

# Vermont Produce Tracking and Traceability Project Focused on Solutions for Small and Medium Sized Farms

## Final Project Report

to the

Vermont Agency of Agriculture Food and Markets (VAAFAM, project #14-SCBGP-VT-0051)  
and

Vermont Housing Conservation Board (VHCB, project #Lot Tracking Project 09-16)

UVM Project Numbers (VAAFAM: 032849, VHCB: 032794)

Project Title: The Vermont Produce Tracking and Traceability Project

Project Period: 9/1/2016-8/31/2017

Reporting Period: 9/1/2016-8/31/2017

Project Website: <http://go.uvm.edu/productracking>

November 21, 2017

Christopher W. Callahan – UVM Extension, Project Director

Michael Kilpatrick – In the Field Consultants, Project Consultant and Tech

Michael Stenta – Farmier and FarmOS, Developer and Programmer

Stan Ward – Stan Ward Consulting, Project Founder and First Phase Director

This project was made possible with support from The Vermont Agency of Agriculture Food and Markets via the Vermont Specialty Crop Block Grant (VAAFAM, project #14-SCBGP-VT-0051) and The Vermont Housing Conservation Board (VHCB, project #Lot Tracking Project 09-16). This project was supported by the U.S. Department of Agriculture's (USDA) Agricultural Marketing Service through grant USDA-AMS-SCBGP-2015. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA.

## Summary

This project aimed to improve produce tracking and traceability on Vermont farms. Vermont farmers and buyers were surveyed related to produce related data systems, tracking and traceability. The Produce Safety Alliance Training modules, Food Safety Modernization Act (FSMA) Produce Safety Rule (PSR), and USDA GAPS Checklists were reviewed to summarize record keeping requirements associated with tracking and traceability. The project team reviewed over 65 software solutions considered relevant to the need for produce tracking and traceability. This review took the form of web-based research, gathering grower / user experiential learning via phone interview, using trial / sample accounts of solutions and attending training webinars on products. This list was narrowed to 14, but several new options were added when research uncovered new information. The final number of solutions that we researched extensively was 17. Out of the 17 that were researched, 6 were noted to have continued merit. Unfortunately, based on our review we found that there were no strong options for commercially available software systems that support the anticipated needs of produce tracking among Vermont's small- and medium-sized farms in the face of the FSMA PSR. The project plan was adjusted mid-term to adapt to the need for development of appropriate near-term solutions.

Based on our review of stakeholder need and available solutions, we developed parallel path focused on near-term, highly flexible solutions that would be most beneficial to Vermont's small and medium-sized producers using standardized spreadsheets and open-source web-based record keeping as follows.

1. Standardized Spreadsheets - Some farms have developed customized spreadsheet based solutions that integrate farm planning and tracking. These solutions are likely to remain the best option for early adoption of digital tracking and traceability in the near term among those farms that currently have no digital system. The project aggregated and standardized spreadsheet based approaches to planning and tracking resulting in a set of Google Sheets.
2. FarmOS Open-Source - In parallel with the development of simple standardized spreadsheets, the open-source approach by FarmOS was leveraged to provide a tailored, cloud-based, and mobile / responsive solution that integrates with whole-farm record keeping and management.

The project has successfully developed prototype record keeping systems according to this re-plan. A set of Google™ Sheets have been developed to allow easy capture of required records on any device. Additionally, a new Produce Safety module has been developed for FarmOS. The two approaches have also been developed to integrate with each other using comma-separated-variable (CSV) format data import and export.

These tools provide necessary guidance and functionality to log farm activities related to food safety and to initiate the necessary data stream to allow for produce tracking and traceability.

Our next steps include outreach and pilot testing of each approach. We have also identified future work related to the need for (1) automated lot number generation, (2) improved off-line access to FarmOS, (3) improved integration with QuickBooks™, and (4) improved integration with label printing systems.

# Project and Activity Overview

## The Project

Effective food traceability is increasingly important for Vermont produce growers. Large wholesale buyers have begun to demand produce traceability systems, and many additional grocery stores and distributors are expected to require produce traceability over the next few years. These market demands for traceability are being driven by federal legislation in the form of the Food Safety Moderation Act (FSMA) Produce Safety Rule (PSR) and food safety concerns as well as ingredient certifications such as organic and GMO-free labeling.

Most Vermont specialty crop producers do not have the financial means to research tools and techniques to comply with these food traceability requirements. The “Vermont Produce Traceability Project” aimed to enhance food safety in Vermont’s food system by identifying traceability systems appropriate to produce growers at varying scales and piloting these systems with farmer partners in order to provide a suite of traceability solutions to produce growers and service providers in Vermont and promote adoption of produce traceability systems.

## Goals

In order to achieve this intent, the following **project goals** were established:

1. **Improve understanding** of the current state **of information technology** systems and knowledge in place and in use **on VT farms**.
2. **Increase** grower and service provider **knowledge of produce traceability requirements** related to the tracking needs of the sector across all scales of production and compliance regimes.
3. **Increase** grower and service provider **knowledge of available produce traceability solutions**.
4. **Provide a suite of pilot-tested produce traceability solutions** appropriate for Vermont farms at varying scales to growers and service providers.

## Objectives

The project was originally conceived to achieve these goals through the pursuit of the following **objectives**:

1. **Analyze & Summarize:** Analyze and summarize data already collected as part of the Vermont Digital Traceability Project for Produce Growers (grower surveys, buyer interviews, list of digital technologies). Publish an interim report and share with produce and service provider networks.
2. **Identify Potential Traceability Solutions:** Develop a short list of technology solutions including paper-based, DIY spreadsheet, and commercially available options.
3. **Pilot:** Engage six farmer partners in the research and demonstration project who will commit to exploring potential solutions in order to screen their functionality and ease of use.
4. **Report & Share:** Create a fact sheets outlining requirements for produce tracking and a consolidated summary report of produce traceability solutions. Share with produce and service-provider networks.

Based on the results of activities completed under objectives 1 & 2, the project plan was adjusted to focus on development of an improved paired solution of spreadsheet templates and a FarmOS-based

produce safety module. Trial licenses have been obtained under the funding provided for this project to enable pilot testing of the new module by 6 Vermont farms beginning in Winter 2017/2018.

## Accomplishments & Milestones

Progress toward project goals is summarized in the table below. Details of each activity is provided following the table.

#	GOAL	BENCHMARK	PERFORMANCE MEASURES, TARGET and <b>STATUS</b>
1	Improve understanding of the current state of information technology systems and knowledge in place and in use on VT farms.	Survey work completed in Phase I	USER SUMMARY - Current information systems and knowledge related to produce traceability on VT farms will be summarized in an interim report to inform project execution, educational approaches and farm decision making. The report will be published on the project website and shared within producer and technical service provider networks. (400 contacts). <b>STATUS: The survey review was completed early 2017. This is summarized in the current report below. It was presented at the 2017 VVBGA Winter Meeting (250 contacts). To be published on UVM Extension Ag Engineering Website following sponsor review and feedback.</b>
2	Increase grower and service provider knowledge of produce traceability requirements related to the tracking needs of the sector across all scales of production and compliance regimes.	No benchmark currently exists.	REQUIREMENT SUMMARY - A consolidated summary of produce traceability requirements is created that provides clarity for producers and technical service providers related to the tracking needs of the sector across all scales of production and compliance regimes. A fact sheet/report is developed to codify this knowledge and is distributed via project website and producer and technical service provider networks. (400 contacts) <b>STATUS: The Produce Safety Alliance Training modules, FSMA Produce Safety Rule, and USDA GAPS Checklists were reviewed to summarize record keeping requirements. A set of functional requirements was developed and is detailed below. These were presented at the 2017 VVBGA Winter Meeting (250 contacts) and will be published on the UVM Extension Ag Engineering Website.</b>
3	Increase grower and service provider knowledge of available produce traceability solutions.	No benchmark currently exists.	RECRUITMENT - Six (6) farms are engaged as partners in the research and demonstration project and commit to exploring potential solutions over the winter period in order to screen their functionality and ease of use.  SCREENING - Six partner farms perform a solution screen task during the winter months to review potential solutions "in-situ", on-farm. The Project Tech provides direct support as required. Summary results are shared within the project cohort at a facilitated session.  An interim report is created to summarize these findings and is published on the project website and share with producer and technical service provider networks (400 contacts).

