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Cover Page Footnote

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Perceived Benefits and Barriers to Livestock Mortality Composting

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Abstract. We conducted webinars in 2020 about livestock mortality composting (LMC). Forty-five attendees completed a survey to evaluate the webinar and help define future educational needs. Major barriers to LMC were lack of experience, public and neighbor perceptions, and environmental management. Most respondents indicated convenience, cost, biosafety, use of product, and environmental management as benefits. An unexpected emotional theme indicated that LMC also supports the "circle of life" and "respect for the animal." We propose that this theme may be a uniting message to improve public and producer perception of LMC, increase use of LMC, and improve public-producer relationships overall.

INTRODUCTION

Composting is an increasingly attractive option for disposal of livestock mortalities. Routine and emergency losses of livestock present significant economic, environmental, biosecurity, emotional, and waste-management concerns for animal operations. Disposal of carcasses and offal is becoming increasingly difficult and expensive as renderers close and restrict accepted materials (McGinnis, 2018). Livestock mortality composting (LMC) is an environmentally sound, cost-effective, and accessible disposal method that can be practiced within most livestock operations. Composting is increasingly used for management in viral disease outbreaks, as the temperature, microbiology, and chemical stresses created in composting destroy many pathogens (Lepesteur, 2021). LMC also recycles valuable nutrients from carcasses and produces an agronomic amendment that improves plant growth and soil health (Mubarak et al., 2022). LMC can often be performed on-site, which supports biosecurity and provides an emotional benefit that is noted by producers.

Knowledge and acceptance of composting as a safe and effective means of carcass disposal are increasing. In the nation's 17 major dairy states, the percentage of dairy cow mortalities disposed of by rendering and burial decreased from 85% in 2002 to 55% in 2014. In the same time, dairy mortalities disposed of by composting increased from 7% to 29% (Price et al., 2008; U.S. Department of Agriculture, 2018). State and federal regulations and guidelines for animal-carcass disposal increasingly include or encourage composting. This shift is especially true in management guidelines for mass-mortality events, such as extreme weather events and certain disease outbreaks, including avian influenza (U.S. Environmental Protection Agency, 2021).

In 2020, we produced educational webinars to increase awareness and practical knowledge for on-farm LMC among producers and regulatory officials. A survey was used to assess the effectiveness of these educational efforts and audience perceptions about LMC. Our objective in this study was to assess perceived benefits and barriers to LMC among our audience and to glean insight on aspects of future education efforts that may increase adoption of LMC.

METHODS

Our survey was administered following two live presentations of a webinar. The webinar was created as a replacement for an in-person field-day demonstration (during a time with in-person gathering restrictions due to COVID-19). The webinar included general information on composting, instructions for composting livestock mortalities, detailed photos and videos of the carcass-composting process, and interviews with three producers and a composting facility manager who use composting for carcass disposal. A section covering regulations and permits was tailored to each webinar's audience. The regulation section was specifically requested by the project funder, the Washington State Department of Agriculture (WSDA), to clearly indicate that LMC is allowed for most livestock-carcass disposal in the state.

The webinar was presented live on three different platforms and occasions (Table 1). The webinar was advertised through (a) the Washington State University (WSU) Farmer's Network website and LISTSERV, (b) relevant departments in WSDA, (c) eOrganic website and LISTSERV, and (d) statewide livestock industry groups, including the Washington Cattlemen's Association, Washington State Dairy Federation, and WSU Cattle Feeders. At the end of the first two webinar presentations, all attendees were asked to fill out the survey, which was hosted online through the WSU-licensed Qualtrics software.

We designed the survey with input from WSDA and Washington Department of Ecology livestock-waste experts and following best practices for Knowledge, Attitude, and Practices (KAP) surveys. We designed questions to assess (a) whether the webinar increased participant knowledge about LMC; (b) participant perceptions of LMC benefits and barriers, and whether they changed after the webinar; and (c) whether participants planned to use LMC after participating in the webinar. The survey was granted exemption from full review from the WSU Institutional Review Board. Data were collected anonymously through Qualtrics. A link to the survey was shown on the last slide of the webinar, and all participants received a follow-up email containing the link; the survey was available for 6 months following the first two webinars. The full survey is included in the appendix.

