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RiteTrace Track & Trace System

Introduction

Root crop, vegetable and fruit growers record information useful for tracking produce from the field to a storage or packing facility. Sometimes growers collect this information for their own purposes; often this is done to comply with rules related to traceability. Good traceability data not only provides buyers and processors with the information they may need to track produce back to the field, it also helps growers to trace problems during storage back to specific areas in fields. The challenge is often in the record keeping. Recently, a grower was quoted as saying *"Record-keeping is the least enjoyable part of operating a farm for many farmers, and when you're in a rush to get the work done, you forget little details and later have to work out what you did. If we capture the data automatically you don't have to do any record-keeping."* (Source: Louisa Burwood-Taylor, AgFunder Newsletter, Feb 23, 2016)

This document describes the Greentronics RiteTrace system for automatically tracking truck loads of potatoes or other root crops during harvest from the field into bulk storage bins. The tracking system is based on a form of Radio Frequency Identification technology, similar to the commonly known RFID systems.

Summary: In the RiteTrace system, harvesters are equipped with Harvester Monitors to track trucks in the field as they are loaded. If a harvester operator detects certain conditions (e.g. wet, rot, heavy trash, stones) he can Flag a load. The Harvester Monitor writes its own ID plus the field and load IDs plus Flag status to the Transponder on the truck. All tracking data are stored in internal memory on the Harvester Monitor and can be copied to the ruggedized USB flash card for easy transfer.

Each truck or trailer used in harvest operations is equipped with a Transponder. Transponders broadcast their ID signals**.** Transponders also broadcast the signal from the included shaft speed sensor at the bulk bed drive to allow the scanner to detect which truck is unloading.

Truck unloading points are equipped with Receiving Station Monitors to track trucks as they are unloaded. At the receiving station, the Receiving Station Monitor reads and stores the harvester, field, and load ID information and also the Flag status. This data is then erased from the Transponder to prepare the truck to be filled with the next load. The Receiving Station Monitor can be configured with a list of acceptable field ID's. If a truck arrives from a field not in the list, the Monitor will sound an alarm. Similarly, when the Receiving Station Monitor detects a Flag, it will sound its alarm. Receiving Station Monitors store all data in internal memory which can be copied to the ruggedized USB flash card for easy transfer.

Finally, sensors on each piler track the exact position of the pilers' head in each bin over time. The location data is stored in internal memory which can be copied to the ruggedized USB flash card for easy transfer.

When data from all three sources are combined, a custom Window-based Viewer program produces Bin Maps, Field Maps, and Summary Reports to identify loads in storage and link those back to areas within fields.

Basic Functions:

1) Truck & Load Identification – Recording in the Field

Each truck has a Transponder attached, usually at the rear to the left side of the bulk box. Each Transponder has a unique ID number, so that every truck can be uniquely identified. Any Transponder within range of the scanner will be detected. If more than one Transponder is detected, the system only logs the one closest to the scanner.

Each Harvester Monitor includes a Console, a Scanner, and a shaft sensor to monitor and record harvester activity.

An RF Scanner is installed on the harvester, positioned to reliably read the Transponder while the truck is in loading position beside the harvester.

The harvester is also equipped with a shaft rotation sensor at the drive shaft of the truck loading boom. When the sensor does not detect shaft rotation, the system will not log truck ID numbers. This avoids false data logging in areas where the harvester is not picking up any crop or when it is turning on head lands.

A Console with keypad and display is installed in the cab of the harvester or of the tractor pulling the harvester. The Console is connected to a GPS receiver and logs the GPS position along with the ID number of the Transponder on the current truck. The data also shows the date and time at which each truck was loaded. The Viewer Program produces Field maps showing exactly when and where each truck load was filled. The sample map shown here has different colors for different loads. Each load is also identified with a unique load number.

2) Dealing with non-sequential loading

Under normal conditions, trucks are loaded in sequence and each load is full before the next truck pulls under the harvester. However, trucks may break down, get stuck, or be directed to the side in areas where "suspect" potatoes are harvested for immediate processing. The RiteTrace system can deal with all these situations.

The Harvester Monitor records truck ID and position with date and time. It also writes five pieces of information to the Transponder on the truck: harvester ID, field ID, load number, Flag status. It also sets the load status to "Loaded". The Transponder retains this data, which is later read by the Receiving Station Monitor. As the truck unloads, the Receiving Station Monitor erases the data from the Transponder. When the truck returns to the harvester to be re-filled, the Harvester Monitor will see the load status as "Unloaded" on the Transponder, assign a new Load number and write the new number to the Transponder.

