

Food Loss in Vermont

Estimating Annual Vegetable & Berry Loss

A Salvation Farms' Analysis



Theresa Snow, Founder and Executive Director
Salvation Farms

Elana Dean, MPP
Isgood Community Research, LLC

Food Loss in Vermont

The focus of this report is to identify how much wholesome food is currently being lost on vegetable and berry farms around Vermont¹. Wholesome food is food that we can eat; when this food is not connected with people – either through being purchased or donated – it becomes “lost”. Based on our estimates, **14.3 million pounds of wholesome vegetables and berries are lost in Vermont each year²**.

This Salvation Farms’ analysis is the first empirical study of food loss in Vermont. The U.S. Census of Agriculture does not collect data on statewide food loss, nor do farmers keep records of individual farm food loss. We therefore administered a survey – the Vermont Food Loss Survey – to farmers across the state at the beginning of 2016. In total, 58 vegetable and berry farms completed the survey, representing 13 out of the 14 counties in Vermont. It is from these farmers’ responses that we are able to calculate an estimate of food loss, and develop a better understanding of reasons for this loss.

The new estimate of 14.3 million pounds of food loss in Vermont far exceeds the previous estimate of 2 million pounds.³ Its magnitude highlights the great opportunity to place more Vermont-grown food onto people’s plates. One way to do this is through increasing support of Vermont’s gleaning, food rescue, and surplus management operations. Indeed, in 2015, the major gleaning operations in Vermont – the Vermont Gleaning Collective⁴ and the Vermont Foodbank Gleaning Program⁵ – gleaned a combined 617,696 pounds of produce⁶. More support, however, would enable these operations to capture even more of the existing food loss around the state while professionalizing services that ease the process of reducing food loss for farms. At the same time, there is the opportunity to explore the use of financial incentives to compensate farmers who donate food that otherwise would be lost. In addition, there exists the need to identify and connect farmers to markets where they can sell more of their produce that would become food loss. Through these different avenues, more of Vermont’s food loss can be redirected to people’s plates.

This report begins by exploring *when* and *why* wholesome food is lost, presenting insights gleaned from farmers in the Vermont Food Loss Survey. We then discuss our methodology for calculating the number of pounds lost on Vermont farms each year, and review our findings in detail. After reviewing the limitations of our calculation, we

¹ Fruit and nut farms were also attempted to be surveyed, but due to low response rates we were unable to estimate fruit or nut loss in Vermont

² This figure is based on an estimated yield of 0.5 lbs of produce per square foot and farmer estimates of percentages obtained from the Vermont Food Loss Survey. A full discussion of potential limitations is included in a separate section in this report.

³ Salvation Farms: <http://legislature.vermont.gov/assets/Documents/2016/WorkGroups/House%20Agriculture/Local%20Agriculture/W~Theresa%20Snow~Salvation%20Farms%20Introduction~1-14-2016.pdf>

⁴ Salvation Farms’ 2015 Annual Report, available at http://www.salvationfarms.org/SF_annual_report_2015.pdf

⁵ Vermont Foodbank: <https://www.vtfoodbank.org/gather-food/gleaning>

⁶ To note, this poundage includes apples that were gleaned or picked up

outline opportunities for next steps. We conclude by emphasizing the enormous potential to reduce the amount of food loss in Vermont.

When and Why is Food Lost?

Food can be lost at a number of stages in between being planted and being eaten. This study narrows in on food that is lost at two particular stages: in the field and after storage or market.

Loss in the Field

A large portion of food loss occurs in the field. Of all of the crops that are successfully grown on a farm, farmers do not pick everything. Based on farmers' responses from the Vermont Food Loss Survey, the average vegetable and berry farmer picks 85% of the produce that grows. Some of this is due to the crop being damaged – by animals, insects, diseases, or weather – to the point of being inedible. Some portion of the crops that are not picked, however, farmers do consider to be edible. Indeed, the average vegetable farmer considers 34% of what is left unpicked to be edible, and the average berry farmer considers 25% of what is left unpicked to be edible. Why, then, is this food left in the field?

Based on responses from the Vermont Food Loss Survey, the main reasons that farmers do not pick this edible, wholesome food is that the produce is blemished, or that the farmers are not confident that they would be able to sell the produce. A number of farms attribute being unable to pick all of the produce to a lack of available and/or affordable labor. A few farmers also noted that competing harvesting priorities left them with a lack of time to both harvest and ready produce for market. Others shared that they did not have enough storage bins and space to keep the produce had they harvested it. Table 1 below shows the breakdown of farmers' responses.

Table 1. Reasons for not picking produce

	Number of Farms	Percent of Farms
Blemished produce (albeit edible)	28	48%
Not confident would be able to sell	24	41%
Lack of Available Labor	18	31%
Lack of Affordable Labor	6	10%
Other	12	21%

While some of the edible produce that is left unpicked by farmers is captured by gleaners, a large percentage is turned under in the field or fed to pasturing animals. It is this food – that which never makes it onto people's plates - that we consider food lost in the field.

Loss After Storage and/or Market

Of the produce that farmers pick, only some portion is sold via direct sales, to in-state and out-of-state wholesalers, or at farmers markets, farm stands, and CSAs. To note, some portion of picked produce goes directly to be marketed and some portion is stored as it is marketed. Based on farmers' responses from the Vermont Food Loss Survey, the average vegetable farmer sells 81% of the produce they have picked, and the average berry farmer sells 86% of what they have picked. The top three reasons farmers are not able to sell their produce include a general lack of demand for the produce, oversaturation of the market with the produce, or the produce – while completely edible – having blemishes. A few farms noted that sometimes their produce is only partially edible by the time it is being sold. Based on farmer interviews, this includes examples of lettuce wilting at farmers markets or potatoes deteriorating during storage while waiting to find a wholesale or direct market. Table 2 shares the reasons farmers gave for not being able to sell produce.

