National Organic Standards Board
Crops Subcommittee
Protecting Against Contamination in Farm Inputs
Preliminary Bibliography and Discussion Document
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I. Introduction

Organic farmers have always made use of organic materials from a wide range of on-farm and off-farm sources—in compost, some plant materials without prior composting, mined minerals, and animal by-products such as fish or slaughterhouse waste. OFPA addresses residues of such materials in agricultural harvested crops. However, residues of pesticides, heavy metals, genetically engineered organisms, and other contaminants are problems not only for the consumer, but also for the grower, and the regulations require their management in a way that protects crops, soil, and water. Residues may reach the organic farm through different media, but here we are concerned about protecting the farmer from contamination coming from off-farm inputs used directly from these sources.

The purpose of this discussion document is to share the research results obtained by the Crops Subcommittee so far and collect public input, with the aim of identifying more experts and ultimately proposing a process for addressing contamination of inputs that may be brought onto the farm. It is the plan of the Subcommittee to meet with experts and receive additional public comments as part of the process for determining whether the NOSB should propose recommendations on this subject.

This review identifies resources that document issues associated with contamination of farm inputs --those materials that are brought into or added to the organic system and may be contaminated with residuals of synthetic or natural materials not permitted in organic production. Of course, there are also concerns with unavoidable residual environmental contaminants, which are a separate but related issue. For example, there may be some land areas that are so contaminated by background levels or ongoing contamination (through water and air) that the viability of the organic operation is threatened.

To ensure the quality of organic food, investigating sources of potential contaminants and ultimately adopting uniform preventive measures to avoid contamination of organic systems is important. Some examples of topics that have become issues in the last few years include:

- Heavy metal contamination of manure, compost, mined minerals and fish products.
- Neonicotinoid residues that could harm pollinators when taken up by plants.
- Insecticide residues such as bifenthrin that can be detected in compost
- Excessive foreign materials in compost and green waste.
- Antibiotic residues in manures that can result in tetracycline-resistant bacteria.
- Genetically engineered plant material that may or may not break down in compost and soil.

This review starts with an examination of pathways by which contaminants may enter organic production systems, products, and eventually consumers.

II. Some Contamination Incidents
In 2010, bifenthrin was found in commercially available composts. California Department of Food and Agriculture prohibited use of compost from three producers in organic production.[1] NOP allowed use of the compost as unavoidable residual environmental contamination (UREC).[2]

A 2005 ATTRA publication advised that, "Poultry litter applied at agronomic levels, using good soil conservation practices, generally will not raise arsenic concentrations sufficiently over background levels to pose environmental or human health risks. However, recent studies show that more than 70% of the arsenic in uncovered piles of poultry litter can be dissolved by rainfall and potentially leach into lakes or streams. Thus, organic producers must take care when they handle and apply poultry litter."[3] In 2011, Consumers Reports documented significant arsenic concentration in rice, including organically grown rice.[4]

III. Pathways

A. Fertilizers/Soil Amendments
Fertilizers contain trace amounts of heavy metals as impurities, which may build up in the soil. Application of certain phosphate fertilizers also adds heavy metals to the soil, including cadmium, fluorine, mercury, and lead.

Heavy metal contamination may come from inputs of organic matter:
The application of numerous biosolids (e.g., livestock manures, composts, and municipal sewage sludge) to land inadvertently leads to the accumulation of heavy metals such as As, Cd, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb, and so forth, in the soil…. Although most manures are seen as valuable fertilizers, in the pig and poultry industry, the Cu and Zn added to diets as growth promoters and As contained in poultry health products may also have the potential to cause metal contamination of the soil. The manures produced from animals on such diets contain high concentrations of As, Cu, and Zn and, if repeatedly applied to restricted areas of land, can cause considerable buildup of these metals in the soil in the long run.[5]

Compost and mulch materials are probably the most common vehicle for contaminants above unavoidable residual environmental contamination levels to arrive on organic farms. Heavy metals, pesticides, and antibiotics are among the contaminants that arrive in organic materials used for compost and mulch. Nevertheless, "Considerable remediation of the hazardous wastes or contaminated plants, soils, and sediments can be accomplished by composting. High microbial diversity and activity during composting, due to the abundance of substrates in feedstocks, promotes degradation of xenobiotic organic compounds, such as pesticides, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs)."[6]

