstrates that organic farming can help prevent anthropomorphic climate change, and some strategies employed by organic farming can also help with resilience to current climate challenges such as drought and flooding. Although several researchers are examining this issue, additional work is needed to pinpoint specific strategies

that organic farmers can take to reduce greenhouse gas emissions and respond to current climate challenges threatening the future of our food security. Life cycle analysis of organic inputs and practices is critical. In particular, work is needed on comparing soil-based and soil-less systems, as well as the effects of farm scale on greenhouse emissions.

16. Nutritional Value of Organic Crops

How do organic soil health and fertility practices - crop rotations cover crops, compost and other organic or natural mineral amendments, etc. - affect the nutritional value or “nutrient density” of organically produced crops? How do organic production and shipping methods (including methods of production, handling, and time in transport) influence the nutritional quality, taste, palatability, and ultimately preference for organic vegetables and fruits? There is a lack of sound, rigorously conducted studies of this kind. How can growers and handlers retain nutrition through post-harvest handling and transportation? Additionally, can providing organic producers with information on soil biology and soil nutrient composition help improve nutrition? Finally, more studies are needed to examine how organic crops compare to conventional crops with regards to nutritional value.

17. Organic No-Till and Minimum Tillage

Organic no-till can increase soil health and provide for increased biodiversity. Organic no-till preserves and builds soil organic matter, conserves soil moisture, reduces soil erosion, and requires less fuel and labor than standard organic row crop farming. Farmers are employing several different approaches to organic no-till. Some are using a roller-crimper to terminate cover crops for in-place mulching. They then transplant or seed directly into the cover crop mulch. Others are utilizing polyethylene sheets (silage tarps) to prepare land for no-till planting. This approach often involves termination of a cover crop, as with the roller-crimper systems, but seemingly as often, or more frequently, is utilized to prepare fallow ground (for stale seed bedding, termination of crop residue and subsequent incorporation via soil fauna), or in conjunction with large applications of compost or other sources of organic matter.

Increased research is needed to develop organic no-till systems that function for a wide variety of crops in diverse climates and soil types. Annual crops such as commodity row crops and specialty crops, as well as perennial crops such as tree fruits, berries, and grapes, would all benefit from organic no till practices.

Research areas that could be covered include:

- Development of plant varieties that have specific characteristics, such as early ripening, to aid in the effectiveness and practicality of organic no-till.
- What combination of mulch crops and cultural systems sustain crop yields, provide soil health benefits, and suppress weeds?
- How does organic no-till influence pest, weed, and disease management?
- What potential pest problems can be caused or exacerbated by cover crops used as mulches, and how can those problems best be managed?
- In perennial cropping systems, such as fruits, what are the benefits or drawbacks of using this mulching system on weed, pest, and disease management, as well as soil fertility?
- What are the biodiversity benefits to living and/or killed mulches, and how does this contribute to pest, weed, and disease management?
- Do these systems affect the nutrient balance of the soil and subsequent fertilization practices, including use of outside inputs?

- Based on the improved soil health, when there is less soil disturbance and more plant decomposition resulting in higher organic matter, how does this system affect soil microbial life
  and nutrient availability, and does this then result in crops that are less susceptible to disease and pests?
- Research is needed on seeds, specifically for good cold germination, rapid emergence and establishment, seedling vigor, nutrient uptake efficiency, and overall weed competitiveness to crop cultivar development goals for organic conservation tillage systems.
- How can reduced tillage weed management be improved, including development of new tools and techniques that provide greater weed control for less soil disturbance?
- Research that assesses the ecosystem benefits of reducing tillage in patches (field-level) across a farm is also needed. For example, the relative benefits of reducing tillage are greater in areas prone to surface water runoff. Research is needed to "inform" where reduced tillage practices are likely to have their greatest impact.

18. Managing Cover Crops for On-Farm Fertility

Growing cover crops and green manures is a foundational practice on many organic farms. In addition to conserving soil, increasing water holding capacity, and providing weed suppression, cover crops supply important plant nutrients and increase soil organic matter. As farmers seek to grow their own fertility, more research is needed on the efficacy of relying primarily on cover crops to meet production needs, particularly for horticultural crops. At present, there is inadequate data on the nutrient benefits of different cover crop mixes and how those benefits vary according to species mix, mowing practices, tillage regimes, subsequent planting time of the cash crops, and the preceding practices that define the legacy of individual fields. Further, there need to be more programs to breed seeds for cover crops.