Survey results were statistically analyzed by using Stats iQ functions within the Qualtrics software. Mean values for scaled questions (e.g., questions 2, 3, and 6; see the appendix) were analyzed with paired *t* tests; before and after "yes/no" questions were analyzed with paired *t* tests after recoding values (yes = 1, no = 0). Data were analyzed according to the number of respondents to each question, not to the survey as a whole, because some respondents did not answer some questions.

RESULTS

The two rounds of the survey garnered a total of 45 responses. Seven of the 45 respondents identified as producers; the largest group (53%) was government employees (Figure 1). Of the seven producers, operation types included beef, poultry, and mixed operations. Only 27% of respondents had previous experience performing LMC, while 40% had no experience with it; the remainder had observed LMC or used a composting service.

Survey responses indicated that the webinar was successful in increasing knowledge about the process and materials, safety, and regulations. Participants indicated that their average level of knowledge (scale 0–4, *no knowledge* to *expert*) on the process of LMC increased from 1.7 to 2.2 ($p < 0.00001$). The average level of knowledge around safety concerns surrounding LMC (scale 0–4, *no knowledge* to *expert*) increased from 1.7 to 2.2 ($p < 0.0001$). Knowledge of regulations ("yes" or "no") increased from 51% to 93% ($p < 0.00001$). Knowledge of whom to contact for assistance increased from 53% to 97% ($p < 0.00001$). The only "no" respondent for this question was from Canada, who explained that their regulations and contacts would be different. Overall view of LMC (sliding scale 1–4, with 4 being most positive) increased from 3.4 to 3.8 ($p < 0.01$).

After the webinar, 44% of survey respondents indicated they would be very likely to use on-site LMC, and another 29% were somewhat likely (Figure 2). All producer participants were either "very likely" or "somewhat likely." Nearly half of the respondents indicated that they would use (or promote) LMC for routine mortalities; cumulatively, 29% intended to use LMC for larger death events, such as catastrophic events or depopulation (Figure 3). Fourteen percent selected routine and large events. Many of the "other" responses in this question were from government workers, researchers, or industry support persons, who indicated that they did not have an operation but would promote LMC use where appropriate. Additional text responses to the same question indicated intentions to use or promote LMC for offal from slaughter ($n = 3$). Twenty-six percent of respondents agreed that the COVID-19 pandemic and its cascading effects had caused an increased interest in or need for LMC.

Almost all survey respondents said that they were likely to share information they learned with other people (Figure 4). The one person who said "no" gave the reason that they were an agronomist in Canada, so the regulations are different for their audience. There was an option for respondents to explain their choice; reasons that people selected "yes" included "really good info and simple to do and good for the environment"; "As a[n] agriculture regulatory employee, I highly recommend learning about and utilizing mortality composting"; and "Composting is a very natural way to handle mortalities. It's part of the full circle of life. It's superior to any other method of disposing of an animal carcass. The end result is the ultimate in recycling."

Survey respondents indicated that "environmental management," "convenience," "use of end product," "cost," and "biosecurity" were the top benefits of or reasons to consider using LMC, with at least 66% of respondents choosing each of these options (Figure 5). Nearly half of respondents also indicated that a lack of other options was a consideration in adopting LMC. Multiple answers in the "other" fill-in option described composting as a "natural," "circle of life process" or "way to 'honor' the animal"; it is important to note that this theme resonated with many participants in the webinar and the survey, as discussed below.

