

Modernizing Agricultural Methods: Automatic Identification Traceability Technology and the Small Scale Limited Resource Farmer

S. Craig Littlejohn

(Department of Industrial and Electrical Engineering Technology
South Carolina State University Orangeburg, South Carolina 29117)

Abstract: - With the propagation of technology and the expansion of the possible applications of technology, extension professionals are presented with opportunities to use these tools to help small scale limited resource farmers modernize their businesses. This article illustrates how one type of Automatic Identification Technology (AIT) called Radio Frequency Identification (RFID), is being used to help a small scale limited resource produce farmer. The current success of RFID use for this farmer is promising towards pushing for future more widespread efforts to provide similar technology to other small scale limited resource farmers.

Keywords: - Traceability Technology, Radio Frequency Identification, Agricultural Supply Chain Management

I. INTRODUCTION

The focus of this article is on the potential for Automatic Identification Technology (AIT) applications within the agricultural industry. The authors of this article are currently performing research and extension work with the objective of determining how this technology can be used to help food handlers to increase the level of security present within their businesses and supply chains. AIT is a category of tracking (or traceability) technology that can be applied in many industries including (but not exclusive to) the following:

1. Retail
2. Healthcare
3. Banking
4. Agriculture

Extension professionals need to understand the prevalence of recalls within the agricultural industry. Existing examples from recent history concerning the increasing concern of food recalls are emphasized for the purpose of accentuating the need and potential impact of traceability technology implementation within the agricultural industry. AIT systems being used on commercial farms have helped in tracking and reliability. The particular type of AIT being used by the farmer within this project is described later in this article.

Within the context of this research and extension project, the participating local farmer has stated that he is finding AIT helpful within his farming operations. The long term focus of this work is the advancement of food security and accountability of food handling processes within low income/limited resource farms and their subsequent supply chains. Better food security can lead to the following:

- a. A safer food supply
- b. An increase in consumer confidence
- c. Decreases in the number of food recalls
- d. Overall quality improvements

Since AIT has specific applications relevant to the agricultural industry (particularly in cases of recalls) the next section identifies some recent food recall occurrences.

II. FOOD RECALLS

Over the span of several years there have been many recalls on produce throughout the United States. Below is a list of some of the most recent recalls.

In June 2014, Olde Thompson Inc. issued a recall of its Kirkland Signature Coarse Ground Malabar Pepper. This food product was sold exclusively at Costco Wholesale Clubs between the months of April and June. The purpose for the recall was for potential Salmonella contamination. [1]. According to this article from Food Safety News, salmonella "...can cause serious and sometimes fatal infections in young children, elderly people, and others with weakened immune systems. Healthy persons infected with Salmonella often experience fever, diarrhea, nausea, vomiting and abdominal pain. In rare circumstances...salmonella can result in the organism getting into the bloodstream and producing more severe illnesses."

Also in June 2014, Baptista's Bakery Inc. of Franklin, WI, voluntarily recalled over four thousand cases of its LiveGfree Gluten Free Rosemary and Olive Oil Multiseed Crackers. The specific focus of the recall were products that were given a best-if-used-by date of November 24, 2014. Once again possible Salmonella contamination was the recall motivation. [2].

During the week of April 30, 2014, the American Pop Corn Company issued a recall for three varieties of Jolly Time Microwave popcorn [3]. The products were:

1. Jolly Time Microwave popcorn, Butter, 3/3-oz bags/carton. The cartons are packaged 12-cartons/case. Individual carton UPC 028190007876, on the 12-ct case – UPC 10028190007804 and 48-ct case UPC 128190487873 with a Best By 03/27/15 (Julian date) 4086.
2. Jolly Time Microwave popcorn, Extra Butter, 3/3-oz bags/carton. The cartons are packaged 12-cartons/case. Individual carton – UPC 028190008477, on the 12 count case – UPC 10028190008474 and 48 ct shipper with UPC 128190488474 with a Best By 3/31/15 (Julian date) 4090.
3. Jolly Time Microwave popcorn, Homemade Classic Stovetop Flavor, 3/3-oz bags/carton. The cartons are packaged 12-cartons/case. Individual carton – UPC 028190007807, on the 12-ct case – UPC 10028190007804, 48-ct shipper UPC 128190487804 with a Best By 04/04/15 (Julian date) 4091.