Table 2. Reasons for farmers not selling produce at market

	Number of Farms	Percent of Farms
General lack of demand for the item	27	47%
Oversaturation of the market with the item	25	43%
The produce- while completely edible - had blemishes	20	34%
The produce was only partially edible	6	10%
Other	10	17%

Of the produce that is not sold, some portion is donated to community organizations. This could be produce that is leftover after a farmers' market, or food unsuccessfully sold from an on-farm storage unit. However, according to responses from the Vermont Food Loss Survey, only 33% of vegetables that are not sold are donated, and only 4% of berries that are not sold are donated. While some of this produce that is neither sold nor donated is eaten by farmers (or their friends and families), or made into value-added produce by the farmers themselves, a large percentage is made into compost or fed to animals. It is this food - that which never makes it onto people's plates - that we consider food lost after market.

Total Food Loss

Loss in the field and loss after storage or market are the two main stages at which wholesome food is lost in Vermont. Together, edible food that is left unpicked and picked food that is neither sold nor donated constitute total food loss. Below, we discuss in detail the amount of total food loss generated across Vermont.

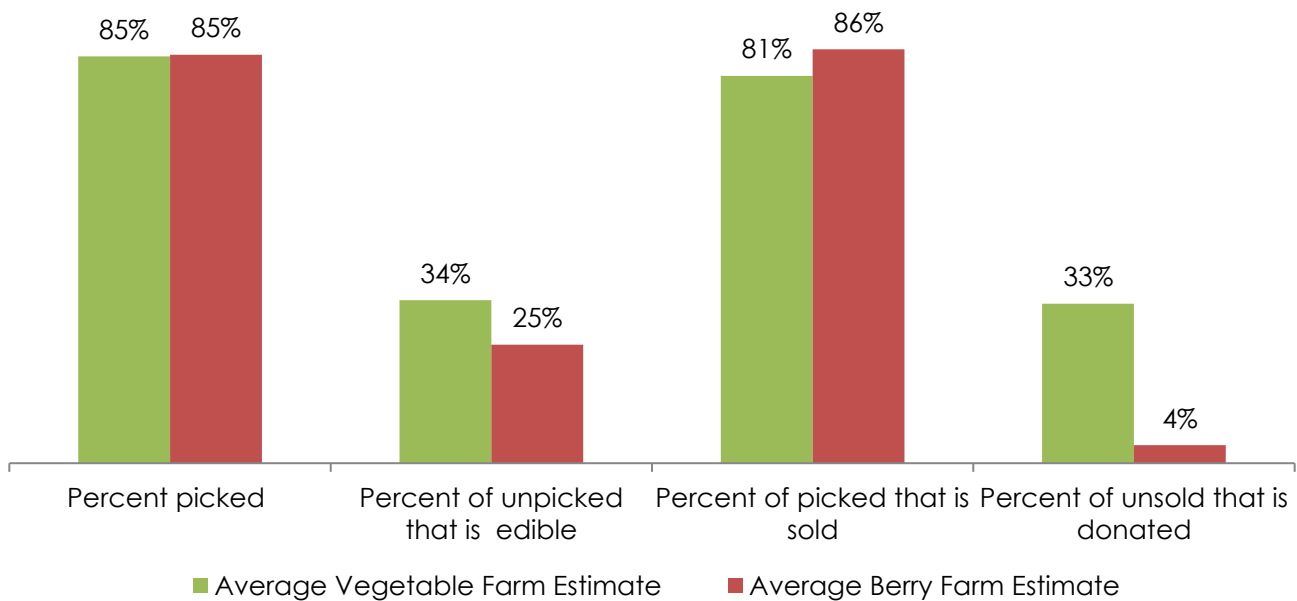
How Much Food is Lost Annually in Vermont?

Each year, farmers in Vermont harvest 3,897 acres of vegetables⁷ and 601 acres of berries⁸. Of the produce that is successfully grown on these acres, some portion does not make it onto people's plates and is "lost". Below we first review the calculation we used for estimating this food loss and then we present estimates of how many pounds are lost each year on Vermont farms.

Food Loss Calculation

In the Vermont Food Loss Survey, we asked farmers to estimate four percentages: the percent of successful crops that they picked, the percent of unpicked produce that they would consider edible, the percent of picked produce that they sold, and the percent of produce that was not sold but was donated. Graph 1 below shows the average estimates for each of these percentages split out by vegetable farms and berry farms.

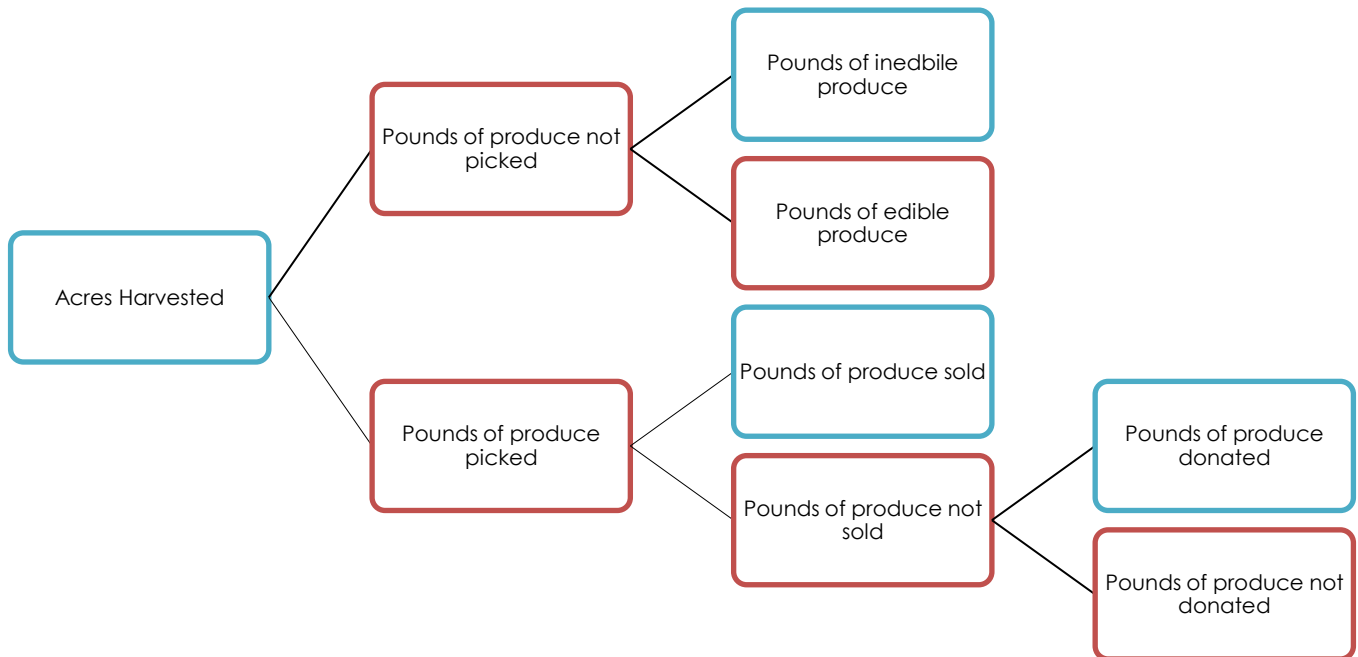
Graph 1. Average Farm Estimates, by Vegetable Farms and Berry Farms



