Abstract

The Food Chain Traceability market is growing with the increasing awareness about food safety among consumers and governments. Several high visibility cases of food contamination brought public awareness. Consumers are demanding more complete information and transparency about the food products they consume. Governments are making regulations to track food as it is directly impacting consumer health. An outbreak of foodborne illnesses can have a direct impact on the national budget and the country’s economy. The social and political requirements for food traceability drive the introduction of industry standards and open the door to technology providers interested in developing solutions that will track the food supply chain. The solution space involves technologies in areas such as labeling, data capture, data transfer, data aggregation, system integration, and analytics. Established supply chain IT companies as well as dynamic start-ups are deploying hardware and software that will enable the new applications and solutions.
Summary

One of the trends that has accelerated in the last 15 years is the social awareness of the impact of food quality on health issues. In particular, due to increased perception of problems in the production and distribution of food, people have strong concerns about food-related illnesses and often support any initiatives towards improving food safety. Consumers want the ability to trace food, verify marketing claims, compare quality, and make the right decisions at the time of buying.

Business that participate in the supply chain, from farm growers to retailers share similar views. Food recalls and food-related illnesses can have a serious impact on the economies of growers, distributors, and retailers. They not only impact the normal business operations but they also damage brands and erode customer confidence.

Because of the common social need to invest in food safety, the different industry sectors that participate in food production, distribution, and retail have been developing food traceability standards and best practices. The standards are known as PTI; the acronym for Product Traceability Initiative, which is the industry organization driving the standard adoption.

Implementing PTI standards across the industry is not an easy task. There are many challenges like the difficulty of labeling products during harvest, the difficulty of integrating traceability information into heterogeneous IT systems, and the lack of simplified information analytics and reporting for the users. Despite the challenges, the industry is currently on a major drive to improve and integrate traceability solutions. Many companies providing IT services for the food industry have embraced the standards. Many start-ups promoting different business perspectives have also embraced the standards and are currently working towards innovative solutions in this space.

Introduction of Food Chain Traceability

Food recalls are expensive. The average cost of a food recall is $30M. Several high visibility cases of food contamination brought public awareness such as the 2006 Spinach E.Coli outbreak that costed $425M, the 2007 Florida tomato salmonella costing $500M, the 2008 Beef recall costing $117M and the 2009 Peanut butter recall costing $1B. As a result, consumers are demanding food safety measures with the ability to know where their food comes from. Food recall also tarnishes brand names. Contamination can happen anywhere in the supply chain, so companies want to save their reputation and know where their food supply comes from.
There are two primary drivers towards deployment of food traceability solutions. One is legislation such as the 2011 Food Safety Modernization Act. The second one is pressure from consumers to have access to better information. Accurate information for fresh foods is especially important because they are more prone to spoilage and contamination. Foodborne illnesses from contaminated food cause approximately 152 billion a year in total economic costs [9]. Food Chain Traceability helps establish and improve consumer confidence resulting in additional sales lift for the foods industry. End-to-End food traceability will result in information awareness in the supply chain, allowing food suppliers and buyers to monitor the demand and transfer operations at any point, and communicate directly with the consumers.

Hypothesis

The Food Chain Traceability market is busy with many entrants with similar solutions using their own proprietary technologies, network, data storage and modeling. Small stakeholder, customers and suppliers do not have yet full participation, disrupting the end-to-end flow of food tracking along with the ability to track and validate the authenticity beneath the level of large batches. Big data and Cloud computing can bring a second wave of Software Defined opportunities. Opportunities that will provide end-to-end food chain visibility, improve efficiencies with standardized data models, analytics software, and visualization tools. The
second wave will help removing complexity layers while providing supply-chain transparency not only to major supply-chain industry players but also to customers and farms.

