Report

Documenting California Produce Growers' Approaches to Maximizing Crop Utility

Voices from the Field Project, Phase 1

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Executive summary

Food loss and waste is a growing problem in the U.S. with significant social and environmental consequences. Although loss and waste occur at every stage of the food supply chain, previous research indicates that a substantial share of fruits and vegetables produced in North America (20-40%) are lost on farms. Many programs and policies aim to recover on-farm food losses for human consumption, yet growers' voices are often absent from conversations about program design and implementation. Because growers are critical partners for successful food recovery, our study investigates how growers experience and perceive the problem of food loss and the potential for food recovery. We conducted 35 semi-structured interviews with California growers of three important crops: leafy greens, peaches, and tomatoes. Interview topics included growers' perceptions of the primary drivers of food loss, total volumes of losses, prior experiences with food recovery programs, and barriers and opportunities for maximizing crop utility. We analyzed the interviews to identify insights of potential interest for food recovery programs, policymakers, researchers, and growers who might be interested in the experiences of others.

On-farm food loss: Definitions and scale

- There is little consensus about the official definitions of "food loss" and "food waste," leading to different quantitative estimates of loss and waste.
- Food loss is therefore an "essentially contested concept" (Gallie 1955; Connolly 1974), with stakeholders variously defining it according to its origin in the supply chain, its final destination, or individual perceptions about its avoidability, desirability, or edibility.
- On-farm loss is divided into two categories: in-field and post-harvest loss. In-field loss occurs when food is left unharvested or abandoned in the fields. Post-harvest loss occurs when picked produce is sorted on the farm and lower-quality produce is culled.
- Interviews suggest wide variance in the estimates of in-field and post-harvest losses for the three crops in the study. There was also dramatic variance in the quantity of loss for any given year, or even for different periods within a growing season.

Drivers of loss

- Growers reported that on-farm losses are driven by two key factors, which they do not control: the market and the natural environment. These are interrelated, as environmental events impact market prices, and market conditions impact the degree of weather-related damage that suppliers will accept.
- Market-driven losses are often caused by rigid quality specifications, and prices also determine the intensity with which growers will cull produce. Loss is also driven by oversupply-cases in which there is effectively no market for even perfect produce.
- The calculation of what is worth harvesting and packing based on market conditions depends on where in the process farmers incur the greatest cost. For example, half of the production cost for leafy greens is in harvesting.
- Unpredictable weather also impacts the volume, quality, and timing of crops and associated losses.
- Many-though not all-growers also talked about labor as a significant influence on loss. In some cases, labor shortages had led growers to leave product in the field or delay harvesting. Rising labor costs have also shifted the cost-benefit analysis of what is worth harvesting, thus indirectly driving loss.

Lost but not wasted

- When growers choose to till unharvested produce back into the soil or divert it to animal feed, they may prevent more environmentally harmful food waste at later stages of the supply chain. Life cycle analysis demonstrates that landfilled food generates substantially greater greenhouse gas emissions than the food lost on farms (Gillman, Campbell, and Spang 2019). Therefore, farms may be the best place for food loss to occur.
- Growers of all three crops reported diverting lost produce to animal feed. For leafy greens growers, this constituted a small portion of overall loss. On the other end of the spectrum, fresh peach growers reported diverting a large portion of their culls to feed.
- Growers of all three crops reported that all produce left in the field, as well as some post-harvest fruit in the case of tomatoes or peaches, gets disked back into the soil or left to rot somewhere. Opinions about how this impacts soil quality were mixed.

Recovery opportunities

- Almost all growers reported efforts to recover crops that did not make it to primary markets for human consumption, though in most cases recovered food constituted a small percentage of overall loss.
- Recovery opportunities fit broadly into two categories: donations to the emergency food system and side markets for off-grade produce.
- Three key factors shape whether growers are able or inclined to recover food losses:
- (1) fluctuating demand for rejected or surplus product, (2) costs of recovery relative to compensation, and (3) logistics of the recovery process.
- Some growers specifically pack donations for emergency food organizations. Others donate only when their crops are rejected from primary markets or they cannot find a suitable buyer.
- Gleaning was not a popular mode of food recovery among growers, who shared negative experiences with volunteer labor or fears of legal liability for volunteers' injuries.
- Few of the growers in our study reported taking advantage of the available state or federal tax incentives for donation.
- Growers reported seeking various markets for off-grade produce, including discount retailers, processors, farmers' markets, and informal markets.

The bigger picture

- In interviews, growers often talked about themselves as having little power to impact food loss within the supply chain, instead responding to broader structural issues and constraints set by other actors.
- Many growers - particularly large-scale conventional growers - portrayed themselves as both socially generous and stewards of the land, in some cases feeling misunderstood or miscast by a progressive movement focused on the social and environmental impacts of waste.

Introduction

This research was initiated to capture farmer perspectives on the topic of food loss on farms. The premise of this project is that growers are the experts when it comes to maximizing the utility of what they plant, and that members of research, policy, or non-profit communities interested in on-farm food loss need to understand growers' experiences and opinions when addressing this topic. By documenting and sharing approaches on different farms (while ensuring confidentiality), the project is also intended to generate resources for growers who might be interested in the experiences of others.

Food loss and waste is a serious and growing problem in the U.S. with significant social and environmental consequences (Spang et al. 2019; Winans et al. 2020). While estimates of food loss and waste vary based on differing definitions of these terms (Bellemare et al. 2017), most assessments suggest that it is a significant issue to be tackled (Gustavsson et al. 2011; US EPA 2016). For example, one study estimated that 40% of food is currently wasted in the United States, up from 30% in 1974 (Hall et al. 2009, 1). Food loss and waste occur at all levels in the supply chain, but most of the attention has focused on the processing, retailer and consumer levels rather than on the farm (Harwood and Baker 2016, 2). Relative assessments of loss tend to justify this focus. According to an estimate by Feeding America, more than 6 billion pounds of fresh produce go unharvested or unsold each year (Gunders 2012, 8). In contrast, Buzby and coauthors estimated most than 38 billion pounds of fruits and vegetables lost at the retail and consumer levels in 2008 (Buzby et al. 2011). Yet some have suggested that food loss on farms has been underestimated, particularly in the arena of fresh produce, leading advocates to overlook the significant potential for recovery (Harwood and Baker 2016). One FAO study estimated 20% loss in fruits and vegetables in North America at the agricultural level—described as "losses due to mechanical damage and/or spillage during harvest operation (e.g. threshing or fruit picking), crops sorted out post-harvest, etc.," (Gustavsson et al. 2011, 2)—with 30% loss occurring in later stages of the food supply chain (2011, 7).

Responding to this potential opportunity, researchers have attempted to better quantify how much food is left behind or discarded at the farm level. Recent scholarship has produced regional estimates of agricultural food losses in California (Baker et al. 2019; Milepost Consulting 2012), North Carolina (Johnson et al. 2018), and Vermont (Neff et al. 2018). The research detailed in this report was conducted as part of a broader project, funded by the Walmart Foundation and the Foundation for Food and Agricultural Research (FFAR), called "Maximizing Farm Resources and Edible Food Rescue." The project aimed to estimate crop losses in diverse regions, crop types, and production systems. Our study of on-farm losses in California leafy greens, peaches, and tomatoes complements parallel investigations that were conducted in Arizona, Florida, Idaho, and New Jersey.

Data and methods

Our study complements this quantitative focus by providing a qualitative assessment of how growers experience and perceive the problem of food loss. The survey and interview-based studies noted above offer some grower accounts of drivers of loss and mitigation strategies (Milepost Consulting 2012; Snow and Dean 2016). Beyond presenting a point of comparison for these findings, our work offers a more comprehensive portrayal of grower perspectives, as told in their own words. Growers must necessarily be key partners in any efforts to reduce on-farm loss. Yet we know little about how they understand food loss, the extent to which they see it as a problem, the kinds of decision-making processes involved in leaving or discarding produce, and where growers might see opportunities for improvement. This project is an initial step toward addressing these gaps.

The crops evaluated in this study were selected in consultation with our project partners to address large-scale crops with differing cultivation types (row versus orchard crops) and a diversity in the geography of production. The chosen crops enable comparisons with the same crops grown in regions studied by project partners; California crops were compared to cultivation of the same crops in New Jersey (peaches), Florida (processing and fresh tomatoes), and Arizona (leafy greens). Outside of California, the broader project team also evaluated potato losses in Idaho. Table 1 displays the scale of production of lettuce, peaches, and tomatoes in California.

Table 1: Scale of Lettuce, Peach, and Tomato Production in California (2015-2017)

Crop	CA Rank in U.S.	Acreage Harvested (1000 acres)	Production (1000 tons)	Total Value ($1000)
Lettuce (head)	1	85	1606	916,927
Peaches (freestone)	1	20	253	198,132
Tomatoes (fresh)	2	28	386	244,167

Source: (California Department of Food and Agriculture 2018)

Following a standard qualitative research method, we relied on semi-structured interviews to capture growers' perspectives on a range of topics related to food loss. (See Appendix A for the interview questionnaire.) Rather than following a set script, the interviewer orients the conversations around a series of broad questions but allows the respondent to guide the conversation. This more informal approach is ideal for respondents who might feel reticent about being interviewed (as was the case with some growers, as noted below), as well as for preliminary research in which the goal is to explore the range of views within a given group rather than to determine the frequency of these views. As we proceeded with the interviews, we identified recurring themes and added or modified questions to follow up on particular issues or deepen our knowledge of emergent topics. We also deliberately sought to disconfirm things we had heard by seeking out respondents with different perspectives. We recorded all in-person interviews except for one case in which a grower requested not to be recorded. We did not record phone interviews, but rather took detailed notes throughout the conversation, generating relatively close transcriptions.

Interviewee recruitment required first building trust among growers. We began by reaching out to individuals within the UC Cooperative Extension (UCCE) system and had follow-up phone calls with eight Cooperative Extension specialists who work with one or more of the three study crops. These UCCE advisors then put us in touch with other intermediaries—for example, leaders of crop-specific research institutions or grower associations. We decided to conduct preliminary phone interviews with these intermediaries, both to gain their trust as we sought their help in contacting growers and to capture their perspectives. The feedback we got from many UCCE Specialists and Advisors and intermediaries was that the term "food loss" or "food waste" would be a turnoff to growers. First, they worried that growers would think that the project in general might generate "bad press" for agriculture. Second, they noted that the term "loss" or "waste" presumed something that not only seems like a criticism of growers, but also might not be true—in talking to growers, we might find there was in fact little or no loss depending on how the term "loss" is interpreted. In response to this feedback, we revised the project description to focus on documenting growers' efforts to maximize crop utility, and then worked backward to see if there might be ways to enhance growers' existing efforts in this area. A couple of individuals also suggested dropping references to "policy" in our outreach materials, as growers are often wary of government interventions that could lead to further regulation. Finally, we experienced some grower reluctance to on-site interviews, so we also decided to conduct interviews by phone, as needed.

We reached out to 23 UCCE personnel and researchers, and nine other grower intermediaries to help recruit interviewees. The breadth of this original outreach effort may be an indication of some of the difficulties of engaging with growers around this topic. As other researchers and UCCE advisors affirmed, growers are often extremely busy (particularly during harvest season) and wary of talking with researchers about topics they feel might be politically sensitive or emphasize negative aspects of agriculture. "No good deed goes unpunished," as one intermediary put it. As such, arranging grower interviews involved cautious outreach to develop a supportive network, building trust among people who could facilitate grower contacts, and revising how we approached interviews. Once we were able to conduct initial interviews with growers, we employed a "snowball" sampling strategy by asking interviewees to suggest other contacts we could interview. This approach was very effective: after speaking with us, most growers were willing to share names of others we might contact.

In total, we conducted 35 interviews with growers, including on-site interviews at 21 different farms, and 8 phone interviews with growers unable or unwilling to arrange a site visit. (See Table 2.) Interviews took approximately one hour but were modified to accommodate growers' schedules. We followed a strict protocol to guarantee the confidentiality of participants and their businesses in this report, so no names or identifying information are linked to responses. The category "grower" includes people holding different roles on the farm, such as harvest manager, owner, sales representative, and other positions, both due to convenience (we talked to whomever was available at the time of the site visit) and because we were interested in understanding the topic of food loss from different perspectives on the farm. Our sample was small relative to the number of farmers growing these crops in California, was based on convenience and previous connections, and—given the resistance we initially encountered— was likely biased in favor of growers more open to the idea of addressing food loss through research. Thus, our findings cannot be interpreted as a general representation of growers' views, or even growers of these specific crops in California, but rather present an initial portrait of the range of opinions growers might have about the topics covered.

Table 2: Interview Respondents

	Interviews	**On-farm site visits**
Leafy greens	9	5
Fresh peaches	8	5
Processing peaches	3	0
Fresh tomatoes	6	4
Processing tomatoes	5	3
Greens and fresh tomatoes	3	3
All three (fresh)	1	1
TOTAL:	35	21

We used a professional service to transcribe all in-person interviews. These transcripts, along with the detailed notes taken during phone interviews, were analyzed with the qualitative data analysis software program Dedoose (version 8.3.10, 2019). We first reviewed all the materials to create an initial set of codes for analysis, which we refined over time through iterative discussions with the research team. In creating the codes, we also relied on our reflections on emerging themes that we generated throughout the data collection process, pausing after each interview or site visit to note what was learned, what seemed to reinforce what we had previously heard or observed, what diverged from what we had heard or seen elsewhere, and what new areas of inquiry had emerged. Dr. Gillman coded all interview transcriptions and, based on collections of excerpts organized by code, generated an outline for the report and an initial draft. In the report, we tried both to indicate areas of relative consensus among growers and include divergent views, paraphrasing little and using growers' actual words whenever possible.

Roadmap

The report is organized as follows: First, we address variations in how "food loss" is defined and understood by growers. Next, we describe growers' estimates of the quantity of food lost across three California crops: leafy greens, tomatoes, and peaches. Then, we characterize the types of food that are lost and examine three of the main drivers of food loss, including market dynamics, weather, and labor. Then, we describe how growers manage on-farm food losses and explain how food is often lost but not wasted. The next section examines opportunities to recover lost food for human consumption, either via donations to emergency food organizations or secondary markets. Then we review the key factors that influence food recovery, including demand, costs, logistics, and interpersonal relationships. The report concludes by considering how growers fit within the broader context of agricultural markets and the food waste movement, explaining how growers feel that their role in both contexts is often misunderstood.

What counts as loss?

There is little consensus among government agencies about the official definitions of "food loss" and "food waste," and differing definitions lead to different quantitative estimates. For example, the U.N. FAO defines "food loss" as "the decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption," meaning agricultural production and post-harvest processing, whereas "food waste" is associated with retail and consumption (Gustavsson et al. 2011). With these definitions, the FAO estimates that 20% of fruits and vegetables produced in North America and Europe is lost at the site of production, and 5% is lost at the postharvest and processing stages. In contrast, the USDA defines "food loss" as occurring post-harvest "at the retail and consumer levels," and they estimate that 31 percent of the food supply was lost in 2010, equaling 133 billion pounds (US EPA 2016). Finally, the EPA describes food waste as "food going to landfills from residences, commercial establishments (e.g. grocery stores and restaurants), and institutional sources (e.g. school cafeterias)," which excludes food that might be lost earlier in the food chain, and they estimated that 218.9 pounds of food waste per person was sent for disposal (US EPA 2016).

Similarly, the growers in our study also had different ideas about what constitutes "food loss." Some defined food loss as including all food that is diverted from primary markets, even if it is later recovered for human consumption, whereas others had personal definitions more in line with one of the official definitions above. Growers described how defining what constitutes "food loss" can be challenging when considering imperfect produce left in the field. For example, in the case of leafy greens, harvested fields are strewn with leaves. As one grower explained, "It so happens with when you harvest a head of lettuce, the crew is going to decide whether it's big enough or solid enough. And then they're going to clean the head up, to maybe pack as a naked head or a wrapped one. And there are leaves that will come off of that head, the outer protective leaves." But growers tend to estimate loss based on the number of heads harvested, not their mass. One respondent noted, "If you went through and all the heads were picked and the leaf was left behind it would be considered 100 percent picked." The FLW protocol defines food as "any substance that is intended [emphasis added] for human consumption" (FLW protocol, pg 2). When walking through a field of harvested Napa cabbage, one grower acknowledged that the leaf mass left behind might be edible, but explained, "It's just that, that's not cabbage. So that's like the protection or the structure to develop the cabbage." Another respondent commented, "The outer leaves left behind, that is the workhorse of this plant, not waste… You wouldn't go out into a tomato field and see all of those vines and go, "Oh, what a waste!" It's not waste. It's what we needed to grow the vegetable."