⁷ Table 38, 2012 US Census of Agriculture
⁸ Table 40, 2012 US Census of Agriculture

Then, taking the annual expected yields for Vermont - 84.9 million pounds of vegetables⁹ and 3.9 million pounds of berries¹⁰ – we followed the decision tree illustrated in Figure 1 below to calculate (1) the pounds of edible vegetables and berries that were unpicked and, (2) the pounds of picked vegetables and berries that were neither sold nor donated.

Figure 1. Path to calculating food loss



The sum of these two categories is *salvageable* food loss – wholesome food that can be sold to consumers or donated to community organizations. Below, we look at the magnitude of these estimates.

⁹ This estimate is based on there being 0.5 pounds of vegetables harvested per square foot, a number developed by the Rutgers New Jersey Agricultural Experiment Station. This estimate is for small-scale farms that grow a large variety of vegetables, much like the typical Vermont vegetable farm. Published in: Rabin, Jack, Gladis Zinati, and Peter Nitzsche. *Yield Expectations for Mixed Stand, Small-Scale Agriculture*. Issue brief. Vol. 7, Issue 1. Rutgers New Jersey Agricultural Experiment Station, September 2012. Of the vegetable farms that took the Vermont Food Loss Survey, they harvested an average of 33 types of vegetables on 15.2 acres. Of the berry farms that took the survey, they harvested an average of 4.6 types of berries on 2.7 acres.

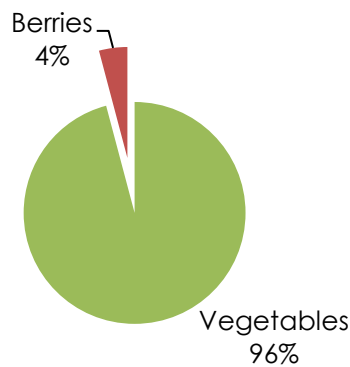
¹⁰ This estimate is based on there being 0.15 pounds of berries harvested per square foot, an estimate obtained from averaging the expected yields for strawberries, blueberries, and raspberries that were published in: Grubinger, Vern. University of Vermont Extension. *Vegetable and Berry Crop Yield Estimates for New England*. May 2013.

Statewide Food Loss Estimate

Vegetables vs. Berries

Of the **14.3 million pounds** of food loss in Vermont, there is **13.7 million pounds of vegetable loss** and **590 thousand pounds berry loss**. In Graph 2, we see this breakdown in terms of percentages: 4% of the total food loss is berries, while 96% of the total food loss is vegetables. This is due to the fact that Vermont grows 22 times more vegetables than berries. Indeed, a comparable percentage of total vegetables and berries are lost: **16% of vegetables grown** and **15% of berries grown** are lost.

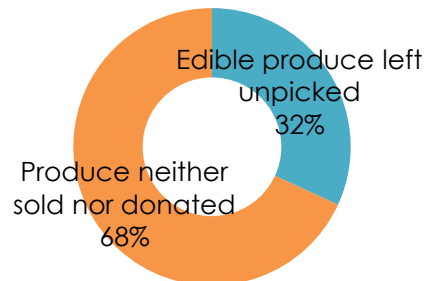
Graph 2. Total food loss, by vegetable loss and berry loss



Loss in the Field vs. Loss after storage or market

Of the **14.3 million pounds** of food loss in Vermont, **32% is edible produce that is unpicked**, and **68% is picked produce that is neither sold nor donated**. Graph 3 below illustrates this breakdown.

Graph 3. Total food loss, by category of food loss



There were **4.6 million pounds** of edible vegetable and berries that were unpicked. This estimate consists of **4.4 million pounds of vegetables** and **145 thousand pounds of berries** (Graph 4).

Graph 4. Edible vegetables and berries that were not picked, in pounds



Put another way, **5% of edible vegetables and 4% of edible berries were left unpicked** by the farmers who grew it.

The amount of picked produce that was neither sold nor donated is estimated at **9.7 million pounds**. This consists of **9.3 millions pounds of vegetables** and **445 thousand pounds of berries**.