When asked about barriers to or problems of adopting LMC, "lack of experience" was the most common selection (62%; Figure 6). Other commonly selected options included "environmental management (e.g., containing leachate and

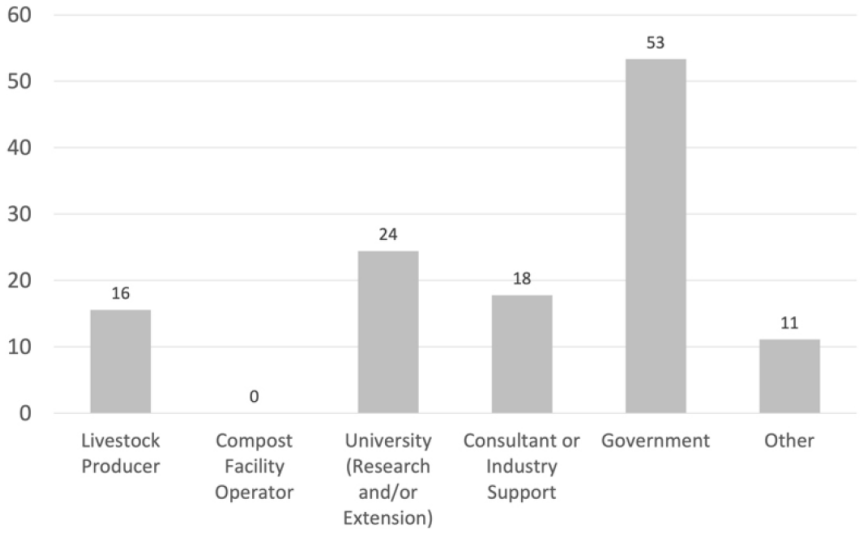

Figure 1. Profession/Role: Self-selected profession/role of attendees of livestock mortality composting webinars, displayed in percentage; respondents (n = 45) were able to select more than one option.

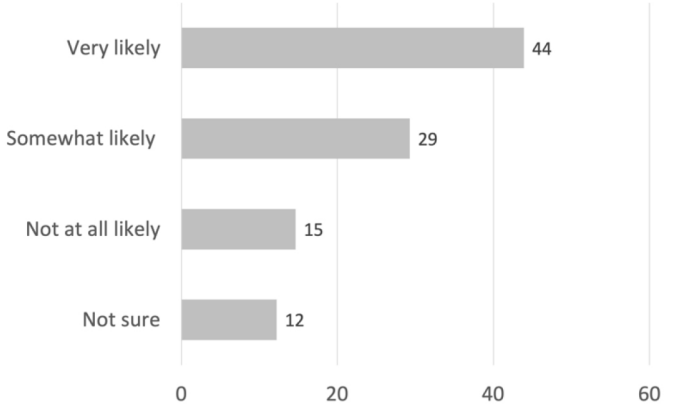

Figure 2. How likely are you or your operation to use on-site livestock mortality composting? Results are displayed in percentage of responses (n = 41); only one option could be selected for this question.

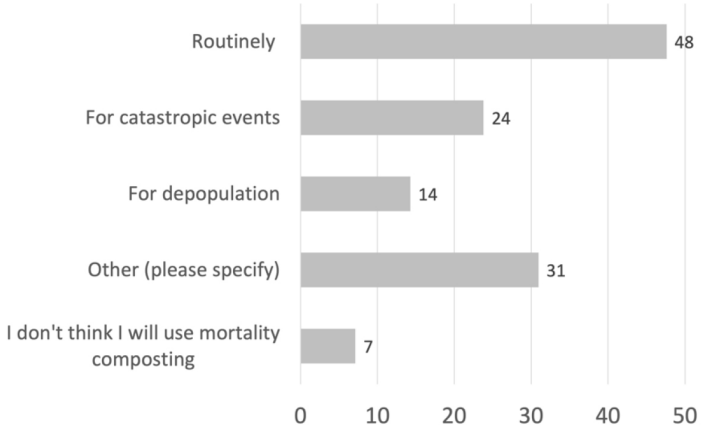

Figure 3. When is your operation likely to use mortality composting? Results are displayed in percentage of responses; respondents (n = 42) were able to select more than one option.