19. Pathogen Prevention

Third-party food safety auditors believe that some biodiversity-maintenance strategies employed by organic farmers may increase the risk for introduction of human pathogens on the field. While some research has been conducted disproving this hypothesis, more research, extension and education are needed to fully understand the relationship between on-farm biodiversity and food safety – and this research must be communicated to third-party food safety auditors and incorporated into their audits.

20. Management of Problem Insects, Diseases, and Weeds

There is a large pool of research on the control of insects, diseases, and weeds using organic methods. Many controls use a systems approach and are quite effective. However, some arthropod pests, including new invasive species, are problematic, and in several cases the organic control options are very limited or nonexistent. The organic community needs more information on their biology, life cycle weak points, and natural enemies to implement targeted and systemic management.

Examples are:

- Spotted wing drosophila.
- Brown marmorated stinkbug,
- Spotted lanternfly,
- Swede midge,

- Leek moth, Corn rootworm beetle (northern and western),
- Cutworms (army, western bean, etc.),
- and others.

Disease management in organic fruit and vegetable production relies on a systems approach to succeed, but even with current systems plans in place, growers frequently struggle to manage commonly occurring blights and citrus greening. The NOSB underscores the need for systems research that addresses solutions to these and related diseases that are workable for farmers, that reduces adverse health effects on farmers and fieldworkers, and that also limits adverse effects on the soil and water in which the crops grow. To this end, we call for systems research that identifies disease resistant material and biological controls that limit the use of copper-based compounds and other fungicides where possible. Specifically, targeted research is needed to identify management practices and less toxic alternative materials for a wide range of crops.

More research is needed on many of the crop/disease combinations, including:

- Comprehensive, systems-based approaches for managing individual crops in a way that decreases the need for copper-based materials including researching crop rotations, sanitation practices, plant spacing, and other factors that influence disease.
- Soil management and crop cultivar development for enhanced beneficial crop-root microbe partnerships that protect organic crops from soil borne and foliar pathogens.
- Improved materials and methods for fire blight control in rosaceous crops.
- Evaluation of plant nutritional strategies to lessen disease impacts.

Further research into certain diseases in vegetables (including, but not limited to, early blight, late blight, downy mildews, etc.), fruits (including, but not limited to, apple scab, fire blight, peach leaf curl, little cherry disease, X-disease, grape botrytis, etc.), and soilborne or other diseases affecting organic crops that require mitigations such as approved fungicides or the increased use of copper.

Weed management is one of the greatest challenges to successful organic crop production. Development of integrated organic management strategies that effectively control weeds in specific cropping systems without excessive tillage continues to be a top research priority for organic producers. For instance, Canadian thistle, pigweed (including invasive palmer amaranth and water hemp), wild sunflower, giant ragweed, cocklebur, and other perennial weeds can be very difficult to control in reduced tillage systems. Research into new technologies, such as electroshock weeders, interrow mowers, camera-guided cultivators, laser-weeders incorporating AI (artificial intelligence) and robotics, propane flamers, etc., is critical to success in field crops, whereas tarping, solarization, and a new generation of hand tools have great potential in small- to medium-scale vegetable crops. For large scale vegetables as well as row-crop producers, strip tillage and compatible weed management tools including row cleaners, finger weeders, and high residue cultivators can combine reduced tillage and cover crops into one practice set.

Future cropping systems will utilize multiple elements of soil, crop, arthropod, disease, and weed management. The integration of tools, such as weed-suppressive cover crops and rotations, livestock grazing, flaming, beneficial insect habitat, intercropping, etc., into annual and perennial cropping systems needs more research.

21. **Studies of the effects of long-term (2+ years) use of in-situ plastic weed barriers/landscape fabric on soils in greenhouse and container growing systems. This includes changes in nutrient levels and biodiversity above and below the soil level, as well as any needed remediation measures once the plastic has been removed.**
    These systems may rely on liquid fertility inputs and landscape cloth in the exact location for 10 years or more. What happens to the soil under that woven landscape plastic? Is there an imbalance of soil nutrients? Is the soil compacted or in good condition? Once the landscape cloth is removed, is there any special remediation that needs to be done to this soil to allow crops to grow in it? How does long-term use of landscape cloth affect biodiversity both above and below the soil?