Graph 5. Picked vegetables and berries that were neither sold nor donated, in pounds



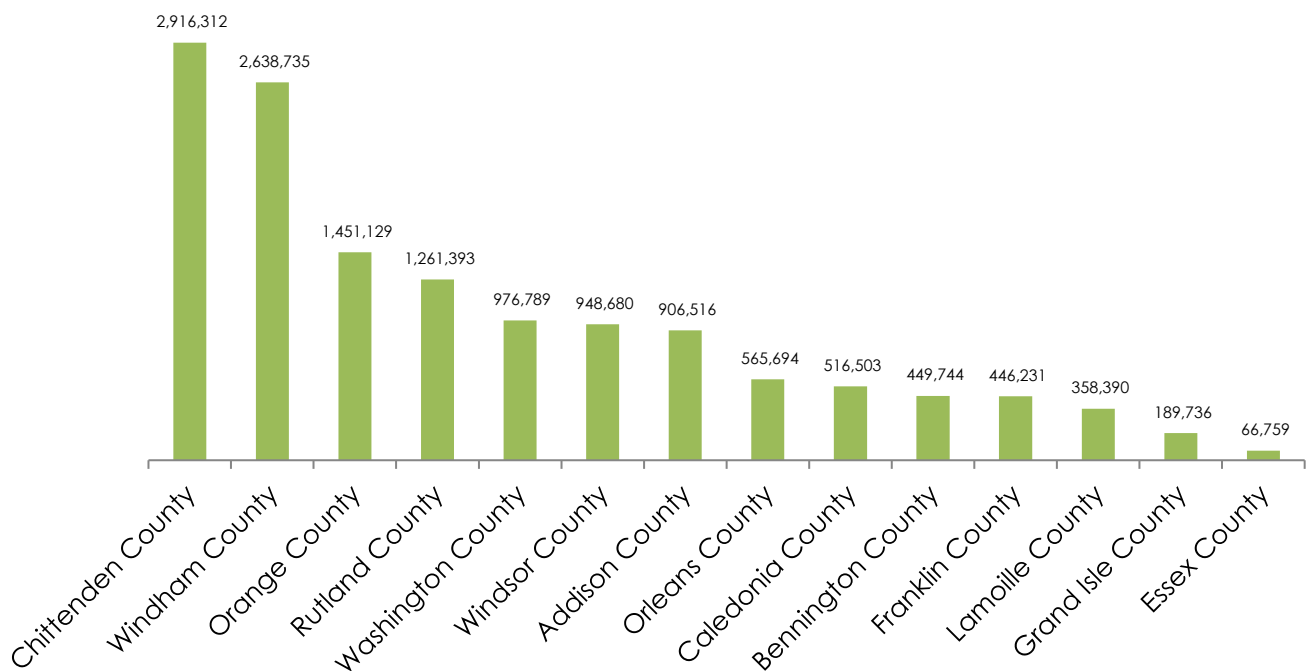
Overall, **11% of picked vegetables and 11% of picked berries were neither sold nor donated**.

County Food Loss Estimates

Vegetable and berry production is not evenly distributed around the state of Vermont. For example, 830 acres of vegetables were harvested in Chittenden County, but only 19 acres were harvested in Essex County. Using this county-level variation in acres planted, we generated estimates for food loss in each county. To note, these estimates are based on the assumption that food loss rates do not vary by county.

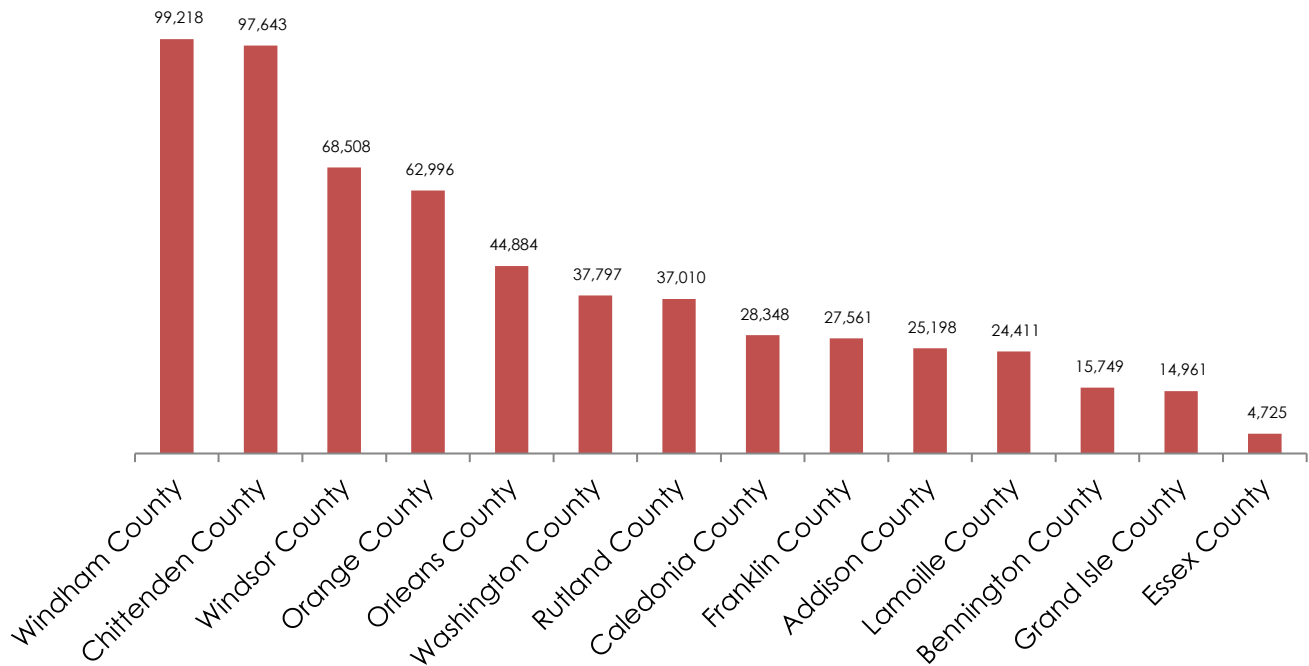
Graph 6 below shows the total estimated vegetable loss by county. Please refer to Appendix B for a complete breakdown. Chittenden County and Windham County are estimated to have the highest vegetable losses, each exceeding 2 million pounds of vegetable loss.