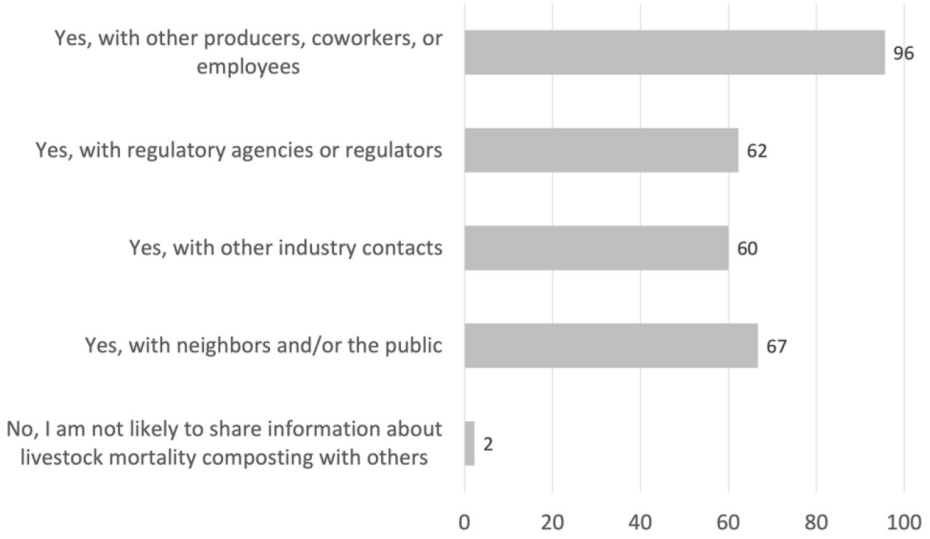

Figure 4. Are you likely to share information about livestock mortality composting with others? Please select any that apply. Results are displayed in percentage (n = 45); respondents were able to select more than one option.

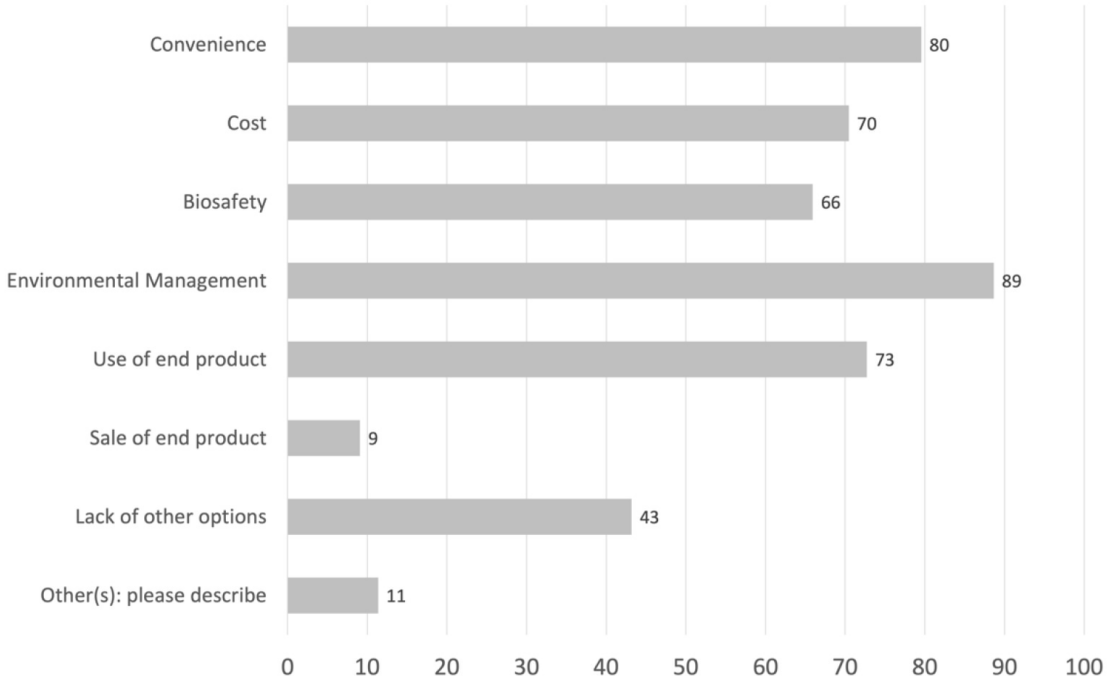

Figure 5. What do you see as benefits of or reasons you would consider livestock mortality composting? Please select all that apply. Results are displayed in percentage; respondents (n = 44) were able to select more than one option.

