



Final Report

Development of a Digitally Integrated, Low-cost Farm-to-Consumer Product Tracking System for Small Scale Farmers and Grower Networks

Executive Summary

Circle Fresh Farms is a network of small to medium sized greenhouses producing organic certified fresh vegetables. In order to remain competitive and compliant with emerging expectations to provide farm-to-consumer product tracking systems, Circle Fresh needed to create a product track and trace system that was compatible with industry standards but accessible in cost and complexity for smaller producers. After extensive analysis of the existing track and trace system providers, Circle Fresh selected **PTI Print** to develop an easy to replicate track and trace system for its network of 8 greenhouse producers. After extensive assessment of the circumstances, resource constraints and operational dynamics of this diversity of producers, **PTI Print** and Circle Fresh developed a system that successfully implemented both product tracking and inventory management and financial system integration. Financial efficiencies developed during the project resulted in a nearly 50% reduction in the anticipated system installation and operations costs. This enabled Circle Fresh to double the number of farms participating in the pilot project (from 3 to 6). As part of the implementation of the pilot program, Circle Fresh has also developed a step-by-step track and trace implementation handbook for small-to-medium scale producers and a series of on-line video tutorials to guide producers through all of the major steps in establishing a successful track and trace system.

Background of Project

The following sections provide an overview of the factors that compelled Circle Fresh Farms and its network of participating growers to pursue the development of a technically effective but financially affordable digital track and trace system.

Changing Market Expectations Impact Small Farms

With the rapid internationalization of the food industry, concerns over food safety have grown exponentially. These concerns have been magnified by a series of high profile food borne illness outbreaks that have caused both sickness and death. As a consequence, many producers have been seriously impacted by recalls as well as general consumer avoidance of foods linked to the outbreaks. Often these producers



have no role in the outbreak and may be thousands of miles from the incident. However, without a clear means of demonstrating that their products are not responsible, farmers cannot substantiate the safety of their crops.

In response to these concerns, the Federal government passed the Food Safety and Modernization Act in 2011 ([Food Safety Modernization Act](http://www.fda.gov/food/food-safety/modernization-act)) that significantly expanded previous food safety responsibilities for the food industry. Final rule making for this Act is still in process, but it is clear that the new law will require substantially more record keeping and accountability for primary producers. (See <http://www.fda.gov/Food/FoodSafety/FSMA/ucm334114.htm> for more information on proposed rules).

Given these trends in the produce industry, the development of a low-cost product tracking system is an integral element in a larger strategy to create access for small farmers (less than \$250,000-Economic Research Service typology) to larger regional/national fresh food retailers. Such a system would also have several important market positioning advantages: 1) it would provide small-producer cooperatives an efficient platform for aggregating and differentiating supply; 2) it would enable small producers the ability to maintain brand identity and uniqueness even as they are part of producer cooperatives or marketing consortiums; and 3) it would enable both producers and retailers to significantly improve food safety tracking and risk management systems.

Project Objectives

With these industry standards in view, this project established five major objectives that form the basis of developing and implementing a small-farm produce track and trace system. These five objectives were:

1. Delineate the critical product tracking factors necessary to meet current and anticipated market expectations.
2. Identify the critical operational factors that must be considered in designing such a system.
3. Identify, compare and contrast the five leading options for product tracking accessible to small farmers.
4. Select and develop a product tracking system
5. Conduct a 6 month pilot project

Project Implementation Strategy

Using the five objectives as the core focus for all activities, three areas of project activity were identified:



Product Tracking System (PTS) Scoping, assessment and design—In this initial stage of the project, representatives of the Circle Fresh Farms (CFF) staff and participating farm representatives conducted three actions. In the first phase—**scoping**--the critical features of a track and trace system suitable for CFF’s small farmer network were identified and ranked. . This included both the features desired or required by the market place and the operational issues facing both producers and purveyors on the implementation side. The second step—**assessment**—focused on evaluation of the leading PTS systems and identification of the best candidates for small farm circumstances. Finally, the **design** phase formulated the protocol and performance metrics for a six-month product tracking pilot project integrating the activities of the three participating producers.