Graph 6. Total vegetable loss, by county



Likewise, Graph 7 below shows the total estimated berry loss by county. Appendix B also includes a complete breakdown of berry loss by county. Windham County and Chittenden County are estimated to have the highest berry losses, each exceeding 97 thousand pounds of berry loss.

Graph 7. Total berry loss, by county



Limitations

There are three main concerns, or limitations, with regards to our food loss estimate. First regards how to estimate the expected yield of produce per acre. Second is whether we have sufficiently taken into account the imprecision of farmers' estimates for the percentages. And, third, is whether we have overestimated the amount of edible produce that is left unpicked or the amount of picked produce that is neither sold nor donated. Below, we review each of these concerns in more detail.

Yield per Acre Variation

The first concern is whether we have either underestimated or overestimated the amount of food loss by having inflated or deflated the expected produce yields. In our vegetable loss calculations, we used the 0.5 pounds/ft² estimator published by the Rutgers New Jersey Agricultural Experiment Station to arrive at the estimate of 84.9

million pounds of vegetables being grown annually¹¹. With berries, we used 0.15 pounds/ft², which is the average of the expected yields for strawberries, blueberries, and raspberries published by University of Vermont Extension's *Vegetable and Berry Crop Yield Estimates for New England*¹².

Were we to use lower estimators to calculate expected yields - below 0.5 and 0.15, respectively - the estimates for food loss would also decrease. Conversely, if we were to use higher figures - above 0.5 and 0.15 - the estimates for food loss would also increase. It is important to keep in mind that our food loss estimates are rooted in having generated expected crop yields based on the 0.5 pounds/ft² for vegetables and 0.15 pounds/ft² for berries, and that altering these estimates does change the food loss estimates.

As a robustness check to the expected vegetable yield per square foot, we calculated the average yield estimate based on the specific crop yield estimates that the University of Vermont Extension published¹³. The average of a 'good yield' was 0.44 pounds per square feet - equivalent to the Rutgers estimate.

Farmer Estimates

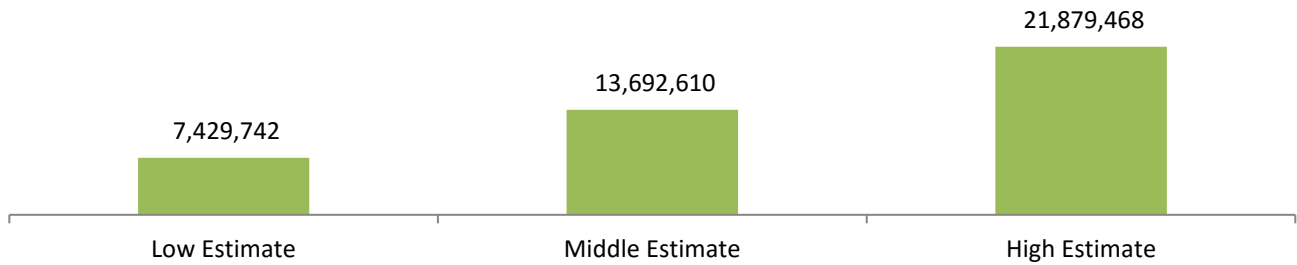
The second concern is whether we have sufficiently taken into account the imprecision of farmers' estimates for the percentages on which we generate our food loss figures. Our vegetable and berry loss estimates were calculated using the mean responses that farmers gave in the Vermont Food Loss Survey. For example, when calculating the amount of vegetables that were neither sold nor donated, we relied on the average farmer response that 19% of picked vegetables were not sold, and 67% of unsold vegetables were not donated. Since we had only 53 vegetable farms and 27 berry farms complete the survey, our estimates have a large margin of error. In order to determine whether the farmer responses are imprecise, we calculated confidence intervals for each of the farmer estimates (please refer to Appendix A for tables). Using the lower bound estimates of the confidence intervals decreases the food loss estimates; conversely, using the upper bound estimates of the confidence intervals increases the food loss estimates. To illustrate the effect of using the lower bound and upper bound figures on estimating the vegetable loss, please refer to Graph 8 below. Using the lower estimate would decrease the total vegetable loss estimate from 13.7 million pounds to 7.4 million pounds, while using the upper estimate would increase the estimate to 21.9 million pounds.

¹¹ Rabin, Jack, Gladis Zinati, and Peter Nitzsche. *Yield Expectations for Mixed Stand, Small-Scale Agriculture*. Issue brief. Vol. 7, Issue 1. Rutgers New Jersey Agricultural Experiment Station, September 2012. Online.

¹² Grubinger, Vern. University of Vermont Extension. *Vegetable and Berry Crop Yield Estimates for New England*. May 2013

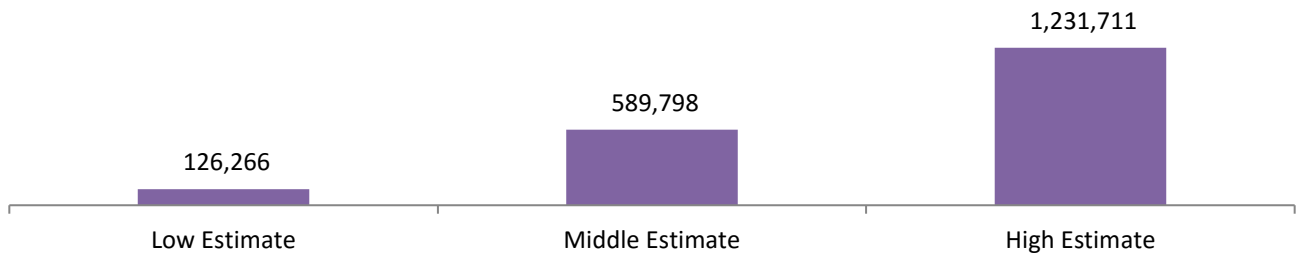
¹³ Grubinger, Vern. University of Vermont Extension. *Vegetable and Berry Crop Yield Estimates for New England*. May 2013

Graph 8. Range of total vegetable loss based on use of low, mean, and upper bound estimates of farmer percentages



Likewise, using the lower or upper bound estimates instead of the mean would also change the estimated berry loss estimates. As you can see in Graph 9, using the lower estimate would decrease the total berry loss estimate from 590 thousand pounds to 126 thousand pounds, while using the upper estimate would increase the estimate to 1.2 million pounds.