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[1] OMRI, 2010. Composts Disallowed in California and An Update on Pesticide Residues, http://www.omri.org/news/81937/compost-update-pesticide-residues
OMRI, 2010. An Update on Pesticide Residues in Compost- Part 2, http://www.omri.org/news/85720/update-pesticide-residues-compost-part-2
[2] USDA, 2010. NOP 5016, Guidance: Allowance of Green Waste in Organic Production Systems.
[3] Barbara C. Bellows, 2005. Arsenic in Poultry Litter: Organic Regulations, www.attra.ncat.org/attra-pub/PDF/arsenic_poultry_litter.pdf
[4] http://www.consumerreports.org/cro/magazine/2012/11/arsenic-in-your-food/index.htm Arsenic in your food: Our findings show a real need for federal standards for this toxin.
[5] Raymond A.Wuana and Felix E. Okieimen, 2011. Heavy Metals in Contaminated Soils: A Review of Sources, Chemistry, Risks and Best Available Strategies for Remediation. ISRN Ecology, Volume 2011, Article ID 402647.
[6] Allen V. Barker and Gretchen M. Bryson, 2002. Bioremediation of Heavy Metals and Organic Toxicants by Composting. *The Scientific World JOURNAL* (2002) 2, 407–420.

Heavy metals cannot be destroyed by composting, but may be converted into organic compounds or chelates that are less bioavailable than inorganic metal compounds. On the other hand, heavy metals may also become concentrated because of the removal of carbon in the composting process. [7]

Contamination with herbicides is a particular problem because it can cause damage to plants.[8] It is recognized that although composting destroys many pesticide residues, it does not necessarily eliminate toxic impacts:

"The nature of the organic contaminant, composting conditions and procedures, microbial communities, and time all affect mechanisms of conversions in composts or soils…. The Büyüksönmez review noted that mineralization of organic pesticides was only a small fraction of pesticide degradation, with other prominent fates of the pesticides being partial degradation to secondary compounds, adsorption to compost, and volatilization….The secondary compounds may be as, or more, toxic than the original pesticide. Losses by volatilization essentially mean that the pesticide has been moved from one place to another. If recalcitrant materials, including metals, are present in feedstock, they may be unchanged or concentrated during composting. Recalcitrant pesticides are persistent and may show no changes during composting or have a half-life of a year or more. …Destruction of pesticides depends on the pesticide and on the substrate in which the pesticide is undergoing co-composting…. The general conclusion from research with pesticide degradation by composting was that pesticide concentrations were lowered to nonhazardous levels for crops in soils receiving the composts. However, if pesticides that are persistent or recalcitrant to degradation are present in the feedstock, special care may be needed not to use the compost on sensitive crops in the year in which the compost was made. Caution may need to be taken in some cases not to grow plants in 100% compost in containers." [9]

Herbicides of the class known as pyridine carboxylic acids, which includes aminopyralid, clopyralid, fluroxypry, picloram, and triclopyr, are registered for use on pasture, grain crops, and lawns, among other sites. "[S]ome of these herbicides can be persistent and may remain active in the hay, straw, grass clippings, and manure, even after they are composted. Some of these herbicides have a half life of 300 days or more and aminopyralid has been reported to remain active in compost for several years…. Most of these herbicides have a rotational crop restriction of at least 18 months for vegetable crops. When used as

[7] Allen V. Barker and Gretchen M. Bryson, 2002. Bioremediation of Heavy Metals and Organic Toxicants by Composting. *The Scientific World JOURNAL* (2002) 2, 407–420.
[8] Herbicide Carryover in Manure and Hay: Caution to Organic Farmers and Home Gardeners http://compostingcouncil.org/admin/wp-content/uploads/2012/07/Herbicide-Carryover.pdf
United States Composting Council, 2011. Composter Alert: New DuPontTM Herbicide "ImprelisTM" Will Persist in Compost. http://compostingcouncil.org/admin/wp-content/uploads/2011/05/Imprelis-alert-final1.pdf
EPA, 2011. Imprelis stop sale letter. http://www.epa.gov/pesticides/regulating/imprelis-stopsale-letter.pdf
US Composting Council, 2013. USCC Position: Persistent Herbicides. http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/9199/USCC%20Position%20Statement%20on%20Persistent%20Herbicides%20FINAL.pdf
US Composting Council, 2014. USCC comments on registration of picloram. http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/9199/USCC%20Picloram%20Reregistration%20Comments%20Final.pdf
Frederick C. Michel, Jr. and Douglas Doohan, Clopyralid and Other Pesticides in Composts. Ohio State University Extension, publication AEX-714-03. http://ohioline.osu.edu/aex-fact/pdf/0714.pdf
[9] Allen V. Barker and Gretchen M. Bryson, 2002. Bioremediation of Heavy Metals and Organic Toxicants by Composting. *The Scientific World JOURNAL* (2002) 2, 407–420.