Product Tracking Pilot Project Implementation—This phase of the project focused on actual implementation experience of the pilot tracking system selected for evaluation. Information on the performance of the system was gathered and posted to a web-based observation platform that other producers or interested parties can access to observe the lessons being learned. As part of this pilot phase, the producers worked with Whole Foods to evaluate the viability of a consumer education kiosks that could be located in the produce section of WF stores that will enable customers to use smart phones or other digital readers to scan products delivered from the participating producers and gather information about the product, the company, the timing of harvest, health statistics and other information like recipes or compatible companion products.

Product Tracking Outreach and Education—In this phase of the project, CF developed materials to provide other producers and retailers educational materials. The products associated with this phase of the workplan are described in greater detail below.

The project identified seven major deliverables:

1. Deployment of track and trace systems at three participating farms
2. A comprehensive project report describing the outcomes of the project
3. A “Product Tracking Systems Comparison Matrix” comparing the features and benefits of at least four of the best candidate Track and Trace systems.
4. A “Growers Track and Trace Handbook” providing an overview of product tracking and key issues for consideration in developing a track and trace system
5. A financial analysis of the prospective costs for implementing a Track and Trace system.



6. A simple track and trace start-up guide for developing a similar track and trace system
7. Development and preliminary testing of a mobile track and trace application that could be adapted for both product management and consumer education and marketing.
8. The development of a series of outreach events and activities to disseminate information about the results of the project including meetings with producers, in-store demonstrations with consumers, development of an on-line information portal (Facebook and Youtube), school demonstrations and media days.

Project Narrative

On May 2nd, 2012, we were informed that our proposal for development of a fresh produce track and trace system had been awarded a SARE Grant. These funds were to be utilized to develop a farm-to-consumer produce tracking program for the network of farms supplying produce under the Circle Fresh Farms brand at stores throughout the Front Range of Colorado.

With the notice of grant award, Circle Fresh began soliciting quotes from potential Track and Trace service providers. From these quotations, CF selected PTI Print (<http://www.ptiprint.com/>). An initial equipment configuration was selected and an initial implementation budget developed.

Partial distribution of grant funds took place in late July. During the waiting period, CF worked with PTI Print to do several initial tests of equipment configurations. This resulted in our improving the implementation plan by simplifying some of the equipment features originally proposed by PTI Print, making the system both simpler to operate at the farm level and less expensive on a per-farm installation basis. Through this collaboration, the per-farm implementation cost was reduced from the original estimate of \$5,500/farm location to as low as \$2,500 (depending on hardware choices made by each farm). **This nearly 50% reduction in costs enabled Circle Fresh to double the number of farms involved in the pilot project from 3 to 6 sites plus add a separate pack house facility system.**

System Deployments

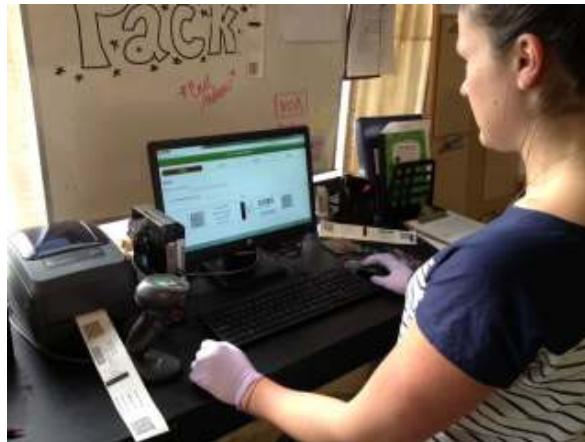
Yarrow Farms/Circle Fresh--With the receipt of funds in early fall, CF made its original equipment order through PTI Print for a first system to be placed at Circle Fresh's central



production and packing facility located at partner Yarrow Farms in northwest Denver. The initial installation was made in early September and fully functional by late in the month.

This system had all of the core components to a basic track and trace system: a central computer with keyboard and display, a label printer, and a hardwire scanner. These items are all shown in the picture of the CF Track and Trace station located at the Yarrow facility.

Track and Trace station at Yarrow Farms



The initial label design that was created for Circle Fresh was designed to provide a two-directional visibility on packed cases. The basic label contained a reference to Circle Fresh, the customer, the type of product, the pack date and the country of origin (required). All of this information was also imbedded in a QR code that could be scanned by any scanning device or a smart-phone using a QR scanning app. This enabled a consumer to go directly to the CF website and learn more about the product and the farm it came from.