Graph 9. Range of total berry loss based on use of low, mean, and upper bound estimates of farmer percentages



In order to obtain narrower ranges of estimates for vegetable and berry loss, we would need to obtain more farmer survey responses. An opportunity for future research, therefore, is to survey a larger sample of Vermont farmers.

Overestimation

The third concern is whether we have overestimated the amount of edible produce that has not been picked or overestimated the amount of picked produce neither sold nor donated.

The first way in which we could be overestimating food loss is by not taking into consideration that some portion of the edible produce that is unpicked is currently being gleaned. This is not a large concern, however, when we take into account that

the major gleaning operations in Vermont – the Vermont Gleaning Collective¹⁴ and the Vermont Foodbank Gleaning Program¹⁵ – gleaned a total of 617,696 pounds in 2015, or 14% of the total number of pounds of edible produce that is unpicked¹⁶. To note, it is likely that a high percent of this produce was not “field gleaned”, but picked up from farms. However, since not all gleaning initiatives distinguish between methods of collecting surplus crops, we will move forward with using this figure as a high estimate of the amount of produce currently “field gleaned” in Vermont. If we were to subtract this 617,696 pounds from the current estimate of 4.6 million pounds of food lost in the field, however, the estimate would still only decrease to 3.9 million pounds. Based on responses from the Vermont Food Loss Survey, the rest of the edible produce that is unpicked is either turned under in the field or fed to pasturing animals – i.e. never makes it onto people’s plates – and is therefore considered food lost in the field.

Another way in which we could be overestimating the number of lost pounds is by not taking into consideration that some portion of the picked produce that is neither sold nor donated is being eaten by the farmers, or distributed to their family and friends. This food, clearly, is not being “lost”, as it does make it onto people’s plates. However, even if we estimate that all 789 vegetable farms and 535 berry farms in Vermont (1,324 farms total – which is overestimating the number of farms, as many farms are *both* vegetable and berry farms) fed a family of four people one pound each a day for four months during the growing season (120 days), that would be 635,520 pounds of produce. Taking the 9.7 million pounds of picked produce that is neither sold nor donated, this would only decrease our estimate to 9.1 million pounds.

We could also be overestimating the number of lost pounds by not taking into consideration that some portion of the produce that is neither sold nor donated is made into value-added products by the farmers, such as strawberry jam or frozen peas. To note, this is different than produce that farmers would successfully sell to others who make value-added products – that would just be considered sold produce. Based on farmer responses from the Vermont Food Loss Survey, 5% of farms use produce that is neither sold nor donated to make value-added products. Even if we assume that 5% of vegetable and berry farms use 100% of their picked produce that is neither sold nor donated to make value-added produce, this would only constitute 486,596 pounds. If we subtracted this figure from the total estimate of picked produce that is neither sold nor donated, it would only decrease from 9.7 million pounds to 9.3 million pounds.

Based on responses from the Vermont Food Loss Survey, the rest of the produce that is neither being sold nor donated is being used for compost or fed to animals - i.e. never makes it onto people’s plates – and is therefore considered food lost after storage or market.

¹⁴ Salvation Farms' 2015 Annual Report, available at http://www.salvationfarms.org/SF_annual_report_2015.pdf

¹⁵ Vermont Foodbank: <https://www.vfoodbank.org/gather-food/gleaning>

¹⁶ To note: this estimate includes pounds from apples.

If we were to subtract our rough estimates of produce gleaned, produce consumed by farmers, and produce made into value-added product by farmers – a total of 1.7 million pounds - this would still only reduce our total food loss estimate from 14.3 million pounds to 12.5 million pounds. Therefore, while we recommend further research, we do not think that it will significantly change the magnitude of the estimate of food loss in Vermont.

Future Research

In this section, we discuss two main areas for future research regarding food loss in Vermont: calculating food loss and reducing food loss.

Calculating Food Loss

Vegetable and Berry Loss

Moving forward, it would be valuable to obtain more information on food loss with regards to the ‘top’ vegetables and berries grown in Vermont. The 2012 Census of Agriculture reports that the top vegetables grown in Vermont, in terms of number of acres harvested, are tomatoes, potatoes, sweet corn, pumpkins and squash (winter and summer). The top berries, also in terms of acres harvested, are strawberries, blueberries, and raspberries. In the Vermont Food Loss Survey, the average vegetable farm grew 33.4 types of vegetables and the average berry farm grew 4.6 types of berries. Taking into account that unique strategies will need to be developed in order to capture crop-specific food loss – i.e. food rescue turnaround time needed for strawberries vs. potatoes – it would be beneficial to understand more details about particular crop loss. Seeing as there is such a large diversity of crops grown in Vermont, we recommend starting with the ‘top’ crops.

We also think it would be worthwhile to measure the amount of vegetables and berries that are lost during the washing & packaging, storage, and transportation stages. While no farmers in the Vermont Food Loss Survey said that they lost “a lot” of produce during any of these stages, a few did say they lost a “moderate amount”. Indeed, Table 3 shows that most farms only lost “very little” during these stages.

Table 3. Number of farms who lost produce during washing & packaging, storage, or transportation stages, by amount of produce lost

	A moderate amount	Very little	None
Washing & Packing	5%	66%	14%
Storing	22%	57%	7%
Transporting	2%	24%	60%

Further exploration, however, is needed to understand better what “very little” and “a moderate amount” constitute. In the survey, however, only one farm indicated that they keep records of the amount of produce lost during washing & packaging, storage, and transportation stages, so we anticipate needing to collect this data through observational fieldwork. Depending on more specific measurements, investing in certain interventions during the washing & packaging, storing, and transporting stages may be worthwhile.