directed on the labels, these herbicides should not cause these problems. The problems arise when the hay, manure, grass clippings, etc. leave the hands of the individual who applied the herbicides."[10]

The U.S. Composting Council has been particularly concerned about contamination of compost with persistent herbicides. In a position paper on persistent herbicides, it says,[11]

> "Herbicide-contaminated compost is not a new problem. The first incidents of herbicide contamination in compost were reported in 2000 in Spokane, Washington, where compost produced from yard trimmings contaminated with clopyralid damaged vegetable and garden crops….
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> Since the first incident, evidence of compost contamination by persistent herbicides has been documented throughout the United States, including California, Oregon, Pennsylvania, Texas, Maine, New Jersey, New York, Kansas, Idaho, North Carolina, Minnesota, and Vermont….
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> In Vermont in 2012, the Green Mountain Compost facility (owned by the Chittenden Solid Waste District, CSWD) received 510 confirmed complaints of herbicide damage to a variety of garden plants and ended up paying 449 claims. Settling those complaints and retrieving unsold product from its resellers, cost CSWD an estimated $270,000. CSWD incurred another $372,000 for testing and legal assistance to address the issue. The loss in value added sales of products that could not be made or sold due to the presence of persistent herbicides added another estimated $150,000. CSWD's costs totaled approximately $792,000. The culprit? Mainly aminopyralid, although other primary persistent herbicides of concern (clopyralid and picloram) were also found in compost. That regulators were unable to identify all sources of contamination is a most troubling aspect of this incident.
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> Other troubling aspects of the Vermont experience:
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> The compost was found to cause plant damage with concentrations of aminopyralid as low as 1 ppb.
> No government or independent lab exists in the United States that can adequately test for aminopyralid in compost at or below the 1 ppb level.
> Only the persistent herbicide manufacturers (Dow AgroSciences and DuPont) are currently capable of testing for herbicides in complex matrices with high organic content such as composts and manures at the low part-per-billion levels at which sensitive garden plants are impacted.
> Lack of testing capability contributed to Green Mountain Compost's loss of value added sales.
> Regulators could not determine the source of the contamination; that is, which feedstock accepted by the facility was contaminated with aminopyralid.
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> …The most common pathway known for persistent herbicides making their way into compost is through manures and bedding, although grass clippings and other yard debris can be contaminated as well."

Persistent insecticides are also a problem in compost and mulch materials. As mentioned above, bifenthrin was found in commercially available composts in 2010. California Department of Food and Agriculture

[10] Jeanine Davis, 2009. Herbicide Carryover in Manure and Hay: Caution to Organic Farmers and Home Gardeners. North Carolina State University, Mountain Horticultural Crops Research and Extension Center. http://compostingcouncil.org/admin/wp-content/uploads/2012/07/Herbicide-Carryover.pdf

[11] US Composting Council, 2013. USCC Position: Persistent Herbicides. http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/9199/USCC%20Position%20Statement%20on%20Persistent%20Herbicides%20FINAL.pdf

prohibited use of compost from three producers in organic production.[12] NOP allowed use of the compost as unavoidable residual environmental contamination (UREC).[13]

Neonicotinoids pose a more defined threat. They are applied to seeds and plants, and are taken up by the plants. They remain in plant residues and accumulate in soils, and can later be taken up by other plants. Very minute quantities are hazardous to honeybees and other pollinators that might consume pollen, nectar, or sap from plants containing residues of these insecticides.[14]