22. **Research-based information on corn and soybean trade deficits:**
    Assessment of imports and exports to determine the causal factors and viable solutions to unfavorable trade disparities will be very useful. Research on the use of organic traceability and supply chain technology will enhance the collection of accurate market data and generally improve supply/demand transparency.

    The potential for fraud in the international organic market is high, and many organic farmer stakeholders have stated that they are under financial duress due to it. There is a need for unbiased research utilizing all available data to identify any fraudulent sales and weaknesses in the international organic market.

LIVESTOCK

Top priorities for organic livestock research

1. **Elucidate the barriers to increased organic pork and beef production and markets**
   Production of organic pork has lagged behind chickens, eggs, and dairy. We request holistic investigations into what the barriers are including, but not limited to, markets, pricing, input costs, processing facilities, and production constraints such as lack of hardy breeds and housing/humane standards (including indoor and outdoor space standards as well as outdoor soil and vegetation requirements) and effective parasite management. Competition from non-organic pasture-raised, local, and other production claims should be included, as should evaluation of methods to avoid the need for farrowing crates. Similarly, the majority of organic beef marketed in the US appears to be imported. We request research into the reasons for this, and into how domestic production can be increased.

2. **Develop balanced organic livestock rations that incorporate high percentages of diverse, regionally adapted grain crops to reduce the reliance on corn and soybeans and allow farmers to realize more marketing opportunities for a robust crop rotation**
   The US organic livestock demand and consumption of organic corn and soybean meal in feed rations exceeds US production. To help encourage farmers to utilize robust crop rotation programs that are specific to their geographical region, give livestock producers more product availability/flexibility of ingredients, and reduce the dependence on corn and beans, there needs to be proven equitable rations in all livestock segments that include alternative energy and protein sources.

Ongoing organic livestock research topics

3. **Prevention and Management of Parasites**
   Livestock production places large numbers of cattle, sheep, goats, poultry, etc., in relatively close contact with each other on fields and in barns. Organic production does not allow antibiotic use and requires that livestock be raised in a manner that approximates the animal's natural behavior. The organic farmer can use synthetic parasiticides in an emergency but not prophylactically. Synthetic parasiticides have many limitations. Even if prophylactic treatment with parasiticides were possible, parasite immunity to chemical control will inevitably occur. Thus, prevention of parasites is critical. The research questions on prevention and management of parasites must be systems-based. What farm systems, bird and animal breeds, and herd or flock management systems have shown the best results with parasite control over the last twenty years? What regional differences are there in the US in parasite prevention? Are there specific herbal, biodynamic, diatomaceous earth, or other treatments that have been proven to work over time? What are the parasite-resistant breeds? Are there plant species in pastures, hayfields, and scrublands that could be incorporated into the annual grazing system to reduce the spread of parasites or to provide prevention through the flora, fauna, and minerals ingested? Which pasture management systems are best for parasite prevention in various parts of the country? Are pasture mixes being developed that include plants known to prevent parasites in various breeds?
   An area of particular concern is control of *Ascaridia galli* and *Heterakis gallinarum* in laying and replacement chickens.

4. **Evaluation of Methionine in the Context of a System Approach in Organic Poultry Production**
   Methionine is an essential amino acid for poultry. Prior to the 1950s, poultry and pigs were fed a plant and meat-based diet without synthetic amino acids such as methionine. One former NOSB member stated, in compliance with NOP regulations §205.237(5)(b) which prohibits organic operations from feeding mammalian or poultry slaughter by-products to mammals or poultry, "We have seemingly made vegetarians out of poultry and pigs." As the organic community moves toward reducing, removing, or providing additional annotations to synthetic methionine in the diets of poultry, a heightened need exists for the organic community to rally around omnivore producers to assist in marshaling our collective efforts in finding viable alternatives to synthetic methionine and to help find approaches for making them more commercially available.