Ideally, all of this new food loss data could be collected in one of two ways: dispersing a research crew to conduct in-season, on-farm observations of food loss, and/or analyzing farmer agricultural records. Both of these methods would enable us to rely on measurements instead of farmer recollections. The former would also allow us to collect data that no one is collecting now, such as more precise measurements of how much of the produce that is neither sold nor donated goes into farmers’ meals, is fed to animals, is put into compost, or that farmers’ make into value-added product.

In terms of analyzing farmer agricultural records, the Vermont Food Loss Survey shows that many farmers do indeed keep records of how much they plant, harvest, and sell. However, they do not keep records on how much they did not harvest or how much was damaged during washing & packaging, storage, or transportation (Table 4).

Table 4. What farmers keep records of

	Number of Farms	Percent of Farms
Amount planted	43	74%
Amount Harvested	39	67%
Amount Not Harvested	2	3%
Amount damaged during Washing & Packaging	1	2%
Amount damaged during Storage	1	2%
Amount damaged during Transportation	0	0%
Amount Sold	40	69%

Many farms keep the records of how much they plant, harvest, and sell in paper and/or computer systems. Only a few farms say that they use a Smartphone app for recording. Table 5 shows the breakdown of where farmers keep their records.

Table 5. Where farmers keep records, by what farmers record

	Amount Plant	Amount Harvest	Amount Sell
On Paper	50%	50%	34%
On Computer	47%	31%	52%
On Smartphone App	5%	3%	0%

Of farmers that used a computer program, most used Excel or Quickbooks. The rest used a hodgepodge of computer programs. Obtaining access to these paper, computer, and smartphone app records that farmers are keeping would enable us to cross-check certain figures from this present study, as well as learn more about specific crops. It will not, however, provide us with all of the data we need to understand food loss beyond what we do based on farmer estimates. To do that, future researchers would need to conduct in-season, on-farm observations of food loss.

Other Produce Loss

Future research could also focus on food loss on fruit farms in Vermont¹⁷. According to the 2012 Census of Agriculture, there were 298 fruit farms with 1,827 harvestable acres of fruit trees, indicating the great potential opportunity. Seeing as the Vermont Gleaning Collective gleaned 38,881 pounds of apples in 2015, there is particular promise in focusing on apple orchards¹⁸. While we attempted to obtain fruit loss estimates in this current study, due to a low response rate among fruit farms, we were unable to calculate reliable estimates.

In addition, while there are only 18 nut farms with 18 acres of nuts in Vermont, future research could understand if there is sufficient magnitude to justify focusing on capturing nut loss. Of course, there are also 10,837 harvested acres of grains, oilseeds, dry beans, and dry peas grown in Vermont, too. Potential research could therefore focus on estimating fruit, nut, grain, oilseed, dry bean, and dry pea loss to add to the current estimates of vegetable and berry loss.

Reducing Food Loss

Another area for future research is to understand how to reduce the amount of food loss in Vermont. Below, we discuss three areas for further research: access to markets, incentives for farmers, and expansion of gleaning and food rescue operations. Each

¹⁷ According to the 2012 Census, fruits grown in Vermont include apples, apricots, cherries (sweet and tart), grapes, nectarines, peaches, pears, persimmons, plums/prunes, and other non-citrus fruits.

¹⁸ Salvation Farms' 2015 Annual Report, available at: http://www.salvationfarms.org/SF_annual_report_2015.pdf

speaks to the larger question of how to create a system that better supports and benefits farmers, and ultimately place more food on people's plates.

Access to Markets

Farmers sell their produce in a number of different markets - via direct sales to restaurants and food cooperatives, to in-state and out-of-state wholesalers, and at farmers markets, farm stands, and CSAs. Indeed, most farms sell their produce at more than one type of market. Table 7 illustrates the variety of markets at which the farmers who took the Vermont Food Loss Survey sell their produce.

Table 7. Markets at which farmers sell their produce

	Number of Farms	Percent of Farms
Direct Sales	38	66%
Wholesale In-state	31	53%
Farmers Markets	28	48%
Farmstand	26	45%
CSA	24	41%
Wholesale Out-of-state	18	31%
Other	7	12%

As we found out from the Vermont Food Loss Survey, however, farmers often do not pick produce because they do not have an identified market for it, because the produce is blemished (albeit edible), or they lack access to affordable labor. We also found that farmers are often unable to successfully sell picked produce for four reasons: general lack of demand for the item, oversaturation of the market, or the product having blemishes, or only being partially edible. Further research is necessary to understand whether there are markets at which to sell this food, to understand better if and how farmers could connect to them, or if new market avenues need to be created.

Financial Compensation

Another potential way to reduce food loss is to financially compensate farmers for their surplus and seconds. In the Vermont Food Loss Survey, however, farmers did not share much enthusiasm for an existing program to do so: the federal enhanced tax deduction currently available to farmers for donating food. We found that 92% of farms did not claim this deduction for food donations that they had made in 2015 (this includes those that were unsure whether they did). In addition, only a quarter of farms were 'probably' or 'definitely' planning on claiming federal tax deductions for food

donations in 2016. However, the federal tax deduction was only recently extended to all farms in December 2015; as farmers and farm service agents become more informed of this change, we anticipate farms will begin to take advantage of this resource for their eligible food donations.

In addition to the federal tax incentive, 62% of farms expressed interested in the state of Vermont providing financial compensation for donating food (Table 6). While this incentive does not currently exist, it is important to note farmers' interest in it.

Table 6. Would you be interested in the state of Vermont providing financial compensation to farmers for their food donations?

	Number of Farms	Percent of Farms
Definitely not	2	3%
Probably not	2	3%
Might or might not	10	17%
Probably yes	9	16%
Definitely yes	27	47%

More research is needed, however, to understand whether the federal tax deduction is working as either an incentive or benefit and what the Vermont financial compensation should look like in order to best support farmers and capture more food loss.