Green Pastures--After working through a number of initial programming refinements, a second system was deployed to CF's network farm run by the company Green Pastures in mid-October. This Pueblo-based site grows lettuce for CF in a 7,000 SF facility. The photos below show install team and images from inside the greenhouse where the system was installed.



Lettuce germination area at Green Pastures where the track and trace system was to be installed



Installing system in a protected cabinet at the back of the greenhouse



Ben Fuller of PTI Print configuring software for the system



The Green Pastures system went fully live by late in October and had all of its inventory in tracking by November 1st. CF then began working with PTI Print to improve some of the data inputting features and reports. It was also realized at this point that a mobile scanning system would be needed to enable CF's delivery driver to be able to make deliveries directly to stores without having to bring the inventory all the way to CF's central distribution facility. CF contracted with PTI Print to write this application that could be loaded on any smart phone device for use as the scanning hardware. This application is being finalized now and will be ready for full implementation by early February.

During this period, CF also identified ways to bring the initial installation equipment costs down, enabling it to potentially expand the number of sites that can receive equipment as part of the Western SARE grant. In preparation for this expanded roll-out, CF included additional track and trace training as part of a CF grower network meeting on January 13th, of this year. Four additional sites for installation were identified and scheduled for deployment in February.



Trinity Farms—As one of the largest farms in the Circle Fresh network (40,000SF), the Trinity site represented an opportunity to begin to test the implementation of the track and trace system in a larger farm setting. The system was deployed prior to the full-scale production of a new crop that had been planted in late 2012.

Issues associated with plant health have slowed full-scale production at the site. However, all cases being produced are now labeled and integrated into the larger Circle Fresh product tracking system.

Elliot Gardens—As the first active nursery operation to add a vegetable operation. Elliot Gardens it was an exciting addition to the track and trace system. Given the relatively small size of this facility (12,000SF), this was also an excellent opportunity to test the efficiencies of smaller scale facilities with the track and trace system. These dynamics contributed to further development and innovation in the CFF track and trace system including reducing the label size from the original corner wrap 2"x10" label to a simple 2"x4" label that can be easily applied with a one-handed label applicator.





Boulder Fresh—As the second farm in the CF network and one with significant weekly production (400 cases+), the implementation of the track and trace system at Boulder Fresh provided an important benchmark for labor efficiencies in a medium scale facility. The system was implemented in February and has been working without any major issues since that time. The integration of the track and trace system with the weekly sales and marketing systems at Circle Fresh has also enabled new efficiencies in production coordination and sales management between the network farms like Boulder Fresh and the central sales and coordination entity (Circle Fresh).



Growhaus—The only non-profit owned farm in the Circle Fresh network, Growhaus is a demonstration urban farm and community education and economic development entity. Growhaus's 8,000SF of growing space are used primarily for lettuce and other greencrops. Careful tracking enables the organization to monitor what portion of their products are being used for community purposes versus being sold for revenue to support the organization.

Trainings

In preparation for the implementation of the system, CF had its first training meeting with its grower network on August 8th, 2012. During this meeting, we did the initial orientation around track and trace systems, discussing the key concepts and the primary control points that the farms would all be responsible for developing. The farmers were universally excited about being able to adopt a system that would give them greater confidence in the ability to monitor their own produce as well as help reduce the likelihood of unnecessary recalls or shut downs due to food safety issues.





**Circle Fresh Network Farmer Training,
Yarrow Farms - August 2012**

**Circle Fresh Network Farmer Training,
GrowHaus – January 2013**



In January, Circle Fresh had its second training with network growers to outline the revised system configurations and prepare the network for a second phase of system roll-outs.

Each participating farm is assisting where possible with utilizing existing equipment and infrastructure and equipment. With these cost savings and close coordination with the track and trace vendor PTI Print, CF has been able to expand the number of farms that will receive systems from the original grant proposal of three participating farms to a total of six farm locations. The next three installations took place between January and June of 2013.