If the truck had been pulled aside for any reason and returned to the harvester to be topped up, the Monitor in the harvester will see "Loaded" status on the Transponder and continue with the Load number already in the Transponder until the truck pulls away again. As long as the load status of the

Transponder is “Loaded”, the Monitor in the harvester will continue with the Load number already in the Transponder and not switch to a new load. In this way, the field map will show exactly which areas were harvested to fill each truck.

3) Truck ID Recording at the Storage Facility

A Receiving Station Monitor is installed at the storage facility, at the point where trucks are unloaded. The Receiving Station Monitor includes a Console, an RF Scanner and a shaft sensor. The scanner must be mounted so unloading trucks are well within range of the scanner (preferably within 20 feet).

The Receiving Station Console stores the ID of each truck that is unloaded, along with the date and time at which it was unloaded. Harvester ID, field ID, and load number are also copied from the Transponder to the Receiving Station Console. It will also store the Flag status for each load. The shaft sensor is installed at one of the shafts for the unloading conveyor and provides an additional reference in the data for when trucks are unloading.

The Receiving Station Monitor can be configured with a list of acceptable field ID’s. If a truck arrives with a field ID that is not in the list, the Monitor will sound an alarm and display a warning message. Mounting the Monitor close to the unloading point will allow the driver to hear the beeping when he walks to the rear to open the end gate. The Monitor will also sound its alarm when a load arrives where the harvester operator attached a Flag. This warns people at the unloading point to double check whether this load is good to go into storage or whether it should be diverted (e.g. for immediate processing).

If there is no miss-match or other problem the truck unloads and the Receiver will transmit a message to the Transponder resetting the load status to “Unloaded”. When it returns to the harvester, the Harvester Monitor will recognize the “Unloaded” status and start a new load.

Each truck transponder connects to a shaft rotation sensor on the drive shaft of the truck’s unloading belt. This enables the RiteTrace system to detect and record when a truck is unloading. Any trucks within range of the scanner that are not unloading will be ignored.

Note: In some operations, some loads will go straight from the field for washing and processing. Other loads may go straight from the field to an alternate location (perhaps a small local buyer/processor). If there is no Receiving Station Monitor at the unloading point for these loads, the load status will not be reset to “Unloaded”. To avoid a situation where the harvester cannot initiate a new load number, the Transponder uses signals from the shaft sensor to update the load status to “Conveyor Ran”. When the truck returns to the harvester, the Harvester Monitor will detect the “Conveyor Ran” status and initiate a new load number.

The harvester operator can also manually select a new load number for any new truck.

The Receiver Station Monitor records data as long as power is applied, so its operation is fully automatic, with no operator interaction required.

4) Bin Filling Position Recording at the Storage Facility

In order to correlate the location where the crop was harvested with its position in the storage facility, it is necessary to track where in the storage each truck load ends up.

A storage facility consists of one or more rectangular storage bins. To place each truck load within a bin, a Greentronics Position Monitor is installed on the bin piler that fills the bins. When the bin piler is positioned to begin filling a new bin, the operator enters the name or number of the bin into the Position Monitor. The Position Monitor tracks the position where potatoes are discharged in the bin using a

number of sensors. Each time the bin piler or its boom moves, the new position information is recorded, along with the date and time.

A wheel sensor is used to measure the distance the piler travels along the floor of the bin. This sensor is used to measure both distance and direction, so that the Position Monitor can keep track of the pilers' position when the piler is moved forward and backward.

A second sensor similar in design to the wheel sensor measures the extension and retraction movement of the telescoping boom.

A tilt sensor is mounted to measure the tilt angle of the boom.

An angle sensor is installed at the pivot point for the lateral (side-to-side) swing action of the boom and measures the lateral angle.

A shaft rotation sensor is mounted on the drive shaft for the boom belt to indicate when the piler is operating.

Readings from all these sensors are combined to calculate the position of the discharge end of the piler over time.

The Position Monitor records data as long as power is applied, so its operation is fully automatic. The only operator interaction required is to enter a new bin number or name at the start of each bin.

At installation time, each of the sensors must be calibrated.