Expanded Gleaning and Food Rescue

Finally, additional research is necessary to understand how farmers can better partner with gleaning, food rescue, and farm surplus management organizations to reduce food loss in Vermont. As we can see in Table 8 below, many farms are very interested in having partners to work with them in a variety of capacities.

Table 8. What services would you like community groups to provide to your farm this coming year?

	Number of Farms	Percent of Farms
Picking up produce from the farm	27	47%
Purchasing produce	26	45%
Gleaning fields	20	34%
Receiving produce at their location	12	21%
Transporting produce	11	19%
Picking up produce from the farmer's market	11	19%
Processing produce	9	16%
None	7	12%
Washing & Packing produce	5	9%

There is enormous potential to scale up efforts and capture larger amounts of the available food loss. The more integrated these efforts are with farms' existing operations and routines, the more successful they will be. This would likely necessitate an increase in both the availability and professionalization of gleaners, food rescuers, and avenues into secondary or yet to be established markets. Further research is needed to understand how to successfully structure these efforts to best support farmers and capture food loss on a larger scale.

Conclusion

14.3 million pounds of vegetables and berries are lost each year in Vermont. They are either left unpicked in the fields, or picked but neither sold nor donated. In order to capture this large amount of food loss, a robust "food loss management" plan needs to be implemented in Vermont with the farmer at its core. This plan needs to expand market opportunities for farmers, compensate farmers for the foods they produce, and support larger-scale, professionalized gleaning, food rescue, and farm surplus management operations that strengthen farms and the regional food system. In each of these ways, farmers will benefit and more food will enter the local food system. From farmers to gleaners, food rescuers to policymakers, and consumers to purchasers, each can play a role in capturing this wholesome food that otherwise is lost.

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Laurie Beyranevand, JD
Associate Director of the Center for Agriculture and Food Systems
Associate Professor of Law, Vermont Law School

Robert Q. Bui
Consultant, Deloitte Consulting LLP

Vern Grubinger, PhD
Vegetable and Berry Specialist, University of Vermont Extension
President of the Vermont Vegetable and Berry Growers Association

Jane Kolodinsky
Professor and Chair of the Community Development and Applied Economics
Department, University of Vermont

Roni Neff, PhD MS
Assistant Professor, Environmental Health Sciences, Johns Hopkins Bloomberg
School of Public Health
Director, Food System Sustainability and Public Health, Johns Hopkins Center for
a Livable Future

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Appendix A

Table A-1. Confidence intervals for farmer percentage estimates regarding vegetables obtained in the Vermont Food Loss Survey

	Lower Bound of Confidence Interval	Mean Farmer Estimate	Upper Bound of Confidence Interval
Percent of vegetables picked	81%	85%	89%
Percent of vegetables not picked	11%	15%	19%
Percent of unpicked vegetables that are edible	24%	34%	43%
Percent of picked vegetables sold	74%	81%	87%
Percent of picked vegetables not sold	13%	19%	26%
Percent of unsold vegetables donated	24%	33%	42%
Percent of unsold vegetables not donated	58%	67%	76%

Table A-2. Confidence intervals for farmer percentage estimates regarding berries obtained in the Vermont Food Loss Survey

	Lower Bound of Confidence Interval	Mean Farmer Estimate	Upper Bound of Confidence Interval
Percent of berries picked	77%	85%	93%
Percent of berries not picked	7%	15%	23%
Percent of unpicked berries that are edible	11%	25%	38%
Percent of picked berries sold	76%	86%	97%
Percent of picked berries not sold	3%	14%	24%
Percent of unsold berries donated	0%	4%	8%
Percent of unsold berries not donated	92%	96%	100%

Appendix B

Table B-1. Vegetable loss, by county

	Acres of Vegetables Harvested	Percent of Vermont Vegetable Acres Harvested	Edible vegetables left unpicked (lbs)	Picked vegeables neither sold nor donated (lbs)	Total Vegetable Loss (lbs)
Addison County	258	7%	291,664	614,852	906,516
Bennington County	128	3%	144,702	305,043	449,744
Caledonia County	147	4%	166,181	350,323	516,503
Chittenden County	830	21%	938,300	1,978,012	2,916,312
Essex County	19	0%	21,479	45,280	66,759
Franklin County	127	3%	143,571	302,660	446,231
Grand Isle County	54	1%	61,046	128,690	189,736
Lamoille County	102	3%	115,309	243,081	358,390
Orange County	413	11%	466,889	984,239	1,451,129
Orleans County	161	4%	182,008	383,687	565,694
Rutland County	359	9%	405,843	855,550	1,261,393
Washington County	278	7%	314,274	662,515	976,789
Windham County	751	19%	848,992	1,789,743	2,638,735
Windsor County	270	7%	305,230	643,450	948,680
Total	3897	100%	4,405,488	9,287,121	13,692,610

Table B-2. Berry loss, by county

	Land in Berries (Acres)	Percent of Vermont Land in Berries Harvested	Edible berries left unpicked (lbs)	Picked berries neither sold nor donated (lbs)	Total Berry Loss (lbs)
Addison County	32	4%	6,195	19,003	25,198
Bennington County	20	3%	3,872	11,877	15,749
Caledonia County	36	5%	6,969	21,379	28,348
Chittenden County	124	17%	24,006	73,638	97,643
Essex County	6	1%	1,162	3,563	4,725
Franklin County	35	5%	6,776	20,785	27,561
Grand Isle County	19	3%	3,678	11,283	14,961
Lamoille County	31	4%	6,001	18,409	24,411
Orange County	80	11%	15,488	47,508	62,996
Orleans County	57	8%	11,035	33,850	44,884
Rutland County	47	6%	9,099	27,911	37,010
Washington County	48	6%	9,293	28,505	37,797
Windham County	126	17%	24,393	74,825	99,218
Windsor County	87	12%	16,843	51,665	68,508
Total	749	100%	145,002	444,796	589,798

Note: Total acres of harvested berries are not published by the Census. Land in Berries includes harvested and unharvested acres.