			<p><b>STATUS: This summary information was presented at the 2017 VVBGA Winter Meeting, the relative lack of strongly aligned commercial-off-the-shelf (COTS) solutions has led to a re-plan of the project activity focused on development of appropriate tools as detailed below.</b></p> <p>A live panel session is planned as part of the 2017 Winter VVBGA meeting which will summarize project findings via a Farm Partner panel. (200 contacts). <b>STATUS: The live panel was not held due to the lack of suitable commercial, off-the-shelf solutions for piloting.</b></p>
4	Provide a suite of pilot-tested produce traceability solutions appropriate for Vermont farms at varying scales to growers and service providers.	No benchmark currently exists.	<p>Farm Partners and Project Team gain direct knowledge of various solutions through screening process. Project team and Partner Farms present interim findings at VVBGA Winter Meeting to 200 farmer peers. <b>STATUS: A summary of requirements and available software tools was presented, there is a relative lack of aligned tools for the set of requirements developed.</b></p> <p><b>STATUS: The project team determined an appropriate path forward was to focus on (1) collection, review, consolidation and distribution of farmer-developed spreadsheet approaches to tracking and (2) support of the FarmOS open-source, Drupal platform for farm data management. The remaining project time and budget was focused on this effort.</b></p> <p>PILOT - Six Farm Partners adopt a suite of solutions on a pilot basis during the Spring/Summer production season. A final report is created to summarize findings and is published on the project website and share with producer and technical service provider networks (400 contacts). A live panel session is planned as part of the 2018 Winter VVBGA meeting which will summarize project findings via a Farm Partner panel. (200 contacts). <b>Planned for Winter 2017/2018 focused on the spreadsheet and FarmOS platforms.</b></p> <p>Educational materials are revised with improved project information to increase practitioner knowledge of the traceability needs. <b>STATUS: To be completed according to change in project path.</b></p> <p>Project findings are documented as a report for future reference, fact sheets for educational programming, and tools and templates for DIY approach. <b>STATUS: Completed with this report and summary presentation on the UVM Ag Engineering Website. Conference and meeting presentations are planned for the winter meeting season in Vermont and in other states.</b></p>

## Performance Relative to Goals

Goal #1 - Improve understanding of the current state of information technology systems and knowledge in place and in use on VT farms.

A survey was deployed in January of 2015 and received 38 responses. For most farmers, data tracking was being done with a mix of paper and electronic means. Most growers were frustrated with the current way it was being done and wished they had a better way.

The survey previously conducted as part of this project yielded informative results in several areas.

**FARMS** - Technology use on the farm is high in Vermont with 100% of respondents using a computer on their farm, 76% using a smartphone or tablet, and 34% already using a smartphone in the field as part of their harvesting records system.

The main obstacle to record keeping among farmers were noted as;

- TIME - "Lack of time." "Time constraints" "Very time consuming to keep up all the records."
- CAPACITY - "Small operation, only two of us"
- AVAILABLE SOLUTIONS - "Lack of a good system."
- EASE OF USE - "Need a system that is easy to use." "No easy to use record keeping infrastructure."
- OPERATIONAL COMPLEXITY / DIVERSITY - ... "we often harvest 50+ varieties from 6+ different fields" "small amounts of same crop from multiple plantings in different plots" "different size containers"

Based on this feedback, a key guiding principle for any record keeping solution is: **Make it quick, easy, and flexible.**

Farmers noted the need for help in the following areas (with percent of respondents requesting each noted).

- 92% Interested in a tracking system
- 50% Training
- 48% would be interested in a computer-only or smartphone based system.
- 37% Interested in a paper-based system as well as a computer / smartphone system
- 34% Technical Assistance

**BUYERS** - With a high proportion of respondents selling through wholesale channels (82%), the buyer's perspective was important to capture. Buyers reported shipping into New England, NY and Canada. At the time, cases were not required to have labels but buyers noted moving in that direction with product, quantity, and farm name required. Buyers requested that invoices contain product, quantity, farm name and address, date of harvest. Most buyers were using a paper system for tracking now but switching to barcode or other electronic tracking systems. Buyers noted the following frustrations with the current produce tracking approach;

- LABELS - "Would like to see labels." "No product identification." "Old labels from repacking into old boxes." "Not saying what is in the box."
- LEGIBLE INVOICES - "Scrawled invoices."
- "Invoice being used as bill of lading."
- "Math not being correct."

In summary, Buyers were voicing a desire for growers to be able to: **Accurately label what you send us.**

Goal #2 - Increase grower and service provider knowledge of produce traceability requirements related to the tracking needs of the sector across all scales of production and compliance regimes.

Lot tracking and traceability refers to the ability to track produce “one up and one down”, i.e. to be able to quickly and reliably know to whom an entire lot of produce was sold (possibly multiple customers), and to know where it came from. There are many ways to assign lot numbers, and this becomes a balance between fine resolution of lot numbers (i.e., having many lots in order to limit the economic impact of a recall) and the record keeping and operational burden associated with that (i.e. opting for a single, large lot like “date of harvest”). The risk with the latter is that an entire day of harvest (and sales revenue) may be exposed during a recall instead of, perhaps, a subset of the harvest assigned a wash/pack batch lot number.

Ultimately, the ability to assign finely resolved lot numbers depends on the level of detail of data and record keeping related to farm operations.

For this reason, lot tracking and traceability are inherently linked to farm record keeping and data systems.

To determine the requirements for data management in these systems, the FSMA PSR, USDA GAP, and Vermont CAPS programs were reviewed for documentation requirements that would impact tracking and traceability.

Six (6) main areas of record keeping emerged from this review as noted below. This list is not intended to replace the information provided in the final PSR, associated PSA trainings, or other produce safety systems. It is included here in summary form only for ease of reference and to frame the current project.

### **FUNCTIONAL REQUIREMENTS**

1. **Worker Health, Hygiene and Training** - Monitoring restroom and hand wash facility provision, records of cleaning and stocking, as well as maintaining first aid kits, is required. Records of training employees in sanitation, harvest protocols, and incident response are required. Proper documentation includes the name of trainer, materials/information covered, printed names and signature of attendee, and manager signature.
2. **Soil Amendments** - The type and source of the amendment, rates and date of application, and handling and sanitation practices should be documented. If amendments are purchased from a third party, supplier contact info, what was purchased, date, amount, and lot number should be recorded. The supplier should also document that they have used scientifically validated treatment process and monitoring. Compost also requires documentation as a soil amendment. Key records include length of composting, temperatures, turnings, and any additional processing steps.
3. **Land Assessment** - A map of the farm with the locations of all production plots is recommended as well as pre-planting land assessment for contaminants, animal activity and any mitigating actions taken. Before harvest, a pre-harvest risk assessment should be conducted that inspects for animal intrusion and contamination, and any other contamination and records of any corrective action

taken. Growers need to document if there is any visible source of contamination such as flood, chemical spill, sewage spill, or animal and any corrective actions taken.

4. **Production, Pre-Harvest and Harvest Water** - If surface water is used for irrigation, an initial microbial water quality profile (MWQP) has to be developed with 20 or more tests over a period of 2 to 4 years. 5 new samples are rolled into that profile every year after an initial survey. If using water from a public water supply, a report from the water utility is sufficient. If groundwater is used, then 4 samples over 1 year are required with an additional samples rolled into the data set each year. Corrective measures have to be recorded as well as scientific data or information to support compliance including treatment, calculations, and testing.
5. **Postharvest Water** – Packing house water also requires microbial water quality profile testing. The tests should show no detectable generic E. Coli in 100 mL samples. Packing house water should be tested and documented for quality, pH, temperature, and turbidity. Also, if an antimicrobial solution is used, the rate, frequency and type needs to be recorded.
6. **Postharvest** - Records need to be kept related to postharvest handling, storage and shipping. A map of the flow of product through the wash area, with clearly designated zones of contact may be helpful. Cleaning, sanitizing and clean break protocols, and cooler temperature monitoring need to be recorded. In addition, records of worker training on cleaning and sanitation, pest management strategies and implementation, and vehicle cleaning and inspections need to be maintained.
7. **Food Safety Plan** – The FMSA PSR does not require a food safety or traceability plan but they are highly recommended. In the software requirements, we are requiring that it be possible to track or upload a food safety plan.
8. **Document Center** – Although not required by the FSMA PSR, a document center was noted as being helpful for documenting other things not easily captured elsewhere. This would allow you to upload pictures, maps, policies, SOPs, training records, emergency contact info, supplier and buyer contact information, and recall and food safety plans. Furthermore, this is a way to help growers bridge between paper record keeping systems and digital platforms.