Another form of contamination in compost is heavy metals, especially arsenic, from poultry litter. Composting concentrates arsenic in poultry litter. Water and carbon dioxide lost during composting reduce the litter volume by 25 to 50% and the litter weight by 40 to 80%. Thus, poultry litter that contains 30 ppm arsenic before composting will contain 50 to 150 ppm arsenic after composting.[15]

Newspaper is used both as a mulch and as an ingredient in compost. There is a lack of clarity about contaminants in newspaper, derived from both paper processing and inks. The current listing on §205.601 is for "newspaper or other recycled paper, without glossy or colored inks." The U.S. Composting Council argues that paper is a beneficial addition to compost. "Paper products contain very low levels of contaminants, in most cases below those found in yard waste."[16] However, a 1991 risk assessment considered the cancer risk associated with applying newspaper to farmland:

Newspaper consists primarily of carbon black dye, mineral oil, and paper. Carbon black contains approximately 0.1% polycyclic aromatic hydrocarbon (PAH) impurities. The EPA has found that certain paper products contain 10–100 ppt dioxin. Newsprint has not yet been evaluated. Since the production of newsprint is unlikely to create many dioxins, the lower range figure of 10 ppt was used. The cancer risk from vegetarian vegetable consumption, based on the levels of these two contaminants, was evaluated for both a 200 and 5 ton/acre application rate. The potential risk from contaminated vegetable exposure ranged from 1×10^{-3} to 2.5×10^{-5} for PAH and from 7.2×10^{-6} to 1.8×10^{-7} for dioxin.[17]

This risk, which does not include glossy or colored inks, exceeds EPA's "negligible risk" level of 10^{-6}. On the other hand, a 1992 study found no significant differences in heavy metals in soils mulched with newspapers compared to soils not receiving newspaper.[18] Although blogs and popular literature abound with claims that since today's newspapers are printed with soy-based inks, there should not be a risk associated with newspapers as mulch or a compost ingredient, these claims do not appear to be based on scientific research, so more investigation is needed.

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[12] OMRI, 2010. Composts Disallowed in California and An Update on Pesticide Residues, http://www.omri.org/news/81937/compost-update-pesticide-residues
OMRI, 2010. An Update on Pesticide Residues in Compost- Part 2, http://www.omri.org/news/85720/update-pesticide-residues-compost-part-2

[13] USDA, 2010. NOP 5016, Guidance: Allowance of Green Waste in Organic Production Systems.

[14] Goulson, D. (2013), REVIEW: An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology, 50: 977–987.

[15] Barbara C. Bellows, 2005. Arsenic in Poultry Litter: Organic Regulations, www.attra.ncat.org/attra-pub/PDF/arsenic_poultry_litter.pdf

[16] US Composting Council, 2010. Factsheet: The Benefits of Including Paper in Composting. http://compostingcouncil.org/admin/wp-content/uploads/2010/09/Benefits-of-Including-Paper-in-Composting.pdf
Although dated 2010, all references are much older.

[17] J. A. Bukowski , 1991. Cancer Risk from the Application of Newspaper to Farmland. The Analysis, Communication, and Perception of Risk Advances in Risk Analysis Volume 9, pp 267-274.

[18] David A. Munn, 1992. Comparisons of Shredded Newspaper and Wheat Straw as Crop Mulches. HortTechnology 2(3): 361-366. http://horttech.ashspublications.org/content/2/3/361.full.pdf

Manure from animals raised in nonorganic agriculture often contains residues of antibiotics fed to the animals. These residues may or may not decompose during composting. Dolliver et al studied the effects of three forms of composting –a manure pile with no disturbance after initial mixing, a compost pile turned weekly and adjusted for moisture, and compost made in a rotating drum—to determine whether the practices made a difference in the decomposition of four antibiotics. There was no difference among treatments, but there was a substantial difference among antibiotics. Chlortetracycline degraded almost completely (>99%), monensin and tylosin were reduced 54-76%, and sulfamethazine did not degrade at all.[19]

Pesticide products used in organic production or that end up in composted material may be contaminated with substances that are active ingredients in other products.[20] EPA's Pesticide Registration Manual states,