Food loss is therefore an "essentially contested concept" (Gallie 1955; Connolly 1974), with stakeholders variously defining it according to its origin in the supply chain, its final destination, or individual perceptions about its avoidability, desirability, or edibility. Given that our goal in this report is to listen carefully to growers about their

experiences with food loss, we refrain from offering our own definitions and instead focus on what growers called food loss. Below, we describe how growers quantify food losses according to their own definitions.

How much is lost?

On-farm loss can be broadly divided into two categories: in-field loss and post-harvest loss. Post-harvest loss occurs when picked produce is sorted on the farm and produce that fails to meet quality standards is culled. In-field loss occurs in two ways. The first is when, during harvest, food is left in the field or orchard because it is imperfect in some way. The second is when a grower decides not to harvest whole rows or fields of crops--what some have called "walk-by" or "pass-over" fields. We found wide variance in estimated loss for the different crops examined in each of these categories. There was also dramatic variance in the quantity of loss for any given year, or even for different periods within a growing season. Several growers noted that focusing on average losses does not give an accurate portrayal of the issue. As one leafy greens harvest manager commented, "I don't see it as one percentage or any percentage number that really could categorize the whole, as far as waste goes." As discussed below, large variances in relatively low-probability events present particular challenges for constructing solutions, which may be overlooked when focusing on averages.

Leafy greens

We interviewed farmers who grow a wide variety of leafy greens, including Napa cabbage, spinach, red and green lettuce, iceberg lettuce, romaine and romaine hearts. With leafy greens, almost all on-farm loss occurs pre-harvest, as greens tend to be sorted and packed in the field, and the cost of harvesting is nearly half the cost of overall production. According to growers, post-harvest loss occurs infrequently and only under two types of circumstances. First, after picking and packing, growers might find pest infestation or rot in a package and have to throw it away. Growers reported this as an infrequent event. Second, in cases where growers sell on the open market, packed food sitting in cold storage might have to be discarded if the sales team cannot find a buyer before the produce becomes unmarketable. However, harvest and sales teams reported having well-refined systems for coordinating harvest timing to prevent such occurrences.

"Walk-by" fields occur in leafy greens either when there is no market for surplus product, or when there is excess damage due to disease, pests, or weather problems. One respondent commented, "I think that anything that's less than fifty percent [viable product], they're not even going to go in [the field to harvest]…. Sixty to 95 percent might be worth going in there." Grower estimates of percentage loss due to walk-bys varied between 5% and 15% per season, and it depended in part on the size of the farm. One large producer reported, "With walk-bys, the less the better, clearly. So I would say at least it would be, average number, I would say probably less than 5 percent are walk-bys" Another organic leafy greens grower related, "My guesstimate would be 5 to 10 percent [walk bys]. I don't think it's ever zero… But I don't know. We don't seem to lose a lot." A smaller-scale producer estimated 10-15%, but he said he expected lower numbers among larger producers who have secondary products, like bagged lettuce, that they can transition to in the case of a somewhat damaged field. One very small grower, who sold only at farmers' markets and a farm stand, said he had no walk-bys as compared to large commercial growers who might overplant in the hopes of a higher market price. He explained:

> *So I'm not playing a market or anything like that. I know that from a historical standpoint I can sell 300 heads of lettuce in a day, so I plant enough to give me that amount of lettuce. Not any more, not any less…. Whereas a larger grower, you know, he's gambling, he's trying to get a good market. And then when he doesn't hit that market is when he calls the gleaners out and says, 'Here, I got an acre of lettuce. Come get it.' And as small growers, we really can't afford to have a lot of stuff left over that we're not going to do something with.*

Another respondent commented that the frequency of walk-bys is mitigated over time through market adjustments, since it is easy to plant more or less acreage of greens (as compared, for example, to tree fruit). She noted, "Yeah, we're going to have certain times when things aren't worth getting out of the field. But if that were the case a lot, then we would be out of business, or our business would be smaller. So it's self-adjusting. So we would just cut back in that case." She gave the example of how growers were adjusting to diminishing markets for iceberg lettuce and growing demand for kale.

Many growers, when asked whether there was any loss in the field, stated that "everything" was harvested. "So I would say, in a good market you're going to probably pick everything on the field. Everything worthy of a head of lettuce," one harvest manager asserted. One grower declined to be interviewed, because, as she explained, "We wouldn't be good people to talk to because we plant only what we need for the contracts we have with the shippers, so there really isn't anything that gets left in the field." Other growers gave modest estimates of loss, between 5% and 10%. The owner of a larger commercial operation estimated higher amounts of loss. "For the iceberg lettuce, you probably harvest, if you are lucky, 75 percent of what you planted…. A successful crop, maybe you go to 85 harvested and leave just 15 behind." A couple of growers commented that how lettuce is packaged—whether in bulk or in cartons of heads specified by size—can impact loss. One respondent explained, "In the bulk lettuce, pretty much everything goes, but if you are doing cartons, you're going to have those smaller sizes that are going to get left in the field." Another grower noted, however, that they found greater post-harvest loss with bulk lettuce, as any pest infestation could ruin a whole bin. As noted above, the range of loss in any given season can be high, depending on conditions, meaning that averages tell a limited story. With too much moisture, one harvest manager commented, they could easily lose 20% due to decay. Another grower noted, "One hundred and fourteen degrees in the valley, you're going to lose half, 50 percent. Stays eighty degrees… [you won't]."

The case of romaine hearts stands out as a particularly difficult case for assessing loss. On the one hand, growers related particularly low rates of loss in terms of head count, since they can discard outer leaves that might have been damaged in some way, and still recover the romaine heart. One owner explained, "Our romaine hearts, typically, the rate of harvest is actually high, meaning around 90%, because we have the luxury of stripping all those leaves that are not good enough. However, he continued, "You still have many leaves and you've seen that it's a carpet that are on the ground that could be considered partially as waste." On first glance at a harvested romaine hearts field, it can be hard to determine what portion of the field has already been picked. One study in central California found that growers of head lettuce report losses between 3-6% pre-harvest, 1-4% post-harvest, and another 1-4% in packing culls (Milepost Consulting 2012). Another recent study in northern and central California estimated 114% loss in the case of romaine hearts, indicating that more of the crop was left in the fields than was harvested for market (Baker et al. 2019). However, it is important to note that this estimate comes from the researchers' assessment of edible romaine leaves left in the field, not the growers', and that researchers considered the outer leaves that were left behind to be "perfectly good, edible Romaine leaves" despite the growers' claims that the outer leaves are not intended for human consumption.

The image of a "carpet" of leaves in a harvested lettuce field contributes to a gap between leafy greens growers' and outsiders' perceptions of loss. One leafy greens grower noted, "To me it's such a small percentage [lost] that it's not worth it at this point on leafy greens. There are bigger issues with other commodities, really, I think." In contrast, one processing tomato farmer, when asked about the prevalence of food loss in general, commented, "Not here, not in production agriculture here. But have you been down to Salinas Valley and gone through a lettuce field? Does that blow you away? It's disgusting, isn't it?" One respondent summarized this gap in perceptions: "I have been in the leafy greens business forever. I have done a ton of tours. They go out there and go, 'Oh my god, I can't believe there is so much waste!' And I'm going, 'Waste? What are you talking about? We just got the maximum yield here!' So we are worlds apart."

Tomatoes

Fresh tomatoes

We interviewed a range of fresh tomato growers, including one large-scale farmer, a number of organic farmers, and two very small-scale farmers. In the case of fresh tomatoes, most of the loss occurs pre-harvest, as fresh tomatoes are hand-picked with more than one harvesting pass per field – an approach that leads to high harvesting costs. Loss occurs because of cosmetic imperfections, but also due to the cost-benefit analysis of going in for another pick—particularly given that tomatoes, unlike leafy greens, are picked when temperatures might exceed 100 degrees and, as one grower commented, vines can start to look like a "jungle" after various picks. As one grower explained, "We want to get the majority. We want to maximize that trip to the field. So I don't want to send you in to get one box. I want to send you in when I think there's 10 boxes ready. You may lose some…But I don't want to send you in when they're too green, either. So you have to – we watch the field every day. We look at and look at it. We try to forecast."

Fresh tomato growers gave relatively broad estimates of loss, generally stating between 15% and 25% of loss across the range of farm sizes. However, one small-scale grower of heirlooms estimated 5% loss at the sorting station, and other organic growers estimated 10% loss with heirlooms. One grower stated as low as 2% loss with organic cherry tomatoes.

When asked what portion of his product doesn't make it to market, one small-scale grower commented, "It would be a wild guess. Out of all the perfect tomatoes, I'd say maybe 80, 90 percent of the perfect ones. Out of all the tomatoes, it's probably more like 70 percent or 60 percent. Some years, there's a row of 'God, why did I plant those?'" Another organic grower estimated, "I think it's at least a third, if not more." Loss estimates differed depending on the product. When asked to estimate loss, an organic grower commented, "Oh boy. That's a hard one to judge. With cherry tomatoes it's probably – this year especially – maybe 80 percent, 85 percent [that go to market]." His loss estimate for heirloom tomatoes was a lot higher. As he noted, "On heirlooms, they're very subject to weather conditions, the quality and the quantity. On years where you have wide fluctuations in temperatures or rain or whatever, you end up with more being left in the field than thrown away. I've had it as low as 50 percent yield that were usable tomatoes. I've probably had it as high as 80 percent, but I think that's about the max." As this comment illustrates, loss levels can fluctuate dramatically by year or even within a given season.

Processing tomatoes

Processing tomatoes are machine-harvested only once, when they are at peak ripeness. Timing is key to eliminating loss, as tomatoes are primarily rejected from the machine either because they are too green or moldy. Unlike fresh tomato growers, processing tomato growers generally stated low levels of loss with confidence, with most estimating between 2-5% loss. As one grower commented, "The reality is, you always have a few overripe, and a few green, but you like to be in that 95 percent range ideally." Two growers estimated higher levels of loss. One respondent, who also grew fresh tomatoes, mentioned up to 10% loss. Another organic grower, who didn't own his own harvester, said they had a case of 20% loss when their tomatoes had gotten overripe due to a "logjam of everyone's tomatoes" ripening when harvesters were scarce. Again, growers reported variances over time and by field:

> *Some days it's 100 percent. It's 99.9 percent. Other days it might be 90 percent… So it can change from one day to the next. You can be in fields that are 100 percent red, and then the next day you go to another one that's a different variety and it's ready to harvest, but it might have five or 10 percent green, something like that. So it just depends. It depends on the variety, the weather, the soil, a whole bunch of different factors.*

All growers noted one particular case in which losses might be high: what is called a "split-set." A split set occurs when weather conditions cause tomatoes to ripen at different times. As one grower explained:

> *Usually what happens is during the summer, it will be hot when the flower is setting, and it burns the bloom, the flower. And if you burn a lot of it, the flower will keep growing, but all of a sudden you have the flower that didn't die that will continue to grow. And then you're waiting for the plant to regenerate and start off again. But the flowers in the middle died. But if you get just the red ones, you won't' have a big crop. So people will try to hold as long as they can, until they are losing more red than gaining by green.*

In this case, a grower might lose 10-20% of the crop that hasn't ripened in time. One grower noted, "I've seen 20 percent thrown on the ground because you didn't have a choice. But those are ones you couldn't wait for." Split sets are somewhat rare. One grower suggested it might happen with certain fields every five years or so.

Growers did report cases of walk-by fields, either when the market was saturated or when tomatoes were damaged. One respondent commented, "Now on a wet year, after it rains…you could lose a whole field because it's too much mold." Another reported abandoning fields that might be 50-80% marketable because "…you get behind during the season and something gets rotten…But if you can't sort those out and get it through the grade inspector [at the processing plant] no sense harvesting it." In times when crops are booming, processors might not be able to take more tomatoes. "So you may get to the point where everyone has tomatoes, they [canneries] won't take any. You try to sell to as many people as you can, at any price, but there are times you can't sell them. That does happen from time to time," one grower reported. He estimated that this might happen every five years, and he could lose 2-3,000 tons tomatoes in this case.

Particularly when the market price is low, growers may tend to slightly underplant rather than overplant to avoid selling tomatoes at a steep discount. As one respondent explained, "I would rather come up short a little bit…Because what I don't want is to have to sell tomatoes at $30. Whereas if I just put a little bit higher number [expected yield] here on my contract, then I'm more likely to get full price. But you do run the risk of having canneries constantly disappointed or not happy with you because you don't fill your target." He described this as a delicate balance that depends both on the price and growers' confidence in their estimates of expected yield. One grower related negotiating with a processor to absorb all excess: "You fill all your contracts, and you still have tomatoes in the field, and you can't get rid of those because there's no market for them…. Now, it hasn't happened to me for a long, long time, because I negotiated one of my contracts that they take all of the extra tomatoes from their acreage. So it's been working out every year that I don't have to disk any tomatoes for probably 25 years."

Levels of post-harvest food loss in processing tomatoes depend on what different canneries will accept. Some canneries will send entire loads back to the grower if there are too many rejects in the batch, at which point the grower can either incur further costs to sort it and send back an improved load—which must happen in a matter of hours to prevent rot—or dispose of it. One grower commented, "All the tomatoes could be perfect, but if there's 10 percent dirt the whole load's coming back. Because they don't want to sort it out." He described rejected loads as "a rarity," however.

The level of imperfect tomatoes any given cannery might accept varies. Another respondent noted, "Usually anything over 8% is a reject, but if they have good quality in other fields, and they [the processor] can bring in yours that are over 8%, they can accept them. But if it's a rain that is statewide, then they have to drop it to 4%, because everyone is sending in bad fruit." Growers noted that though canneries may charge a deduction in price for imperfect tomatoes, which gets calculated as a loss to the grower, they might in fact use green, broken or moldy ones for making paste rather than peeled tomatoes. Growers reported that, on average, canneries will take up to 3% green tomatoes for paste. One grower explained, however, that though his produce might be used as food, he

incurs a fiscal loss in this case: "The other loss, from my point of view – and this is a controversial thing in the industry – when I send in green tomatoes, and I get a deduction on that contract for my green, the canner still uses them." As discussed further in the final section of the report, food that is not lost from the perspective of communities focused on food insecurity and environmental issues often still means "loss" for a farmer.

Peaches

Under normal conditions, growers of both processing and fresh peaches reported picking all peaches from the tree, leaving sorting for the packing process. As one respondent related, "This orchard will get picked six times. If you're going to come back a few days later, they're stripping everything. Almost all of it's going to come out of there." Since peaches left on trees can be detrimental to the tree health, becoming "mummies"—rotten fruit that can attract insects— all fruit is picked or shaken off if needed. When asked how much fruit would be left in the orchard, one grower responded, "Usually none of it. Unless it's a rotten piece of fruit. So it's a handful of pieces that we throw on the ground," noting that they bring it in "unless it's going to create a juicy mess inside the box."

While most growers stated that, as a rule, orchards were fully picked, some mentioned occasions when they might limit the number of times pickers would go through an orchard due to cost considerations. As one grower put it, "It always comes down to profit/loss, right? So it's either the fruit out there is good and you're going to abandon it, because you can't pay to pick it, that's seldom what happens. Or you won't pick it because there's not really that much left; it's kind of a—you get 10 acres and you get 200 boxes out there, go find that. It's just not economical from a efficiency standpoint really with labor." One grower commented that, in the case of low market prices, he might limit the number of picks and leave smaller fruit to fall or be shaken off, whereas in a stronger market all sizes would get picked. Another grower explained, however, that because he is "vertically integrated"—noting, "I have the farm, I have the trucks, I have the sales…"—there is never a point when it is was not worth it to him to pick all of the fruit. "No. I never tell myself don't. I'll find someplace to put it." In contrast, he observed, "Now, if I was a commercial packer and you were my grower, there's an economic threshold that you can't pick for that I can, because I'll make a dollar over here that you as a grower would not if you had to take it through a commercial packer."