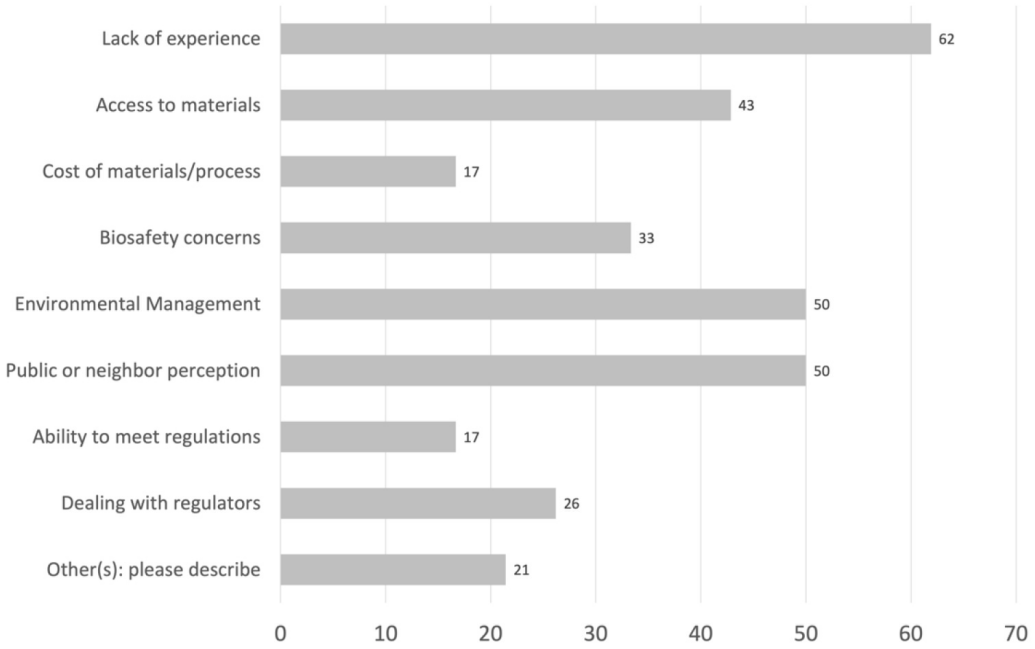

Figure 6. What do you see as barriers to or problems of livestock mortality composting for your operation? Please select all that apply. Results are displayed in percentage; respondents (n = 42) were able to select more than one option.

odors)" and "public or neighbor perception" (both at 50%). All of these concerns could be addressed in future educational activities regarding LMC.

When respondents were asked to rank their preferred form for accessing the type of information provided by the webinar, "Online videos and webinars" was the most frequently chosen. "In-person events" were also a highly rated choice, in second place, with "online text/articles" coming in third, and "printed materials (magazines, books, etc.)" rated lowest. "Universities" were selected as the most common source that participants would like to use for information about a topic like LMC (83%), followed closely by "state, county, and other government agencies" (79%). More than half (60%) also relied on "other producers/operators," and some looked to "consultants or industry support" (43%). The producer-respondents usually selected all four of the options for this question.

DISCUSSION

The survey results provide valuable information about the experience, benefits, and perceived barriers for on-farm composting of animal mortalities and could help inform the development of future research and Extension projects on this topic. The results show that the webinar was effective at increasing participants' knowledge about LMC and their intent to share this knowledge with others. A majority of participants were government employees, which is notable. The current target audience for LMC education includes regulators and educators along with producers; promotion and adoption of LMC will be successful only when both of these groups are aware of the technical steps of the process, the regulation (or lack thereof) around necessary permits, and the potential benefits it can offer.