   Continued research on the use of synthetic methionine in the context of a systems approach (nutrition, genetic selection, management practices, etc.) is consistent with the NOSB unanimous resolution passed at the Spring 2015 Board meeting in La Jolla, California. A systems approach that includes industry and independent research by USDA/ARS, on farms, and by agricultural land grant universities is needed for:

   A. Evaluation of the merits and safety of natural alternative sources of methionine such as herbal methionine, high methionine corn, and corn gluten meal, potato meal, fishmeal, animal byproducts, and other non-plant materials including insect protein in organic poultry production systems. Additional research on the more promising alternative methionine sources with the
      goal of bringing them into commercial production is also encouraged.

B. Evaluation of poultry breeds selection that could be adapted to existing organic production systems – inclusive of breeds being able to adequately perform on less methionine.
C. Management practices impacting the flock's demand for methionine should be included, such as flock management practices, access to pasture, and pasture management; and
D. Using the European Union as a case study, assessing how EU farmers manage the methionine needs of their flocks in the absence of synthetic methionine use. Research findings and collaborations under various climates, housing types, geographical regions, and countries should be noted and researched, where applicable. The fruition of these types of research topics could take years to achieve; however, an aggressive and/or heightened research focus could lead to findings that can positively impact the organic poultry industry and the organic brand.

The National Organic Standards Board is committed to the phase-out of synthetic methionine for organic poultry production and encourages aggressive industry and independent research on natural alternative sources of methionine, breeding poultry that perform well on less methionine, and management practices for improved poultry animal welfare.

5. **Develop a dairy program to address climate change mitigation strategies where production capabilities are not hindered, and effective forage rotations are maximized**
To further acknowledge the central role the certified organic industry will play in the fight against climate change, an opportunity exists to both empower the economic resilience of organic dairy farmers while harnessing the soil building potential of diverse perennial and annual forages, we encourage the research community to dedicate resources to the following needs:
A. Identify an index of dairy cattle genetics to which producers could breed their existing herds and achieve a minimum of 12,000 lbs. of milk production per year on 100% forage diets. In considering the genetics selected, also identify animals bred for longevity as the more lactations on a cow, the more spread out the fixed costs of raising her as a heifer becomes.
B. To assist dairy farmers in having the tools to consider a forage-based rotation for their herds, research and identify crop rotations that have three functions: produce high quality forage, maximize soil building, and provide the most profitable outcome for the dairy producer.

6. **Per- and Polyfluoroalkyl (PFAS): Alternatives to eliminate usage and remediation strategies to mitigate contaminated areas**
Background: There is a need for increased research examining PFAS substances. PFAS is a broad term that contains thousands of chemicals used in consumer, commercial, and industrial products. There is evidence that PFAS substances, also known as "forever chemicals," contaminate farmland, water, food, consumer goods, and more. PFAS substances can negatively impact human health and animal health in direct and indirect ways over time. Many researchers and scientists are looking into matters related to PFAS substances.

The NOSB is requesting additional research on the following:

A. To find safe and eco-friendly alternatives so PFAS substances can be eliminated in the production of consumer, commercial, and industrial products to prevent any future contamination.
B. To quantify the impact of PFAS substances on the environment, including agricultural land and water, and human and animal health.
C. To utilize tools to identify, measure, and remediate PFAS contamination that has already occurred in the environment and on organic and non-organic farmland. Explore measuring total organic chlorine to ensure that all PFAS variants are captured.
D. To identify viable programs for addressing the financial and emotional costs of land that must be removed from production due to PFAS contamination.

7. **Barriers to increased organic insect production**
   There is interest in producing organic insects for high-methionine chicken feed. Stakeholders have pointed out that insects, though technically livestock, do not fit well into NOP livestock regulations, including outdoor access requirements, etc. An overview of insect rearing practices and how they may be accommodated into organic systems is needed.

FOOD HANDLING AND PROCESSING

Prioritized order within categories; categories not ordered by priority.

Improving methods and practices for organic handling and processing

1. **Research on best practices** for identifying potential vectors of heavy metal contamination in organic systems, including strategies for effective testing in soils, water, organic processing, etc. that could lead to the identification and prevention of heavy metals transgression in organic systems.