EPA evaluates the composition data to determine whether impurities could constitute a significant component of the residues in food and feed commodities. Impurities that arise in the manufacture of pesticides can become a residue problem if they are not identified before tolerances are established. Dioxins and nitrosamines are the best-known examples of significant impurities of toxicological concern. If impurities are at levels that may lead to toxicologically significant residues in crops or the environment, then adjustments to the manufacturing process or additional purification steps will be necessary to reduce the impurities to a safe level.[21]

A level that is not "toxicologically significant" under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) may nevertheless be considered the addition of a nonpermitted material in organic production if not put on the National List. Information about impurities in pesticide products is not easily available, but arsenic levels from 3 to 100 ppm (3, 7.2, <10, <10, 10, <25, 100) have been found in copper sulfate products available as fertilizers, according to the Washington State Department of Agriculture fertilizer database.[22]

Six fertilizers containing rock phosphate and approved for use in organic production by the Washington State Department of Agriculture contain arsenic at levels from <1 to 75 ppm, cadmium from 2 to 49 ppm, and lead from 5 to 47 ppm.[23] However, a 2004 report by the California Department of Food and Agriculture found that in most cases, applications of phosphate and micronutrient fertilizers resulted in little increase in soil concentrations of arsenic, cadmium, and lead.[24]

B. Irrigation

The three main problems that can arise from the quality of irrigation water are salinity, sodicity or alkalinity, and toxicity.[25] Pathogens may also be a problem in some cases.[26] Sundquist (2007) summarizes the extent of the problem for the U.S. and California.[27]

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[19] Holly Dolliver, Satish Gupta, and Sally Noll, 2008. Antibiotic Degradation during Manure Composting. J. Environ. Qual. 37:1245–1253.

[20] EPA, 1996. Toxicologically Significant Levels of Pesticide Active Ingredients. PR Notice 96-8. http://www.epa.gov/PR_Notices/pr96-8.pdf

[21] EPA, 2010. Pesticide Registration Manual: Chapter 11 –Tolerance Petitions. http://www.epa.gov/pesticides/bluebook/chapter11.html

[22] http://agr.wa.gov/PestFert/Fertilizers/FertDB/Product1.aspx

[23] http://agr.wa.gov/PestFert/Fertilizers/FertDB/Product1.aspx

[24] Andrew C. Chang, Albert L. Page, and Natalie J. Krage, 2004. Role of Fertilizer and Micronutrient Applications on Arsenic, Cadmium, and Lead Accumulation in California Cropland Soils, final report submitted to California Department of Food and Agriculture. www.cdfa.ca.gov/is/docs/cdfafinalreport.pdf

[25] I.P. Abrol, J.S.P. Yadav, and F.I. Massoud, 1988. Salt-Affected Soils and their Management. Ch. 6, Water Quality and Crop Production. FAO Soils Bulletin 39 Food and Agriculture Organization of the United Nations, Rome.

In the U.S.,

- 20% of irrigated land suffers from salinization.
- About 21% of irrigated cropland is fed by drawing down water tables.
- About 25% irrigated land suffers from some degree of salinization or waterlogging.
- Salt accumulation is lowering crop yields on 25-30% of irrigated land.
- 25% of irrigated soils were salty or alkaline to the point where productivity was lowered.
- Dry cropland areas in the western US where production has ceased or is significantly reduced due to increased salinity is growing at 10%/ year.

In California,

- About 25% of irrigated land has undergone moderate- to heavy salinization.
- The amount of water-storage capacity lost through aquifer compaction in the Central Valley is over 40% of the combined storage capacity of all human-made reservoirs in California.
- Some 1620 km^2 of irrigated farmlands in San Joaquin Valley are affected by high, brackish water tables, resulting in a 10% reduction in productivity since 1970.
- San Joaquin Valley crop yields have declined 10% ($31.2 million) since 1970 because of high saline water tables. Losses are expected to increase to $321 million/ year if action is not taken.
- Not far below the surface of San Joaquin Valley and Imperial Valley (like the Tigris-Euphrates Valley) is a tight layer of material that blocks water passage. Hence saltwater builds up. When it meets the roots of plants, salt is drawn up to the surface, destroying the irrigation system.
- Imperial Valley (Southern California) experienced about 90% of the agricultural damage from salinity in the US portion of the Colorado River Basin.
- 85% of the water reaching rivers in the Grand Valley is irrigation water, carrying salt from marine shales that lie under local farms.

