

## On-Farm Food Loss: Farmer Perspectives on Food Waste

### Abstract

Although food waste is a widely discussed topic, most efforts have focused on consumers, with on-farm food loss receiving little attention. Our pilot study in California revealed the variability and complexity of reasons for on-farm food loss, many of which farmers cannot control. Interviewees spoke of market volatility and unpredictable weather as key contributors to loss, noting that much lost food is repurposed on-farm rather than ending up in a landfill. On the basis of our findings, we identify potential strategies for better aligning food recovery efforts with farmer limitations and needs and make suggestions for the role Extension can play in research and food recovery efforts.

**Keywords:** [on-farm food loss](#), [on-farm food waste](#), [California agriculture](#), [food recovery](#)

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Food waste is becoming a recognized public issue, attracting attention from academics, activists, entrepreneurs, policy makers, and the public. Reducing total food waste from farm to consumption has the potential to support multiple goals: increasing farmer income through secondary markets, reducing the use of scarce environmental resources, and contributing to food security through linkages with food banks or other community-based organizations. Achieving these goals will require an accurate appraisal of the causes of food waste and creative thinking about potential remedies. Extension is increasingly involved in this effort, and the breadth of our relationships and connections from farm to fork positions us to make significant contributions to public understanding of the problem and development of solutions. Research to date has focused on consumer and retail food loss with relatively little attention on the loss that occurs on farms, at the site of food production.

In collaboration with the California Food Waste Roundtable (also referred to herein as Roundtable), we undertook a pilot study to better understand on-farm food loss, gathering data by interviewing representatives of 12 fruit and vegetable operations in California. The goal was to better understand, from the farmer perspective, (a) the extent and nature of on-farm food loss, (b) the drivers of loss, and (c) the potential for various food recovery strategies. The research was exploratory in nature. Initially intended to inform development of a statewide grower survey, findings from the research instead led to a more rigorous follow-up study involving a wider sample of farmers that began in January 2017.

We define food loss as occurring when edible food is never harvested or is lost between harvest and sale. We deliberately use the term *food loss* rather than *food waste*, as much of the food fitting this category is reused as compost or animal feed or for other purposes and, in that sense, is not wasted. As is true in many emerging areas of research, definitional challenges abound in this domain. As both the literature and our data suggest, there are not yet clear and widely shared understandings of what constitutes "loss" or "waste" or even consensus on whether loss is a problem to be solved or simply a fact of life in farming operations (Bellemare, Çakir, Peterson, Novak, & Rudi, 2017).

## Previous Research

Our study was informed by a small number of previous studies examining the extent and causes of on-farm food loss, uses to which lost food is put, and challenges to reducing loss. There is little peer-reviewed literature examining on-farm food loss, with only a few *Journal of Extension* articles that even mention loss (Gentry, Edgar, Graham, & Kirkpatrick, 2017; Timmons, Wang, & Lass, 2008). Much of the available information has come about due to the trailblazing efforts of researchers associated with the Natural Resources Defense Council. Reports from their work and others indicate that the main factors influencing loss include market conditions, quality standards, and labor challenges (Berkenkamp & Nennich, 2016; Gunders, 2012a, 2012b; ReFED, 2016; Snow & Dean, 2016). Highly perishable products, such as peppers and lettuce, are more susceptible to loss than relatively hardy root vegetables, such as potatoes and onions (Berkenkamp, 2016a; Gunders, 2012a).

The most common response to on-farm food loss has been to till unharvested crops back into the soil (Berkenkamp, 2016a; Gunders, 2012b; ReFED, 2016; Sigler, 2009). Although many farmers would be interested in diverting this loss to donation centers or alternate markets, a key challenge for recovery efforts is the variability and unpredictable nature of on-farm food loss (Berkenkamp & Nennich, 2016; Sigler, 2009). This variability also has proved challenging for researchers attempting to identify accurate metrics of food loss (Berkenkamp, 2016b).

## Methods

Leaders from the California Food Waste Roundtable approached the University of California, Davis, in July 2016 seeking help with a statewide survey of growers. Initial discussions led to agreement that it would be useful to conduct pilot interviews to get a better feel for farmer perspectives and to test potential survey questions and wordings. In pursuit of this objective, our team prepared a draft survey which was reviewed by Roundtable leaders and leading food waste researchers. We also prepared an institutional review board–approved protocol for a semistructured interview of farmers. The protocol was designed to explore potential survey questions but also to ask additional questions related to the three main research goals of estimating loss, identifying drivers, and considering recovery options. In designing the protocol, we drew on previous studies (Berkenkamp, 2016a; Gunders, 2012a, 2012b; ReFED, 2016; Snow & Dean, 2016).