## **OTHER REQUIREMENTS**

Our review of prior survey results, combined with direct grower feedback and interviews resulted in other requirements beyond the functional requirements noted above.

1. **Ease of Use** – Growers clearly noted the need for the software to be intuitive and easy to use. That is one of the reasons we required that comma-separated-variable (CSV) import and export be provided by solutions. The intent is to avoid having to spend hours on data input that could be done easily by uploading existing planting and harvest planning spreadsheets that are already in use.
2. **Cost** - The software solution needs to be affordable for farmers. Most solutions were quite affordable in the \$100-300 range, but some of the larger farm produce traceability options ran into the several thousand dollar range with a yearly access fee. This also has been a limitation of prior summaries of available solutions; they tend to focus on larger scale, more expensive options that are less relevant to small and medium-sized growers such as those in Vermont.
3. **Multi-language Support** - For many US farm workers English is a second language. It is important that solutions support at least English and Spanish.
4. **Quickbooks™ Integration** – Quickbooks™ is generally the industry standard accounting software. It was important for the produce tracking solution to have good integration capability with this platform.

5. **Mobile and Off-network Friendly** - It is important for growers to be able to access the data and be able to enter data in the field where they may not have internet connectivity. This is especially important to growers that live in Vermont and this was something that the survey indicated was important.

Goal #3 - Increase grower and service provider knowledge of available produce traceability solutions.

#### Summary

The project team reviewed over 65 software solutions considered to be relevant to the need for produce tracking and traceability. This review took the form of web-based research, gathering grower / user experiential learning via phone interview, using trial / sample accounts of solutions and attending training webinars on products. This list was quickly narrowed down to 14, but several new options were added when research uncovered new information. The final number of solutions that we researched extensively was 17. Out of the 17 that were researched, 6 were noted to have continued merit.

Some of the software that was immediately discarded was outside our scope, such as software that would help do record keeping but wasn't tailored to the produce industry. Others were targeted at larger scale operations with implementation costs of tens of thousands of dollars.

#### Background

Currently, most software being made for the produce industry falls into one of three areas:

- Traceability,
- Enterprise Resource Planning (ERP), or
- Farm Production Planning.

**Traceability Software** - Traceability software is currently being implemented across the country in many larger operations as evidenced by the Produce Traceability Initiative (<http://www.produce-traceability.org>). There are over 30 traceability solutions on the market today in this dynamic marketplace. The Institute of Food Technology commissioned a report (McEntire, 2012) in cooperation with the FDA that discussed in detail the current state of the industry and what was required to implement traceability in several different production systems. This work is mainly focused on larger scale, national systems and often is out of reach of regional or smaller scale operations. We reviewed several traceability software solutions in the hope that they would be relevant to this project's target audience. Products reviewed in this category included:

- Foodlogiq
- HarvestMark
- Redline Field

**ERP Software** - ERP or Enterprise Resource Planning / Management software is used by an organization to manage the business and automate back office functions. This software is used to track and direct the flow of product in wholesaler's warehouses. We looked into this software, but most of it was capable of only tracking produce once it landed in the packhouse or wholesalers dock. Frequently, traceability is built into this software, but several other produce specific requirements proved elusive.

Products reviewed in this category included

- Farmsoft
- Produce Pro Software
- PTIPRINT
- VirtualOne Software

**Farm Production Planning Software** - Farm production planning software is designed to manage the deployment of resources and track different metrics of the farm. Operations like field prep, seeding, irrigation, harvest and worker time allotments are often captured or recorded in these systems. Much of this software is geared toward the small grower but does not yet include the food safety requirements identified above.

Products reviewed in this category included

- Farm Produce Manager
- FarmERP
- TEND
- Agrivi
- FarmOS
- Agsquared
- GAPpro/COGpro

The initial list of 60 solutions were reviewed with 17 selected for further study. These were further filtered to 6 for more detailed review. These final candidates were ranked according to the requirements developed and summarized above. The result of this ranking is provided in Table 1.

#### Methods

After identifying a software solution as a good fit the company was contacted for a demo of the software. Project background and goals were provided. Most software companies provided demonstrations of the software, but some did not. Some software looked like it would work very well, but the company refused to provide a demo and/or were hard to get information from. Other companies required a non-disclosure agreement to discuss their software with us.

Interestingly, compost is a topic most software companies haven't considered. Currently, most software solutions treat it as a soil amendment but don't provide functionality to record more details for it than that. After reviewing the FSMA PSR requirements for record keeping, the functionality of compost tracking should be implemented with ease. Key data are the length of composting, temperatures, turnings, and any additional processing steps.

Results

The final scoring and ranking of systems is provided in Table 1.

	Farm planning focused			Focused on both		Traceability focused
Name of Product	AgSquared	FarmOS	Tend	GAP Pro	HarvestMark	Foodlogic Q
Geared towards	Small/medium	Small/medium	Small/medium	Small/medium	Large	Large
<b>Overall Rating</b>	<b>37</b>	<b>32</b>	<b>21</b>	<b>37</b>	<b>35</b>	<b>37</b>
<b>General Functional Requirements</b>	<b>19</b>	<b>12</b>	<b>9</b>	<b>14</b>	<b>17</b>	<b>18</b>
Cost (\$)	299+	50+imp	Free	129/year	1000+2000+ imp	??+ imp
CSV upload	3	2	Implementing	0	3	2
Mobile Friendly	4	3	4	4	3	4
Mobile off-network	4	1	Implementing	0	3	4
Bilingual ability	4	1	4	4	3	4
Ease of use	2	2	1	3	2	1
Data export?	2	3	Implementing	3	3	3
QuickBooks, etc. integration?	Yes	In progress	Planned	No	Yes	Yes
Purpose built for GAP/FSMA?	No	No	No	Yes	Yes	No
Customization	Yes, for a fee	Yes, for a fee, but also open-source	Open to feedback	Yes and No	For a fee	For a fee
<b>FSMA / PSR requirements</b>	<b>18</b>	<b>20</b>	<b>12</b>	<b>23</b>	<b>18</b>	<b>19</b>
Employee training and health	3	3	Implementing	4	3	3
Soil amendments	4	4	3	4	3	3
Compost	2	2	2	2	1	1
Land Assessment	3	3	1	3	3	2
Water	2	3	2	4	3	4
Harvest and Traceability	2	2	2	4	3	4
Document Center	2	3	2	2	2	2

Table 1 - Summary Ranking of Final Commercial System Options

Goal #4 - Provide a suite of pilot-testing produce traceability solutions appropriate for Vermont farms at varying scales to growers and service providers.

Unfortunately, based on the work described above we found that there were no strong options for commercially available software systems that support the anticipated needs of produce tracking among Vermont's small- and medium-sized farms in the face of the FSMA PSR.

There are a number of available solutions which made it into the final round of review. However, they fail to provide a one or more critical functions as noted below.

- AgSquared – Limited focus on food safety (FMSA PSR/GAP)
- FarmOS – Limited focus on food safety (FSMA PSR/GAP)
- Tend – Limited focus on food safety (FSMA PSR/GAP), still developing functionality.
- GAPPro – No CSV import which increases the burden of setup on the part of users and also no off-network access.
- HarvestMark – Focused on larger, higher capital farms. Limited compost focus. Vendor never provided a trial version for testing.
- FoodLogicQ – Challenges with ease of use / user experience. Cost is not clear.

We felt strongly enough about the lack of alignment that we did not pursue pilot trials of any of the commercially available options.

Based on our review of stakeholder need and available solutions, we developed parallel path focused on near-term, highly flexible solutions will be most beneficial to Vermont's small and medium-sized producers using standardized spreadsheets and open-source web-based record keeping as follows.

1. Standardized Spreadsheets - Some farms have developed customized spreadsheet based solutions that integrate farm planning and tracking. These solutions are likely to remain the best option for early adoption of digital tracking and traceability in the near term among those farms that currently have no digital system. The project aggregated and standardized spreadsheet based approaches to planning and tracking to include summarization of best practices from current users.
2. FarmOS Open-Source - In parallel with the development of simple standardized spreadsheets, the open-source approach by FarmOS was leveraged to provide a tailored, cloud-based, and mobile / responsive solution that integrates with whole-farm record keeping and management.