Growers related that certain conditions, such as a hailstorm, might cause enough damage to "cause a grower to walk away." One grower commented, "It seems like every year there's probably something where it grows and I can't waste any money out in this field. Or based on what the losses are, rather than get five or six times, I'll just say, 'You know what? I'm going to have to find the best day to go pick them, and spend one day working the group through the field because I can't afford to have them go through there multiple times.'" In such cases, he related, "You could lose half the crop, in some cases, the whole crop. It just depends on the circumstances." Another grower commented on the wide variability of these losses, by year, or even by location on a given year. "So some years it's 20 percent, some years it's not, most years it's nothing. Hail as a phenomenon is usually isolated to very small patches. And some growers could be widely affected in devastating amounts, a 100 percent loss. And our neighbor 300 yards away will be zero damage."

Taking into consideration these variances, one fresh peach grower estimated that, on average, only about 2% of the fruit is left in an orchard. Estimates for processing peach growers were relatively similar. As one grower commented, "Ooh, it varies. I would like to say it's under 3-4%, but this year with all of the heat and things ripened, I bet you in some blocks it grew to about 12 or 15%. You hope it is 4-5% and it's incidental and it's a constant." With processing peaches, growers can decide between hand-picking and machine harvesting, and one grower noted that losses were higher with machine harvested fruit. In the case of hand-picking, he observed, "There's always 1-2% that's left out in the field. Sometimes it'll be labor misses a limb or something, or it just isn't to size." However, he estimated 3% for machine harvesting, explaining, "The machine it has sizing chains on it, so it's a lot more….you know if you put a human there they tend to miss a little, but with the machine if it's small it's gonna fall through the machine."

Fresh peach growers reported high levels of post-harvest loss, sorting between one-fifth and one-third of all peaches as culls in the packing house. As one grower commented, "We throw away, daily, a quarter of a million pounds, and that's conservative—daily, 250,000 pounds worth of fruit." Another grower reported, "This is just an example here, let's say out of one of those facilities, we pack a million and a quarter pounds and we throw out 412,500 pounds." Again, growers noted that the percentage of culls varied greatly, and it increases as the season advances. One grower commented that culls can run anywhere from 10% to 50% of the harvest, noting, "The last picks are going to be smaller. Maybe a few more soft, misshapen. Issues that creep up on old stuff that you left on the tree longer." One very small-scale farmer reported that about 50% of his peaches do not make it to market because they are young trees, it is a small operation, and they are still relatively early in the learning phase in terms of maximizing yield.

As noted below, there are various recovery options for fresh peach culls, and two growers with similar levels of culls reported very low levels of actual loss. One stated that he only disposes of about 5% of product per year and another stated that for the last two years he had zero actual loss. Post-harvest loss levels for processing peaches were much lower than for fresh peaches and, much like in the case of processing tomatoes, depend on the cannery—one grower related an average of 8-12% "deductions" in the peaches he sent to the cannery, though he commented that, while a financial loss for him, not all of these peaches were actually being rejected. As he noted, processors will accept damaged fruit "but they don't want to pay for it. Like a split pit, it's that one example where the fruit will pull the pit apart and leave a pit half and then it has to go to a second dice line, that takes a bigger chunk of the flesh out. They still use it. Just that they want us to compensate them for that second pass."

What is lost?

As described above, in some cases perfect produce gets left in the field or discarded for lack of a buyer. However, much of what is left is in some way considered "imperfect." The top reasons growers reported for rejecting produce included size, ripeness, cosmetic imperfections, and more serious problems like decay or pest infestation. The relative portion lost due to these various factors depends on the crop, but also on the season or the field. Quality standards that determine rejections also vary by different markets. In discussing what portion of lost crop would be edible, growers highlighted the subjectivity of this criterion, which depends on when the produce will be eaten and by whom.

Quality standards

In the case of leafy greens, one grower described cosmetic defects such as discoloration, insect damage, or windburn. Pointing to a misshapen head of romaine in the field, he commented, "When it gets really hot, romaine can sort of twist like that. [And once you've got the] whole thing twisted that's not aesthetically pleasing to the customer." A fresh tomato grower noted problems such sunburn, blossom end rot, split from too much water at wrong time, and stinkbug damage. One fresh peach grower explained the difference between "condition defects," which will get worse over time, such as "bruises, soft, any kind of decay that shows up—any kind of mechanical damage would be a cut from either your fingernail, equipment box," and cosmetic imperfections that remain stable, such as a scar from a rubbing branch, noting, "A scar is going to be a scar. It's static." Being overripe was a primary consideration in all three fresh crops, though fruit rejected as "overripe" might still be very under-ripe for eating, as it usually needs to be able to travel long distances. A fresh tomato grower noted that any tomatoes that were "breaking pink" and not perfectly green might get rejected. One respondent commented that most peaches are picked so green that "they could break your windshield," though almost all growers insisted that they push the envelope in terms of maturity in order to maximize taste.

Size is a particularly prevalent factor in supplier rejections of both fresh and processing peaches and leafy green heads. One processing peach grower explained:

> *The cannery has a size piece that they want. Anything below that is considered small fruit and the cannery does not want small fruit. It slows them down, their line. And it causes issues for them. So anything that doesn't make the size is of no value to them. And then we just throw it on the ground.*

A leafy greens grower commented, "If you need a 10-inch head of romaine, and there's a 7-inch head of romaine, they're just going to walk right by it… It has to meet a minimum. There's not like, medium romaine, large romaine. So, if it doesn't meet that minimum criterion, it just gets left behind." The length of the core in the romaine is also a reason for rejection. As another grower noted, "So a 3-inch core is okay, especially in the romaine a 3-inch core is okay. 4-inch core, it will get rejected. If the whole field has 4-inch core, and it's a bad market, we won't cut it, we'll walk away…" Size has practical as well as aesthetic importance, as a precisely packed box prevents damage in transport. As one grower noted, small heads get left behind "because we need that full box. If you got lettuce rolling around the box it'll get rejected."

When asked to rank the primary quality issues driving rejections, growers often differed in their answers. One fresh peach grower listed "shape, color, and how firm it is" as the three biggest determinants of culls. "Because if something has shape and color but it's not as firm, it's not going to travel. So if something's not as colorful, people are going to look at it and say, oh, this must not be good because it doesn't have as much color as this one." Another fresh peach grower commented that the problem could vary by period or by field:

> *Before we run every walk we actually go through each tote, and we actually do an assessment of what it is that's the defect in that field. And you can have one field that has a tremendous amount of hail damage and nothing else. You could have another one where, for some reason, you want to get through now and it has a lot more soft than the other one has. So the primary defect is soft. It just depends on the circumstance of the day. And you could have one where half this fruit's going to be undersized.*

The exception was processing tomato growers, for whom the reasons for rejection were consistent: fruit is rejected for being either too green or moldy.

Growers sell to different markets with varying quality standards. One leafy greens grower noted that they can sell smaller sized heads to discount markets. Another leafy greens grower explained how they sell different quality products under different labels:

> *Like if you have a certain level, a standard of quality for your top label, no matter what the market is you don't want to go below that level of quality for your top label. So maybe you have spinach that's still good but maybe the leaf size is small or, you know, maybe the color's not as deep. So then you put that in your second label as long as the conditional quality is okay. As long as you're not, you know, you don't have decay or slime or anything like that.*

A peach grower explained how their industry used to have a marketing order requiring growers to pack only one grade—"U.S. Number One General Grade"—but that growers eliminated the order to meet different customer demands. A grower explained how they now pack three different grades of peaches:

> *And then probably seven or eight years ago, we started packing, what we call, a choice grade. Which is—we call it like a one and a half, it's not a utility, because people used to pack utility and still do. But this is a step up from utility, it's a choice. And this will actually go to chains and to jobbers, like most people are shocked how*

> *nice it looks. It has just a little bit of scarring, healed both cracks, no condition issues, just grade. So it's absolutely as good as the number one, but it's got maybe a tiny hail mark on it. And I could show you some of the boxes, you would go, I would buy that any day. And it's sold at quite a steep discount…"*

A fresh tomato grower described a similar system: "You have prime and choice. Prime is your number ones. Choice is your number twos. Prime people usually pay a little more, or they can get a little bit of a bargain on choice." Growers mentioned different retailers that accepted different grades, but generally asked that these remain off the record to maintain the reputation of these establishments.

Assessing the edibility of abandoned products

In the case of peaches and fresh tomatoes, growers tended to judge that a high portion of left or abandoned fruit was edible. As one fresh tomato grower commented on his heirloom fields, "There's probably very little of the stuff that's left in the field that would not be edible in some way. You can cut off a crack or a split and leave the tomato. The only thing is if it's over mature. That's probably not edible." Another fresh tomato grower estimated 70 to 80 percent of lost produce was edible, with the other portion being "just too far gone" in terms of maturity. When asked what portion of culls was edible, one fresh peach grower responded: "Every single one of them—well let's say 99 percent. I mean there'll be a few that will be overripe. But those probably will be the most delicious. Asked what percentage of culls of fresh tomatoes are edible, one fresh tomato grower summarized, "Whatever the culls, if it's just the color, or the cathead, all of that is edible. It's just the view of it. Just like clothes. Old variety of clothes, you can still wear them, but you can't get rid of them."

Edibility has an important temporal dimension. On one hand, produce that is edible in the field might no longer be edible by the time it reaches the consumer. As one fresh peach grower commented, "You could eat that [peach], right now, but I don't think you could eat that if it traveled for a day or something." As another fresh peach grower explained, for fruit to be edible in a practical sense it had to be able to endure some level of transport:

> *Very few of them [the culls] are not edible. Even the soft is edible. It's just too soft to handle to get it to anybody. It's the best eaters, really. That's what I take home to eat, to my grandkids and stuff. I take the soft peaches. But it doesn't have to ride on a machine or go on a five-day truck ride to the East Coast, you know? It just won't make it. So it's all edible, but some of it's even too soft for me to get to the food bank. For me to get it to the food bank, it has to be able to run down my machine and then get in a box.*

Leafy greens growers also noted that edible produce with a minor imperfection might develop decay over time that make it unsafe to eat. As one grower noted:

> *If there's imperfections, that can lead to breakdown. You would have certain flaws, or a lot of times if it's product that's either past what we call its bloom, and it's not going to have the shelf life, and you start trying to push that into regular channels or into other channels, it may lead to food safety issues or shelf life issues, which can lead into food safety issues.*

Produce that is edible at the time of harvesting might get damaged in the harvesting process, as is the case with processing tomatoes that are passed through the harvester and thrown on the ground. Conversely, produce that is relatively inedible in the field might become edible over time, as in the case of tomatoes that are picked green and require some storage capacity.

In some cases, only a portion of the product is edible. Pointing to a small bruise on a fresh tomato, one grower commented, "So that one took a hit. Would you eat that? I might. I would just cut that off, and then look, you have all

that tomato." In the case of leafy greens, edibility is a more difficult line to draw; as noted above, many growers consider outer leaves part of the structure of the plant, rather than the food that they are trying to produce. When walking through a field of harvested cabbage, one leafy greens grower was asked whether leaves strewn on the ground were in fact edible, and he replied, "Yeah, see, but who would want to eat that?" Another leafy greens grower commented, "I'd say most of the stuff we leave behind is just not desirable for customers. The exception is inedible." However, he also noted that once separated from the plant, the outer leaves quickly wilt and become dirty. Another grower also noted the impracticality of trying to capture the edible portion of a harvested field:

> *Lettuces, whether it's iceberg or romaine or green or red. They still trim a lot of leaves off. Some of those leaves aren't edible, some of them are though. Especially in romaine hearts, when you're chopping half the head just to get to the heart. There is a lot of product material wasted if you will. The challenge is, how do you collect all of that? How do you handle it?*

Growers also raised the question, edible to whom? One leafy greens grower noted that, for a "farmers' market cut," they might leave more outer leaves on the head, as buyers might be inclined to use those as stock, whereas these leaves would be discarded for other retailers. Another organic tomato grower commented, "Nice people like you guys will go to the farmers' market, and you'll not care if it's slightly oversized, undersized, misshapen; something that doesn't fit perfectly in the box. It might be super ripe; not rotten, but too ripe to ship..." A small-scale grower commented, however, that institutions accepting less than number-one grade produce still have certain standards that exceed just technically edible. As he commented:

> *I've never heard of a food institution that doesn't want good quality stuff, because, again, you send them stuff that isn't so good, and they've got to spend more labor on fixing it up and making it look good, making it presentable. And everyone has the same labor issues. They want to spend as little time as possible in preparing it…*

Drivers of loss

Growers reported that food loss on farms is driven by two key factors, which they do not control: the market and the natural environment. These factors are interrelated, as environmental events impact market prices, and market conditions impact the degree of weather-related damage on agricultural crops that suppliers will accept. A primary preoccupation among growers is developing strategies and expertise for mitigating these two drivers of loss. Growers also talked about labor scarcities and costs as impacting loss, though they mostly emphasized the longer-term threat that labor problems present to California growers.

Market-driven loss

Various growers described market conditions as the key driver of loss. Much of this loss is driven by rigid consumer preferences—or at least rigid retailer interpretations of consumer preferences. If growers anticipate that a customer will not buy a food product, there is no sense in harvesting or packing it. As one leafy greens grower explained, "Customers, they eat with their eyes. So if the product doesn't look good on the shelf, if there's any discoloration, or any little thing, customers won't eat it, or buy it. So that's why [we leave things behind]. Our customer base is just so picky." Another peach grower related, "We throw away, daily, a quarter of a million pounds…Maybe it's overripe, maybe it's misshapen, maybe it's a split pit…I could take you to a packing shed and you'd watch the cull line and you'd go, why are you throwing that away? But that's how particular the market is." As noted above, quality requirements vary for different markets. For example, a small-scale grower of heirloom tomatoes who primarily sells at farmers' market had a higher bar for what was considered "marketable" than an organic tomato grower selling wholesale who reported he needed to effectively "produce perfect tomatoes."

Market prices also determine the intensity with which growers will cull fruit, either in the field or at the packing stage. As one fresh peach grower explained, "Usually if you're abandoning it, the market isn't great enough to overcome some problem that you have with the product itself." Another leafy greens grower stated, "When the market is bad, that is when you're most likely to step over something, or really get picky. So maybe you don't take a chance putting a short head of lettuce in, or something ugly. So, you have more waste, but when the market is bad, and the grower is losing money every day." In a weak market, growers might determine that it is not worth harvesting a particular field or going through for later picks. As one organic tomatoes farmer explained, "Once in a while with heirlooms, if the price gets too cheap, or what we deem is too cheap, we'll quit picking for a week and let them go." A peach farmer described leaving particular sizes of fruit:

> *Usually markets are equated by size, so the bigger the fruit, the more they pay, and the smaller the fruit, the less they pay. If there's too much fruit, nobody wants these bottom sizes. Two years ago, there was no market basically for medium to small fruit because there was so much fruit and there was plenty of big. So the packers were telling guys, just leave those small ones on the tree. Don't bring them into us because it wouldn't pay for the picking and the packing, the fruit had gotten so cheap.*

Another fresh tomato grower related leaving produce that was considered "overripe":

> *And now the market is so low, any pink [on the tomato], they will throw it away. Our first set, they were maturing more quickly, and there were some breakers, and my cull percentage went to like 35% to 40%. When it's a good price, the percentage goes lower in terms of higher output. But now, it seems like the market is good till the 4th of July, and then it drops. It seems flat now.*

In contrast, as one leafy greens grower observed, when the market goes "sky high," growers are "trying to scramble to get every leaf."

The calculation of what is worth harvesting and packing based on market conditions depends, in part, on where in the process farmers incur the greatest cost. For leafy greens, half of the production cost is in the harvesting. Thus, as one grower explained, in a weak market, "We won't even harvest it, because then we pay for it twice. We pay for it to be harvested and cooled, and then it just sits there, and then we have to pay for it to get disposed of, so it's cheaper to just cut your losses with the growing costs, and that's it." In the case of peaches, where growing costs are a greater portion of overall costs, one grower explained that they err on the side of picking more, noting, "It's so expensive [to grow peaches] and a lot of your costs are sunk upfront."

Growers also explained that the cost-benefit calculation can be more complicated than just comparing variable costs to market prices, as they need to maintain consistent operations. One leafy greens grower noted that, broadly speaking, "If it takes us $14 to pack the box and we're only getting $13 from it, we're done picking, you know." He continued, "But you still have to take into account that we need to keep our crews busy…. Then you want to keep your customers coming in. You want to have a consistent supply, so that's subjective—all of that just kind of plays into it too. So it's not that cut and dry…" Another grower of processing tomatoes noted that the current price is so low, "I'm not really even making this money this year"; however, he had to continue producing to maintain his contracts and hopefully turn a profit the next year.