The cause for these recalls was a detected potential for contamination of the food products with stainless steel metal fragments.

Fresh Express Company issued a recall in March 2014 for a limited number of cases of 10-oz. and 6-oz. Italian Salad with the already expired Use-by Date of March 26 and a Product Code of H071A11A . The reason for the recall was a contamination of *Listeria monocytogenes* which may cause a possible health risk. According to the article, “*Listeria monocytogenes* is an organism that can cause foodborne illness in a person...Symptoms of infection may include fever, muscle aches, gastrointestinal symptoms such as nausea or diarrhea.” The salad had originally been distributed in limited quantities to areas within the Eastern and Mid-Atlantic United States. At the time no illnesses were reported and no other foods from Fresh Express were recalled [4].

In January 2014, Sobeys Inc. recalled the following product in Ontario, Canada: Compliments brand Stir-Fry Style Vegetables. The motivation for the recall was a possible *Listeria* contamination. A photo of the recalled food is below:



Figure 1.: recalled compliments brand stir-fry vegetables, package front, January 2014 [5]



Figure 2.: recalled compliments brand stir-fry vegetables, package back, january 2014 [5]

This section has briefly highlighted recent instances of recalls within the food industry. The next section discusses the AIT that is being used by the limited resource small scale farmer: Radio Frequency Identification (RFID) Technology.

III. RADIO FREQUENCY IDENTIFICATION TECHNOLOGY

Radio Frequency Identification (RFID) technology employs a wireless non-contact system that uses radio-frequency electromagnetic fields to transfer data from a tag attached to an object, for the purposes of automatic object identification and tracking. The tag contains electronically stored information which can be read from up to several meters away. It is not mandatory for bar codes to be placed directly in front of the reader in order for tags to be read. RFID is used in various industries to help keep track of a wide range of supplies, inventory, and other valued items. There are a number of different types of RFID tags. RFID tags are designed specifically to be used:

1. Within various environmental surroundings.
2. For use on different surfaces of tracked items.

This means that certain RFID tags are specifically designed to be useful for wet environments or environments with extreme temperatures or for use on particular surface types. The choice of a specific category of RFID tag to use is determined based on the projected conditions for general tag applications. Some categories of RFID tags are:

- a) Pino Tag: Designed to enable cost-efficient and reliable tracking of wooden pallets, one of the main transit item platforms in use globally. It is also suitable for identifying similar wooden items from timber to finished structures. The tag should be installed into the corner blocks because the truck's metal forks will block the signal from the tag otherwise.
- b) Carrier Tag: This is a special tag with a strong grip for plastic surfaces. It can be easily attached to various containers. It provides good visibility for various items that need to be carried ranging from oranges to automobile engines.
- c) Steelwave Micro Tag: This is a miniature UHF on-metal tag, which for its size provides unparalleled performance. It offers great possibilities for companies to improve their asset management, especially computers and other devices that contain valuable information. In order to achieve the optimum performance, the Steelwave Micro tag must be placed on a metal surface without covering its front side with metal. It should be used on an even surface to ensure that there is direct metal contact underneath the whole tag. The metal background should be as large as possible and the tag should be placed so that its left side is on the metal edge.
- d) Steelwave Tag: This is an on-metal tag designed for indoor asset management and tracking solutions where small size is required. Typical applications include high value asset tracking, IT asset tracking and for tracking pieces of art, medical devices in healthcare. In order to achieve the optimum performance, the Steelwave Micro tag must be placed on a metal surface. Select an even surface so that there is direct metal contact underneath the whole tag.
- e) Versa Trak Tag: The Versa Trak tag is an on-metal tag designed for indoor asset management but also provides outstanding performance when mounted on non-metallic assets as well. The Versa Trak tag can be used to track returnable transport items, pallets, and other logistics containers. Because of its small footprint, the Versa Trak tag can be easily integrated unobtrusively into most types of assets.

