National Organic Standards Board
Livestock Subcommittee
Integrating Livestock and Agroforestry Crops Discussion Document
Fall 2025

Introduction

Pasturing domestic animals in tree crop stands has been practiced for many centuries by cultures around the world. Modern farmers are implementing it as well. It enables fuller utilization of land, and benefits livestock via shelter and forage. Integrating livestock into crop systems is considered a key practice for improving soil health. Tree crops can also benefit from increased nutrients in animal manure and reduction of weedy competition or pests. This discussion document examines food safety aspects of pasturing domestic animals in tree plantings that produce human food crops, and whether National Organic Program regulations might be optimized for them. The Livestock Subcommittee requests feedback from stakeholders on this document.

Discussion

Examples of this type of "tree crop pasture" include the common practice in Europe of grazing cattle in cider or perry orchards, and more recently, in America of cattle in pecan groves, chickens in areas planted to hazelnuts and elderberries, turkeys in tree fruit, or sheep in chestnut plantings and vineyards. Geese and domestic pigs are also commonly run through tree crops. While beneficial in many ways, there is concern that these practices may increase levels of human foodborne diseases such as *E. coli O157:H7, Salmonella, Listeria, Campylobacter*, etc., in the fruit or nut crops via livestock manure. Managing this concern has three key aspects. First, what is a sufficient time period to reduce the incidence of potential pathogens in the human food crops after animal grazing; second, are pathogens transferred to harvested fruit and nut crops; and third, are there ways of sanitizing harvested fruit or nuts to further reduce potential pathogens?

Private good agricultural practice (GAP) programs typically address the first two food safety issues by excluding domestic or wild animals from human food production fields before harvest. Legally, the Food Safety Modernization Act (FSMA) has no requirement for a waiting period between animal grazing and harvest. As reported on the FDA website (FDA 2015),

> In the final version of FSMA, "the FDA decided to reserve a decision on the minimum application interval and to conduct additional research and a risk assessment, which can evaluate the impact of interventions that include the use of application intervals.
>
> …We have placed restrictions on how raw manure is applied. The final Produce Safety rule requires that covered farms not apply raw manure in a manner that contacts produce covered by the rule during application. And these farms are required to minimize the potential for contact after application.

To minimize the chance of contamination, we also stated that we believe it would be prudent for farmers to comply with the USDA's National Organic Program standards related to raw manure use while the research and risk assessment is ongoing. These call for a 120-day interval between the application of raw manure for crops in contact with the soil and 90 days for crops not in contact with the soil."

For organic farmers, the Organic Foods Production Act (7 U.S.C. 6513(b)(2)(B)(iv)) requires at least 60 days between manure application and harvest of human food crops, but National Organic Program requirements are currently stricter.

The National Organic Program regulations state (7 CFR 205.203):

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

(c) The producer must manage plant and animal materials to maintain or improve soil organic matter content in a manner that does not contribute to contamination of crops, soil, or water

… by plant nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances. Animal and plant materials include:

(1) Raw animal manure, which must be composted unless it is:

(i) Applied to land used for a crop not intended for human consumption;

(ii) Incorporated into the soil not less than 120 days prior to the harvest of a product whose edible portion has direct contact with the soil surface or soil particles; or

(iii) Incorporated into the soil not less than 90 days prior to the harvest of a product whose edible portion does not have direct contact with the soil surface or soil particles;

In the case of animal pasturing, normal excretion can be considered an "application" of raw manure. The manure is not generally incorporated into the soil, but is left on the soil surface.

The pre-harvest interval of 90 or 120 days after animal manure application greatly reduces the time windows available for tree crop pasture. For instance, grazing would need to cease in a chestnut orchard by mid-May if harvest started in mid-September, a typical scenario in Pennsylvania. Pasture growth by mid-May is only a fraction of what it would produce over the rest of the normal grazing season, and most weed management benefits from grazing would be lost. Although grazing in this example could be resumed after harvest, many potential benefits would not be realized. An interval of 60 days, on the other hand, would allow for efficient integration of grazing into the orchard system. Anecdotally, we are aware of farmers who have avoided or dropped organic certification because of its strict requirement.

Regardless of the crop management benefits of orchard grazing, food safety concerns are of primary importance.

Relevant research has been done on the effects on pathogen levels after grazing various species on cover crops, which were then tilled under and the fields planted to vegetables (Pires et al, Ramos et al, Cheong et al). These studies show clearly that pathogens can be introduced when manure is applied, and that it takes at least 2-4 months for pathogen levels to subside to pre-application levels in the soil. The studies generally support the NOP 90- or 120-day waiting period between manure application and vegetable harvest to reduce pathogen levels. While these studies were not done in tree crop pasture systems, they provide key evidence that concerns over pathogen introduction via manure are real and important.

A 2004 study showed that pathogens decreased more quickly when manure was left on the soil surface compared to when it was tilled into the soil (Hutchinson et al). When inoculated slurry manure at 10^6 colony forming units (CFU)/gram was incorporated immediately after application, soil samples taken later that day showed densities of about $10^{3.75}$ CFU/gram due to mixing with the soil. *Campylobacter jejuni* presence in soil samples declined rapidly to 10^0 (a 3.75 log reduction from day 1) after 35 days, while it took 120 days for *E. coli O157* and *Listeria monotytogenes* to decline to 10^0.