Consumer Outreach

During the period of the grant, Circle Fresh has been maintaining active outreach to customers through its point of sale demonstration program. This has begun to familiarize consumers with both the CF brand and the unique identification and tracking systems we are using. The QR code systems is now set up so that any consumer that scans a QR code will be taken to the Circle Fresh website where they will get information on the product they scanned including the date of harvest, farm of origin, and more information about both Circle Fresh and that particular farm in the Circle Fresh network. Despite the decision by Whole Foods to postpone the implementation of a track and trace kiosk system in the near term, CF has build the capability into its existing system and can utilize the website pointing feature of its QR codes for special promotions or events.

Circle Fresh Farms Point of Sale Information and Outreach



Additional System Innovations

As the pilot farms and central processing facility became more experienced with the initial track and trace system configuration, a number of additional improvements and innovations were created.

Wireless remote scanning—working closely with the **PTI Print** tech team, Circle Fresh supported the development of a wireless scanning system that can be linked to any smartphone or tablet device. This enables much greater flexibility in being able to enter or remove product from digital inventory, a flexibility especially important for pick-up and delivery.



Pallet Tagging—For farms shipping less than pallet sized loads of a particular product, it is more complicated to develop separate digital pallet tags that make shipping and receiving more efficient. Working with small farms, **PTI Print**'s staff was able to develop a pallet tagging system that enables mixed pallet loads to still be tagged efficiently.



Palletized load of mixed produce showing both case level labels (under shrink wrap) and pallet tags summarizing the number of cases of each type of product

Financial System Integration—One of the most difficult aspects of the Circle Fresh farms production network business system was the management of inventory and farm payment reconciliations. Prior to the implementation of the track and trace system, this required a weekly effort to reconcile product tracking being conducted in excel spreadsheets and financial payments being managed in Quickbooks. Working with the PTI team and its accountants, Circle Fresh was able to develop an integration system that now enables all product tracking to be communicated seamlessly between the PTI tracking system and the Quickbooks financial system. With all of the growers now



handling scanning on-site, Circle Fresh has real-time knowledge of all inventory within the production network as it becomes available.



The photo shows a typical grower manifest report that is printed and processed with each pick-up.



Findings

Track and Trace System Comparisons

As part of the analysis to evaluate which track and trace system would be most suitable for the Circle Fresh Network, a comparative analysis was conducted on the four leading system providers with products suitable for small producers. The four vendors selected for comparison were:

1. **PTI Print**
2. Harvest Mark
3. Tru Trac/Foodlink
4. Redline Systems

A list of 28 system attributes were compared across the four vendors. The results from this analysis are displayed in the figure below.



Track and Trace Company Comparison

Feature	PTI Print	Harvest Mark	TrueTrac/FoodLink	RedLine-PTI Lite
Help Obtain Company Prefix, PTI Milestone #1	YES	NO		
Help Assign & Manage GTIN Numbers & GLN, PTI Milestone #2	YES	PTIPro		YES
Data Synchronization Files, PTI Milestone #3	YES	PTIPro	YES	
PTI Compliant Labels, PTI Milestone #4-5	YES	PTIExpress + PTIPro	YES	YES
Read & Store Information on Inbound Cases, PTI Milestone #6	YES	PTIPro	YES	YES
Read & Store Information on Outbound Cases, PTI Milestone #7	YES	PTIExpress + PTIPro	YES	YES
Know how much to pay your growers/vendors	YES		YES	
Know how much to bill your customers	YES		YES	
Automatically Generate Purchase Orders, Bills, Sales Orders, and Invoices in QuickBooks TM ©	Additional Fees Apply		NO	NO
Easy To Use Software	YES	PTIExpress + PTIPro	YES	YES
24 Hour Technical Support	YES	PTIExpress + PTIPro		YES
VoiceCode & RPC Support	YES	PTIExpress + PTIPro	YES	YES
Free software updates	YES	PTIExpress + PTIPro	YES	Annual renewal fee
Secure data storage	YES	PTIExpress + PTIPro	YES	YES
Sync GTIN lists and label templates with co-packers	YES	PTIPro	YES	