2. **Effect of various types of food packaging on organic products,** including suitable alternatives to packaging that contain any of the following: phthalates, plasticizers, per- and polyfluoroalkyl substances (PFAS), BPA (Bisphenol-A), and antimicrobial nanoparticle surface coatings. Additionally, PFAS research should investigate testing for total organic fluorine in addition to specific PFAS materials.

3. **Evaluation of postharvest physiology of organic fruit and effective decay management practices to combat unique post-harvest issues:**
   Many varieties of organic fruit on the market require specific post-harvest handling conditions (e.g., temperature, moisture, light). There are few items on the National List aimed at supporting decay management, but these may work better on some items than others and/or be restricted only for use on specific products. Research aimed at illuminating unique problems and effective strategies depending on the fruit type would be beneficial to organic fruit handlers.

4. **Research on the potential benefits of organic handling, including the environmental, economic, and health benefits that accrue to society, communities, businesses, and/or individuals from organic processing:**
   The current body of research compares the on-farm productivity and the profitability of organic farms relative to conventional operations. A smaller body examines handling of organic products, including studies of the supply chain. However, questions related to whether organic

handling facilities are less damaging to the environment or communities have not been addressed. It is well understood that lack of markets, including access to certified organic processing, remains a barrier to expansion of organic acreage and introduction of new organic crops and products. Improved access to information about the benefits of organic handling may help more processors enter the organic market and offer organic handling capacity.

Expanding market opportunities for organic products – e.g., consumer expectations, products based on rotational crops, etc.

5. **Evaluation of the essentiality of § 205.605(a), § 205.605(b), and § 205.606 substances:** In review of substances on the National List at 205.605 and 205.606 during the sunset process questions related to essentiality and commercial availability of organically produced substances, and if supplies are lacking knowledge of the barriers to organic production, are often the focus of the review by the Handling Subcommittee and of stakeholder comments. There are often commenters that blanketly state that all items should be removed from 205.606 - inferring that there should be the ability to produce all these substances organically. Therefore, it would be beneficial to comprehensively understand the status of essentiality of these substances and if organic alternatives exist; and if not what the barriers are that prevent a vibrant organic market for these substances.

6. **Alternatives to conventional celery powder for curing organic meat:** Celery Powder is used in a variety of processed meat product (hot dogs, bacon, ham, corned beef, pastrami, pepperoni, salami, etc.) to provide "cured" meat attributes without using prohibited nitrites (note: products must still be labeled "uncured"). Celery powder is naturally high in nitrates that are converted to nitrites during fermentation by a lactic acid culture. It has proven difficult to produce celery powder under organic production practices with sufficient levels of nitrates for cured meat applications. Are there growing practices or regions that could produce celery under organic conditions that would yield a crop with sufficient nitrate content for cured meat applications? Are there agriculturally derived substances (other than celery) that could be produced under organic production practices that provide nitrate levels sufficient for cured meat product applications of comparable quality?

7. **Consumer food product development research for crops integral to organic farming systems (e.g., rotational crops).**

8. **Multi-product stream crops with potential for use in organic products, including organic produce items with strong pigment levels that could be sold for direct consumption and processed into organic colors.**
   Several nonorganic colors remain on the National List; while the crops named as the color source are grown organically, those crops may not be varieties appropriate for color production. Research on crops that are both directly palatable and potentially useful as organic color sources could give farmers additional flexibility and market opportunities and help the organic sector transition to use of exclusively organic colors.

9. **Opportunities for and barriers to organic alcohol production from rotational crops:** Organic (and nonorganic) farmers are increasingly incorporating new crops into rotations to support soil health and natural pest control, but the economics of this practice remain challenging where the rotation crops do not have strong existing markets. The organic spirits

sector could potentially incorporate some of these crops, but more research is needed on which crops and how to use them in alcohol production.

10. **Phosphates used in processed foods.**
    Phosphates appear in many different compounds used in processed foods. For example calcium phosphates provide unique functionality in organic baked goods and are used in a variety of other organic food products. Additionally, calcium phosphates provide two essential nutrients in food – calcium and phosphorus –and may be used as an alternative to replace sodium phosphate and lower the sodium content in food. Some research has alleged that phosphates are associated with adverse health effects, such as cancer and cardiovascular risk, and more research is needed for conclusive results. Currently these claims have not been validated and are not supported by current scientific literature. The risk of bioaccumulation of phosphorus in the human body and at what level does it produce adverse effects to the cardiovascular and renal system need to be researched.