- f) **Data Trak Tag:** This is one of the smallest tags in its class. It is designed to perform on metallic and non-metallic surfaces of small assets. It can be attached with high performance adhesive or by the tethering hole.
- g) **Foam Tag:** The name FOAM tag is given because of the foam backing that is provided to the RFID label. The tag can be attached on to an asset. It works very well on metallic and non-metallic assets.
- h) **Silicone Tag:** This is a metal mount tag, created by employing a MSOP (Micro Small Outline Package) chip on board electronics designed in a rigid, sealed impact resistant silicone molded package. It can be mounted by tie wrapping it around an asset.
- i) **Mini Metal Flex Tag:** A surface independent tag created by employing rugged chip on board electronics design in a flexible tubing package. This tag can be mounted by tie wrapping it around an asset. The flexibility of the tag provides the ability for the user to mount it around a circular shaped asset. There is no compromise on the read range of the tag because of this mounting condition. This tag is designed for use in high temperatures and performs well under harsh environmental conditions.
- j) **Teflon Flex Tag:** It is a flexible wire based tag, employing a rugged MSOP chip enclosed in a flexible plastic package. The sealed FEP Teflon Tube provides ultimate environmental stability for the tag. It can be attached with metal screws to hang from metal surfaces. This tag can also withstand high temperatures and perform well under harsh environmental conditions.

The list above shows some of the variety that is present within RFID tags. The variety of tag types allows for utilization in a wide range of working environments in different industries including agriculture. The tag information was provided by Asset Pulse, which is the name of the RFID equipment and software business participating with this extension work. The next section discusses possible traceability technology benefits.

Traceability Technology Potential Benefits

An important aspect of food security is accountability and transparency across the supply chain of any food product. In order to create this accountability and transparency, some form of traceability technology needs to be utilized within these food supply chains. Companies and farmers who have traceability technology implemented into their systems have a distinct advantage over their competitors in terms of public perception as well as the ability to sell their food (and food related products) in additional markets. As stated earlier, forms of this technology have been used on commercial farms, however small scale and low income farms have generally been overlooked demographics for its use.

This work is being used to determine the feasibility and possible benefits for use of this technology within small scale low income farming environments. The costs of equipment, software, and training are covered by this research and extension project. This means that there are no financial costs placed on the participating farmer. Findings from this work are to be used as the foundation for performing additional similar extension work in which this technology is provided to other farmers at no cost to the farmers.

Traceability technology can be useful in helping farmers to increase their revenue. If the farmer can clearly determine which produce is selling better and where he or she can maximize produce sales in a specific area, then he or she may be able to reduce their disposal percentages. It can be used by the farmer as a tool for facilitating the observation of trends in demands from different locations. Understanding the trends can allow for more efficient responses. For example, a higher demand for products at a particular store or market usually requires comparable supply levels at those specific locations. This is true even if empirical data shows that lower levels of supply have been sufficient previously. Increases in supplies in order to meet greater demands are important in order to prevent the reality of lost sales. Greater sales volume leads to greater revenue. Through proper use of this technology, the farmer may also be able to ascertain what produce should be planted in greater quantities in future seasons.

Traceability technology visibility and usage is increasing slowly within the agricultural environment. A meeting with a larger scaled well-funded farmer (different than the small scale limited resource farmer who has received the project funded equipment and software) was helpful in illuminating the possibility of installing and utilizing traceability technology within a farmer's existing computer systems. This farmer's RFID technology could display different crops planted and harvested per acre and bushel. The farmer was also able to show what fields the crops came from and where they were stored through use of RFID. It was explained that the farmer is allowed to input information into the program. This corresponds with the procedures that have been utilized within this current research and extension project. Traceability technology can also be utilized as a tool to:

1. Help with soil preparation for upcoming seasons
2. Make plans for future crop planting in order to maximize production

This section has presented a discussion on some benefits of traceability technology within farming environments. The next section will discuss the RFID based technique used within this extension work that allows for more precise tracking across the small scale low income farming supply chain of the participating farmer.