Finally, loss can simply be driven by oversupply—cases in which there is effectively no market for even perfect produce, or as one greens grower explained, "the pipelines are filled up." This could be due to a weak market, or because a grower yields more than expected, experiencing a "bumper crop." One grower described high levels of loss "when it was just a great year for tomatoes and we have more than we have markets committed." One leafy

greens grower noted that rising input prices had caused growers to be much more conservative in their planting. As he noted, "There's so much money you're investing in it, so I would say what's taking care of a lot of that [oversupply] is people adjusting their plantings because the cost of inputs has risen so greatly. I think if you're still in this business, you're really fine-tuning your buying schedule because you lose so much [money when you walk by]." One small-scale grower who primarily sells at a farm stand and farmers' markets noted how scale also impacts growers' planting decisions—as he explained, there is far less fluctuation in demand for his small-scale operation, but he also cannot afford to overplant.

Contracting versus selling on the open market also shapes the degree of loss and planting calculations. One leafy greens grower asserted that, as contracting has expanded, the resulting market rigidity has reduced the tendency to overplant:

> *Most, or at least a lot, of the leafy greens are contracted, so you have that amount of cash flow, and anything more than that has made the markets more inelastic. That all impacts kind of your topic [of food loss] here, because you're not going to overplant. You don't have the situations where there's a lot of food out there that you're going to be wasting.*

Processing tomatoes are also sold under contract, and one grower noted that with a low market price, he was more inclined to underplant than overplant. He would slightly overestimate his expected yield in the contract because the potential gain of selling more underpriced tomatoes was not worth the potential cost of having excess produce. In contrast, he noted, "If the price was high and it was $85, I might risk having a few leftover– I might plant a few extra." One processing tomato grower had negotiated contracts in which the cannery agreed to take his entire yield, and thus he avoided disking any acreage under. Similarly, a processing peach grower said that their contracts tend to be based on acreage, not tonnage, and thus surplus produce was not an issue. Instead, adjustments were made on a yearly basis, as the cannery might reduce the contracted acreage as demand declines.

One of the biggest challenges for growers is responding to market fluctuations, not only from year to year but within a given growing season. Some such fluctuations were relatively predictable—many growers noted that later in the season, market supply increases and suppliers can afford to become stricter about quality standards. One fresh tomato farmer described quality requirements as a "sliding scale," explaining, "Early in the season, hey, a little blemish, I'm still selling it, because people will buy it. But when there's a point where there's a million perfect ones—if it's got a crack, pitch it and grab the good ones." A leafy greens grower noted, "So you want to plant enough that you have enough contracts, but not overplant to where you just can't sell what you got. So that's why we use historical data. Sales has trends of their customer demand – obviously before Easter, big holidays, Labor Day, Memorial Day weekends, you always see a spike in consumption."

Other fluctuations are difficult or impossible to anticipate, particularly when growers sell on national or even global markets. A fresh peach grower related how a storm in the Southeast could dramatically boost the market for California fruit, explaining, "On a year like this where the south is completely devastated, you can sell every size of fruit." Another leafy greens grower observed, "It's a worldwide market. I mean if, you know, spinach could be coming out of Mexico. It could be coming out of Vancouver. But they could get a heat wave and ruin their spinach." Consequently, she explained, the decision to leave a field is a last-minute one. "Yeah, you don't walk by a field until the very last, last. I mean because you think, you've dedicated that soil, that land to that crop for that many months. So you're still, you're still investing in it until the end." The environmental factors described below, and particularly weather, interact with market conditions to drive loss, as damage due to environmental conditions in other areas can drive up prices in California. The combination of uncertainty about market conditions and environmental events creates substantial uncertainty for growers' decisions around planting, harvest, and loss.

Growers make efforts to predict market conditions, and then harvesting and packing teams work closely with sales teams to adjust to more sporadic market changes. Ultimately, however, their ability to control profit and loss—of food, and consequently revenue— is limited, leading various growers to describe farming as "a gamble."

Weather-driven loss

The number one environmental issue that farmers described as impacting loss was unpredictable weather. As one leafy greens grower explained:

> *You know, like weather's the only thing that farmers, that we can't control. That's what makes prices go up and down for product. Like we can predict usual weather, you know. In August it gets 100 degrees so you plant that variety for that time of year. But then if it's really cold in August suddenly, then it's like well, that seed variety is not going to do well. We should have planted another variety. So it's weather that we can't predict is what affects us.*

Problems can arise from unpredictable changes in temperature, e.g. unseasonably hot or cold temperatures for part or all of a season. Another peach grower explained, "It's been oppressively hot—it's ridiculous. At 100 degrees [Fahrenheit], you know, the tree protects itself first always, it doesn't worry as much about the fruit." A leafy greens grower noted how temperatures could "all of a sudden go from 67 to 99 for two weeks, and back down," damaging a crop.

Loss is also driven by too much or too little moisture, including periods of drought or excessive rain. One leafy greens grower pointed out the impact of drought, noting, "See all the salinity. Sodium is just the table not being flush, so the aquifers have a lot of salt right now." Moisture-related damage can also result from too much dew or humidity. Sun and wind can also impact a plan. Finally, growers related loss due to more sporadic weather events. As one leafy greens grower recalled, "I will never forget having this really humid storm in September. And all of the lettuce right after the storm didn't have any life to it. So you couldn't ship it anywhere. When it got the east coast, it was all blotchy and looked terrible. It was all because of this environmental event that occurred." Fresh peach growers in particular reported high degrees of loss resulting from storms, and especially hail, noting that "30 seconds of a hailstorm" can ruin a whole area.

In some cases, weather causes loss by directly damaging the fruit. In peaches, hail creates pockmarks and wind sometimes causes the peach to rub against the branch, leaving some scarring. As one leafy greens grower explained, "Sometimes with romaine there could be a little bit of wind damage just on the very tip, the little tip burned, and a bad market, we'll walk away from that. Lettuce, sometimes you get salt and pepper inside where you see a little bit of brown spots on the end of the leaf, which is due to too much humidity." Weather can also cause more substantial problems of decay in a plant. Sunburn on tomatoes is an aesthetic problem and can also lead to mold.

Weather also impacts loss by influencing how and when a plant matures. A fresh tomato grower described how "zippering"—a line down the middle of the tomato—occurs: "If the temperatures are low, if it's below 50 or something like that, that flower will stick on the tomato. That's where you get some of that." A leafy greens grower noted how, in the case of a heat spell, "The plant will try to reproduce, or [shoot a core] through the middle of it. You still get lettuce, but we're only allowed to have a core twice the size the width of the trunk. So a 4-inch core, it will get rejected." Another greens grower explained, "I think we walked over 40 acres of romaine last November because of heat. It just never got cold and it just never stopped growing." A fresh peach farmer recalled:

> *So, in the spring it was really, really wet and so it was time to cull—when the trees were pollinated less—there's less opportunity for them to fertilize as many flowers as possible. So the crop set was light… And so it happens a lot of the time when you don't have enough fruit on a hanger, they'll grow so fast that the split—the pit will split in half. And you can't pack that. So that's been a big problem.*

As one peach grower explained, weather overall impacts yield: "If we have good weather, the trees will set better. Then we'll have more of a crop. If the weather is kind of junky, then your crop won't set, and then your things reduce. Your numbers reduce."

Weather can also cause problems by impacting the timing of ripening in ways that impact harvest. In the case of fresh tomatoes, for example, various growers reported how warm temperatures can cause too many to ripen at the same time, making them hard to harvest and generating a surplus for the market. As one grower explained:

> *Well when it gets that hot, our plants, it just kind of stops them. It slows them down….On fresh market, we are supposed to have a certain amount per week. But two weeks are combined now. Because it slowed down our tomatoes. But now they are growing again, but the younger ones caught up. Some people even had to disk under, because there is too much maturity at the same time.*

The opposite problem can occur in the case of processing tomatoes, where the goal is for a field to ripen at the same time since harvesting occurs only once, generating a "split set" of green and red tomatoes.

Beyond—and in some cases related to—weather, growers also reported pests and disease as environmental factors that drive loss. For example, downy mildew is a foliar disease in leafy greens, related in part to excess moisture, which has "wreaked havoc" on particular crops. One grower noted that it is particularly hard to control in organic produce.

As with market fluctuations, growers invest a great deal of effort in trying to mitigate losses due to environmental impacts, with techniques ranging from careful control of soil nutrients and irrigation to installing large nets over orchards to protect peaches from hail. For example, growers work hard to identify and improve varietals that are well-suited for changing environmental conditions. Even for veteran growers, however, managing environmental factors to reduce loss can feel like more of an art than a science. One processing tomato grower explained, "So it can change from one day to the next. You can be in fields that are 100 percent red, and then the next day you go to another one that's a different variety and it's ready to harvest; but it might have five or 10 percent green, something like that. So it just depends. It depends on the variety, the weather, the soil, a whole bunch of different factors." As one fresh peach grower explained:

> *Sometimes there's no way to figure out why it [loss] happens and –we could see maybe 30 to 40 percent culls. And that changes by the hour. We're at eight percent culls. Now he's doing a hundred bins a line – 50 percent culls. Because I did something wrong. Not enough water. Or not enough shade canopy on the trees. They got sunburned…. If it's a really overcast, hazy, smoky day – something's in the air, and it's 105 degrees, and leaves stain and discoloration on the fruit. Go in there tomorrow and again, the weather is clear. Yeah, if anyone ever solves that problem, finds a way to fix it, they can retire immediately.*

Labor and loss

Many, though not all, growers talked about labor as a significant factor influencing loss. As one grower of leafy greens and tomatoes commented, "Labor is on the forefront right now, for sure. It's a bit of a moving target, but it's

the biggest issue we're going to face." In some cases, labor shortages had led growers to leave product in the field or delay harvesting. The grower above continued, "Because of limited labor resources, you're having to prioritize whatever is going to get you the best and maybe leave something behind." Another fresh tomato grower reported, "Right now a lot of people are short on help…And when you're short on people, your crops go, you can't harvest it, it's over mature. We had probably about 5 acres that just got too mature, too red. So we let that go. And if it keeps the same, we will…. I'm afraid it might happen later." Another fresh peach grower related, "In years past, there's been times when we couldn't pick it timely. Then we got a forty-acre block, and I only had enough people to pick 10 acres of it today, and it all needed to be picked." Other fresh peach growers also reported higher cull rates when "you're a day later than you'd want to be" with picking due to labor shortages and the fruit becomes overripe.

Growers also commented on how rising labor costs have shifted the cost-benefit analysis of what is worth harvesting, thus indirectly driving loss. One leafy greens grower described how they rely on H2A visa recipients, driving up input costs. As he reported, "Domestic labor around here, it's really tough. But I'd say for me, right now, I got my five crews. They're all H2A…We're not having issues as far as our products go, just because we have that secured labor. But the overhead for them is just outrageous." Some noted changing minimum wage and overtime laws are driving up labor costs, anticipating how a shift to a $15 hourly wage and a 40-hour a week limit would impact their ability to hire the labor needed to grow and harvest their crops. Others saw the problem as simply a lack of people available to do the job, commenting that they already paid above minimum wage. "Minimum wage is not the threat. It's the availability of a population of people who want to make money and are willing to work hard for it," one processing peach grower commented.

Various growers claimed that there is no domestic workforce willing to do agricultural work. Noting that the federal H2A program is viable only for larger-scale producers due to costs, one small-scale grower of tomatoes and greens commented, "But I guess I have a hard time understanding why we have to go that far to bring people into the country to allow them to work. I've tried to get white people out here to do fieldwork. It doesn't happen. I have tried so many times, and they don't last." Two growers suggested that social welfare programs in California were to blame, suggesting that the support they provided allowed people to turn away agricultural jobs. On the other hand, many observed a decline in the migrant labor pool. Various growers noted that the children of an aging migrant population were less likely than their parents to go into agriculture. One fresh peach grower commented:

> *So when it gets to $15 an hour and a 40-hour work week, everybody would say, "Well, you just hire more guys and keep everybody working a 40-hour work week." The problem is, there's no one to hire. There's no farmworker raising his son to be a farmworker. When he's farmworking, he's aspiring for his son to be a doctor, a lawyer, a professor…It's the American Dream in action. So we're not raising any more farmworkers….The food in America will always be picked with a foreign hand. It'll either be picked with a foreign hand in America or a foreign hand in a foreign country and brought in here. It's not going to be picked with guys who were born and raised here in America and went to college and decided to come back and be a farmworker.*

Various growers also noted how shifting immigration politics have reduced the supply of labor coming across the borders. A leafy greens grower observed:

> *Because let's face it, legal visas, you're going to have to wait five or six years, minimum, so forget about that. So if I am a Mexican potential immigrant, I would say, "Okay, how much risk would I take to find the greener grass on the other side, going through the territories of drug cartels, being kidnapped, or raped on the way, and for what?"…On top of that you have all the circumstance of the politics, where it's being portrayed as doing the wall. It's all coming and there is a fear of, I see of immigration and INS and all of that thing, that those guys are going to be caught and brought back. So basically, it's getting more and more difficult to go through the border and people stay home.*

One fresh peach grower commented, "We could be wiped out tomorrow if they went to E-Verify, probably, you know? I don't know for sure, but I would assume that most of those guys in the fields – I don't know if that's true. I'm not a forgery expert, but I have a feeling…." As one processing tomato farmer concluded, "We haven't come up with a farmworker program, and there is not more labor coming into California anymore…So it's harder and harder to get labor as less people want to work on the farm."

While most growers saw the overall availability of labor decreasing and costs rising, the situation varied from year to year, or throughout the year. One peach grower described an abundance of labor this year, attributing it to a labor migration from the Southeast, where weather had devastated the peach crop, a weak vegetable harvest due to drought, and a light California crop of peaches. Others noted how demand for labor can increase and supply can tighten at particular moments in the season, depending on which tasks need to get done on the farm and what other crops are coming to maturity. One processing peach grower commented, "So, we are still okay…we can get started and get about 2/3 of the way through [the harvest] and then when the grapes and almonds start the labor force diminishes a bit. And when the raisin trays start you might as well forget it. There's no way. Nobody's gonna come pick peaches for you. Everybody likes to pick raisin trays. So, the last 1/3 of the way you're kind of on edge to make sure you don't fall behind."

A couple of farmers related having no issues with labor, suggesting that growers experiencing labor scarcities might bear some responsibility. As one leafy greens grower commented:

> *I think everyone's scared of labor issues, but we, at least here, have not really faced a lot of labor issues…People whose crops go to waste due to labor – and this is just my opinion – I would ask what those people are paying… When you hear about a vegetable or fruit grower who lost stuff because of people who are trying to pay minimum wage or pay below market, and when there is a contraction in the labor market, obviously, those people are the last to get anybody. And they get the worst. But yeah, we have not faced too much. I mean, just typical – labor is never perfect. But we haven't been not harvesting because we can't get labor.*

An organic fresh tomatoes grower reinforced this sentiment: "It's about working conditions. And pay. That's what it's about. So if you have both of those things in alignment with what the employee needs, you'll have plenty of people."