## FarmOS Produce Safety Module

Following a mid-project review and re-plan, our work focused on the development of a Produce Safety Module for FarmOS. Although development within this platform was required to be completely aligned with the user functional requirements, the platform benefits from several features we felt were important. Specifically, the platform is farmer-driven, flexible, open-source, based on a strong underlying data architecture and already had several of the functional requirements identified in the development queue. The

ensuing project activity involved direct engagement with Michael Stenta the creator and curator of FarmOS. Along with this development effort, the team also developed spreadsheet templates in Google Sheets. These spreadsheets provide a ready-made collection of record keeping sheets that can document produce safety activities on their own or be imported as comma separated variable (CSV) format files into FarmOS. The spreadsheets can also be imported into Excel™ or other spreadsheet applications.

The Produce Safety module for farmOS provides produce safety related record keeping functionality. This new “community module” sits on top of the main farmOS platform and utilizes many of the core architectural elements such as Areas, Assets, Logs and People while also making use of other specific system features, including Plantings, Equipment, Compost, and various log types. The goal was to leverage the common record keeping capabilities that were already provided by farmOS, and extend them to facilitate record keeping requirements that are specific to the Produce Safety Rule and other produce safety requirements that may develop in the marketplace.

The Produce Safety Module is structured according to the functional requirements noted above as follows.

### [Dashboard](#)

The module provides a Produce Safety Dashboard (available as a tab within the farmOS dashboard) which acts as an organized starting point for produce safety record keeping. Documents and files that are specific to the operation’s food safety plan and procedures can be uploaded to the dashboard for storage and easy reference.

Quick links are provided for managing records within each of the 5 main produce safety focus areas (described below).

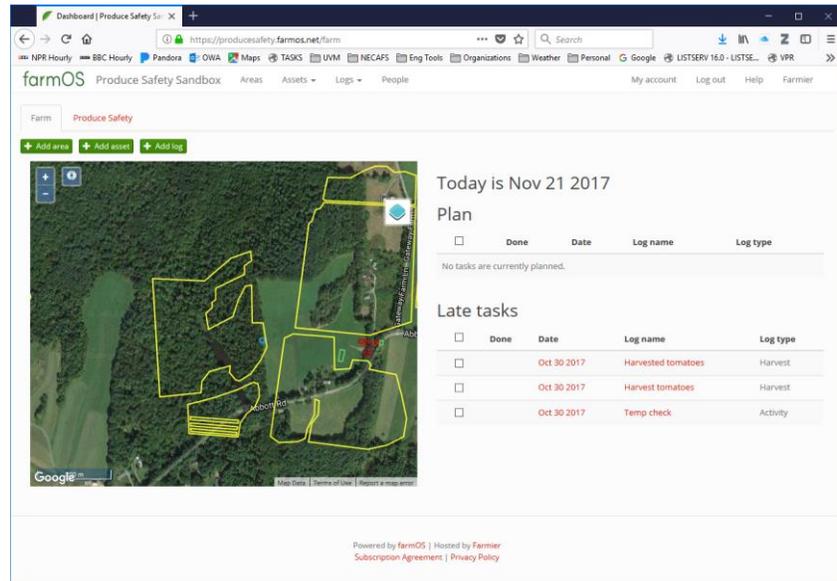


Figure 1 - The main landing page for a FarmOS account shows the farm map and upcoming scheduled tasks. Note the "Produce Safety" tab that links at the Produce Safety Dashboard described below.

Logs that are added via the quick links will automatically be assigned to the "Produce Safety" category for easier lookup in the future (as well as additional categories that may be specific to the activity being recorded). Remember that farmOS can be used for more than just Produce Safety record keeping, so it is up to the user to keep records organized in a way that makes them easy to find for management and reporting purposes.

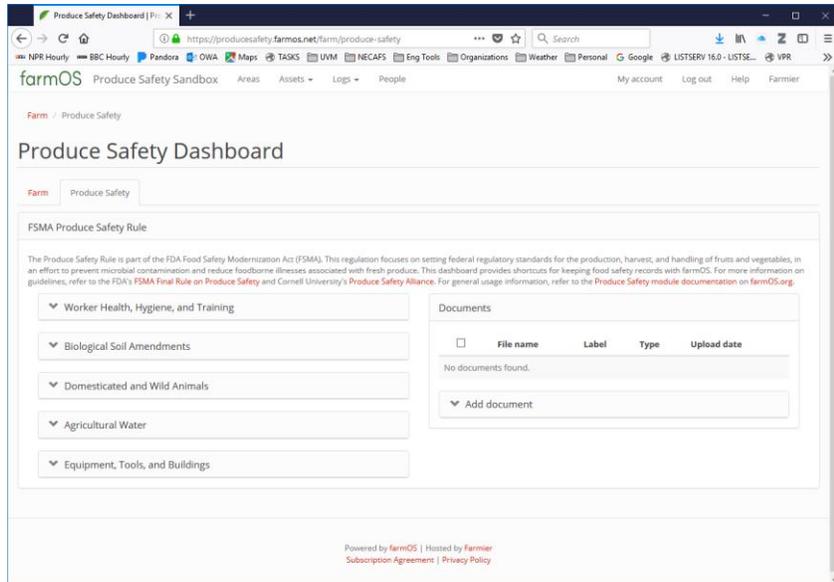


Figure 2 - The Produce Safety Dashboard provides quick links to the key produce safety related focus areas and any content uploaded to the document center.

### Focus areas

The record keeping requirements are divided into five main focus areas; worker health and hygiene, biological soil amendments, domesticated and wild animals, agricultural water, and equipment, tools & buildings.

### Worker Health, Hygiene, and Training

This focuses on maintaining records to demonstrate that farm workers are properly trained, are provided with stocked and sanitary facilities, and any health problems are properly documented.

In addition to the core log types provided by farmOS, the Produce Safety module adds two that are specific to the Produce Safety Rule's record keeping requirements, which focus on farm workers:

Training logs are used to record details about training sessions that are attended by workers on the farm. Training logs can include a list of attendees, trainer(s), and details about the material that is covered.

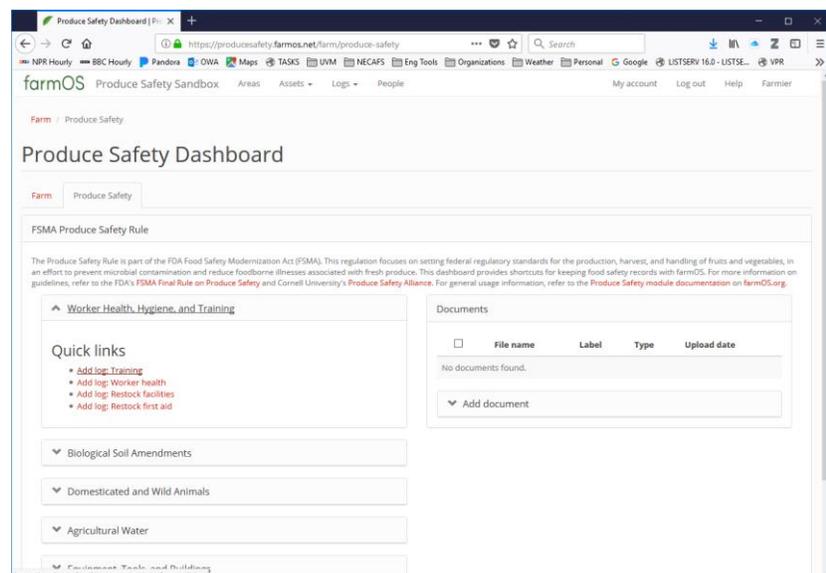


Figure 3 - Quick links such as "Add log: Training" are provided in the dashboard.

Log Training | Produce Safety Sandbox

https://producesaf... 90%

farmOS Produce Safety Sandbox Areas Assets Logs People My account Log out Help Farmer

Add log / Log Training

## Log Training

General information

Date \*

Month \* Day \* Year \* Hour \* Minute \* Second \*

Nov 4 2017 11 41 13

Training topics \*

Hand washing and sick leave policy

Summarize the topics covered by this training. More details should be provided in the "Training materials" field below.

Training materials

Hand washing poster from National Gaps Program  
Farm Sick Leave policy

Include training materials and provide an outline of the training topics discussed. Also reference any relevant SOPs or sections of your farm produce safety plan that apply.

Trainer

- None -  
John Doe - johndoe@foodsafety.farmos.net  
Jane Doe - janedoe@foodsafety.farmos.net  
Chris Callahan - chris.callahan@uvm.edu

Who is administering the training?