Our webinars included a section on regulations, permitting, and appropriate contacts. More than 90% of respondents indicated that they understood the regulations surrounding LMC and knew whom to contact for technical help with LMC after viewing the webinar. Despite this apparent success in transfer of information, 17% of respondents indicated that the ability to meet regulations was seen as a barrier, and 26% cited difficulty in dealing with regulators as a barrier. Interestingly, 29% of the seven attendees who identified as producers cited dealing with regulators as a barrier, as did 18% of the 22 attendees who identified as government employees. This number included the only attendee who identified as both a producer and a government employee. Such barriers may be further reduced through thoughtful outreach efforts. In our final webinar, the presenters emphasized the simplicity of meeting regulations in Washington State, that most livestock operations in Washington need no additional permit to practice LMC, and that state regulators want more

operators to use LMC. Increased on-site demonstrations, face-to-face interactions between producers and regulators, and clear instructions and forms should be provided when possible to reduce these concerns.

Online videos/webinars were rated a highly preferred source of information. This survey finding was supported by the viewing of YouTube recordings. In the first 6 months, there were more than six times as many YouTube views as the number of original webinar attendees. Recorded webinars have the advantage of being available to a wider audience for extended periods of time compared to in-person events and, therefore, can be considered an important tool for Extension, even moving beyond the limitations that the COVID-19 pandemic established.

When participants were asked about barriers to or problems of adopting LMC, "lack of experience" was the most common selection. Increase in knowledge on a subject has been linked to increased adoption of practices in many cases, and these increases in knowledge and adoption followed participation in Extension programs (Wang, 2019). The need for experience in using a new procedure can be overcome through outreach efforts to teach LMC step-by-step. Although not as convenient to access as online materials are, field days and hands-on training are still needed to provide intimate familiarity with LMC. Efforts are needed to connect producers and regulators without experience to those who do have experience. Train-the-trainer events can develop a wider population of subject-matter experts to provide direct training in many locations accessible by producers and workers.

The importance of experience is critical when LMC is used to manage an emergency event or depopulation, which was indicated as an intention from 29% of respondents. Fifty percent of those preparing to use LMC for large events also intended to use or promote routine mortality composting, leaving another 50% who did not intend to use it routinely and, therefore, may have no prior experience when a large event happens. J&K Dairy (Sunnyside, Washington) was able to quickly compost hundreds of cows after a blizzard in 2019 because the operation was already using composting for routine mortality management: "When this happened, we knew we needed to move quickly, and we knew what our options were" (Talamo, 2020). Climate change is expected to increase the frequency and severity of extreme weather that could increase livestock deaths on a routine basis and in catastrophic events (Lacetera, 2019). Therefore, this time is critical for developing and implementing mortality-management plans.

Other significant barriers to LMC were "environmental management" concerns and "public or neighbor perception." These concerns should be addressed in future educational efforts tailored for different audiences. Neighbor perception may be an especially prevalent concern for peri-urban producers. The barrier of public perception could be reduced by highlighting the advantages of LMC that producers and the public care about. A large majority of respondents indicated an environmental-management benefit from LMC. Members of the public who are environmentally motivated may also support LMC for its environmental benefits. Broader efforts toward improving public perception of composting in general may also increase acceptance of LMC.

Multiple respondents also indicated that LMC has heretofore unreported benefits that may be classified as emotional, spiritual, or animal welfare. In open-ended questions, composting was described as "natural," "humane," "circle of life process," or "way to 'honor' the animal." Two of the producers we interviewed in developing the webinars made similar statements (one of which was included in the webinar); other than this mention by the interviewed producer, these responses from survey participants were unprompted. To our knowledge, this observation that on-farm composting of livestock mortality is seen as a choice that provides emotional, nonphysical, nonmonetary advantages is novel.

Livestock may be perceived by producers along a continuum between food source and pet. Small "hobby" farms may be most likely to build close relationships between humans and livestock (Holloway, 2001). But even in large commercial operations, people build emotional connections with animals they interact with for many years, such as dairy cows and breeding sows (Bock et al., 2007). The death of livestock can contribute to severe stress and even suicide risk among producers (Peck, 2005). The act of composting a livestock carcass includes preparing a location and material base, burying the body in selected organic materials, monitoring to ensure heat and biological processing, and moving and sorting finished material, and it may also include land application. Many of these activities share similarities with human funeral rites and may help provide a sense of closure or other mental-health benefits for producers and farmworkers who have cared for the animal. This advantage of being able to respect and repurpose a lost animal through composting may be a useful theme to emphasize in future education and outreach events to producers, agricultural professionals, regulators, and the larger public. Although this benefit may be difficult to quantify, it resonated with numerous respondents and may increase empathy in public-agricultural relationships.