Existing Market Overview

Food Chain Traceability is a collection of technologies and business practices to identify and track the places where food/produce has grown, and every place it has been before reaching your table. The forecasted market size per Allied Market Research, is 10.6 billion dollars in 2014 and increasing to 14 billion dollars in 2020 [1]. Nearly 6 billion cases of fresh produce are shipped across the United States alone each year. There are multiple solution providers working in parallel in the traceability space, providing similar solutions in their own proprietary technology within their network of suppliers and customers. Some of the well known industry players are profiled below. They are also each other’s competitors.

Harvestmark

Harvestmark is a Silicon Valley startup with 30-40 people [2]. They provide a horizontal solution associating lot data to item-level packaging data. Using their mobile application, consumers can get instant access to data related to the fresh food they purchased, such as where it comes from, how has it been transported and where has it been stored.

Harvestmark differentiate themselves with their competitors by being more tech savvy. Their technology is branded as a high-end solution that is higher in cost but provides higher value delivering useful information and a good customer experience. In 2009, Harvestmark traced more than one billion items [10]. During practice, Harvestmark noticed it is very difficult to persuade farmers to pay for their service as a pure risk-avoidance measure. Whenever there was an outbreak, the industry gains a lot of attention but companies still believe that it is something that it could not happen to them -- they do not need to buy technology solutions to mitigate risks. Other companies are incurring outbreaks because they did not have good safety procedures.

So, HarvestMark tried to focus instead on providing a service that connects produce suppliers (e.g. farms) to their end consumers (customers at retail). Initially, they created a mobile phone application to allow customers to find information about produce and rate it, and expose this data back to the producer. However, they found it difficult to achieve critical mass; most consumers would only scan an item if it had very poor quality, and not scan it regularly.

To provide more data back to producers, HarvestMark created a program called “Daily Shopper”, in which they employed low wage workers in 18 top metro markets to visit retail locations and rate HarvestMark-labeled produce against a carefully specified rubric. This allowed producers to analyze their delivery chain and see whether the produce was arriving at the final location in good condition.
This program allows retailers and suppliers to more accurately discover issues in their shipping and operations. For example, if retailer A says to grower X "your strawberries always go rotten in 3 days", grower X will have the ability to analyze the data and see that the strawberries picked on the same day made it to retailer B in 3 days, but to retailer A in 5 days. Harvestmark can tell retailer A that their competitors are shipping food faster -- providing for more freshness -- or that the trucks are not providing proper refrigeration or that items are sitting on a hot dock somewhere. This information is valuable for both the retailer and the producer. The drawback of this model is that it is still a hard sell for companies who are used to small margins - shaving hundredths of pennies off of cost of a label. As a result, Harvestmark has not yet achieved the desired wide industry adoption.

**Redline**

Redline is a 17 year old company based in Santa Clara, CA. Their end-to-end integrated technology solution has automated over 120 produce growers, packers, and shippers across North America. They use electronic tracking, record keeping, and provide integrated solutions adopting PTI compliance. Redline’s complete end-to-end solution comprises of software, hardware, professional services, planning, installation, training, system launch, online support and monitoring. Redline won the 2014 North America fresh produce traceability company of the year award.

The key to their fast, accurate whole chain traceability is their automated electronic tracking.
and record keeping system. RedLine solutions uses their barcode technologies to deliver flexible traceability solutions for all stages of production and distribution as shown in the figure above.

For growers, traceability starts in the fields. Redline solutions enables the growers to meet case labeling traceability requirements for field-packed items. The software will capture and manage traceability information from harvest to delivery at the cooler. The Redline system provides the flexibility for different commodities and harvest methods. This will help companies to gain real-time insight into their harvest operations and crew productivity. Redline software will generate barcodes for case and bin labels with wireless printers that can work in the office or out in the fields. Their solution comes with rugged mobile computing devices that capture traceability information during harvest. Redline offers electronic traceability information to create traceability reports from the fields providing rapid response to daily changes.