Attendees

- None -  
John Doe - johndoe@foodsafety.farmos.net  
Jane Doe - janedoe@foodsafety.farmos.net  
Chris Callahan - chris.callahan@uvm.edu

Select all people who attended this training.

Location

Notes

Category

File attachments

Log status

Mark this log as done.

Done

Save log

Figure 4 - A typical training log. Each section heading with "v" can be expanded to include more detailed information and file attachments such as a smartphone picture of a roster or sign in sheet for easy record keeping.

Worker health logs are used to record incidents related to worker health. Injuries or illnesses that occur on the farm should be recorded with these logs, and should be related to the specific area(s) that they may have occurred in.

Activity and/or observation logs should be used to record checking and restocking of first aid and facilities.

#### Biological Soil Amendments

All soil amendments should be recorded with input logs. Soil test logs should be used to keep track of any lab tests that are performed.

If compost is being produced on the farm, it is necessary to keep records of production time, temperature measurements (via observation logs), and pile turnings (via activity logs), to ensure that the compost was produced in a manner that reduces the risk of biological pathogens. Logs should be tagged with both the "Produce Safety" and "Compost" or "Soil" categories, as appropriate.

#### Domesticated and Wild Animals

If domesticated animals are present on the farm, they should be managed as Animal assets in farmOS.

Risk assessment should be performed (and recorded via observation logs) before planting and before harvest, to reduce the risk of contamination.

If intrusions or contaminations are observed, they should be recorded as observation logs. Corrective actions should be recorded as activity logs. Logs should be tagged with both the "Produce Safety" and "Animals" categories.

#### Agricultural Water

Water test logs should be used to record lab tests that are performed on water. This includes both field water (pre-harvest) and water that is used to wash produce before packing (postharvest).

Any corrective actions that are taken should be recorded as activity logs with categories of both "Produce Safety" and "Water" (these categories are applied automatically by the quick links within the Produce Safety dashboard).

#### Equipment, Tools, and Buildings

All areas relevant to produce safety (fields, buildings, facilities, etc) can be managed as Areas in farmOS. Tools and equipment can be managed as Equipment assets.

When areas or equipment are cleaned/sanitized, this should be recorded as an activity log with the "Produce Safety" category applied.

## Summary of Activities

Phase	Work Plan Project Activity	Related Objective	Who will do / has done the work?	When will the activity be accomplished / What is the status of the activity?
	Project Phase I	#1 Analyze and Summarize	Stan Ward (Original PI)	October 2014–April 2016
	Project Phase II		Chris Callahan (Current PI)	September 2016–September 2017
I	Survey Vermont produce growers to gain an understanding of (A) current level of traceability being performed and (B) the digital technology requirements and constraints of Vermont produce growers.	#1 Analyze and Summarize	Stan Ward led the survey work, including the survey design, development, outreach, and administration.  Ginger Nickerson assisted in the survey design, development, and outreach.	Survey work completed as of December 2015. Analysis to be completed in Phase II. <b>Done previously in 2015/2016.</b>
I	Research digital food traceability solutions available to Vermont produce growers through internet research and survey results.	#2 Identify Potential Traceability Solutions	Stan Ward	Initial list of digital technologies completed as of December 2015. Analysis and summary to be completed in Phase II. <b>Done previously and updated in current phase as noted above.</b>
II	Analyze and summarize survey work from Phase I	#1 Analyze and Summarize	Chris C. & Project Tech	9/1-9/30/2016. <b>Done</b>
II	Recruit Project Tech	General	Chris C.	9/1-9/30/2016. <b>Done.</b>

Phase	Work Plan Project Activity	Related Objective	Who will do / has done the work?	When will the activity be accomplished / What is the status of the activity?
II	Recruit Farmer Partners (6) of diverse scale and operation to represent state.	#3 Pilot	Chris C. & Project Tech	9/1-10/31/2016. <b>Our plan is to engage 6 farms with The Google Sheets developed and/or trial licenses of FarmOS using the new Produce Safety Module beginning in Winter 2017/2018.</b>
II	Draft summary requirements for produce tracking from (a) VT-CAPS, (b) USDA GAPS, (c) FSMA Produce Safety Rule and (d) farmer partner input / user needs to (1) direct project and (2) provide a fact sheet as output.	#1 Analyze and Summarize	Chris C. with Farmer Partner input	9/1 – 9/15/2016. <b>Done.</b>
II	Draft summary short list of technology solutions including (a) paper-based, (b) DIY spreadsheet template and (c) commercially available options.	#2 Identify Potential Traceability Solutions	Chris C. and Project Tech	9/1-10/31/2016. <b>Done.</b>
II	Work with Farmer Partners to determine appropriate trial solution(s) for them to explore (1-2) and establish access to trial formats.	#3 Pilot	Project Tech and Chris C. with Farmer Partners	11/1-12/31/2016. <b>Our plan is to engage 6 farms with The Google Sheets developed and/or trial licenses of FarmOS using the new Produce Safety</b>

Phase	Work Plan Project Activity	Related Objective	Who will do / has done the work?	When will the activity be accomplished / What is the status of the activity?
				<b>Module beginning in Winter 2017/2018.</b>
II	Farmer Partner test runs and down selection (winter season).	#3 Pilot	Farmer Partners	1/1/2017-2/28/2017. <b>Postponed based on findings from prior activities. Our plan is to engage 6 farms with The Google Sheets developed and/or trial licenses of FarmOS using the new Produce Safety Module beginning in Winter 2017/2018.</b>
II	Sharing Session #1 – Farmer partners share lessons learned from trial runs. Perhaps as part of VVBGA Winter Meeting.	#4 Report and Share	Project Tech and Chris C to coordinate, Farmer Partners to attend and share.	2/15/2017. <b>Our plan is to engage 6 farms with The Google Sheets developed and/or trial licenses of FarmOS using the new Produce Safety Module beginning in Winter 2017/2018.</b>
II	Regroup with Farmer Partners to confirm tool to be used in growing season.	#3 Pilot	Project Tech and Chris C. with Farmer Partners	<b>Replaced with following item due to project findings.</b>
II	<b>NEW: Determined an appropriate path forward focused on (1) collection, review, consolidation and distribution of farmer-</b>	#2 Identify Potential Traceability Solutions and	<b>Project Tech, Chris C, Partner Farmers and FarmOS team.</b>	<b>July 1, 2017. Completed. August 2017. Our plan is to engage 6 farms with The Google Sheets developed and/or trial licenses of FarmOS</b>

Phase	Work Plan Project Activity	Related Objective	Who will do / has done the work?	When will the activity be accomplished / What is the status of the activity?
	<b>developed spreadsheet approaches to tracking and (2) support of the FarmOS open-source, Drupal platform for farm data management.</b>	#3 Pilot		<b>using the new Produce Safety Module beginning in Winter 2017/2018.</b>
III	Farmer partner use of selected tool in Spring / Summer season	#3 Pilot	Farmer Partners with TA from Project Tech	<b>4/1-7/31/2017. Our plan is to engage 6 farms with The Google Sheets developed and/or trial licenses of FarmOS using the new Produce Safety Module beginning in Winter 2017/2018.</b>
III	Sharing Session #1 – Farmer partners share lessons learned from trial runs	#3 Pilot	Project Tech and Chris C to coordinate, Farmer Partners to attend and share.	<b>8/15/2017. To be scheduled following initial trial period.</b>
III	Revisions to Fact sheet	#4 Report and Share	Chris C. and Project Tech	<b>8/15/2017. Project summary and overview of spreadsheet and FarmOS solution has been posted on UVM Ag Engineering site as a living fact sheet.</b>
III	Project Reporting	#4 Report and Share	Chris C.	<b>9/29/2017. Complete with this report.</b>
	Project End			August 31, 2017

Phase	Work Plan Project Activity	Related Objective	Who will do / has done the work?	When will the activity be accomplished / What is the status of the activity?
	Final Report Submitted to Vermont Agency of Agriculture	#4 Report and Share	Chris C.	September 29, 2017

## APPENDIX – DETAILED PRODUCT REVIEWS

### Options Eliminated During Second Round Review

#### FarmERP

This is an Indian based and owned company which makes farm management and sales software for companies mainly based in Asia, Africa and Europe. No one is using this in the US. It covers most of the requirements, but lacked mapping and compost tracking. Major reasons for disqualifying it were the trouble in getting support with the time difference and high cost. Deployment for a small farm was estimated at \$2500+.