All irrigation water contains salts that may harm plants, and most are left in the soil after the water evaporates from the soil or leaves through transpiration. Unless salts are leached from the root zone, they will eventually accumulate in quantities that will affect growth of most crops. Management practices for efficient use of high salinity water include more frequent irrigation, selection of salt tolerant crops and varieties, use of extra water for leaching, conjunctive use of fresh and saline waters, and cultural practices.[28]

Sodicity or alkalinity "develops when irrigation water contains relatively more sodium ions than divalent calcium and magnesium ions while the total concentration of salts is generally not very high. Accumulation of sodium ions on to the exchange complex results in a breakdown of soil aggregates responsible for good soil structure needed for free movement of water and air through the soils." Management practices for efficient use of water presenting a sodicity hazard include application of amendments, mixing with an alternative source of water, irrigating more frequently, growing crops with lower water requirements,

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[26] Irrigation Water as a Source of Contamination, www.ugacfs.org/producesafety/Pages/Basics/Water.html

[27] Bruce Sundquist, 2007. Irrigated Lands Degradation: A Global Perspective. Ch. 5, Degradation of Irrigated Land. http://home.windstream.net/bsundquist1/ir5.html

[28] I.P. Abrol, J.S.P. Yadav, and F.I. Massoud, 1988. Salt-Affected Soils and their Management. Ch. 6, Water Quality and Crop Production. FAO Soils Bulletin 39 Food and Agriculture Organization of the United Nations, Rome.

growing tolerant crops, and adding organic matter. Water treatments, such as the addition of sulfurous acid, have also been used to treat alkalinity. [29] Sulfurous acid for this purpose is on the National List.[30]

Toxic substances such as boron or heavy metals may be introduced through irrigation water. Boron, for example is an essential element for plant growth and nutrition, but is needed only in trace quantities. High concentrations can have a toxic effect on the growth of many plants. Similarly, other ions, e.g. chloride, sodium, etc., could prove toxic to specific crops if present in excessive quantities. Other elements that may be present --such as lithium, selenium, molybdenum, fluoride and chromium—may exert toxic deleterious effects on plants or animals at very low concentrations. [31]

Starting in 1985, the National Irrigation Water Quality Program (NIWQP) conducted a series of field investigations at 26 areas in the Western United States to examine the impact of irrigation drainage on fish, wildlife, humans, and beneficial uses of water. It examined samples of water, bottom sediment, and biota for analysis of trace elements and pesticides and identified contaminants most commonly associated with irrigation drainage by comparing concentrations in water with established criteria. "Selenium was the trace element in surface water that most commonly exceeded chronic criteria for the protection of freshwater aquatic life; more than 40 percent of the selenium concentrations in surface-water samples exceeded the U.S. Environmental Protection Agency (USEPA) aquatic-life chronic criterion (5 micrograms per liter)." Other significant contaminants were boron, molybdenum, arsenic, and uranium. The most common pesticides exceeding criteria were DDT and its degradation products DDD and DDE, and chlordane in bottom sediments.[32]

The Food and Agriculture Organization concludes:

> Field practices that can eliminate or reduce the hazard due to presence of toxic elements include irrigating the crops more frequently. Frequent irrigations reduce the effective concentration of toxic constituents and therefore their adverse effect. Occasional application of excess water to leach the salts will further reduce the amounts of toxic elements in the root zone. Accumulation of sodium in plant parts can usually be reduced by maintaining a favorable concentration of calcium ions in the soil solution. Adequate quantities of calcium in the irrigation water and soil solution prevent excessive uptake of sodium by plants. Application of amendments, such as soluble calcium salts or sulphuric acid, can therefore greatly reduce the toxicity hazard due to excess sodium. Blending of water supplies, planting less sensitive crops, improving drainage conditions through profile modification, use of fertilizers in optimum doses to obtain otherwise vigorously growing plants etc. are some of the other practices that will help overcome toxicity problems. [33]

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[29] I.P. Abrol, J.S.P. Yadav, and F.I. Massoud, 1988. Salt-Affected Soils and their Management. Ch. 6, Water Quality and Crop Production. FAO Soils Bulletin 39 Food and Agriculture Organization of the United Nations, Rome.