In the face of what most growers perceived as a challenging labor situation, they have developed different strategies to ensure enough hands on the farm, such as relying on H2A programs (though smaller-scale growers noted this was not a viable option for them) or moving to piece rates to incentivize greater worker productivity. A couple growers also described efforts to improve systems for mechanical harvesting. As one leafy greens grower related:

> *We are working also a lot on automation…To get rid of the headache of people and bringing in machines. A lot of capital investment is being put into this industry, even venture capital actually, in the past five years to circumvent this issue of labor. So we are right into that because, amazingly enough, the Americans have dropped the ball and it's been easy for too long. We are turning actually to Europe to find some answers.*

Despite these efforts to innovate, many saw the labor situation as unsustainable over time and portended a shift away from fresh produce in California. A processing peach farmer commented, "If we can't find more labor, California ag will continue to go more nuts." One leafy greens grower concluded:

> *The big social dynamic that we have on that is the mindset in this country that we're going to take care of the quote-unquote 'Americans,' whereas if you are in California, you understand what a domestic worker is, which is*

> *actually someone who is here and may or may not be legal…To me, if America is going to be quote-unquote 'great again' or whatever else, we have to be competitive, because if or not, it's all going to go to Mexico. And that's happening.*

Lost but not wasted

Bellemare and coauthors have advocated for a definition of food waste that "remains agnostic about what constitutes a productive use of food, whether 'productive use' means that food is used for human consumption, as fertilizer, as animal feed, or as fuel," asserting, "As long as food does not end up in a landfill, it is not wasted" (Bellemare et al. 2017). Based on this definition, and on the perspectives of our interviewees, waste on farms is rare. As one leafy greens grower reported, "Effectively, I think we are a zero-landfill farm." Only when, after incurring the costs of harvesting and packing, growers were unable to sell or even donate food—meaning a series of miscalculations—would they dispose of it in a landfill. As one leafy greens grower commented, "Yes, it [sending food to a landfill] could happen, but very rarely. You realize that if you already packed something, for that product to hit the landfill, something really bad needs to happen. It would have to be a recall. I mean that would be typically the case and we have those so rarely." Another grower commented, "Maybe a grower who has nowhere to put something, packed a lot of bad stuff, maybe that's where they would take it…. Most of them, they just return it back to the field."

When growers choose to till unharvested produce back into the soil or divert it to animal feed, they may prevent more environmentally harmful food waste at later stages of the supply chain. Life cycle analysis demonstrates that landfilled food generates substantially greater greenhouse gas emissions than the food lost on farms (Gillman, Campbell, and Spang 2019). Therefore, farms may be the best place for food loss to occur.

Animal feed

Growers of all three crops reported diverting lost produce to animal feed. For leafy greens growers, this constituted a small portion of overall loss. As one grower explained, "So our spinach comes back washed and put into clamshells. And so any lost there goes to animal feed, but it's a really small portion." Another related that, when they were packaging lettuce in bulk rather than in cartons, they had pest problems causing bins to get rejected at the cooler, which they would then send to cattle feed. He estimated that 30 acres a year went to animal feed until they stopped using bins.

On the other end of the spectrum, fresh peach growers reported diverting a large portion of their culls to feed. As one grower explained,

> *These extra softs…they're too soft to put in a box. So those go to the cows. We just send them into a truck—they volume-fill trucks, and they haul them out and they dump them in these vats that they grind them up with straw, so they mix the juice of the peaches and the solids with the straw to make the straw real palatable for the cows… We run a lot of fruit. I send at least two to three semi-loads a day, 75 tons a day, to the cows.*

At one fresh peach packing house, all culls were sent through an underground flume to fill large dump trucks that were headed to dairies. One processing peach grower also related diverting culls to animal feed. Another, however, related problems due to the chemicals they apply that leave residues on peach skins (which are ordinarily removed during processing): "You know some people come by and say, 'Hey, can I have some of these for my pig?' But no. They've got spray on them…We spray for brown rot, we spray for worms, and we spray for blight and all that. So you don't want those to end up in animal feed."

Fresh tomato growers also reported sending culls to animal feed, including both chicken and cattle. One processing tomato farmer also related having sheep graze a field he had to walk by:

> *These guys who have sheep are always looking for a cheap place for their sheep. They'll go to a wheat field, and they'll graze that for the summer. So we keep in touch with them, and they keep in touch with us…One year, we put sheep out in the field to help the guys…. We put a fence up, they put the sheep in there. I went by the first day, the sheep are all standing around, not eating any tomatoes. Second day, same thing. Third day I came by, they all have lipstick on. They were eating tomatoes! They had to get hungry enough to eat them.*

As he noted, this was not a regular occurrence, but more of an impromptu arrangement.

What, and whether, growers are paid for culls diverted to animals depends on the price of other feed. Because the price of alfalfa is currently low and the cattle industry now also relies on other products, like almond hulls, growers do not make any revenue. As one fresh tomato grower explained:

> *Years ago, culls, when we had to get rid of it, sometimes people would take it…. But then the cattle industry would get a lot for the feed. For now, we have a contract with one guy with the fresh market tomato culls, and he will take it out, and he takes it to a dairy that purchases tomatoes for so much. We're lucky, we don't have to pay yet to get rid of it. We just give it to that one guy, and the dairy pays him. This year it's getting to be the opposite. Now it's even, but in the future, we may have to pay."*

Two fresh peach growers described having to pay to transport culls to dairies. One grower commented, "You have semis that the fruit is dumped into and then it's goes to the dairies, for free, free. In fact we have to pay it all. And the dairies just let us slop it off there and the cows eat our nectarines, and peaches, and plums." Another fresh peach farmer affirmed, "We have to pay to haul the culls to them [the dairy farmers] just to get rid of them. I have to pay the trucking now. Two years ago, they were paying the trucking and giving me $200 or $300 a load for the culls." One grower said that in some cases it was not worth it to drive culls all the way to the dairy, so they might just be left on the side of the road. "And then you drive through with pick up and then it slings peaches up underneath your truck and it smells like you're driving around in a big peach pie."

Leaving it in the field

Growers of all three crops reported that all produce left in the field, as well as some post-harvest fruit in the case of tomatoes or peaches, gets disked back into the soil or left to rot somewhere. Only one small-scale grower we interviewed did not engage in this practice. As he commented, "We don't leave anything in the field because we are constantly replanting. So it's not like we are doing processing tomatoes where, it's a big crop and then we leave whatever else is there to incorporate… Even if it's bad quality we'll pick it, remove it from the field and then we'll either compost it or feed it to the animals at that point."

In the case of processing tomatoes, anything kicked out by the processor gets tilled back under, and loads rejected from the cannery are dumped somewhere to decompose, often at the grower's property.

A number of growers noted that disked produce is not lost, but instead it "becomes part of the soil again." As one leafy greens grower put it, "So the question is, so what happens to this product that is left into the field. Well, it's organic matter, it goes back into the soil. So from a certain perspective, it's not wasted at all. It becomes expensive organic matter." One leafy greens grower said that this might impact fertilizer application:

> *Well it's good for the field because we are returning, essentially, all the nutrients or at least part of them down to the organic matter, and back to the soil. We do monitor that internally. We have a lab, a laboratory, and we are doing between each crop soil sampling, and we are monitoring nitrogen during the crop cycle. We typically, and then logically, probably have a very good resource on our soil sample for N, P, and K, if you were to incorporate destroyed crop.*

Most growers, however, were either unsure of the nutrient impact or said it would be immeasurably small. One processing tomato farmer explained, "See we do soil tests every year so we know exactly…. If you disk those tomatoes up, by the next year there's going to be acid and different things, but I don't think you're going to add nitrogen." A leafy greens grower commented:

> *It probably depends on the soil type. What the fertility profile was to grow that in the first place. I don't think we've ever said, hey that's a walk by, and therefore we are going to apply less fertilizer. But we will monitor it. So maybe we will apply less fertilizer, but we haven't measured it. But with a walk by, typically you'll harvest just a portion, so you wouldn't measure that.*

When asked whether a walk by field could impact fertilizer application, one processing tomato farmer replied:

> *We've never really measured that--I assume there are a few more nutrients that went it, but that would not be a deciding factor. It wouldn't be enough to help. And I don't think it would help much, because it's pulled the stuff out of the soil to grow the plant and to put into the tomatoes, So once they're pulled out, I don't think that converts to more nitrogen in the soil. I don't even think it would be measurable.*

One processing peach farmer, in describing the process by which they sample soil and adjust as they go, mentioned there was always slight variation based on what was tilled under, but summarized: "Put it this way—kind of like when you make a big pasta sauce, you look at it all of the time, you taste it, you monitor it, but the pasta sauce you make is very similar."

Various growers commented that the impact of disking under depends on the crop that is being tilled, often mentioning broccoli as an ideal cover crop that returns nutrients to the soil, as compared to the crops discussed here. One small-scale farmer of various crops commented:

> *It can go either way, depending on what you're tilling in. If you're tilling in something like lettuce, it really is no impact at all, because it's very little woody value, or, you know, there's very little substance to a lettuce plant. But something like broccoli, we can definitely see when we till it in that there is increase of microbial activity, in about a week or two after you till it in. And generally, that microbial activity is a good thing.*

A leafy greens grower also commented that disked lettuce does not improve soil quality, noting, "All it does is put organic matter back into the soil. It's a carbon source. It's not adding nitrogen." In contrast, he thought that cabbage, which has a greater biomass, "will put a good carbon deposit." Pointing to a harvested field of Napa cabbage ready to be disked under, he explained, "There's a little bit of micronutrients and macronutrients in this. The roots go deeper with these…. Whatever they pull out and it's in the plant, it will be put back into the ground."

A few growers of tomatoes and peaches reported a negative impact on soil quality. One fresh tomato grower noted that walk-bys tend to occur in the case of a bumper crop, so disking a field tends to correspond with needing to apply more rather than less fertilizer. As he explained:

> *Sometimes you get a real heavy crop, but sometimes it depletes it more, so you have to replace it.*

> *Interviewer: So you actually use more fertilizer if you have a big crop that you have to disk under?*
>
> *Grower: Oh yeah. Because, for example, if you eat a normal meal you are fine. But if you are bigger, you have to eat more. Same thing for a plant. When you get a bigger plant, it requires more fertilizer, so you have to replace that for a following year.*

Both peach and tomato growers noted that tilling or leaving culls to decompose can cause problems from excess moisture. As one processing tomato farmer noted:

> *It's actually bad, because, on that spot, because you're just dumping this huge, massive load of water, in a way. And so then you have a really muddy spot there in the field. And doing tillage on mud is not good. If you take a piece of mud like this and smash it, it's going to be a brick when it dries…. You're damaging your field.*

A fresh peach grower explained:

> *There's a little bit of fiber there, but most what you see on the peach is going to be moisture. And we try to keep it out of any fields that have active trees in it just because it could be taken a population of fungus or so back out there. So you don't want to do that. So we typically find open fields where we are in transition, where we are transitioning fields from one orchard to another orchard… and we'll usually put them out there, and then we'll pulverize them.*

One leafy greens grower also commented that the method of tilling influences the potential for disease, explaining that chopping greens with a rototiller-type machine reduces the potential for bacterial growth.

While many growers noted that lost produce effectively reintegrates into the ecosystem, only one small-scale grower reported composting as a specific goal. As he noted: "At the base of what we're trying to do, it's really not about eliminating food waste diverted from the landfill, it's about capturing all of that organic matter that you're producing, and as much as possible reintegrate them into the soil base to improve the organic matter content of the soil." At this point, he noted they were "making compost piles that are fairly static"—what he called "half-ass composting"—but his ultimate goal is to "take it to a level where we're really trying to make compost that could be then reapplied to our production crops." However, he noted that this would require complying with relatively strenuous food safety regulations; he said, "We would have to do a lot more monitoring, quality control and all that kind of stuff."

Recovery opportunities

Almost all growers reported efforts to recover crops that do not make it to primary markets for human consumption, though in most cases recovered food constitutes a small percentage of overall loss. Recovery opportunities fit broadly into two categories: growers may donate product to the emergency food system, or they may pursue side markets for otherwise lost product. Each of these is described below before considering the broader factors that determine whether each of these recovery opportunities are feasible or desirable for farmers.

Donations

Most growers reported at some point donating produce to food banks or other institutions within the emergency food system. The quantity of product varied greatly by crop as well as by grower. On one side of the spectrum, one fresh peach grower reported donating multiple truckloads of peaches each year: "It could've been a quarter million pounds

or so, five or six truckloads of fruit donated to food banks." Another organic grower reported that of his cherry tomato culls, 75% went to food banks. On the other end of the spectrum, a leafy greens grower reported donating very little annually. As he reported, "Maybe five to 10 pallets, which would be two-to-four hundred cases. Two dozen heads per case. That's nothing."

Food donations of otherwise lost food occurred in one of two ways. First, some growers of peaches and tomatoes donate post-harvest food that they specifically pack for food banks. Second, growers donate produce that has already been packed but is rejected from primary markets, or for which they are unable to find a paying market. One leafy greens grower related donating when "it's a local rejection and it comes back to our cooler and we don't think we can ship it out because of age." He summarized, "Leafy green-wise, we're looking at [donations of] rejected product and out-of-rotation product." Similarly, a fresh peach grower commented, "Typically we don't donate culls to food banks… [unless] we have product that doesn't move timely or start[s] to become too old for our cooler." An organic fresh tomato grower described their system of diverting rejected food:

> *Usually the stuff that gets donated is stuff that gets rejected by the buyer. We send it to [the buyer] and they say, no, it's too ripe; by the time we send it out to our stores, it would be rotting, and it would be broken down; we'll just say, okay, boom, send it to – donate it. We've got those wheels pretty well greased. They're like, either you want it back to dump in your field, or we can donate it to a soup kitchen, or we can donate it to a homeless shelter or rehabilitation or prison, whatever. I know our sales team will negotiate with that buyer.*

Smaller-scale growers also reported donating products they are unable to sell at farmers' markets at the end of the day. As one grower commented, "The Lions' Club. They come by and throw like two big banana boxes that are left over and sat in the sun all day and just put it in there. They don't balk at anything. They just take whatever." Growers who donate unsold produce at farmers' markets appreciated the convenience of donation and that it relieves them of the responsibility for transporting the food to another location. As one leafy greens grower explained:

> *You have organizations come, usually that are associated with a food bank of some sort, and they'll come, and they'll take whatever's left at the end of the day that was on your table. Okay? And as farmers, we're happy. We don't have to pack it up and take it home with us, so we're pretty happy to let them have that stuff.*

Gleaning

In interviews, we specifically asked growers about gleaning as a means of recovering lost produce. Many growers reflected negative perceptions or experiences of gleaning. Some noted that volunteer labor is not reliable or resilient enough for harvesting. For example, one leafy greens grower commented, "So it sounds great, but to make it effective, you need a steady supply of people who aren't going to get hot and sweaty and run to their cars every two hours." A fresh tomato grower affirmed, "The trouble is when people start getting out there, they start up in the morning and they're excited and stuff. Then one hour into it they go, 'Man I don't want to do this anymore.'" Two other fresh tomato growers also noted that certain skills are required for picking. As one commented, "Our people [pickers] know what to pick. They [the gleaners] don't know what to pick. They would just come and start hauling stuff out. Half of them might be rotten. It's better that we do it."

Many growers are also wary of legal issues they might face with gleaning. Growers of all crops related avoiding gleaning due to potential liability in the case that someone gets hurt on their property. "Someone falls and then, you know you're done," said one fresh peach farmer. "It's very risky—we're in a very risky business and we like to do risk adverse when we can." A processing tomato grower commented, "You've got liability. You've got people in your fields who don't know what's going on. It can turn into a problem." One leafy greens grower noted the potential educational benefit of gleaning but felt that it ultimately was not worth the risk:

> *You like to have people understand where their food comes from, but you'd be better off having a tour or something, because by the time you do all that [to host gleaners] and then you've taken that risk of one of them getting hurt when they go out to your ranch. Because they don't drive around on those roads, and you've got spraying going on and everything else. It's a nice education, but I'd almost want them contained in a bus somewhere.*

Leafy greens growers in particular also mentioned potential problems with food safety regulations if they allow gleaning. As one said, "And now what do you do with the bathroom, right? If there is a county inspection and those people come with no bathrooms in we get into trouble." Another leafy greens grower explained:

> *You know, you're not going to train everybody out there that goes in and gleans for all your food safety. They're going to show up and they're going to have jewelry on, and who knows if they put on gloves and everything else. By the time you go through all that, it's like, 'We'll just do it for you.' And that's the way a lot of things are these days. It's nice to have people that want to donate time, but maybe you're better off going out and working somewhere and then using the money to pay these guys [hired pickers], you know?*

Leafy greens growers also noted that the narrow window for gleaning a highly perishable product often makes it impractical, particularly given volunteers' scheduling preferences. As one grower commented, "They [gleaners] want to do it on the weekends, and so there goes your three-day harvest window." Another smaller grower related that when gleaners called to clean a field, he replied, "Well basically you have like a ten-minute window. You need to come out today. You can't wait until Saturday to come…Come get everything out and we can [disc] it so we can get it ready for the next crop."