#### Agrivi

This is a European based company which is more focused on large vegetable and row crop farms. It was eliminated because the software only allows one crop per field per year, which differs from cultural practices in our region. It also had a customization cost. GAP compliance was built in.

#### FARMDATA

FARMDATA is a web-based database system for entering and reporting crop production records, including seeding, transplanting, harvest, cover crop, compost, fertilization, irrigation, pest scouting, spray activities, packing and distribution records and customer invoicing. It was eliminated based on lack of support and no customization for FSMA or GAPS. It is solely a farm management system and there are no plans on implementing food safety.

#### Red Line Field

RedLine Field™ is a complete solution that enables grower shippers to meet case labeling traceability requirements for field-packed items. It captures and manages traceability information from harvest to delivery at the cooler. The system provides flexibility for different commodities and harvest methods, and helps companies gain real-time insight into harvest operations and crew productivity. It was eliminated as it only covers harvest and after, no water measurements, amendment tracking, worker training, etc.

#### Produce Pro

PRoduce PRO is a ERP warehouse solution that covers accounting, shipping, pricing, inventory control, traceability, repacking and processing. It was eliminated as it doesn't cover the core FSMA requirements except packhouse management.

#### PTI Print

Another ERP warehouse solution which did a fine job of traceability and management but lacked key FSMA field requirements. Eliminated as it doesn't cover field actions at all, only postharvest solutions.

## Foodlink

Another ERP and logistics software solution. This is designed to manage from the packhouse to the end retailer, giving insights into sales, and helping streamline the back office. Eliminated as it doesn't cover the core FSMA requirements except packhouse management.

## ADKsystems

This is a farm management software developed closely with Jean Paul Cortens at Roxbury Farm. It allows crop scheduling, calculating seed requirements, aggregate distribution among many other things. Eliminated as it doesn't cover many core FSMA requirements.

## Farmsoft

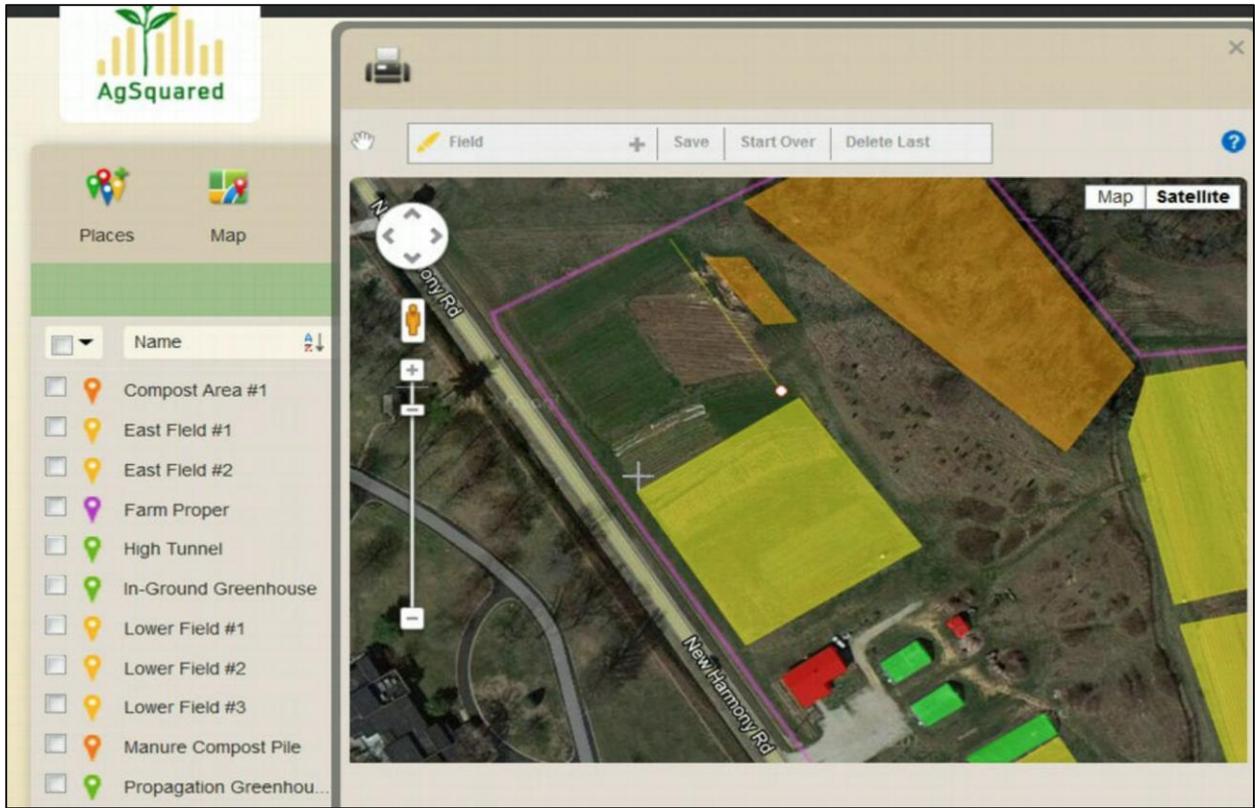
Farmsoft stood out from the beginning as a software that offered much promise. It clearly had GAP compliance in mind when building out the software and did very well from looking at the website and product literature. Unfortunately, the company was very hard to deal with. We had no luck getting them to demo the product for us or talking to someone on the phone. In fact, the representative wanted to only answer questions through email and told us multiple times we weren't big enough to work with them. The cost was substantially high as well. The software would have cost an estimated \$8000 per year with 25% of software cost being used to calculate the yearly maintenance and support fee. Each additional user cost \$350. Additionally, it didn't work off-network.

## Options Reviewed in Final Round

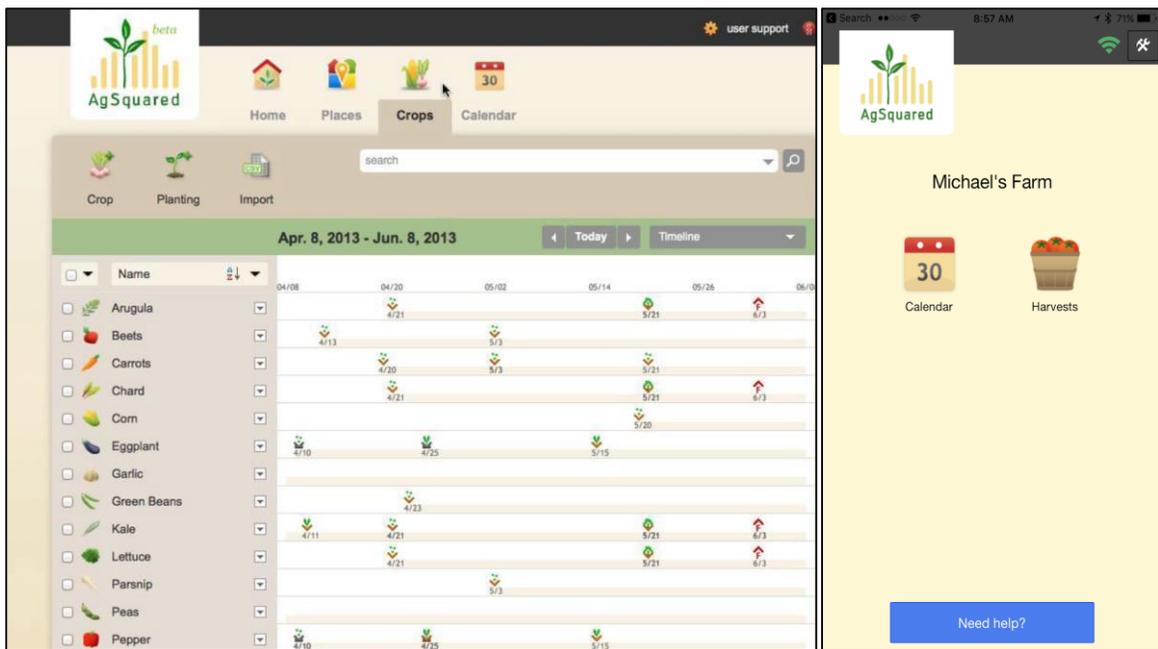
We identified 5 software solutions that could have been made to work although none of them were perfect. Tend, although it scored low, was a 6th that decided to include due its potential. First, for comparison, and second as we had assurances from the company that food safety was on the radar and something they were interested in adding.