The evidence collected from the survey during this education and extension project indicates positive results from our efforts, along with the need for further development and implementation of Extension and educational programming to increase awareness and knowledge surrounding LMC. Webinars provide a conveniently accessible tool to increase preparedness and adoption of LMC. Further outreach efforts that include hands-on activities and discussion of environmental, personal, and community benefits of LMC are rec-

ommended in programs for future outreach to government representatives, stakeholders, and the public.

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APPENDIX

Livestock Mortality Composting Post-Webinar Survey

Dear Participant,

We request your participation in a survey about this webinar and your experience with livestock mortality composting. The survey should be completed by each person in the U.S. attending the webinar, even if others from the same family or facility also complete the survey.

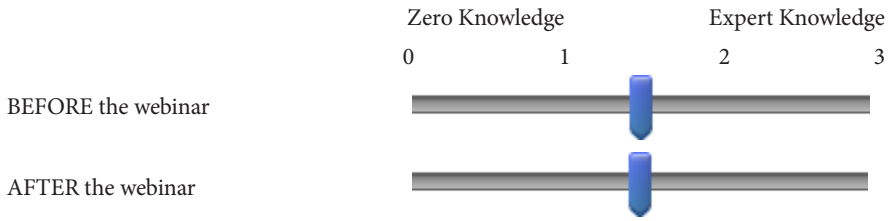
This survey is sent from researchers at Washington State University. All data collected are anonymous and nonpersonal. Data will be analyzed in aggregate, and no data will be traceable to an individual respondent. The intent of the survey is to assess the effectiveness of the educational webinar and the motivating factors for livestock mortality composting. Participation is voluntary and consists of completing an online survey (estimated time 3–5 minutes). Refusal to participate, either total or partial, will not result in penalty or punishment.

This study has been certified as exempt from the need for review by the Washington State University Institutional Review Board. We greatly appreciate your time and effort in providing this data.

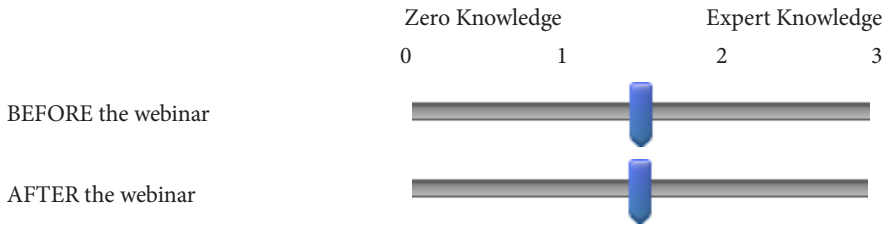
Sincerely,
Lynne Carpenter-Boggs
Professor of Soil Science, Principal Investigator And
Rachel Wieme
Postdoctoral Research Associate

Q1 Please answer the following prompts about your knowledge and perceptions BEFORE and AFTER attending the webinar.

Q1.1 My level of knowledge about the inputs and process of livestock mortality composing was/is:



Q1.2 My level of knowledge regarding the safety concerns (and how to mitigate them) involved in livestock mortality composting was/is:



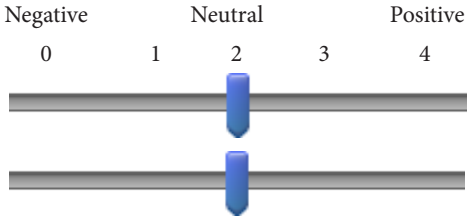
Q1.3 I knew/know the regulations surrounding livestock mortality composting.

	Yes	No
BEFORE the webinar	○	○
AFTER the webinar	○	○

Q1.4 I knew/know whom to contact for technical help with livestock mortality composting.

	Yes	No
BEFORE the webinar	○	○
AFTER the webinar	○	○

Q1.5 Please indicate your overall view of livestock mortality composting before and after this webinar.