One grower with a separate CSA program attached to the larger farm regularly invites gleaners to harvest from the smaller CSA plot and reported positively on the experience. She estimated that gleaners collect about 10 percent of the CSA crop. Two fresh peach farmers also reported worked with gleaners, though in this case volunteers sort through the culls. One grower described this experience:

> *It's pretty cool, it's just a bunch of retired people and there's this place, I've seen it in the foothills over here and they all come and they live in these dorms. And the gleaners will come around and you'll say, 'Hey, you know we've got five acres of blah, blah, blah,' and they'll come in and they'll harvest it. And I think they dry it.*
>
> *Interviewer: And do they actually harvest it?*
>
> *Grower: Well no, we don't want them traipsing around in 106 degrees up on ladders. No, they'll be at the cull shoot and they'll just be picking up stuff out of the culls.*

A couple of larger-scaled growers who were open to working with gleaners noted that the portion of crop recovered is minimal, however. One leafy greens grower commented, "Does it [gleaning] work? Well it does work, but it's really a drop in the bucket to what might be potentially available at times." Or as one fresh peach grower put it, "It's not even a Band-aid."

Financial and Social Dimensions of Donation

While growers generally described the product that they gave to the emergency food system as donations, some also pursued donations to avoid the cost of disposal. As one fresh peach grower explained, "Yeah, and sometimes the food bank is -- It's an opportunity to not have to deal with the fruit. I would have to spend labor to dump it out and

dispose of it. So, the food bank becomes an economic decision to vacate it out in the cheapest way possible." In some cases, growers are able to recuperate some of their costs through the minimal sum that food banks sometimes pay for recovered produce. In the case of rejected or surplus food, food banks might become something of a market of last resort.

While many growers appreciate the payments from food banks as an opportunity to avoid even greater financial losses, a couple growers resisted the idea of being paid for food donations. One small scale grower commented, "No, I don't want the food bank to pay me for product…. that's not the idea. They don't have that kind of money--I mean, not if they're trying to provide meals for people who need them. So, no, I don't think we're asking the food bank to pay for anything." Another leafy greens grower explained how knowing that food banks purchased product impacted how he felt about his personal donations:

> *Growers are companies - and then there's individuals. You know, like I may donate money individually, because I have my own beliefs. But again, if I know that the food bank that I'm supporting is buying from my business, even if it's good from the business standpoint, it kind of makes me, as an individual, feel put out.*

Some growers give to food banks not as a means of recuperating costs or preventing food loss, but rather as part of a social mission, even growing additional crops specifically for donation. One fresh tomato grower explained, "They [food banks] actually have people who are growing stuff for them, just specifically for that. So there is a lot of product." A processing tomato grower explained:

> *We have donated, but we've just gone and picked good tomatoes. Once again, it's not worth trying to pick up a few tomatoes here and there. Because one out of every five is going to be a good tomato and the other one's going to be broken already, or smashed, or something. And so, I go out there with a couple of my workers, with some boxes, before harvest, and we pick tomatoes and donate it.*

Another processing tomato grower related leaving a row of handpick tomatoes at the end of each row specifically for food bank donation, which the harvester passes by. Clearly separating the goal of food loss prevention from the social goal of food provision for underserved populations, one grower noted that it was far more efficient to offer perfect produce, or even just write a check to a food bank, rather than gleaning.

Tax Incentives for Donation

In the United States, federal tax deductions are available for businesses that donate food. Some states, including California, also offer additional state-level tax incentives for food donation. California offers tax credits to businesses donating fresh produce to food banks (10% of inventory costs), plus additional tax credits to help cover the cost of transporting food for donation (50% of transportation costs) (ReFED 2019). However, the growers in our study rarely reported taking advantage of the available tax incentives for donation. Some believed that taking the credit would be considered "double dipping," as they were already deducting the cost of production from their taxes. As one small grower explained, "Everybody thinks these tax credits are a great thing. If we submitted a tax credit from the food bank, the IRS would require us to go back and take off the production cost that was involved in that product that we are donating. So, we don't touch it." Another said:

> *They [the food bank] will take anything. But they're like, "Oh, do you want a receipt?" I go, "No." "Well, don't you want a tax deduction?" And I go, "No, because my tax guy said you can only deduct your cost of production, and he said, 'And God help you if you get audited and you have to determine what the cost of the production was on the eggplant, you know?"*

A large-scale leafy greens grower stated that they did not take a tax credit "because, at that point, if we're not going to harvest it, the market value is zero." As he put it, "Even though there is cost in it, how do you get a credit for that, if the value of the product is really nothing?" Another leafy greens grower speculated that the decision to pursue tax credits might depend on the cost of the produce, noting that peaches as a higher value good might merit documenting. Finally, one processing tomato farmer explained that it simply was not worth the administrative work: "I'm not doing it for the tax deduction, you know? I don't need to have more paperwork that's going to give me a $100 deduction, and I have to follow paperwork all the way through. Oftentimes it's not even worth it."

A handful of growers of each of the products in our study said that they do take a tax credit for donations; however, it does not actually cover the full costs of recovery. One fresh peach farmer said, "I don't think it covers the cost of doing it. But there is some tax help— You're happy to get it back." Another organic fresh tomato grower elaborated, "The tax deductions just don't really amount to much. They don't give us enough protection. It would be nice if we were to get compensated for our harvest and packaging costs. That's not why we do it. It would be nice, but that's not the reason for doing it." A processing tomato grower noted that the recent change in California legislation now allows him to take a tax credit without the "double-dipping" concern.

Side markets

Retail Markets

Some growers sought to sell produce that would otherwise be lost in secondary markets. Distinct from packing a number-two label or grade, as discussed in the earlier sections, growers also sought out more niche markets for "off-grade" produce. One fresh peach grower related, "Now, there has been the rise of lower-income stores, and that's helped with hail damage and some scar. There's a push out through the industry at all the store levels about selling the secondary fruit at a cheaper price to these different guys." A leafy greens grower noted that, since their main customers would not take smaller sized lettuce heads, "we're trying to find some lower end retail customer, more discount marts that can accommodate that size." Another leafy greens grower commented, "There's always someone wanting to get a deal. There's so many outlets out there. You've just got to find them as a seller. And everybody's like – they're in all different markets so we don't have their niche, you know."

Two organic growers also mentioned the "ugly produce" movement as a possible, albeit small, outlet for imperfects. Both noted that these intentional marketing efforts seemed to be on the rise. As one noted, "The ugly produce movement has always been around, kind of ebbed and flowed, but there's a real, with this new generation, there's been a real effort. It seems to be sticking." She reported, however, that these markets account for "very little" of their sales.

Although some smaller-scale growers identified farmers' markets as their primary markets, one larger-scale fresh peach grower cited it as a place to offload culls: "We spill more than they can sell at a farmers' market. But some of the guys [other peach growers]; they do all right, they'll probably sell a load a week at a farmers' market or something."

Some growers also report distributing produce through more informal markets, not as a regular venture but rather as a response to more spontaneous opportunities. One leafy greens grower, who only grows under contract, explained, "Sometimes there will be a little bit of surplus [after contracts are met]. Then our harvest manager figures out what to do with it. It's really informal—it's kind of a network, with buddies he has on speed dial." A fresh peach grower related selling their third-grade product to "peddlers on the street," or "guys that just like come in and buy a pound or two to sell it." As he observed, "A lot of people will just chill out on the side of the street and they'll sell fruit." He estimated about 10 percent of culls are sold by peddlers, "Because that's just a way for them to make their living, you know."

Two growers reported seeking alternative markets with schools, hospitals and other institutions. In both cases, however, these opportunities proved short-lived or unviable due to cost and regulatory restraints. As one small scale grower explained:

> *I've gone around and around with foodservice people, and the schools, and they said, we're happy to buy your stuff, but you have to have consistency. You have to be able to supply us 52 weeks out of the year. You have to have it prepared, cleaned, ready to go, so that our food servers can take it out of a bag, pour it out, for the kids to take. And we want it competitively priced. And I said I can't do any of that. So, there we are, at the same stalemate as they've been talking for years, you know. The schools want local produce, but they're not willing to go the extra mile for it. We want to sell to the institutions, but we're not willing to go the extra mile to make it work. What can you say?*

Another organic fresh tomato grower who had reached out to school districts and hospitals, noting that "they can take a number two product, because they're preparing it," reported, "We've had lots of dialogs. They've never gone anywhere, because they're under so many restrictions." He elaborated:

> *I think the biggest drawback there is just the logistics. School districts cannot go pick it up. They've got this list of specification requirements that is outrageous. We kind of beat our head against the wall for a lot of years with trying to make that work, but it seems like the bureaucracy is immersed in regulations, and it's hard to get your foot in the door with anything different. Also, hospitals and school districts and those kinds of – public park services – they probably pay the least amount of money for their food. They've got really tight budgets.*

Processing

Fresh peach and tomato growers also sought out various processing opportunities. While green tomatoes are a high percentage of processing tomato culls, one grower explained that they were necessary for particular products because some varietals of tomato are actually grown specifically to be green: "They're all green, and they pick them and grind them up; and that's what they make some of these green salsas out of." In the case of fresh peaches, processing markets in some instances can absorb a high volume of culls. A fresh peach grower reported selling 30 percent of his culls for juice and another 10 percent for drying. A processing peach grower also described diverting culls to juice: "Sometimes the canning association will have a juice program, and they'll take the small fruit. Or if you want to go back and clean it, clean your field out, they'll take that and that's based on tonnages." Two fresh peach growers described a former USDA program that bought frozen culls for schools. As one recalled, "The best secondary market that has actually paid something to the growers has been the frozen market. Where that's been a hit is where the government has put frozen peaches into school lunch programs." As elaborated in greater detail below, however, these processing markets can easily become saturated with excess product.

One leafy greens grower also discussed the possibility of selling to processing markets imperfect lettuce passed over in harvesting heads, but he noted that safety regulations for processing make it unfeasible:

> *And I always thought, well, what if you had your crew with your cartons go through first and everything left behind you throw in a bulk bin to go to processing. The issue there is most processing plants require that you get testing done, E. coli tests, different bacteria tests and stuff like that. And that goes by acres, and it's really expensive. So –You can't harvest a field in cartons before a field in bulk, because if you were to harvest a field in cartons and then they go ahead and test it after for bulk, and they discover an acre or two is contaminated, all those cartons that you harvested beforehand are now red-flagged, and they could be on the road, the*

> *customer's already paid for it, you already shipped it. And everything has to be thrown away, so it just is expensive.*

Processing options for smaller-scale farmers differ. One grower said that scale prevents them from pursuing processing options. As she reported, "[Processors] need like 40 thousand pounds in order for their economics to make sense to process an item. So a lot of times we're left out of that stream for moving our seconds because of scale quantity." Two growers related pursuing their own small-scale processing options. One farmer was drying his own peaches, selling them at the farm stand, and had ambitions to expand:

> *We would really like to do more value add opportunities on the farm….If we had a certified kitchen we would do more jams, and jellies, and dried stuff, and probably even some things like salsa and things of that nature. Where I feel we have cosmetically damaged fruit or slightly older fruit or tomatoes in this case, it doesn't matter you know.*

An organic tomato farmer related a similar strategy:

> *A year or two ago, we started making our own sauces, tomato sauce. Then we also started making our own little heirloom tomato chips, basically thinly sliced and then dehydrated. So we make a marinara sauce, and then we make a Bloody Mary mix. So we started making our own proprietary products that we then market and sell. They're really wonderful.*

Growers also reported that some entrepreneurs had reached out to them to pursue new niche processing options with imperfects, for example making juice from romaine leaves or making a peach vodka.

Determinants of recovery

In conversations with growers, three key factors emerged that shape whether they are able or inclined to recover otherwise lost food. These include: (1) fluctuating demand for rejected or surplus product, (2) the relative cost of recovery as compared to compensation, and (3) the logistics of the recovery process. As one leafy greens grower summarized:

> *You need someone to cover that variable cost, or why else would you capture it [surplus or imperfects] in the first place? But the other point is that there is a channel of commerce that it can go into. So you need an organization that wants that product, that will pay for the marginal cost of harvest and then have the logistics to handle it. To get it to whoever the end users are going be.*

Recovery is also determined by the kinds of relationships and communication networks that growers have established. As discussed in the final section of the report, growers' decisions are also shaped by their general orientation toward the issue of food loss and recovery and the networks they are embedded in.

Demand

Growers often noted that donation or side market options are limited by demand. As one organic tomato grower commented, "The only one [side market] for some tomatoes would be juicers or dehydrators or something like that. But I think that market is already saturated by other growers who probably can't move their tomatoes. They're trying to find secondary markets." Particularly for peaches, growers found it difficult to find a market, paying or otherwise, that can absorb massive volumes of culls. When asked what determined what percentage of culls he could

distribute each year, one peach grower responded, "The industry inventory, carried over from previous years." He elaborated:

> *The frozen industry takes two years to build up an inventory they didn't need much this year. The juice processors, the puree processors the same." Another explained that freezers will take off-grade product, but that "they have a glut this year from last year's long peach market. The baby food plants, Smucker's is a buyer at times for jams. There's some juice plants that'll buy it. It just depends.*

Another processing peach grower commented that while he used to be able to sell culls for juicing, the demand is now fully met by growers in another region of California: "I would say it's been over 5-8 years since I've done any juice. And all the small stuff with defects, the graders take it out now and just throw it on the ground." One fresh peach grower felt that there simply was not enough demand overall for the number of peaches being grown. "If you were able to just pack every single box that you had, I don't know that the market could bear it."

Processing tomato growers also noted varying demand for green tomatoes at canneries, which constitute high volumes of lost produce. This demand varied depending on what other growers were sending them -- as one grower noted, if a cannery is getting lots of reds from one grower, it can absorb more greens from another – but also by whether canneries are making peeled tomatoes or paste, which includes more greens. One processing tomato grower explained:

> *We've thought, how can we do this on the harvester when you capture those greens? But it's one thing to capture them—what do you do with them after that? [One particular] processor – they take the greens and the reds. Everything goes in the bin. They utilize it all—when you go to their fields, there's hardly anything left on the ground…Where [another processor] has to isolate everything and separate the green from red. It's just too much of a hassle. There's no value to them to do that… There are a lot of smart people out there trying to figure this whole thing out and see – find different ways to add value. But no one's been able to figure that one out at the peeled plant. They don't want them.*

Leafy greens growers also commented on the limited market for left-behind product. As one grower noted, while plenty of edible leaves may be left behind, the primary problem is no demand for them: "There is certainly plenty of material that comes off the head itself that is good. So it's a matter of figuring out how to capture it. But then of course, the economics comes into play. What do you do with the material? Is there a market for it or a home for it?"

Various growers also commented that food banks can only take so much of a particular product at any given time, particularly during peak season. As one processing tomato grower commented, "The problem with that is, they're getting tomatoes from everybody. They're getting tomatoes from the organic guys. They're getting tomatoes from anybody that has tomatoes – the mom and pop in the backyard…So they're all bringing them to the food bank." Two peach growers related that the volumes of fruit that they might offer during harvesting season could overwhelm a food bank. "But you know the food bank can only take so much, too, you know we could kill them. Their little refrigerator couldn't hold as much as we could send." A processing peach grower described a scenario where this happened:

> *It was a year we had an area where the fruit was small and we didn't want to send the labor in there. So we picked that one…. I want to say it was like 8-10 bins with a machine, and we hauled it over to the local food bank. And they were really happy, but the thing is that they don't have the capacity…. I mean, this fruit when it's picked has to be put in cold storage or refrigerator, and they didn't have the capacity to save it.*

A fresh tomato grower noted that he donates tomatoes when he has excess, but only "when the food banks can actually accommodate them and move them through their system." He explained, "Some of them are limited by refrigeration or days of the week. They can only receive certain days of the week. A lot of them don't distribute on weekends. So, they don't want to pick up a bunch on Friday and then have to hold them through the weekend." One leafy greens grower noted that his donations were limited in part by the fact that food banks do not want more romaine. As he related:

> *The food bank never asks for [romaine lettuce]. There isn't really a lot of marginal places that you can send it because the food bank doesn't really want it. It doesn't have a tremendous amount of nutritional value. Romaine isn't seen as something that they need a lot of at this point, and they're just getting a lot of it thrown at them from salad plants.*

A few growers noted that improving storage and distribution systems for food banks has stabilized demand over time and geographic location. Expanding such systems, however, clearly requires greater investment of resources.