## AgSquared

AgSquared is a farm record keeping software system that has been around since 2009. Since then, they have scaled their business to work with around 11,000 farms. We worked extensively with the software and talked at length with the founder but in the end, this software is just not built for FSMA compliance. There are ways to do most of the different requirements, but it's not easy. It tracks soil amendments and harvest data well. But if you wanted to do training for the crew members, the only way to track it is by tracking each attendee's time as a task ticket. This software is built for farm planning, not food safety. AgSquared is interested in adding FSMA compliance but it falls relatively low on their development list.



Its relatively easy to sketch out the fields and different areas of interest for your farm.



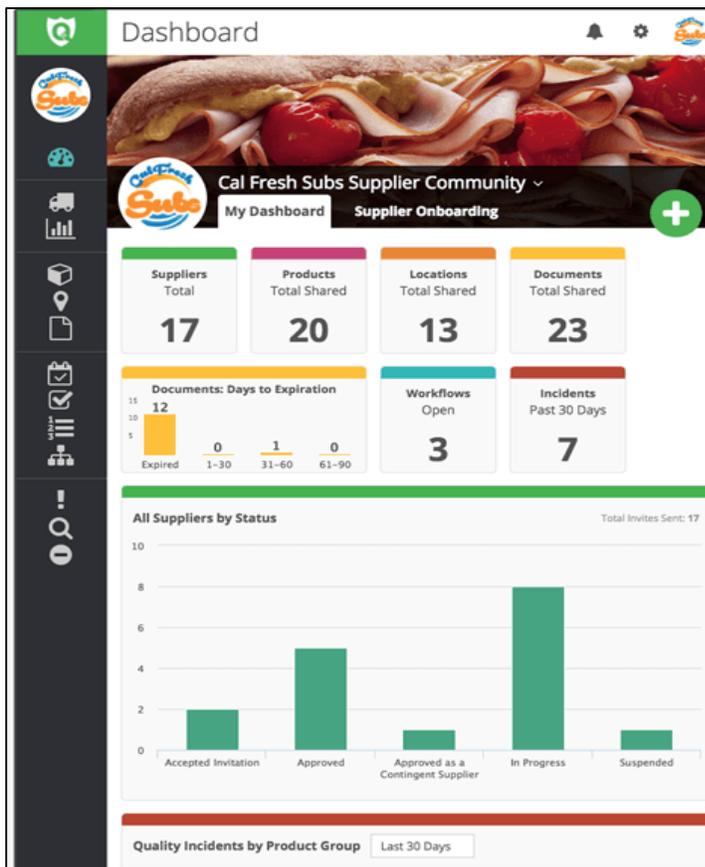
AgSquared makes it easy to visualize your planting dates.

Agsquared also has a app, shown right, which is focused on harvest and your calendar of tasks.

## FoodlogiQ

This program is meant for large wholesalers and brokers to comply with GAP and traceability regulations. The ideal client would be a company like Black River produce who would then use this software to manage their network of suppliers and request different documentation from them such as GAP certificates, water tests, proof of training of employees, etc. This also helps track produce being sent to different places for further processing and shelf life. This product is expensive (they actually never got back to us with an exact cost), takes significant time to customize, and would not be a fit for an individual farm.

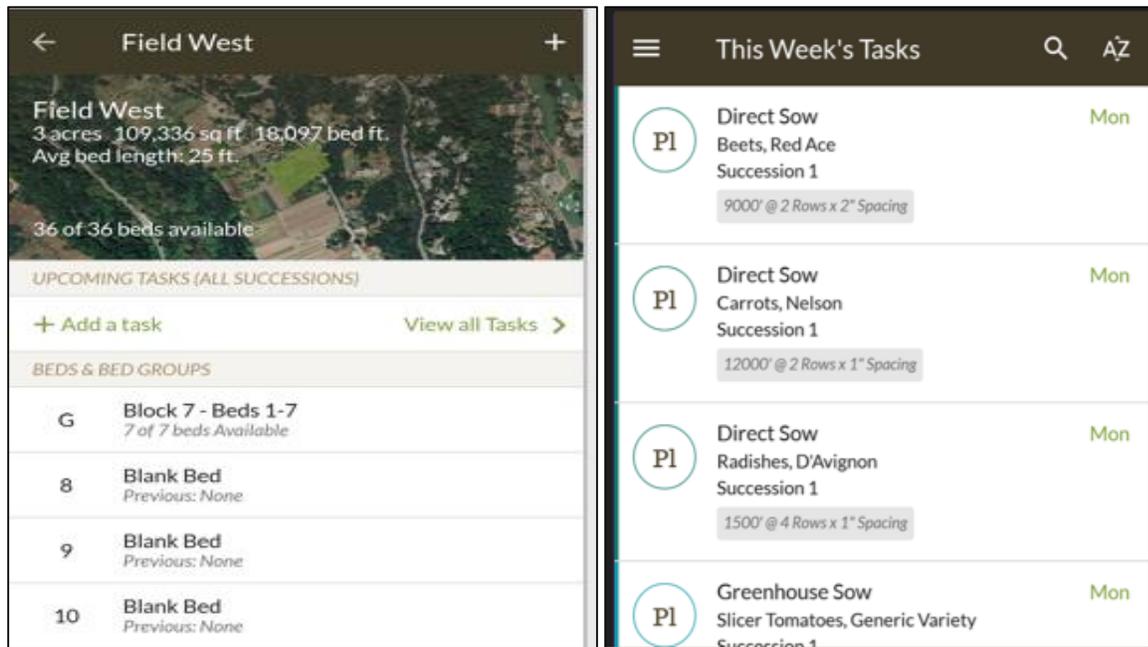
Screenshot of a FoodlogiQ dashboard.



## Tend

Tend is a newer farm tracking, management, and sales software system that shows real promise to help farmers. Their pricing model, forever free, does have its downsides though as there is no customization available. FSMA is on their radar but currently the software doesn't take much of it into consideration. For example, they allow multiple logins, but not an inspector level login. There is no way to track injury or sickness. Water tests or packhouse cleaning records don't exist other than tracing them in the hours and attaching a picture. CSV upload is in process as well as bilingual

ability. QuickBooks integration is in development. We feel that this software would be one to push for future development. See two screenshots below of the software's app.



### HarvestMark

This software is built for large farms to implement traceability, PTI compliance, and to share with the consumer exactly where their food comes from. It does this through QR codes and an app that the consumer can then use to lookup producing the farm and other data about that crop. Coupled with another piece of software the parent company (Trimble) offers, they seem to have a complete solution for GAP compliance. Unfortunately, the software is focused on large farms with the fields planted to few crops. No situations of 6 bed ft of parsley and 25 of burdock root, which characterizes many of the farms we work with. In addition, to implement this, you would need two different software solutions, at a cost of around \$3000+, and pay for customization for your farm. It did have some nice features such as off-network ability to record info in app, CSV upload and is mobile friendly.

### GAPpro

We were very impressed with this software solution. Developed by farmers for farmers, it and its sister program COGpro, which helps farmers track their certified organic paperwork, provide a complete solution for farmers. It easily and succinctly walks the farmer through the different steps required to certify or be GAP compliant. Here is a screenshot of the starting page, you can see the different tabs for different areas that need addressed.

## Good Agricultural Practices

An important component of Good Agricultural Practices is keeping a traceable record trail of all the activities related to the production, processing and shipping of produce from your farm. The GAP notebook uses lot numbers to track crops as they move through each stage of production.

The GAP section is similar to the crops section, and accesses your data that applies to both, such as the farm information, crops and harvests. GAP standards require additional data, so it is best to use the GAP version of these sections to make sure that you are entering all the necessary information.

**General Information:** Basic data about your farm, safety plan, facilities and equipment.

**Training:** Logs for recording the various training sessions required to ensure proper food handling on the farm, such as employee hand washing and food safety awareness.

**Worker Health & Hygiene:** Logs for recording maintenance of sanitary facilities for your workers and noting worker illnesses.

**Farm Conditions:** Detail the conditions in the growing environment that may be a source of contamination to your produce. Document water tests, applications of fertilizers, manures, ag chemicals, etc., and efforts to control animals and manure in the field.

**Harvesting:** Log the sanitation of harvest equipment, note harvest conditions and list the harvest crew, creating a traceable record of the harvest.

**Processing & Packing:** Record the sanitary conditions surrounding your produce as it is prepared for sale, including equipment, wash water, ice products, facilities, and the crew.