[30] NOSB final recommendation for sulfurous acid,
http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5078046&acct=nosb
Harmon Systems International petition for sulfurous acid to be added to §205.601.
http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5057561

[31] I.P. Abrol, J.S.P. Yadav, and F.I. Massoud, 1988. Salt-Affected Soils and their Management. Ch. 6, Water Quality and Crop Production. FAO Soils Bulletin 39 Food and Agriculture Organization of the United Nations, Rome.

[32] Ralph L. Seiler, Joseph P. Skorupa, David L. Naftz, *and* B. Thomas Nolan, 2003. Irrigation-Induced Contamination of Water, Sediment, and Biota in the Western United States—Synthesis of Data from the National Irrigation Water Quality Program. U.S. Geological Survey Professional Paper 1655.

[33] I.P. Abrol, J.S.P. Yadav, and F.I. Massoud, 1988. Salt-Affected Soils and their Management. Ch. 6, Water Quality and Crop Production. FAO Soils Bulletin 39 Food and Agriculture Organization of the United Nations, Rome.

Water used both in production and processing of leafy greens may be a source of pathogens. High demand and pollution of water resources mean that high quality water for these purposes has become increasingly scarce, leading to increased reuse of water, which may increase the hazard of biological contamination with pathogens. [34]

C. Genetically Engineered Plant Material

Studies have shown that some DNA from genetically engineered plants may persist in the soil.[35] Genes may move via horizontal gene transfer to soil bacteria, with unknown impacts on soil communities.[36] Composting appears to greatly reduce the amount of transgenic DNA.[37]

D. Contamination in the Field

As mentioned above, heavy metal contaminants cannot be destroyed by composting, but may be converted into organic compounds or chelates that are less bioavailable than inorganic metals. On the other hand, heavy metals may also become concentrated because of the removal of carbon in the composting process. [38] Although many pesticides and other contaminants may be destroyed by composting before reaching the field, "The effects of composting on pesticides are not always favorable. The secondary compounds may be as, or more, toxic than the original pesticide."[39]

Goulson (2013) notes that although data on persistence of neonicotinoids taken up by plants are scarce, some studies indicate long term persistence in plant tissue, which could lead to contamination of organic soils if those plants (e.g., wheat straw) were used as mulch or compost additions. Limited studies show significant accumulation of imidocloprid with repeated applications.[40]

IV. Testing Resources for Avoiding Contaminated Inputs

The U.S. Composting Council (USCC) has a seal of testing assurance (STA) program that analyzes compost for ten properties: pH, soluble salts, nutrient content (total N, P2O5, K2O, Ca, Mg), moisture content, organic matter content, bioassay (maturity), stability (respirometry), particle size (report only), pathogen

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[34] Irrigation Water as a Source of Contamination, www.ugacfs.org/producesafety/Pages/Basics/Water.html This website provides a list and highlights of articles examining the prevalence and fate of pathogens in environmental water sources; a table listing the results from several surveys examining the prevalence of pathogens in environmental water sources; and a list of review articles *dedicated to the discussion of pathogens in environmental water sources.*

[35] Kari E. Dunfield and James J. Germida, 2004. Impact of Genetically Modified Crops on Soil- and Plant-Associated Microbial Communities. J. Environ. Qual. 33:806–815. Franco Widmer, 2007. Assessing Effects of Transgenic Crops on Soil Microbial Communities. Adv Biochem Engin/Biotechnol (2007) 107: 207–234. Alessandra Pontiroli, Pascal Simonet , Asa Frostegard , Timothy M. Vogel, and Jean-Michel Monier, 2007. Review article: Fate of transgenic plant DNA in the environment. Environ. Biosafety Res. 6 (2007) 15–35.

[36] Kari E. Dunfield and James J. Germida, 2004. Impact of Genetically Modified Crops on Soil- and Plant-Associated Microbial Communities. J. Environ. Qual. 33:806–815. Franco Widmer, 2007. Assessing Effects of Transgenic Crops on Soil Microbial Communities. Adv Biochem Engin/Biotechnol (2007) 107: 207–234. Alessandra Pontiroli, Pascal Simonet , Asa Frostegard , Timothy M. Vogel, and Jean-Michel Monier, 2007. Review article: Fate of transgenic plant DNA in the environment. Environ. Biosafety Res. 6 (2007) 15–35.