Costs

Even when there is a potential home for otherwise lost produce, someone needs to cover the costs of recovery. While many growers reported absorbing the variable costs of harvesting, packing, and transportation associated with donating imperfect produce, many also noted that scaling up and creating more sustainable recovery systems over the long run will require others to help cover these costs.

For leafy greens and fresh tomatoes, much of the additional cost of recovery is in the harvesting. As one fresh tomato grower explained, "The problem with donating them is that most of the work is in picking them. It cost so much money to pick them." A leafy greens grower noted how these costs increase toward the end of a shift or field:

> *Cost-wise it's not sustainable for us to always be doing that [donating to food banks]…. Harvesting is our most expensive cost in the company. Our crew is on piece rates, so they – I'm not sure of the exact amount but it's probably around $2 and 30, 40, 50 cents a carton. So that's just a direct cost my harvesting company charges me. And then each pack, if it takes a little longer, it's a little increased, you know, and so they're getting about a dollar, the harvester itself is getting about a dollar 50 per carton.*

Another greens grower concurred that having workers extend their hours to pick and pack for donation was impractical: "This kind of cost, we never have the luxury to expand his initial hour or his Saturdays, as harvesting product just for the food banks. This, it will never happen."

Two growers noted that even if the harvesting costs could be covered, another problem would be the overall supply of labor. As one processing tomato grower said, "Even if you raise funds [to cover the labor], we can't even get labor hardly to pick the crops we need to pick…. People are losing crops yearly, because they can't bring in enough labor. Crops that are marginal, they pickers don't want to go there." Another leafy greens grower expected that rising costs of labor would impact his ability to donate in the future. He commented:

> *Wages have already gone up a lot, but we all know that the minimum wage in California is going to go from $10 to $15 an hour…What's that going to look like as far as getting that product out of the field?…Trying to do stuff with food banks at $.10 a pound or whatever they basically stick on that, that's not going to work, potentially, in another four or five years.*

Offering an alternative perspective, two large-scale leafy greens growers suggested that the harvesting costs and extra hours might be manageable if they are well-coordinated with the regular picking schedule. For example, one grower said:

> *Sure, labor is tight and can be scarce. But I think you're going to have to change the psychology of it a little bit. It's not about having enough labor to go out there and pick seconds. Maybe they can't get their crews to pick seconds. But in the case of our concurrent harvest, it's just another pack style to the crews. They're going through the fields anyway…. Now, does that slow them down, or does it keep them from covering as much acres as they need to? We don't think so.*

As discussed in the section on logistics, this grower also felt that there might be a limit to concurrent harvesting with particular leafy greens. Another greens grower also commented that the marginal cost of spending an extra forty-five minutes harvesting a potential walk-by field for a food bank might be minimal, particularly given his interest in keeping crews busy during low market periods, but this requires planning. He described a scenario where recovering surplus product might have been viable:

> *So, we walked over this piece, and what I should have done, and what I guess we'll do in the future, is I should have just harvested it. Because we could have moved a crew at the end of the day, and could have cut and dumped them directly into the bins at the food bank. And they could have mowed through this two-acre patch in a matter of probably 45 minutes. And the cost to us would have been minimal, but what the food bank has told us is like, they'll even comp that labor cost if it's a big deal.*

Sorting and packing costs also factor into recovery efforts. While most fresh peaches are taken in from the orchard, and thus harvesting is a sunk cost, the additional costs of packing for food banks or other outlets impacts the amount that growers can recover. One fresh peach farmer explained, "Now that there is a tax write-off, the difference between me putting the fruit in a box to get it to somebody to eat or sending it to the cows, the only cost differences the cost of the box, which is about a $1.25 for 25 pounds of fruit, and the pallet it sits on, and my man to put it on the pallet." A processing tomato grower explained that, while rejected loads might contain mostly perfect fruit, sorting costs have ultimately made salvaging this fruit an unviable business strategy. As he recalled, "There used to be a place you could send the load to a resorting facility, where they did dump it and go through it, and then put it back in the load. But it was very, very expensive. You only get half your tomatoes back. You really didn't make any money on the deal. I don't think they're even open anymore." Transportation costs also influence the amount that growers are able to donate, particularly as local markets get saturated and product needs to be distributed further away. As one fresh peach grower explained:

> *So now they are networking and distributing that fruit all of the place. The hardest part is, it costs $8,000 to send a truck east, and on a truck, there's probably 2,600 boxes of fruit. So there's 25 tons of fruit, basically, and so you've got $8,000, and nobody wants to absorb that on the byproduct market." Another fresh peach grower reinforced this point. "I think logistics are—you know and freight's extremely expensive. I mean it's crazy. I think you could probably gear up for more if you could just turn the faucet on for the logistical part half of that.*

In evaluating processing as a recovery opportunity, a fresh peach grower described how the relative cost to revenue limits this option:

> *We've been trying to answer this question for decades looking for a viable secondary market for peaches, nectarines, or plums. And we spent a lot of money. We put a lot of research money into developing an all-natural fruit blend juice that we could market to see if we could find a viable juicing company and create some sort of secondary market. That was in the 2000s, and you had quite a big trend towards new juices. Even then, by the*

> *time you were done, the economy had said that there was not enough money left over to factor all the work that was done for the grower in order to be competitive in the marketplace. …There's so much cost involved. You're not going to turn dollars back to the ranch. You're going to basically trade the dollars to do it.*

Another fresh peach grower also described frustrated attempts to discover cost-effective processing options for culls—what he called "the holy grail." As he related, "We've also had like little people that have inquired about—'Oh, you know what about using the pits for cosmetics, and like pumice, like a rub or whatever.' And we go, 'How many million do you want? 'And it, yeah it just—nothing's ever—nothing has ever worked out."

Logistics

Growers also commented on the way that both on- and off-farm logistics impact their ability to recover produce. First, where and how crops are sorted shapes recovery options. Two leafy greens growers noted that the fact that produce is sorted in the field can make diverting imperfects difficult. As one related, "We don't really have a sort-out place. At least in the field…. So, if it doesn't meet that minimum criterion, it just gets left behind and there's not enough left behind in a field to really justify going in there. The way the set-up is, you just have one box." One leafy greens grower suggested that the harvesting system could be modified for concurrent harvesting in the case of heads: "Sure you could pick those heads just the same way that we're doing broccoli or cauliflower. You would just do a special container. How pretty you would want to make it or pack it up would depend on what you want to do with it. And there are heads that are left because they are too small, or misshapen, or not dense enough." He was less optimistic about the potential for recovering discarded leaves, such as those left behind after harvesting romaine hearts, but he admitted that it might be possible: "There is probably a way to do that [capture lost leaves]. You might have to redesign the harvester a little bit so that when they trim the lettuce, they are doing that over a basket or a RPC, something to catch it. I don't know, you'd have to go through a bunch of trial and error."

Processing tomato farmers also noted that the sorting process during mechanical harvesting will prevent recovery without some reengineering of the harvesting machine. When asked if there might be a way to salvage greens, one grower responded, "It's not an option to keep the greens. Because there is only one elevator that can take tomatoes. It shakes all of the tomatoes off. You can only process one thing at a time." Another grower commented that even a slight modification to the current harvesting system could impact his productivity to the extent of making it unviable:

> *We can harvest loads of tomatoes in 15 minutes. If I had to have something alongside there that was capturing the green ones; and it took me, instead of 15 minutes, 20 minutes to pick a load; I don't think it would be worth doing it. Plus you'd have more machinery running alongside the harvester, which adds to worker safety and lots of issues like that.*

In the case of fresh peaches, recovery depends in part on the way that the pack line is organized. For example, one grower explained that potential uses for culls were determined in part by what point in the packing stage the sticker was put on the fruit: "Like you'd say, 'Well why don't you send the culls to processing?' But we can't because they have stickers on them. You'll be having a smoothie at Java Juice and there'll be a sticker, which has happened. And just little nuances like that, that just screw everything up." Another grower commented that while one of their packing houses has a separate cull line for a market-quality product, the one we visited was not set up that way. As he explained, "We don't have room for another sorter, where people to do sorting in bins. Just for me to look at a safety point, another forklift moving another pallet is a liability we can't really incur at this point, because of the footprint here. So that's something that we hope to fix in the future, but it's not worth it right now." One peach packing house we visited only has one location for culls—a water flume that dumps culls into large dump trucks—making re-sorting an impossibility.

Off-farm logistics also influence recovery potential. One organic tomato grower described how an entrepreneur contacted him about the possibility of purchasing culls to make sriracha. He related, "So she's cramming sriracha in different products. She was using tomatoes, so she wanted to buy cheaper tomatoes; so she wanted to do organic heirloom tomato salsa, stuff like that. So it didn't matter how it looked or what size it was." In the end, however, they were unable to strike a deal: "We could never quite work it out. We couldn't work out the delivery, the logistics and the sale. I'm pretty busy, and I didn't have too long to work on it."

Many growers commented on efforts to work with food banks and other institutions to overcome the logistical challenges of packing and transportation. One fresh tomato grower related his experience of donating to a local food pantry: "My half-sister brought a bunch of the plastic containers, and then we would get the ones [tomatoes] that didn't quite make it. And we were putting them in other boxes and we said, 'Can you just come here and pick them up?' It was hard just to get someone to come pick them up. I would take them over there." He ultimately concluded that the logistics made it impractical. "It took me like two hours of time. You can't be doing that." A processing peach grower also described hauling culls to a local food pantry, noting, "They don't have any way of coming out to the field and picking stuff up." When asked if he would donate more if they could, he replied, "Yeah, I would be totally for that. If they had the facilities. Or if it was not a big job for me. I would even put it in bins and bring it out so they would just have to take it from our station to cold storage, and they can disperse it from there." One leafy greens grower described how he has worked with a local food bank to improve the process:

> *Yeah, I worked on the logistics. For instance, I sold the food bank a bunch of totes. I told them, "This the way to do this. Don't do this in cartons." So we got the food bank totes….Then we worked a deal with the cooler, where they donated the cooling, because I'm a partner in a cooler...It stays there for the week, and then they can efficiently send a six-pallet truck over, pick it up, and then they don't get inundated with, "Here comes two loads of product." So you have a feed, and they know what's coming, and they can do it in a system.*

Approaching these logistics from the other side of the exchange, one fresh peach grower, who reported having been able to sell or donate virtually all of his culls that year, also noted how his ability to create a well-run and predictable system for juicers was what allowed him to distribute his fruit:

> *When they [the juicing company] take the culls away from us, it simplifies their life if they have a minimum stop time. They go where they're going to get good service. Timely. And where there's enough volume to load their trucks. They don't want to be running around. Through the years, we've been able to adapt. We know in advance when he needs it. And when he shows up, boom, boom. So, it's not just the fruit they're coming for, they're also coming for the service…So, other growers might have the same culls, but they don't have the same service.*

Finally, timing and volume create challenges for recovery. The tempo of harvesting can be so frantic that it is difficult to make adjustments to capture lost product. As one fresh peach grower said, "We operate like a house on fire during the season. It's pretty crazy. So anything complicated with [recovery], I mean it's just not manageable." Another fresh tomato grower commented on the discrepancies between the local food pantries' rhythm and his own schedule of production. He said, "It was more trouble than it was worth to donate. Because the way we do things we have to do things on time and everything. A lot of times these guys [at the food pantry] may not be like that." Two growers also noted that recovery efforts can struggle to manage the sheer volume of product they have available. One explained, "It's got to be a smooth, functional, reliable system…. And they have to have a system where they can handle a lot, because I think to really make it work, you're going to get some huge volumes." Another fresh peach grower reinforced, "It's got to be in mass, it's got to be broad."

Various growers noted that the volume of crops available for recovery at any given time is hard to predict, an additional challenge. As one fresh peach grower commented, "But trying to project out how many culls you're going to have is really tough. And the perishability of our products is pretty high, especially for the stuff going to the food banks." A leafy greens grower noted that the key to was to set up systems ahead of time to take advantage of spontaneous opportunities that might arise, for example establishing a protocol with a food bank for what to do in the case of a walk-by field. A processing tomato grower pointed out, however, that loss can be a high-volume, low-frequency occurrence, and it is difficult to create systems that can absorb that quantity with such short notice. As he noted, when there is a rejected load, for example for 10% mold, there is the potential to sort out the large quantity of acceptable product, but such rejections are rare and unpredictable:

> *Yeah, but see, the problem with that is, how do you have a marketing plan for something you don't even know you're going to have? And you don't know when it's going to appear. And how are you going to get your ten people on that assembly line, all of a sudden, when they call you that once every other year, or twice, when you get a load rejected?*

Communication and relationships

Finally, in reflecting on what determines recovery potential, many growers referenced personal communication and relationships (Meagher et al. 2020). One small-scale grower reflected on the kind of ongoing engagement with food banks that might make donation more plausible:

> *If a food bank or a glean association were to have some kind of a intimate relationship with the growers…I mean a relationship where they could work with the grower more closely, in some way, shape or another. You know, without bugging me, but somehow or another getting a hold of the small grower on a weekly basis, saying, you know, "Hey, you go anything that we might be interested in?" And I might say, "Gee, come to think of it, yeah, I got some lettuce out there. Why don't you come out and get it?"*

A couple of growers described having these kinds of relationships with food banks, some even serving on food bank boards. As one peach grower explained, "His [the food bank director's] kids went to school with my kids here, and we're good friends with them. So we send them lots of truckloads to the food bank." Mutual understanding between growers and food bank personnel was also key. To improve donation recovery systems, one fresh tomato grower explained, "You'd have to have the volunteers to understand our situation." One leafy greens grower described how he had come to better understand the situation of the food banks as well:

> *So, [the food bank coordinator] talked her way past our shipping department and got to me and then said, "Can I just walk through?" And then she pointed and just said, "Where does this go, where does this go?" And when I said, "This goes to goats," she said, "We'll take it." And that started the relationship of realizing what they could take. We didn't know how much they could take. And so now we load two or three - sometimes five or six semi-trucks a week to them of product that we were just disking into the ground…. So, it was just a matter of realizing A., that there's this huge need, and B., that what we consider junk is not, and that they will move it.*

Some respondents also reflected on the kinds of relationships among growers that could facilitate recovery possibilities. For example, when processing tomato growers have surplus product, they might reach out to other growers to find an outlet. One grower explained:

> *I had big deals where I had extra tons and I found another grower who was short on his contract, didn't do well. So we delivered under his contract, and we shared what get got.*

> *Interviewer: Is there some sort of a formal system for working that out?*
>
> *Grower: No, it's informal. And it's pretty easy to find out who is short. They don't like to admit it. But if they can deliver under someone else's contract, they can make money.*

Another grower commented on how he was able to learn about niche entrepreneurial opportunities for processing imperfects through his contacts. A leafy greens grower also reinforced the importance of having good relations with buyers, who can build more flexibility into the system in cases of over- or under-supply:

> *When you develop relationships with customers, they will help you, you know. When you're short you don't just cut them out. You cut everybody back some. Or if you're long, you encourage them. Hey, John, I really need you to take an extra pallet today or, you know, let's lower the price a little bit so you can work it out.*

Finally, one leafy greens grower commented on the need for better communication and coordination among growers to overcome the larger issues driving loss. As he explained, "At the time when we need the industry to move together, finding solution for labor, we are barely seeing some growers getting together here, trying to figure things out… There's some kind of the idea that techniques or issues need to be solved as an industry, not as an individual."

The bigger picture

In responding to questions about farm-level food loss, growers often reflected on broader issues that shape their role within the context of agricultural markets and on the food waste movement itself. Two big-picture issues emerged. First, growers often talked about themselves as having little power to impact food loss within the supply chain, instead responding to broader structural issues and constraints set by other actors. Second, and relatedly, many growers—particularly large-scale conventional growers– portrayed themselves as both socially generous and stewards of the land, in some cases feeling misunderstood by a progressive movement focused on the social and environmental impacts of waste.