5) Data Management

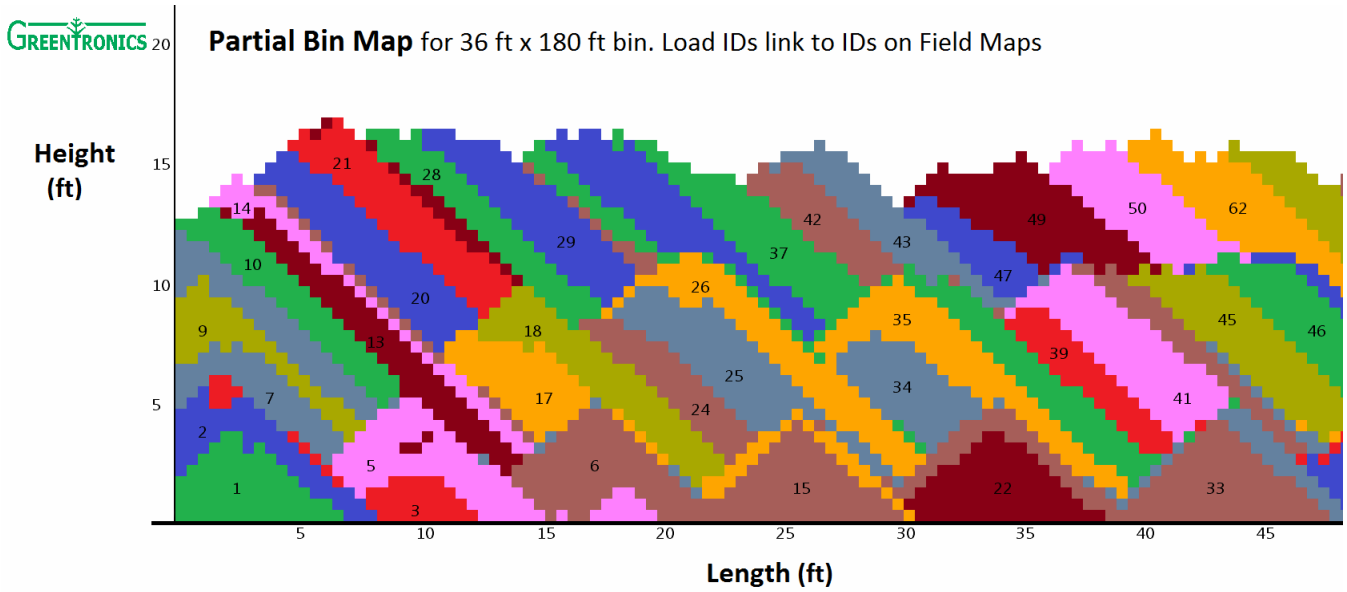
The tracking system involves three separate devices that collect data: 1) the Harvester Monitor, 2) the Receiving Station Monitor, and 3) the Position Monitor.

Data is retrieved from each of these devices using a removable Flash drive. These Flash drives can be read on any standard Windows computer. The data files are then emailed to Greentronics. Trained staff at Greentronics then combine all the data from the three sources into one unified data set for analysis and reporting.