[37] Lasse Dam Rasmussen, Jacob Møller and Jakob Magid, 2004. Composting rapidly degrades DNA from genetically modified plants. Newsletter from Danish Research Centre for Organic Farming, June 2004, No. 2. http://www.darcof.dk/enews/june04/gmo.html

[38] Allen V. Barker and Gretchen M. Bryson, 2002. Bioremediation of Heavy Metals and Organic Toxicants by Composting. *The Scientific World JOURNAL* (2002) 2, 407–420.

[39] Allen V. Barker and Gretchen M. Bryson, 2002. Bioremediation of Heavy Metals and Organic Toxicants by Composting. *The Scientific World JOURNAL* (2002) 2, 407–420.

[40] Goulson, D. (2013), REVIEW: An overview of the environmental risks posed by neonicotinoid insecticides. Journal of Applied Ecology, 50: 977–987.

(Fecal Coliform or Salmonella), and trace metals (Part 503 regulated metals.) The protocols for the various tests that are used are contained in 'Test Methods for the Examination of Composting and Compost' ('TMECC'), jointly published by the USDA and USCC.[41] TMECC does not include standards against which the test results can be measured, nor does it include methods for residues of pesticides, antibiotic, or other anthropogenic chemicals. Bioassays provide a low cost method to test for herbicide residues.[42] The National Organic Program Handbook contains guidance for residue testing, including choosing a lab for testing of pesticide residues.[43]

V. Experts

The Crops Subcommittee has identified the following as areas of expertise in which it should identify possible experts for consulting with the subcommittee:

- Testing, known levels of contamination, problem identification.
- Compost professionals who are familiar with contaminants in compost.
- Laboratory people who work with organic who know how to test and what shows up.
- Organic agronomists who can discuss loading rates (application rates over time) of various materials.
- Certifiers and government officials who have had to investigate problems where contamination may or may not have been behind the problem.
- Researchers who have studied uptake by plants from raw manure.

VI. Questions

The Crops Subcommittee seeks input in the following areas:

1. Contamination incidents in the past.
2. Contaminants of concern.
3. Contamination pathways of concern.
4. Experts and other resources that would assist the subcommittee in its goal of ultimately proposing a process for addressing contamination of inputs that may be brought onto the farm.

VII. Committee Vote:

The Crops Subcommittee moves to accept this document and present it to the public and for full Board discussion at the fall 2014 NOSB meeting:
Motion by: Jay Feldman
Seconded by: Zea Sonnabend
Yes: 5 No: 2 Abstain: 0 Absent: 1 Recuse: 0

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[41] http://compostingcouncil.org/admin/wp-content/plugins/wp-pdfupload/pdf/34/TMECC%20Purpose,%20Composting%20Process.pdf TMECC overview, http://compostingcouncil.org/seal-of-testing-assurance/ USCC testing, http://compostingcouncil.org/test-methods-parameters/ USCC test methods and parameters.

[42] http://www.calrecycle.ca.gov/organics/threats/Pesticides/Clopyralid/Bioassays.htm WF Brinton, E Evans, and TC Blewett, 2006. Reliability of Bioassay Tests to Indicate Herbicide Residues in Compost of Varying Salinity and Herbicide Levels. Compost Science and Utilization 14(4): 244-251.

[43] http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateR&navID=ProgramHandbookNOPNationalOrganicProgramHome&rightNav1=ProgramHandbookNOPNationalOrganicProgramHome&topNav=&leftNav=NationalOrganicProgram&page=NOPProgramHandbook&resultType=&acct=noppub

Appendix A
Atmospheric Contamination and Siting Concerns

The question of siting organic farms seems to be one that cannot be ignored because of atmospheric contamination.

Contaminants may enter organic farms through the air. A study in India found increased concentrations of heavy metals in the leafy portions of plants grown in open air, compared to those grown organically in a field covered with a greenhouse.[44]

[44] J. Pandey, Usha Pandey, 2009. Accumulation of heavy metals in dietary vegetables and cultivated soil horizon in organic farming system in relation to atmospheric deposition in a seasonally dry tropical region of India. Environmental Monitoring and Assessment, Volume 148, Issue 1-4, pp 61-74.