IV. SEGMENTATION OF FARMS

A technique called zonal segmentation has been used in this research/extension work. The use of zonal segmentation creates an ability to provide greater precision and accuracy for traceability activities within the food supply chain. Fig. 3 below presents an illustration of the land for the participating farmer for this project. Fig. 4 presents an illustration of the same land after it was divided into zones. This is very useful in order to be able to perform reverse traceability for activities that may require identification of contamination areas such as in the case of food recalls. The selection of zone locations and quantity was made by the participants within this project (i.e. farmer, researcher, and Asset Pulse).



Figure 3: layout of participating farm

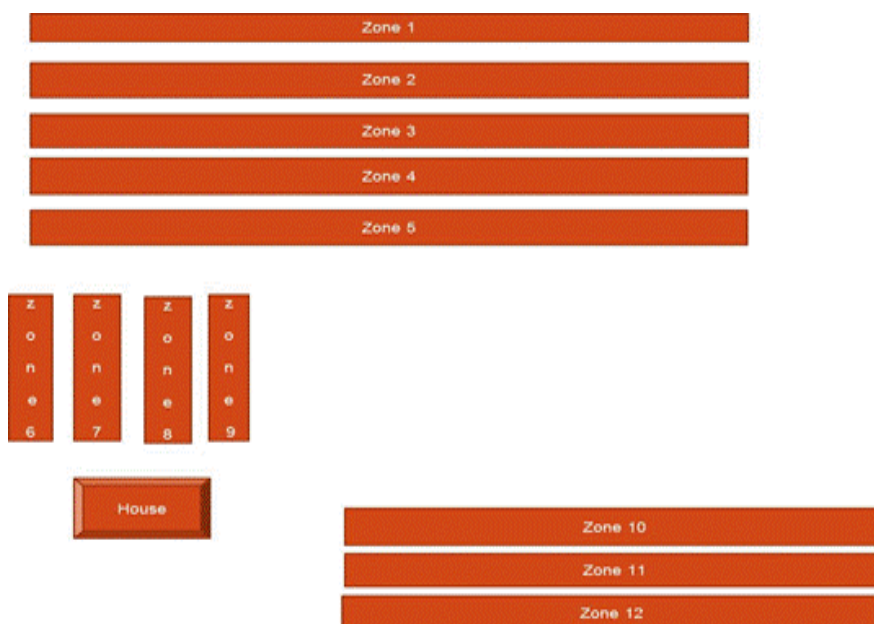


Figure 4.: zonal system layout of participating farm

Fig. 5 shows the proportional utilization of zones on the small scale farmland during the late fall season. The chart in Fig. 3 displays information gathered by the RFID technology used for this research project. All available zones were not used during this period. Zones 4 and 6 were the most utilized areas during this time frame.

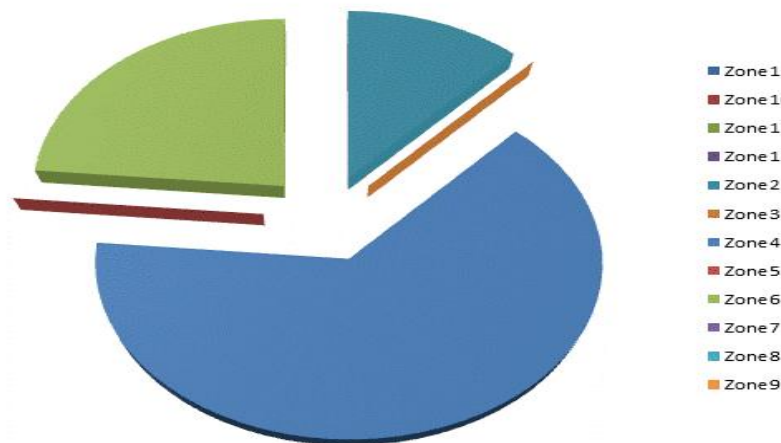


Figure 5: small farm zone usage for november and december

Fig. 6 shows the proportion of each type of produce sold over the period of a year from the area of the farmland designated as Zone 10. The largest proportion of sales consisted of tomatoes. Peas and okra consisted of the second highest proportion of produce items sold.