More than 100 GTIN's	YES	PTIPro	YES	YES
Branded Response/Landing Page	YES	PTIPro	Additional Fees Apply	NO
Production Insights	YES	PTIPro		
Print & Apply Automation Ready	YES	Additional Fees Apply	YES	YES
Implementation Consultation	Additional Fees Apply	NO		Additional Fees Apply
Integration with buying organization systems	YES	PTIPro only	YES	
Item Level Traceability & Mobile End Customer Marketing	YES	Additional Fees Apply	Additional Fees Apply	NO
Computer/Hardware	Customer	\$4,000/site (must buy from HM)	Customer	Customer
Printer	Customer	included above	Customer	\$4,850-PTI Light
Labels	Customer	\$.003/lable (third party)	Customer	Purchase from RedLine
Software	\$995	included above	included in annual fee	Included in annual fee
Annual Fees	\$0	\$1,500 PTI Express, \$3,000 PTI Pro	\$995+FoodLink Membership	\$500
Per Case or Label Fees	<=\$0.025	\$0 case level, \$3.80/thous item	Label Only	No label fees



Four overarching criteria were central to the comparison and selection of the final vendor:

1. Compliance with the Produce Traceability Initiative (PTI)
2. Cost--up front and ongoing
3. Complexity of use and availability of product support
4. Multiple site integration capabilities

All four systems were determined to satisfy the first criteria. The second criteria immediately disqualified one vendor—Harvest Mark. This had been the system the Circle Fresh Proposal was originally constructed around. However, the high costs of installation at each site (\$4,000), the proprietary requirement of hardware, and the high annual renewal costs for each site, disqualified this vendor.

Of the three remaining vendors, only one other vendor was comparable in price (Foodlink), but its systems were not yet configured for multiple site integration. A final consideration that was significant in deciding on the system was the availability of on-site support. As the only vendor with a local presence, **PTI Print** was capable of providing on-site installation support as part of each of the farm deployments—all of this without an annual software fee.

The one downside to the **PTI Print** system was its per/label cost as part of maintaining all of the product information associated with each label. However, at only \$.025/label—and with the many added features such as automatic website landing and QR code integration and readability by smart devices, this was viewed as a good value.

Financial Analysis

A critical factor in determining the viability for integrating track and trace systems for small to medium scale produce greenhouse operations was the cost—both initial installation and setup and ongoing operations. Drawing on the actual operational experience gained after implementing the system at CFF’s central packing facility, a series of cost factors were derived for:

- Initial installation costs
- Materials costs
- Labor costs
- Ongoing service or licensing fees.

These costs were compiled into a spreadsheet model that also enabled cost projection for different sizes of greenhouse operation. Three broad size categories were chosen for comparison based on common greenhouse sizes within the CFF network. These included 10,000 SF (approx. ¼ acre), 22,000 sq ft (approx. ½ acre), and 44,000 SF (approx. 1 acre). The results of this analysis are displayed in the table below. It indicates that costs range from \$.16/case for a small ¼ acre facility to as low as \$.12/case for a larger 1 acre facility. This would suggest that the cost of integrating a full-featured track and trace system make it financially viable for almost any scale of agricultural operation.

Financial Assessment of Track and Trace System Costs

Hardware	
Computer	\$500.00
Printer	\$300.00
Scanner	\$100.00
	<hr/>
	\$900.00
Software	
One-time Set-up	\$995.00
	<hr/>
	\$995.00
Setup Costs	
Prep and programming	\$200.00
Label layout	\$100.00
Setup support	\$300.00
	<hr/>
	\$600.00
Total	\$2,495.00
Years to depreciate expense	\$7.00
Cost/yr for hardware	\$356.43
Cost/case	
@ 5,300 cases/yr	\$0.067
@ 10,500 cases/yr	\$0.034
@ 21,500 cases/yr	\$0.016
Ongoing/Material Costs	
Labels	\$0.02
QR Codes	\$0.02
	<hr/>
Per case cost	\$0.04
Labor Costs	
# of seconds/hour	3600
Labor cost/hour	\$10
\$/second	\$0.00278
Second/label (config/print/apply)	5
Labor cost @ 5 sec/label	\$0.01
Total Cost for System-Labor & Materials	
for 10,000 SF facility	\$0.12
for 20,000 SF facility	\$0.09
for 40,000 SF facility	\$0.07