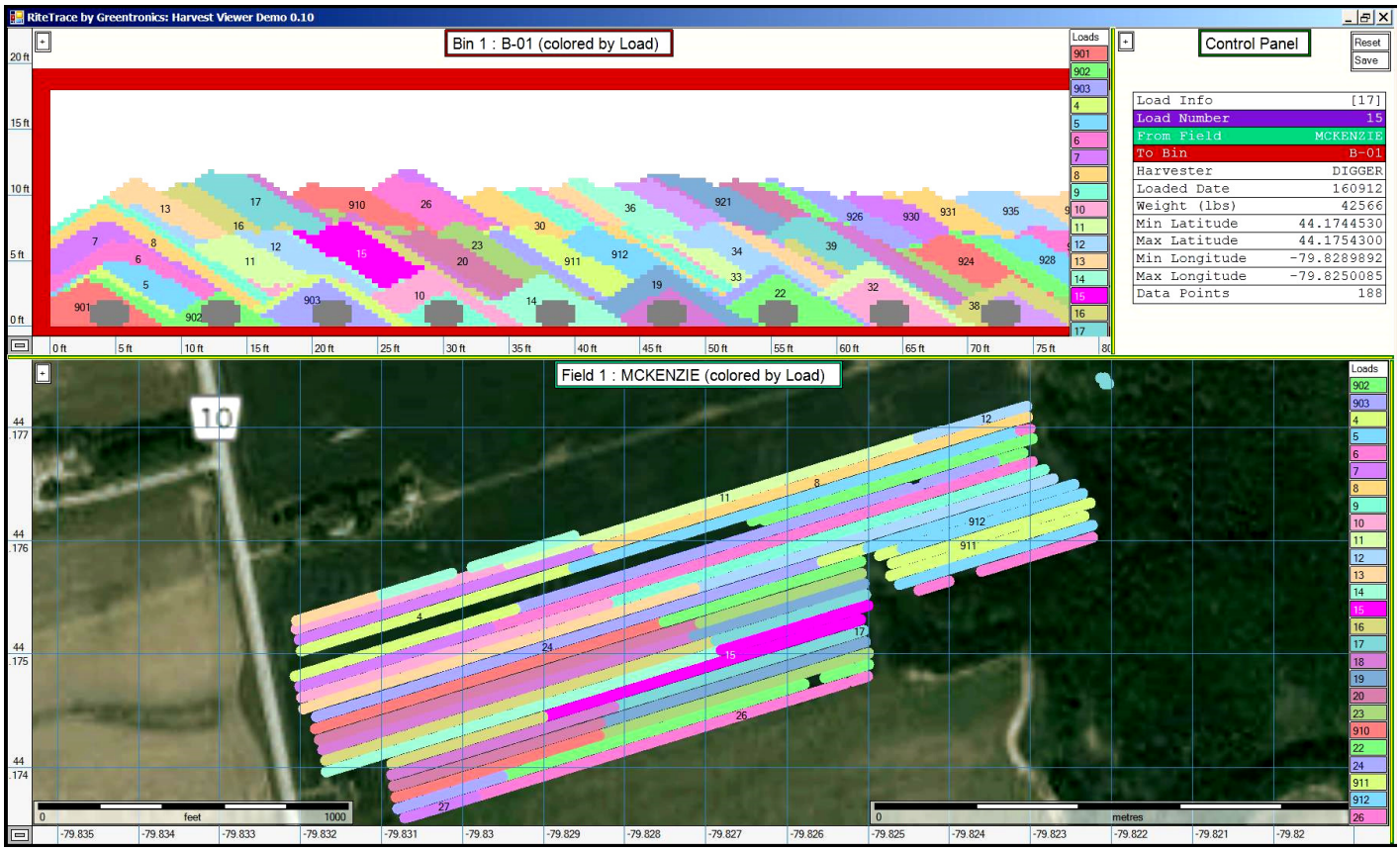
The data can be allowed to accumulate throughout the harvest season and collected at the end of the season, or it can be collected periodically.

6) Data Analysis

At the end of the season, the grower sends all the data files to Greentronics for processing (fees apply). In return, the grower receives the assembled data file along with a custom Data Viewer program that runs on the Windows OS. The Viewer program shows three reports at once: 1) a "Bin Map" for each bin clearly showing the location of each truck load (an example shown below); 2) Clicking on any particular load shows the Field Map for the field where the load originated with the load clearly highlighted; 3) a summary report for that load, including harvest date & time, unload date & time, and field & variety names. The screenshot copy below shows an example of these reports. Please note, different views are possible for the Bin Map. The default view shows all the loads in sequence. An alternative view displays loads by date. Another view shows loads by field ID. Where growers also use the Greentronics yield monitor, the Field Map can be displayed as a yield map identifying yield variation within each load. This would allow a grower to compare yield to quality in storage.



Screenshot of Viewer Program.



Note:

Load 15 was selected (clicked) in the Viewer program. It is highlighted in the Bin Map and the Field Map. Since the grower also had the Yield Monitor, the load detail report shows the load weight.

Each map is easily re-sized to display entire fields or bins. You can also enlarge selected areas to see specific details.

7) System Pricing

The RiteTrace system is modular in design to suit the many varied farming operations. Each module has its own price. It is easy to determine the total system price by adding modules as needed. Pricing is available from Greentronics dealers.

8) Data Processing Service:

This is a “per Load” service fee invoiced directly to end-users.

Options:

In addition to the features described, further enhancements can be ordered.

- Yield Monitor System. The Controller for the Harvester segment of the RiteTrace can also collect and store yield data and load weights together with truck ID. This makes it possible to connect yield with stored crop and determine whether quality and storage characteristics were related to yield. Using the Bin Maps, the summary data for each load will include the load weight.