For the packers, Redline offers complete inventory, traceability, and case labeling solution for packing operations. Their solution captures and manages traceability information from the receipt of the bulk product all the way through to packing. The system can run standalone or be integrated with the grower’s accounting system to automatically receive product. The Redline solution provides lot number displays in GTIN (Global Trade Item Number) format as well as in human readable format giving the Packers the ability to internally trace a product back to a specific pack run. The lot number can be traced back to a source lot. Most of their labels also include the commodity, pack style, country of origin and harvest date.

For shippers, Redline offers a complete inventory management and traceability solution from the moment products are received at the cooler until they are shipped to the customers. RedLine will record and update the inventory information including product location, movement and will validate the order fulfillment with real-time shipping transactions. The result of using their software is fewer errors, improved inventory visibility, and having more trucks shipped each day. This solution replaces the traditional spreadsheet inventory management tracking which will slow down operations and are usually prone to human error. The RedLine software provides a reliable mobile and wireless hardware allowing workers to view the information but to also record their actions right where and when their work is performed. RedLine’s integrated solution will validate all actions in real-time, catching any errors before they occur.

**TraceOne**

TraceOne is a global company based in Boston, MA. They provide a platform that powers three hundred billion dollars per year in activities. Their Product Lifecycle Management platform currently has 35 global brands with a network of over 20,000 manufacturers and
suppliers globally. Their solution provides a single view of the complete traceability network with each facility’s compliance status clearly visible. TraceOne provides supply chain transparency and gap analysis allowing their customers’ product development time to be reduced by one to three months, allowing for the purchase price reduction of 0.5-1.5%, providing productivity increases by 50-60%, visibility into their supply chains increased with 95% reduction in food crises response time. Companies within their network can exchange early warnings and work collaboratively to resolve food crises or alerts protecting their brand integrity. TraceOne’s solution allows companies to easily visualize, control and optimize their complex supply networks. Their software provides a single view of the complete network with each product’s quality controls, ingredients, components and certifications allowing for an increase of engagement from all stakeholders. The below diagram is an example of TraceOne’s dashboard that is easy to visualize, giving the users the ability to drill into the various levels of the supply chain.

![TraceOne Dashboard](image)

**iTradeNetwork**

iTradeNetwork is 14 year old company based in Pleasanton, CA. They have 8,000 customers including 80% of largest US retailers, 90% of largest food distributors, 90% of Fresh shippers. iTradeNetwork is the leading provider of IT solutions for supply chain management for the food and beverage industry. For traceability, the company provides integration with IT solutions such as Advanced Ship Notice (ASN), Purchase Order (PO), etc., certified data pool (GSDN-based system), Cloud-based data archiving and reporting, PTI compliance. The company has participated in several PTI pilots with companies like Safeway and Dot Foods.

iTradeNetwork is an IT infrastructure and software provider delivering solutions that reliably and securely connect buyers and sellers across the food industry. The cloud connects to the iTradeNetwork using the business’ rules, applications and data formats. Once connected,
companies can begin trading, buying and selling goods more efficiently with more than 8,000 companies in the network. The network manages the entire transaction lifecycle including sourcing, negotiations, contracts invoices, rebates, etc. The systems on both sides are updated in real-time allowing for order accuracy and avoiding costly manual processing steps. Most companies find that managing and analyzing data is hard, blocking their ability to gain new insights into the business. iTradeNetwork helps companies providing analytics that can be used to quickly identify compliance issues, monitor supplier performance and uncover new revenue opportunities.

Standards and Technologies

The development of standard practices constitutes an efficient way of creating end-to-end interoperability across heterogeneous industries and players. In the case of food traceability, any standardized practice needs to be sufficiently strict to allow for end-to-end information transfer and product identification, but at the same time it needs to be flexible to allow for the deployment of heterogeneous systems and innovative solutions from individual roles within the ecosystem.