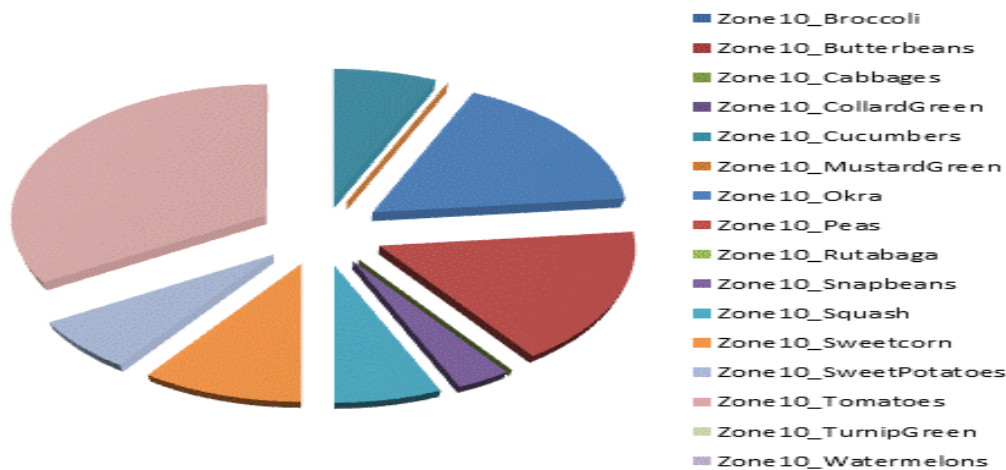


Figure 6: zone 10 produce sells over a period of one year

V. CONCLUSIONS

This article has highlighted the importance of Automatic Identification Technologies. While there are a number of differing categories of this type of technology, the specific focus for the current research is Radio Frequency Identification or RFID. Because of its inherent capabilities, RFID can be a useful tool for providing help with business management and other activities within agricultural environments. Small scale and limited resource farmers are an important source for food provision. These farmers are often either unaware of the potential of these technologies or are unable to afford the financial investment required to purchase, implement, and attain training for use of them. This study is providing a small scale limited resource produce farmer the opportunity to implement RFID within his business supply chain. Ideally this will lead to future work expanding the use of RFID for other similar farmers.

REFERENCES

- [1] Food Safety News . *Costco Black Pepper Recalled for Possible Salmonella Contamination* Retrieved From: <http://www.foodsafetynews.com/2014/06/coscto-warns-of-black-pepper-possibly-contaminated-with-salmonella/#.U5intyinfjV> (June 6, 2014).
- [2] Food Safety News . *Update: More Gluten-Free Crackers Recalled for Potential Salmonella Contamination of Seasoning Blend Contamination* Retrieved From: <http://www.foodsafetynews.com/2014/06/snack-crackers-recalled-for-potential-salmonella-contamination/#.U5ivOyinfjV> (June 5, 2014).
- [3] Food Safety News . *Microwave Popcorn Recalled for Potential Metal Fragment*. Retrieved From: <http://www.foodsafetynews.com/2014/05/microwave-popcorn-recalled-for-potential-metal-fragments/#.U5iixyinfjU> (May 7, 2014).
- [4] Food Safety News . *Fresh Express Recalls Italian Salad for Potential Listeria Risk*. Retrieved From: <http://www.foodsafetynews.com/2014/03/fresh-express-recalls-some-italian-salad-for-potential-listeria-risk/#.U5iYpyinfjU> (March, 29, 2014).
- [5] Food Safety News . *Canadian Firm Recalls Stir-Fry Vegetables for Listerial*. Retrieved From: <http://www.foodsafetynews.com/2014/01/canadian-firm-recalls-stir-fry-vegetables-for-listeria/#.U5ihoyinfjV> (January 26, 2104).