Working with Roundtable leaders and Extension networks, we identified 12 California fruit and vegetable growers willing to be interviewed between late August and early October 2016. As indicated in the appendix, the farm operators we interviewed manage a widely diverse set of farms, ranging from urban diversified fruit and vegetable farms of less than 10 ac to 30,000-ac exporters in the Central Valley. Crops included fresh and processing tomatoes, citrus, tree fruit, lettuce, cabbage, fresh and processing bell peppers, and more. Although the sample reflects a miniscule portion of California's tremendous agricultural diversity, and cannot be used to produce reliable crop-by-crop estimates, the study provided useful initial comparisons based on crop, harvest

method, and type of market in which the produce is sold.

We analyzed the transcribed interviews, applying thematic coding techniques and using both preset and emerging codes (Miles & Huberman, 1994). We read each manuscript first in its entirety and then a second time to identify key answers, concepts, and themes that emerged. Comparing these findings across all 12 interviews, we identified a number of recurring themes on the basis of frequency of mention. We presented these preliminary results to Roundtable leaders in November 2016. The tight timeline proved challenging from a research perspective, and the sample is no doubt to some degree biased toward farmers with a greater than average interest in the topic of food waste, who were more likely to respond to our requests for an interview (29 were nonresponsive or declined our requests).

Most of the 12 respondents were interviewed in person, but a few respondents whose operations were more distant provided information by phone. The on-farm interviews sometimes included opportunities to actually go into the field with farmers to see and discuss particular dynamics surrounding food loss. Interviewees were provided with the survey draft and interview protocol in advance of the interview and told that none of their recorded quotes would be directly attributed to them.

## Emerging Themes

Table 1 presents the five key themes emerging from the interviews, organized by the major sections of our interview protocol: difficulty in estimating on-farm food loss, key factors leading to loss, disposal of food loss on farms, farmer experiences with food recovery, and farmer recommendations for reduction of loss. For each theme, we provide a few representative quotes from our interviews.

**Table 1.**

Key Findings and Related Interviewee Comments

<b>Theme</b>	<b>Interviewee comments</b>
1. Difficulty in estimating on-farm food loss	"[Asking for the quantity of loss] is never going to lead to anything accurate, unless I was a commodity farmer and always grew processing tomatoes and that is all I'm doing."  "It just depends on the weather. It depends on what we planted that time of year. We're always rotating our crops every single season, which means it's not always forever going to be the same. For diversified crops, I could just make up a number and it would be just as accurate."
2. Key factors leading to loss	"This [loss] can vary dramatically from season to season, from crop to crop. For example, 'not harvested,'—that can happen because of market conditions. You can have perfect product in the field, but the market conditions are such that the cost for you to harvest and pack that would be more than what you'd get back from the product."  "There are a lot of demands and restrictions coming from the

- retailers, the warehouses, and the restaurants where we sell our products. They have very stringent standards . . . in terms of quality. They want you to reduce your food waste . . . but at the same time they're very inflexible in their standards. Sometimes it just feels really bad when you have a great crop that's ready to be harvested, but it's just one inch shorter than what it should be."
3. Disposal of food loss on farms
- "At the farm level, everything that's left behind that may be considered food waste would actually be tilled back into the soil. It has benefits to the soil health. When they till that back into the soil, they don't see that as loss. They feel like that's going to help them with their next crop."
- "We're trying to direct all of our food waste away from the landfills to other sources most of the time. It's very rare that anything would go to the landfill. We donate a lot to the local food banks and things like that."
- "There are certain commodities that we bring to the [processing] facility, like artichokes, for which all the [culls] are directed to animal feed."
4. Farmer experiences with food recovery
- "I don't grow things to throw them away, but if I know that everything I grow can actually get eaten, I'm really good with that. Even on certain occasions when we walked away from the field, we called up volunteers from our nonprofit. Sometimes farm workers will come and glean. That's true gleaning. It makes you feel better."
- "It still requires the farmer to coordinate with all these people, which is time they don't have. Oh, I have the time to post this thing that's going to be free, and then I have to coordinate with you. When am I going to get it? Am I going to give you the wax boxes that this stuff is in? Who's going to take it out of the field?"
5. Farmer recommendations for reduction of loss
- "I feel there is potential to do more [to reduce loss]. . . . It has to make economic sense. You can't expect the farmer to go and pick all the different broccoli heads that are left behind and reroute them to some other outlet [e.g., food bank]."
- "I think you look upstream and see what they're doing. We just don't have the imperfects, because we sell to processors. I'd say go to the processors. . . . See if they'll donate their processing time to put it in a form, rather than leave it in the field. They're usually so full they can't do it at that time; that's why it's [out there]."