The number of summer days for a 10-fold (1 log) reduction was less when slurry or farmyard manure was left on the soil surface. Over the first 16 days, mean values were 2.59 (incorporated) and 1.68 (not) for dairy manure; 2.75 and 0.92 for dairy slurry. Pig manure numbers were similar. Poultry broiler litter numbers were smaller, but with little difference (1.11 and 1.04). It is likely that after 16 days, pathogen death rates would have slowed. Nonetheless, leaving manure on the soil surface, exposed to sun and weather, appears to allow for rapid decline of pathogens.

A significant research report on cattle grazing in pecan orchards (Diaz et al., 2022) on different pathogens had contrary results and highlights food safety concerns in a tree crop pasture setting. Pecans are harvested after shaking nuts to the ground. Both Shiga Toxin–Producing *Escherichia coli* and *Salmonella* were present (not quantified) on raw in-shell pecans at harvest in both grazed and ungrazed orchards. In this study, exclusion of cattle for intervals of 0, 2 or 4 months before harvest did not affect pathogen levels on the nuts.

Thus, the potential exists for human pathogens to be present on the soil surface even 120 days after pasturing livestock there, and can be transferred to crops harvested from the ground.

Crops that are harvested directly from the trees or shrubs, and not in contact with the soil, would logically seem to have a low chance of picking up pathogens from manure. This was true for pigs grazing in an apple orchard (Nunn et al 2007), where E. coli was found in soil samples but not in harvested fruit.

But it is not true for crops harvested from the ground. The 120-day pre-harvest interval appears to adequately address food safety concerns for these crops. If the interval is to be reduced, further post-harvest pathogen reduction seems necessary. In these cases, what steps can be taken to reduce pathogen levels?

Food safety protocols generally require a 5-log reduction (1/100,000) of the targeted pathogen compared to the raw product for juice products (FDA 2004). This is usually attained with pasteurization or UV treatment for fruit juices. FSMA provides an exemption for produce that receives commercial processing that adequately reduces foodborne pathogens of public health significance. Crops for products like wine and hard cider with low pH and significant residual alcohol fit into this category. Fallen fruit is not harvested for unprocessed human consumption.

In the cases of walnuts, chestnuts, pecans, and hazelnuts, usually harvested from the ground, contamination potential from manure is high. Many approaches have been used to reduce pathogens in nut crops (Yada and Harris 2022), with varying success. Heat treatments appear to be more effective than baths, but may affect flavor. For instance, for in-shell nuts, a bath in a peroxyacetic acid solution is common practice. One study found that peroxyacetic acid at 200 ppm was not effective at reducing *Salmonella* in hazelnuts (Pearson et al 2018). On the other hand, in pecans, a more than 5-log reduction was obtained when in-shell nuts were treated with steam or hot water at 185 degrees F for 2 minutes (McKay et al 2022). Oil-roasting of pecan nutmeats produced the desired 5 log pathogen reduction (Beauchat and Mann 2011).

Chestnuts are typically roasted in the shell before fresh eating, which should attain the 5-log reduction, though we have not been able to find published data affirming that. Some uses of chestnuts may not involve roasting. Similarly, roasted hazelnut kernels need published data on pathogen reduction. Significant amounts of hazelnut kernels are eaten raw, and thus need other means of pathogen reduction. A study of heat treatments of in-shell hazelnuts was promising (Morrissey 2014). Harvested nuts were treated with 190-degree F hot air for 0, 8, or 15 minutes and did not show differences in consumer acceptance, though the long exposure resulted in darker kernels. Letchworth (2020) found *Salmonella* on harvested in-shell hazelnuts 21% and 47% in different years. A 10-minute hot air treatment at 88 degrees C (190 F) inactivated high levels of five inoculated *Salmonella* strains.

Conclusion

In the 10 years since FSMA was enacted, there is still scant published research on critical aspects related to grazing in orchards producing human food. Tentative conclusions based on the findings above are:

- Pathogen contamination in grazed orchards is a demonstrated health concern.
- Pathogen levels in manure left on the soil surface decline more quickly than when manure is incorporated.
- NOP 90- and 120-day pre harvest intervals are mostly supported by the few studies that have been done.
- Fruits and nuts harvested directly from the trees without soil contact appear to have low pathogen risk (and might reasonably be subject to shorter intervals); those harvested from the ground have a high risk.
- Pathogens on fruits and nuts can be lowered to safe levels after harvest. This might allow the interval between grazing and harvest to be reduced. A variety of approaches have been studied to reduce pathogens in harvested nut crops. More research data needs to be published to determine the best methods that preserve crop flavor and quality.

Questions for Stakeholders

1. Farmers—what are your needs for beneficial pre-harvest intervals after grazing? We’re looking for feedback for all crops and livestock species.

2. All--is there sufficient basis for the NOSB to propose reductions to the current NOP required pre-harvest intervals?
3. Please share any additional information about the effectiveness of post-harvest treatments for nut crops to reduce pathogen levels.

Subcommittee Vote
Motion to accept the discussion document on integrating livestock and agroforestry crops
Motion by: Brian Caldwell
Seconded by: Corie Pierce
Yes: 6 No: 0 Abstain: 0 Recuse: 0 Absent: 1

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