**Sales & Shipping:** Establish a continuous record of your produce as it moves from farm to customer. Record sales and buyers, monitor the vehicles transporting your produce, and maintain a trace back system for product recalls.

To get started, please select the **General Information** tab and enter some basic information about your food safety plan and facilities. Then begin documenting your Good Agricultural Practices.

[GAP Pro Mobile](#)

[See data-entry shortcuts](#)

It covers everything from a FSMA standpoint but does have several downsides which we feel are serious enough not to recommend it. No off-network capacity in the app, which is web-based currently. No ability for CSV upload capacity, everything has to be entered manually. There is no map based reporting or functionality for looking at your fields in Google maps. You enter them manually and then are able to upload a document which could be a picture of the map. There is no general document center to upload other general information. Even a link to a Google drive folder would work really well. You can upload water tests including actual files but there is no feature to graph or calculate a microbial water profile. That would have to be done in other software (or could easily be done in Google drive spreadsheet) There is no QuickBooks connectivity or way to print labels or barcodes.

## Training Logs

In this section of the logbook, you will keep track of the various training sessions required to ensure proper handling of food products on the farm.

**Employee Hand Wash Training Record:** Log employee training sessions covering proper hygienic hand washing procedures to prevent contamination of produce.

**Employee Food Safety Training Record:** Log employee training sessions covering food safety protocols and company standard operating procedures to ensure proper handling of produce.

**Employee Chemical Handling Training Record:** Log employee training sessions covering the handling safety protocols of agricultural chemicals and company standard operating procedures in place to protect workers and produce.

**Worker Protection Standard Training Record:** Log employee training sessions covering workplace safety and company standard operating procedures in place to protect workers and produce.

**Supervisor Farm Security Training Record:** Log training sessions for supervisors covering the food safety protocols, company standard operating procedures and the implementation of good agricultural practices on your farm.

You might save time by duplicating entries and changing them. Click the  plus symbol to duplicate and edit a line. To make changes to an existing line, click the  pencil symbol.

### GAP Animal Monitoring

[View Manure Sanitation Records](#)

[View Pest/Rodent Control Records](#)

[Output Options](#)

[Add Record](#)

#### Filter by Date

From date:

Format: 2017-03-02

To date:

Format: 2017-03-02

#### Filter by Field ID

<Any> 

[Apply Filters](#)

[Reset Filters](#)

	Field ID	Date	Time	Monitor	Status	Corrective Action Needed	Notes	Attachment
 	North Field	04/12/2012		H. Mann	Scat	Yes	Scat removed and 5 ft circle marked.	
 	North Field	04/09/2012		H. Mann	No Animals/Signs	No		

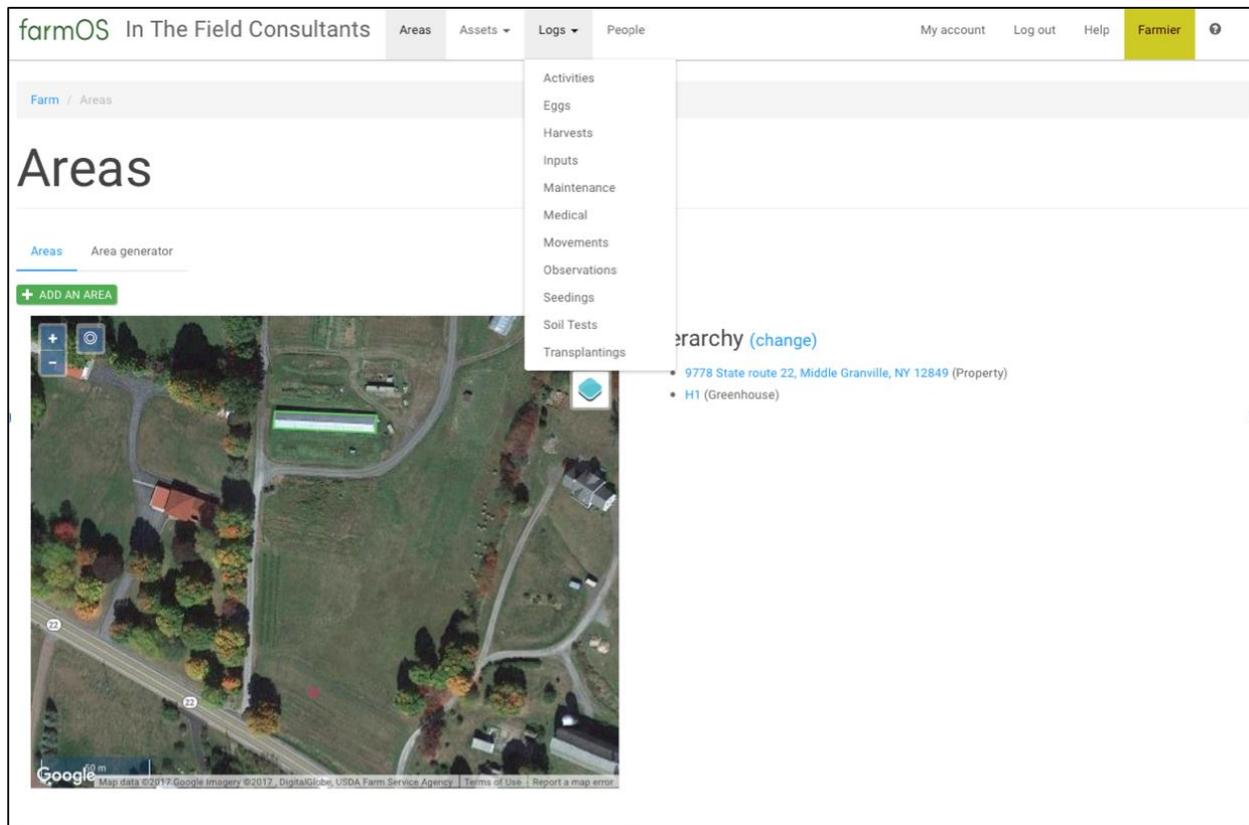
However, based on the other options, this is the only one that is really set up for GAP/FSMA compliance for small farms. Our goal has been to work with the company to add the necessary functionality to make this a solid solution, but this has not come to fruition.

## FarmOS

FarmOS is an open source, web-based farm planning, management, and recording system developed in New England. One of the features that we like about this is that it is open-source and Drupal based which make it very easy to build new functionality on and that this work can be crowd-sourced. Hosting and most development for FarmOS is currently happening through a company called Farmier and by the developer, Michael Stenta.

This software has some great features for farm tracking and support for some pieces of FSMA, although it is not built around GAP/FSMA compliance. The software is built around Areas, Assets, Logs (activities, maintenance, medical, observations, etc), and People.

FarmOS doesn't yet have functionality for sales or order tracking, although they are working on adding a module that will address that. The mobile app is nice, but currently does not allow offline access to data. It also doesn't allow CSV imports currently but that is available and in the development pipeline.



An overview of the homepage of FarmOS.

Filter/Sort							
<input type="checkbox"/>	Done	Date	Observation	Assets	Areas	Quantity	Type
<input type="checkbox"/>	✓	Aug 13 2015	Broken pull cord	Tiller (BCS MC 732 GX340)	Barn (lower level)		General

### Maintenance

Filter/Sort					
<input type="checkbox"/>	Done	Date	Maintenance	Assets	
<input type="checkbox"/>		Apr 1 2016	Replace gas line and hose clamps	Tiller (BCS MC 732 GX340)	
<input type="checkbox"/>	✓	Oct 27 2015	Replaced pull cord... almost	Tiller (BCS MC 732 GX340)	
<input type="checkbox"/>	✓	May 25 2015	Change oil	Tiller (BCS MC 732 GX340)	
<input type="checkbox"/>	✓	May 25 2015	Replace throttle cable	Tiller (BCS MC 732 GX340)	
<input type="checkbox"/>	✓	Apr 19 2015	Remove broken throttle cable	Tiller (BCS MC 732 GX340)	
<input type="checkbox"/>	✓	Jan 30 2015	Notes from dad	Tiller (BCS MC 732 GX340)	

### Movements

Filter/Sort					
<input type="checkbox"/>	Done	Date	Assets	To	From

A screen shot of how maintenance logs work on FarmOS.

Our main reason for wanting to dive deeper into this program is that the developers are interested in adding this functionality, it's open-source and easy for anyone to add additional features, and cost of entry is quite low. We feel that based on the framework, it would be really easy to add the functionality that is needed for FSMA compliance.