A standard for food traceability requires:

- A common grammar to identify the majority of products, sources, transfer points, and processes through all levels of the supply chain
- A collection of guidelines and specifications that can be used to build interoperable hardware and software.
- Commitment from the industry to deploy compliant solutions
- Clear evidence of benefits for all supply chain companies

GS1 is a worldwide standards organization with 40 years of experience in developing standards for supply chain operations. One of the standards developed by GS1 is known as the Global Trade Item Number (GTIN), which is a globally unique identifier for products. A GTIN is a sequence of 8, 12, 13 or 14 digits that are usually encoded as bar codes (see the Figure below). The Universal Product Code (UPC) used often in the US to identify point-of-sale products is one type of GTIN.
The Produce Traceability Initiative (PTI) [6] is a voluntary standards organization created in 2007 in response to the 2006 Spinach Crisis that had large human and economic costs. PTI is sponsored by Canadian Produce Marketing Association, GS1 US, Produce Marketing Association and United Fresh Produce Association. The primary goal of PTI is to develop a standardized industry approach to enhance the speed and efficiency of traceability systems.

PTI compliance guidelines require companies to have proper traceability systems in place tracking all products at the case level from the harvest phase all the way through the customer shipment phase.

PTI elaborates guidelines and best practices to help the industry achieve interoperability. In particular, these guidelines require companies to adhere to the following procedures [3]:

- Apply a PTI label containing the GTIN, lot number, and PTI voice pick code
- Apply hybrid pallet tags to outbound shipments
- Track who receives what shipped product
- Record source and pack lot information
- Maintain electronic traceability records

As of Fall 2014, Whole Foods will require PTI labeling of all produce as part of their transparency and quality standards program.

Several other companies including Oppenheimer, Safeway, iTradeNetworks, Chiquita Brands, Driscoll’s, etc. have been participating in industry pilots to determine best implementation practices to attain PTI compliance [6].

Summary and Opportunities Prediction

As the global food supply chain becomes more complex, the requirement for traceability technology increases. Consumer awareness over food traceability has also increased. According to a study by IBM in 2009, 77 percent of consumers want more information about the content of the food products they purchase, and 76 percent would like more information about its origin. 74 percent are willing to dig deeper and seek more data about how the food products are grown, processed and manufactured. Another study from A. T. Kearney reports that consumers are willing to pay more for local foods because they are more trustful (see the graph below).
However, the reality in the food market today is that although a lot of fresh foods have been labeled with GS1 barcodes with traceability information, there are few consumers who care or are aware about these barcodes and the information they represent. The current practices and deployment efforts have made good progress in terms of business-to-business information exchange but they have had minimal impact in the way consumers shop. HarvestMark developed a mobile app by which the consumer can scan barcode at supermarkets and receive traceability information of the food. Unfortunately, this app is not popular at all. According to the data from Google Play, the total installation number is below 5000 and the average rating of this app is just 3.3. This means that on the consumer side, there are certain usability issues that should be addressed before traceability technologies make an impact. Therefore, increasing user experience and user rewards to attract more consumers to be players in food traceability ecosystem is both challenging and providing additional business opportunities to make the experience richer.

From the supplier side, more business intelligence tools are needed in order to help the suppliers to measure efficiency and identify problem spots or gaps. Possible opportunity areas include:

- Connect all parties in food supply chain together so they can work collaboratively to resolve food crises or alerts.
- Build brand recognition at farm level.
• Enable efficient big data analytics solutions that provide high-value information to supply chain participants as well as consumers.
• Direct connect food suppliers to consumers in order to provide targeted real-time coupons and offers.

References

[10] Personal correspondence

National rankings consistently place UC Berkeley’s undergraduate and graduate programs among the world’s best. Berkeley is home to top scholars in every discipline, accomplished writers and musicians, star athletes, and stellar scientists—all drawn to this public university by its rich opportunities for groundbreaking research, innovative thinking and creativity, and service to society.