Q2 Are you likely to share information about livestock mortality composting with others? Please select any that apply:

- ☐ Yes, with other producers, coworkers, or employees
- ☐ Yes, with regulatory agencies or regulators
- ☐ Yes, with other industry contacts
- ☐ Yes, with neighbors and/or the public
- ☐ No, I am not likely to share information about livestock mortality composting with others
- ☐ Please explain why or why not or what factors determine your choices:

Q3 What is your level of experience with livestock mortality composting?

- ○ I have never observed or performed it.
- ○ I have observed it and/or used a composting service elsewhere for my mortalities.
- ○ I have performed or managed it.

Q4 How likely are you or your operation to use on-site livestock mortality composting?

- ○ Not at all likely
- ○ Somewhat likely
- ○ Very likely
- ○ Not sure

Q5 What do you see as benefits of or reasons you would consider livestock mortality composting? Please select all that apply.

- ☐ Convenience
- ☐ Cost
- ☐ Biosafety
- ☐ Environmental management
- ☐ Use of end product
- ☐ Sale of end product
- ☐ Lack of other options
- ☐ Other(s) (please describe): _____

Q6 What do you see as barriers to or problems of livestock mortality composting for your operation? Please select all that apply.

- ☐ Lack of experience
- ☐ Access to materials
- ☐ Cost of materials/process
- ☐ Biosafety concerns

- ☐ Environmental management (e.g., leachate, odor, disease agents, other)
- ☐ Public or neighbor perception
- ☐ Ability to meet regulations
- ☐ Dealing with regulators
- ☐ Other(s) (please describe): _____

Q7 When is your operation likely to use mortality composting?

- ☐ Routinely
- ☐ For catastrophic events
- ☐ For depopulation
- ☐ Other (please specify): _____
- ☐ I don't think I will use mortality composting

Q8 Has the COVID-19 situation increased your interest or need for mortality composting?

- ○ Yes
- ○ No

Q9 I prefer to gather information on a topic like livestock mortality composting from the following sources (select all that apply):

- ☐ Other producers/operators
- ☐ State, county, other government agencies
- ☐ Universities
- ☐ Consultants or industry support
- ☐ Other (please specify): _____

Q10 I prefer to access information about livestock mortality composting through the following methods (please rank by filling in numbers 1–4, with 1 being your most preferred and 4 being your least preferred):

- ○ Online text/articles _____
- ○ Online videos/webinars _____
- ○ Printed materials (magazines, books, articles, etc.) _____
- ○ In-person events _____

Q11 How did you hear about this webinar? (Please select all that apply.)

- ☐ Other producers/operators
- ☐ State, county, other government agencies
- ☐ Universities
- ☐ Consultants or industry support
- ☐ News article
- ☐ E-mail
- ☐ Social media
- ☐ Other (please specify): _____

Q12 Do you have any other comments you would like to share about the topic of livestock mortality composting or this webinar? We appreciate your feedback!

_____

END OF BLOCK: BLOCK 1

START OF BLOCK: DEMOGRAPHIC INFORMATION

Q13 Please tell us about yourself/your operation:

Q13.1 Profession:

- ☐ Livestock producer
- ☐ Compost facility operator
- ☐ University (research and/or Extension)
- ☐ Consultant or industry support
- ☐ Government
- ☐ Other (please specify): _____

Q13.2 Operation Type:

- ☐ Poultry
- ☐ Dairy
- ☐ Swine
- ☐ Beef
- ☐ Other (please specify): _____
- ☐ Not applicable

Q13.3 Number of livestock (annual live average):

_____

Q13.4 Number of years working in the industry:

- ○ 0–5
- ○ 6–10
- ○ 11–20
- ○ 21+

Q13.5 Certifications and registrations

- ☐ NRCS EQIP
- ☐ USDA organic
- ☐ Animal welfare–approved
- ☐ Other (please specify): _____

Q13.6 Gender:

- ○ Male
- ○ Female
- ○ Other/Prefer not to answer

END OF BLOCK: DEMOGRAPHIC INFORMATION