Complete (or full) materials review

11. **Overarching ancillary ingredient review process for materials used in processing and handling:**
    The topic of ancillary substances contained in substances on 205.605 and 205.606 and how the NOSB should review them has been a topic of discussion since 2013 but has not reached a full resolution. The current process is to review individually during the petition or sunset review process. However, as noted by stakeholder comments this has the potential to result in different decisions due to the gap in time, available information and/or people responsible for conducting the review being different. It would be beneficial to analyze and compare different strategies for conducting ancillary substance review in a more comprehensive manner as opposed to the current individual review process that includes a cost/benefit analysis of each proposed review strategy.

MATERIALS/GMO

In previous years, the Materials Subcommittee prioritized the reduction of genetically modified content of breeding lines (2013) and seed purity from GMOs (2014), issues which are currently being addressed through a comprehensive stream of work on excluded methods. The following research priorities are among the areas that the excluded methods work continues to elevate.

1. **Fate of Genetically Engineered Plant Material in Compost**
   What happens to transgenic DNA in the composting process? Materials such as cornstalks from GMO corn or manure from cows receiving rBGH are often composted, yet there is little information on whether the genetically engineered material and traits break down in composting process. Do these materials affect the microbial ecology of a compost pile? Is there trait expression of Bt (Bacillus thuringiensis) after composting that would result in persistence in the environment or plant uptake?

2. **Integrity of Breeding Lines and Ways to Mitigate Small Amounts of Unwanted Genetic Material**
   Are public germplasm collections that house at-risk crops threatened by transgenic content? Breeding lines may have been created through genetic engineering methods such as doubled haploid technology, or they may have had inadvertent presence of GMOs from pollen drift. The extent of this problem needs to be understood.

3. **Assess the Genetic Integrity of Organic Crops At-Risk**
   Develop then implement methods of assessing the genetic integrity of crops at risk to quantify the current state of the organic and conventionally produced non-GMO seed. Such assessments are needed on the front (seed purchased by farmers) and back end (seed harvested from a farmer's field) of the production chain as well as on points of contamination in the production chain.

4. **Prevention of GMO Crop Contamination: Evaluation of effectiveness**
   How well are some of the prevention strategies proposed by the NOSB working to keep GMOs out of organic crops? For instance, how many rows of buffer are needed for corn? How fast does contamination percentage go up or down if there are more or fewer buffer rows? Other examples could be whether cleanout of combines and hauling vehicles reduces contamination using typical protocols for organic cleaning, whether situating at-risk crop fields upwind from GMO crops can reduce contamination, and what the role may be of pollinators in spreading GMO pollen. Lastly, research is needed on a mechanism to provide conventional growers incentive to take their own prevention measures to prevent pollen drift and its impact on organic and identity-preserved crops. This is policy research rather than field research but is equally important.

5. **Testing for Fraud: Developing and implementing new technologies and practices**
   New technologies, tests, and methodologies are needed to differentiate organic crop production from conventional production to detect and deter fraud. Testing to differentiate conventional and organic livestock products, for example omega 3 or other indicators, is also needed. Additional tools to identify fraudulent processed and raw organic crops require research to combat this problem. Current methodologies include pesticide residue testing, in field soil chemical analysis, and GMO testing. Areas in need of further testing methodology include phostoxin residues, fumigant residues, carbon isotope rations for traceability, validating nitrogen sources using nitrogen isotope rations, or other experimental testing instruments that can be utilized to distinguish organic raw and/or processed crops from conventional items. Additionally, there is a need to develop rapid detection technologies for adaptation to field-testing capacities.

6. **Improving our understanding of the (1) potential threats and (2) costs to the organic sector that result from the use of excluded methods**
   First, identify the set of potential threats the use of excluded methods presents to organic businesses (farms and handlers). The potential threats include crop damage and cross contamination, but we recognize there might be others not yet identified. Second, estimate the costs the threats present to organic farms and organic handlers.