Structural constraints

As noted under the section on "Drivers of loss," growers primarily reported loss as stemming from market-, weather-, and labor-related issues. More broadly speaking, they often commented that loss was therefore largely beyond their control, and that they were extremely efficient given the parameters within which they operate. As one processing peach grower commented:

> *Overall, I think we as an industry are rather efficient at what we do. Looking from how we're using our nature resources. It would be nice to be able to sell every peach that the tree bears, imperfect or perfect. But the plants are very efficient. And if you look at the ecosystem and business of canned peaches, our raw product and our purchasers are in close proximity…. So no, I think we're doing a fairly good job and are pretty efficient. I mean as a farmer, I always want more. I want to sell more peaches. I want to stay in the peach industry.*

As he notes, growers are driven to maximize efficiency because their livelihoods depend on it. A leafy greens grower echoed this sentiment:

> *There is a lot of talk about food waste, and there is a lot of product that is left behind…We're in the business of maximizing the units that come out of every acre, so that's the basis of our business. And the more units we get*

> *from each acre, the more efficient we are, the less cost per unit and the more competitive we are in the marketplace.*

Growers also suggested that other actors within the food system exercise greater influence on loss. Growers often portrayed themselves as at the bottom of the hierarchy when it comes to making decisions about loss. For example, shippers, retailers, and processors set standards and metrics that they must comply with as closely as possible. One leafy greens grower, who grew exclusively for contracts, suggested, "Actually, you really should be talking to the shippers. They are the ones who have control over how much gets planted and quality control and all of that." Another leafy greens grower commented, "I'm not sure exactly what angle you're going to give it, but it wouldn't be complete without talking to the retailers, to the VPs of procurements, because they are the drivers. You might not be looking at the right people here. We are executors." Another affirmed, "I think a lot of it is the retail stores. They're the big players in the game. They make the rules and they make the calls. I'd like to say we're in control, but they're the giants."

Growers also frequently commented that consumers, with their expectations of low prices and perfect products, shoulder responsibility for loss. As one organic tomato grower commented, "People are so wigged out about paying. They're so used to cheap food." As another respondent commented, the entire system is designed to deliver perfect, low-cost food, making modifications difficult: "They built this place for a number-one bar. And that's what drives this machine." Using as an example his efforts to reduce his environmental footprint, a leafy greens grower concluded that consumers simply are not willing to absorb the costs of trying to capture and use the entire crop:

> *It's like, I put in solar panels, and we did a bunch of things with traveling sprinklers that create more water efficiency, and we have slow release – you know, all those things… But does the consumer really... can you sell that? For the most part, people don't want to pay more. Right? It's like anything. There's this product out here, and these guys are really good at using everything, but if you don't have a consumer that is willing to pay that little extra, then what's the point?*

One fresh peach grower suggested that loss can only be reduced through better consumer education that might impress upon them the need to pay a bit more. He noted the need "to get people in bigger cities, like the San Francisco's, LA's, the larger populations, to educate them as a whole to see what their growers have to go through to get this product." He observed:

> *They know it grows on a tree, they know all this stuff, but to get the consistencies in a fruit, it takes much more. It takes the proper water, it takes the proper fertilizers, and all this stuff that we have to do to get that piece of fruit. So I think if more people understood that, I think they would realize that paying an extra quarter, let's just put a quarter on it, would benefit people in that market.*

One leafy greens grower noted that growers are actually responding to retailers' interpretations of what consumers want: "But what we think there's a market for, and the retailers we sell for think that there's a market, it's a different story. We are doing what the retailer wants to do. We don't know the consumers. We don't, so it's a big difference."

Growers also frequently referenced the overall global agricultural system that constrains their choices, which many also predicted would eventually push out California produce given the kinds of regulatory and labor constraints they face. Two growers specifically referenced the competition in produce coming from Mexico, where wages are lower and regulations looser. As one processing tomato grower commented, "And how are you going to compete with somebody in Mexico growing the same crop? They can just put them on a truck and ship them anywhere in the United States just like you can. It's a dilemma." He saw a fundamental tension between rising California wages and international pressures that reduce prices: "What do you do with people that are very low-skilled workers? You can't

just keep raising their wages, because pretty soon the value of their labor is not worth what you have to pay them in the international market, which is what we're in." A leafy greens grower noted that competition from Mexico made marketing imperfects particularly challenging. As he commented, "Are they [consumers] going to get perfect product out of Mexico? Or are they going to want to consume blemished product out of here? You know?" One small-scale organics grower commented more broadly on the farmers' precarious role within the global capitalist system:

> *I just read a little review of a book a woman wrote about the obesity epidemic and how it's tied to the food system and how the food system is tied into all this capitalist stuff, and how farmers are price-takers, not price makers. Because like now, for the next eight weeks, the whole Central Valley is producing tomatoes, and God help you if you don't have a market in place for them. It's so out of control. I don't know how to fix that.*

Many noted how the fresh produce market in California is already contracting, with some growers switching to higher value crops such as almonds, and they saw their own futures as threatened. As one peach farmer commented, "I have a Caterpillar pushing out things as fast as it can push right now—things that I know aren't going to make it here."

In sum, while many growers are invested in efforts to improve recovery systems and reduce loss, many are also cognizant of the limitations they face as "price-takers" in a global economic system. As one grower concluded, "At our level, we can only do so much. It's going to have to happen on a bigger scale."

Growers within the FLW movement

Growers commented both directly and indirectly on the food loss and waste (FLW) movement, revealing some disconnects between different perspectives. Some were hesitant to be interviewed for the project, as they worried that the advocacy community might misrepresent what they are doing and that their comments might be "used against them." As one respondent joked when she declined to share contact information for other growers, "No good deed goes unpunished."

One issue that emerged was the fact that efforts to reduce loss from the perspective of the food waste movement might still involve a loss for growers in terms of revenue. One processing grower offered the example of the portion of imperfect tomatoes in each load he sells, which canneries will deduct from what they pay him but might actually still use. As he explained, "So, in a sense, to me that's waste and I don't get paid for it. When I do an analysis, I might say I averaged 96.2 percent paid weight. In other words, I'm getting almost a 4 percent deduction. But it's not wasted from your [the food waste advocate's] calculations." Another leafy greens grower commented that high levels of donation to a food bank can be a bad thing, as they indicate that a grower is incompetent and may actually be undercutting the market:

> *I mean, if the food bank comes and says, "I'll give you two dollars a box for a box of bell peppers," I guess that's better than zero dollars a box, but we're not going to be in business very long at two dollars a box. So, I don't really want that model, and someone who's dumb enough to plant a bunch of bell peppers and doesn't know how to move them, I kind of want them to lose as much money as they can, so that they're not growing next year. Because they're probably the reason the market's so bad in the beginning.*

Various growers also expressed concern that donations, underpriced surpluses, or imperfects might impact the price for their number-one product. Most growers saw food bank customers as people who would not otherwise be purchasing produce from other outlets, noting that fresh produce is relatively more expensive than other staple food products. Nonetheless, some were aware of the potential for flooding a market with free produce. As one fresh peach grower who frequently donated to food banks commented, "There's a fine line between giving food away to

the poor and taking away business from the stores. So we have to be careful that we don't overwhelm a given area and end up with, 'There's free fruit here, so why should I buy fruit at the grocery store?'" A processing tomato grower also described how efforts to offload surplus crop could depress the overall market price. Describing something of a "prisoner's dilemma scenario," he explained:

> *I have 5,000 tons left over at the end of the year. Boy, if I could sell that, that's just gravy for me. But I don't sell it for $70. Usually, it's at half the price. And so my calculation at that point is I'm still better off selling at half price…. It's one of those decisions where the whole industry would be better if when growers had extra tomatoes, they'd just disk them up. Because what happens is, now the cannery has extra tomatoes in their warehouse, and they got them really cheapo. So their costs are lower on those, and they can average the entire cost of their pack down a little bit, based on the fact that some of their tomatoes were only $30 a ton. Then they have more than they projected in their warehouse, and so what happens is the price gets lowered. When you have canners that leftover inventory at the end of the season, what do they do? They want to get rid of that stuff. How do they get rid of it? They discount the price. And so that just has a ripple effect through the whole industry, and now we got to all have a lower price.*

Commenting specifically on the "ugly fruit" movement, two growers expressed concern that consumers expect to pay less for fruit that is actually just as good as the "perfect" produce. One organic grower explained this dilemma:

> *For example, I was selling regular tomatoes for $25 a box. And say the ugly tomatoes for $12.50 a box. The guys that got the $12.50 tomatoes which are the ones that I eat myself, they find out that they're just as good as those other tomatoes they'd paid for them. So, it takes away from that. They'd rather take all the ugly tomatoes, and then it takes away from ones that are not selling.*

Echoing comments from growers above about the need for consumer education, one organic grower specified that consumers need to understand that imperfects should not cost less. As she noted, "So the real thing is to, I don't know, educate the consumer that it doesn't have to be less money." She saw such education as challenging, however: "But as a consumer, you've got two choices in front of you, which one do you pick up? What is making your decision as a consumer? Pick up the bruised apple as opposed to the shiny, waxed, beautiful country apple. Difficult."

Many growers observed that outsiders—from the consumer perspective but also from the food waste advocacy perspective—have difficulty understanding the reality of farming. Some growers suggested a sense of naiveté within the food waste community in their search for solutions, failing to appreciate the fact that growers have been trying to figure out this problem for ages. As one respondent commented, "When I hear that some group that are funding a project and are tangentially involved are going to come out and figure out how to make this more efficient it's like, hmmm, good luck!" A fresh peach grower reported:

> *"We have people come through from all over the world and they go, "Wow, why are you throwing this away or why are you throwing that away?" We're like, "We wish the hell we weren't." And they're going, "We're going to figure this out." And we go, "Okay, get back to us, yeah."*

One leafy greens grower noted the need for greater support, rather than criticism, from the food waste community. He recalled an encounter with a representative from a local food pantry:

> *They had someone from I guess a district food bank or something, basically complaining. Saying what a waste, they should never throw this stuff away. And I'm thinking that guy should have been knocking on the door of every house telling them you know, here's my card. Next time you're going to dump a load, I'll give you a tax*

> *donation. He was shaming them, but build relationships. Go to those coolers and say do not dump this stuff. Instead of sitting there saying just tsk, tsk, tsk."*

Many growers felt that the general perception of their work, and of who they are as a group, differed significantly from the rather harsh reality. As one leafy greens grower put it, "The bottom line is farmers have to make money. And people tend to think oh, you know, it's so nice to be a farmer and, you know, this romantic theory. But it is frigging hard work and we have to make money." A fresh peach grower commented that "there is nobody corporate wanting to get in our business to speak of, because it's so hard. It's difficult. Most everybody left is family farms." He continued, "It's a fine art growing fruit because it's so timing-sensitive and weather-sensitive. There's no chart. Every day is different, every year is different." Large-scale conventional and processing growers in particular felt misunderstood by the movement toward organics and local food. One processing tomato grower observed:

> *That's one thing we're bad at, farmers—we're bad at marketing, especially conventional sustainable farmers. We're bad at saying, this is the breadbasket of the world. We feed the world from below Salinas all the way to here. We're not getting the credit for it. We don't get enough for our product, you know? It's not good paying. If I'd have to do my whole life over and not be a farmer, and I knew what I know now, I'd go into the promotion of ag products and try to make the farmers get more for what they're getting, for the risk that they take.*

Many respondents were eager to correct the story and offered reflections on farmer character. One processing peach grower commented, "We all kind of look at ourselves as stewards of the ground. Some consider me a fifth-generation farmer. I'm on the same land that my great-great-uncle had and I'm hoping to leave it for my son or daughters and their grandkids." Many also made the point that growers are very generous as a group. As one processing tomato grower put it, "Farmers might seem a little bit stuffy and all that, but they're pussycats when it comes right down to it, you know? They give to their employees. Some of them are jerks, but most of them are pretty forgiving, giving people." Overall, they aimed to be understood as good-hearted people who are doing their best, but they must make a living within the system as it is. An organics grower stated:

> *I don't know if it will take just a total mindset change, like you said, system change. Because food—even with the best intentions—you're still driven by the bottom line, the margin, which, I think, is the biggest thing probably holding back getting people all fed and getting rid of food waste. Like you said, that blows your mind. How can people be going hungry?*

The system itself must change, she concluded. As a leafy greens grower commented, however, growers are generally eager to contribute to efforts to improve the system however they can:

> *We really want to help…This is what we've been working for three or four months, so imagine this is the fruit of our labor. So if we could change that situation, if we were not tied to that vicious circle of economics… We try to be generous. I think, first of all, you think or you will find some willingness on the part of farmers as a whole to help. I mean that's important.*

Conclusion

The goal of this research was to establish a broad understanding of growers' perspectives about food losses on farms. Growers must be key partners in any program to reduce on-farm losses, yet their perspectives are often absent from relevant discussions among policymakers, researchers, and activists. This report represents an initial attempt to capture growers' experiences and attitudes related to food loss in their own words, with the hope that it will be useful not only for stakeholders outside of agriculture who hope to learn more about growers' perspectives, but also that growers themselves will find value in learning about the diversity of experiences represented in this

report. This research is necessarily limited by the bounds of our sample (i.e., Californian growers of leafy greens, peaches, and tomatoes), so it is difficult to know the extent to which these findings apply to growers of different crops or regions. Nevertheless, the findings reveal an important set of issues to consider in designing future FLW programs and research.

One important finding from this research concerns the substantial variability in both growers' definitions of food loss and the magnitude of reported losses. Some growers voiced definitions of food loss that are more conservative than the definitions commonly held by researchers and government officials, for example including all food that fails to find a primary market (regardless of whether it is eventually eaten by humans or not) or including losses that others might exclude due to being unavoidable (e.g., food lost in unforeseen weather events). Conversely, some growers do not recognize as "food loss" plant material that is left in the fields post-harvest that others have counted as loss. An example of the latter is the debate over whether the outside leaves of romaine hearts that remain in the fields post-harvest are food losses or -- like the vines of a tomato plant -- merely a part of the plant that was never intended for human consumption. Although it is well known that "food loss" remains an unsettled category within academic research and government agencies (Bellemare et al. 2017), it is important to recognize that growers, too, understand the term in varying ways. Any effort to reduce on-farm losses must ensure that all stakeholders, including growers, agree on the definition of the problem. Otherwise, it will be difficult to solve the problem of on-farm food losses if many stakeholders disagree about what counts as loss.

Variations in growers' definitions of food loss necessarily lead to varying estimates of how much food is lost. However, growers also reported wide variations in the volume of losses across different crops, regions, and seasons. Losses additionally varied in response to external constraints, including market volatility, environmental conditions, and labor fluctuations. High variability in both the drivers and scale of on-farm losses underscores the lesson that this problem is more complicated than it first appears, and solutions must be context-specific and responsive to shifting external constraints.

Interviews revealed that most growers have participated in some form of food recovery, either via donations to the charitable food system or secondary markets for off-grade produce. Levels of participation varied, with some engaging regularly in recovery efforts while others participated rarely when other market opportunities were exhausted. Findings reveal that just as some external constraints shape the volume and timing of food losses, other constraints influence growers' ability or interest in food recovery. These constraints include fluctuations in the market for off-grade produce, the relative costs of food recovery, and the logistical systems required for recovery. Given the volume and complexity of these structural influences, many growers reported in interviews that they feel relatively powerless to impact on-farm food loss; instead, they see themselves as responding to the conditions created by other, more powerful actors. Efforts to reduce on-farm losses would therefore benefit from considering interventions further up the supply chain that could change the decision-making calculus for growers. Efforts to address the core structural drivers of food loss – by de-incentivizing overproduction and relaxing strict cosmetic standards for produce, for example – would enable growers to maximize crop utility.

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Appendix A. Interview Questionnaire

Background on the Grower & Farm

1. What is your role on this farm?

2. Tell me about your farm. (Prompts if needed: What crops do you grow? What is the total acreage? How old is the farm? Where do the crops go? How are the crops harvested and packed?)

Volume and Drivers of Food Loss

3. How much of what you plant any given year makes it to primary markets? (Prompt for percentage estimate, weight if possible)

4. Does that amount vary by year or season?

5. What are some of the reasons that a crop might not make it to a primary market? (Probe for issues related to markets, weather, pests, labor, regulations, etc.)

Food Recovery

6. What happens to crops that don't make it to primary markets? (Probe for food bank donations, gleaning, secondary markets, plowing under, animal feed, etc. Try to obtain estimates of the proportion of losses going to each.)

7. What kinds of opportunities do you know of, or are maybe even already taking advantage of, to help growers sell or donate crops that don't make it to primary markets? (Probe for secondary markets, tax credits, community organizations, informal networks, etc.)

8. What opportunities do you think are needed or could be enhanced to support growers in harvesting and distributing damaged/leftover/surplus crops? (Probe for policy changes, funding for community projects, etc.)

9. Is there anything else we should know?