## Theme 1: Difficulty in Estimating On-Farm Food Loss

Most farmers saw themselves as operating efficiently, with estimated on-farm food loss as less than 10% of total crop. Across the 12 interviews we heard food loss estimates ranging from .5% to over 50%, depending on a wide range of circumstances (see appendix). A few respondents were reluctant to provide any numerical estimates given the variability, or chose to speak only in broad terms.

Only one farmer reported keeping records of on-farm food loss. Asked to comment on how confident they were in their loss estimates, farmers did not express much confidence, given the lack of records and the constant fluctuations. They were more consistent and confident in their view that the processing and retail sectors are where more waste occurs and where intervention efforts are more likely to be fruitful.

## Theme 2: Key Factors Leading to On-Farm Food Loss

A recurring theme throughout the interviews was that most of the major factors affecting food loss are beyond the farmer's control: market dynamics (e.g., price falling due to gluts), timely availability of labor, weather, and pests. Loss is understandably contingent on the relative degradability of the commodity (e.g., low in processing tomatoes but higher in fresh tomatoes) and quality standards of the buyer. It is the interaction of these factors that leads to the intense complexity and difficulty in calculating and reducing on-farm food loss.

Generally, fruits and vegetables that are sold fresh and are more prone to quality loss due to weather changes and pest infestations have higher rates of loss than those that are hardier or are destined for processing. In our sample, we found that on a spectrum of on-farm food loss values, processing tomatoes and citrus had the lowest loss estimates, whereas fresh tomatoes and leafy greens had the highest percentages of loss.

Outside of these fluctuations, loss that occurs on farms due to quality standards varies by the type of market the product is destined for, be it for fresh consumption or processing. A key tension is between the simultaneous desires to maintain cosmetic standards and increase sustainability by reducing loss.

## Theme 3: Disposal of Food Loss on Farms

Respondents typically disposed of food left in the field after harvest by tilling it back into the soil to act as fertilizer. Some farmers directed food loss to nearby animal operations for feed. For example, a citrus grower interviewee had a historical relationship with nearby cattle producers whereby the grower transferred almost all waste to be utilized as feed. Few farmers saw this as waste, although they also acknowledged that they would rather be able to harvest everything they grow for direct human consumption.

## Theme 4: Farmer Experiences with Food Recovery

Many farmers we interviewed already participated in donating food to food banks and worked with gleaning organizations. However, the amount and type of gleaning reported varied widely, from formal relationships that brought food banks and gleaners onto farms, to informal gleaning by farmworkers as subtly encouraged by growers, to a small amount of food "stolen" by unwelcome individuals. Farmers were more likely to support gleaning if partner organizations provided the proper training, safeguarded farmers from liability, and offered strategies that enhanced rather than detracted from farmer economic viability. Some farmers regularly donated otherwise marketable products to food banks but saw this act as a regular charitable contribution rather than

food recovery.

We found that the degree to which food recovery efforts succeed varies widely based on geographic location and the nature of farmers' relationships with local nonprofit organizations. Farmers who are directly connected to nonprofits that do gleaning are able to call on trusted volunteers who can harvest and transport food before it becomes inedible. Otherwise, farmers are hesitant to partner with unfamiliar organizations due to uncertainty about time commitment and liability.

## **Theme 5: Farmer Recommendations for Reduction of Loss**

In general interviewees saw some potential for reducing on-farm food loss, but they cautioned that efforts must be economically feasible to succeed. They were open to doing more with food banks, but only if their costs (at a minimum the marginal costs of harvesting) could be covered.

Overall, they recommended that food loss reduction efforts focus on the food processing sector, particularly on the nature of marketing contracts. Respondents seemed interested in efforts that would expand the ability of processors to create secondary markets for imperfect produce or processing by-products so that farmers could be paid for more of their product.