Assumptions

Facility Size and Case Production (tomato)	
Size	Yearly Cases
10,000 SF	5,300
20,000 SF	10,500
40,000 SF	21,500

Summary and Conclusions

The original impetus for pursuing the development of a produce track and trace system was the growing awareness that rapidly approaching changes in the expectations of both retailers and consumers would soon impose requirements for farm to consumer tracking systems on all producers. Circle Fresh Farms was founded with the intention of creating market access pathways for smaller producers to larger scale retailers who were likely to be among the early adopters of these product tracking requirements. Consequently, Circle Fresh and its network members were highly motivated to identify options suitable for the operational financial constraints of smaller growers.

The combination of perspectives, motivations and experience of a producer-marketer network created valuable diversity in the implementation phase of the project. Circle Fresh was also fortunate in having selected a track and trace system provider that was willing to jointly develop and optimize systems to address the particular needs and concerns of smaller producers. Through this process a number of important lessons were learned.

1. Simplification of Systems—The initial systems being considered attempted to include both product tracking and production management functions as part of a single application. While the long-term benefits of this approach were apparent, the short-term complexities and costs of this approach made it prohibitive. Working together, CFF and PTI Print (now “**PTI Print**”) were able to significantly simplify the system and in so doing significantly reduce both the upfront and ongoing costs of the system. This streamlining enabled Circle Fresh **to double the number of farms served in the program.**
2. System Cost—One of the key differentiating features between the available track and trace system providers was the costs associated with hardware and software. Those providers requiring both proprietary hardware and annual software fees created systems with much higher upfront and ongoing costs. CFF and **PTI Print** were able to develop a system that enabled farmers to purchase their own hardware (or use existing PC platforms) and dispensed with annual software fees by covering software and information management costs as part of affordable per/label fees. This worked especially well for smaller producers who had smaller label printing volumes and limited up-front capital. **The project team was able to cut the initial estimated system costs by nearly 50% from over \$5,500/farm to as low as \$2,500/farm.**
3. Digital marketing—Initial enthusiasm about use of point-of-sale product scanning as a consumer outreach device proved premature. Both the retailer (Whole Foods) and consumers were less engaged by this capability than originally anticipated. Consequently, CFF significantly scaled back development and outreach efforts associated with this aspect of the project.
4. Financial system integration—One of the powerful benefits that emerged with the evolution of the track and trace system was the integration of inventory management

(PTI Print) and billing and accounting systems (Quickbooks). This integration has proved immensely important for Circle Fresh to enable it to effectively manage and coordinate the highly volatile nature of production agriculture across an expanding network of producers at multiple scales. This integration feature is not available in all track and trace systems but we would now consider it an essential function.

5. Integration with other tracking obligations—As a CCOF certified organic producer, Circle Fresh and its network farms must also comply with rigorous monitoring and reporting of both its practices, inputs and product tracking and recall capabilities. During Circle Fresh’s last round of inspections, the CCOF reviewers were very impressed with the performance and capabilities of the CF T&T program and its compatibility with the reporting expectations of organic certification systems.

In summary, it is now clear that it is possible to develop and implement a comprehensive track and trace program that meets and exceeds all expectations in the current market and regulatory frameworks at a cost and complexity that is accessible to small producers. Circle fresh has documented the process of developing this system in a manner we hope will inform subsequent efforts to provide support to small and medium scale producers interested in pursuing similar systems. The grower’s handbook that has been produced as a companion to this report is intended to provide specific guidance and support to growers in understanding the key considerations and resources necessary for implementing a similar system for their operations.

We are grateful for the support and assistance of the Western Sustainable Agriculture Research and Education program without whose support this initiative would not have been possible. Prior to this project, a comprehensive and affordable track and trace system designed to serve the specific issues and needs of smaller scale fresh produce farmers was not available. We believe the findings and products developed through this project will now provide a relatively simple and accessible set of resources to guide other small producers interested in implementing similar systems. All of these resources are now available online, including tutorial videos, at the Circle Fresh Farms Facebook page: <http://www.facebook.com/pages/Circle-Fresh-Farms-Small-Farms-Track-and-Trace-Pilot/519575298095051>