## **Discussion and Implications**

The results from our pilot interviews underscore the complexity and variability of food loss on farms, which vary by crop and by year, by farm, and even by field, as different natural and socioeconomic forces occur and interact. Designing a uniform grower survey in the face of this complexity would be no easy task. Our data suggest that it would be difficult (though likely not impossible) to design a survey regarding on-farm food loss across California or the country, particularly if the goal is numerical precision. Farmers report relatively low confidence in their loss estimates.

A significant limitation of our study is that we used a convenience sample, constructed to respond rapidly to the Roundtable request for support. On the other hand, the process provided a good example of Extension research that is timely and responsive, and offered a springboard for more rigorous subsequent research. In just 3 months we went from our initial consultation with Roundtable leaders to the completion of the 12 pilot interviews. As a result of our analyses, the Roundtable decided not to pursue a statewide grower survey. More accurate food loss numbers might be generated by studying individual crops over a period of years using in-field measurement approaches, a strategy being pursued via a few projects under way as of fall 2017 (Foundation for Food and Agriculture Research, 2017).

Including packing sheds and other food collection and processing sites in food loss studies is important, as these entities have a greater capacity to estimate loss and divert waste as they manage their sorting practices. For example, they may be better able to separate out lower grade products to supply to food banks. Food banks and other organizations focused on food recovery also should be a focus of future research, which might explore how successful initiatives are overcoming logistical and financial challenges.

Future studies should address the ecological value of tilled crops to soil fertility or of leftover crops as animal feed and incorporate this value into determining whether on-farm food recovery efforts are warranted from an environmental perspective. If there are to be continued efforts to better assess and monitor food loss on farms, this part of the equation must be included, and some means of measuring these values, such as life-cycle

analyses, need to be developed.

As an overarching strategy, we see the value of coordinated research efforts to identify crops with relatively high loss percentages that are also of high utility to food banks. Policy and Extension education efforts could then be focused on these promising opportunities rather than on blanket approaches that provide relatively fewer economic, environmental, or social benefits.

## An Opportunity for Extension

Extension can act as a key player in future research and education aimed at reducing on-farm food loss and other types of food waste. Extension personnel, including those working in agriculture, nutrition, resource conservation, and community development, are well positioned to engage in applied research and to facilitate productive two-way conversations between farmers and food recovery organizations, such as food banks and gleaners. Community engagement based on accurate information can support the important economic, environmental, and food security goals that animate contemporary food waste activities.

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## Appendix

### Characteristics of Twelve California Farm Operations Participating in Interviews

Farm	Acreage	Crop	Food loss estimate	Harvest method	Farm type
1	6,000	Tree fruit and grapes	No estimate provided	Hand and machine	Grower, packer, shipper
2	NA	Peaches, nectarines, grapes	10%–15% on peaches and nectarines; 10%–45% on grapes	Hand and machine	Grower (sells to processor)
3	6,000	25+ fruit and vegetables and tree fruit; nuts	2.5% entire crop	Hand and machine	Grower (sells to processor)
4	>100	Peppers	10% and under, variable	Machine	Grower (sells to processor)
5	<100	Fruit and vegetables	50% or more of crop	Hand	Research farm



					(trials)
6	NA	Processing tomatoes, bell peppers, sunflowers for seed, alfalfa	1% for processing tomatoes, more for bell peppers	Machine	Grower (sells to processor)
7	6,000	Wine grapes, processing tomatoes, rice, wheat, corn, safflower, sunflower, onions, alfalfa, oat hay, etc.	5% processing tomatoes	Hand and machine	Grower, packer (sells to processors)
8	7	50+ diversified fruit and vegetables	10%–50%	Hand	Grower, direct market
9	30,000	Citrus, tomatoes, grapes	2% citrus, 40% fresh tomatoes	Hand and machine	Grower, shipper
10	10,000+	Fruit, vegetables, grain, feed, cabbage, lettuce	15% for cabbage and lettuce	Hand and machine	Grower, packer, shipper (sells to processors)
11	20,000	30+ vegetables	No estimate provided	Hand and machine	Grower, packer, shipper
12	1,000	Diversified fruit and vegetable	5%–10% green beans, 10% lettuce, 10%–25% or more bell peppers	Hand	Grower, packer, shipper

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