Phase Two: National Applied Research Project:

Study of radio frequency identification systems at livestock auction markets and buying stations in Canada

June 2011

Canadian Cattle Identification Agency

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EXECUTIVE SUMMARY – PHASE TWO

In July of 2009, the federal, provincial and territorial Ministers of Agriculture held a meeting at Niagara-on-the-Lake, Ontario and agreed that a national traceability system for livestock is critical for managing animal health and food safety, expanding market access and driving efficiencies. It was agreed, with the exception of Saskatchewan, that a mandatory national traceability system for livestock be in place by 2011. The key elements of a traceability system are animal identification, premises identification and movement tracking.

This multi-phase applied research project was funded through Agriculture and Agri-Food Canada, Growing Forward program, to research the impact of implementation of radio-frequency identification (RFID) systems at livestock auction markets in Canada in support of movement tracking. There were a total of 13 test sites: 10 auction market and three buying stations. Systems from three manufacturers were installed in auction markets at receiving and both before and after the sale ring. Only one facility had multiple systems. The same three vendors installed multiple systems at the receiving area in buying stations.

Phase One was proof of concept of the RFID hardware and research showed it was effective for recording tag numbers on cattle moving through the scanning alleys. The project lasted 11 weeks, during which more than 144,000 cattle in over 31,300 groups were scanned. RFID systems were installed with stand-alone basic functionality software, monitored by project personnel. The key findings were:

1. The location of the system has more impact on business process and speed of commerce than the style of alley configuration. Systems at receiving experienced up to 1.5 hours per day impact on speed of commerce. Facilities with systems either before or after the sale ring experienced a marginal impact of 2 to 14 minutes per sale.
2. Systems at the sale ring had a higher read accuracy than systems at receiving. This is due to smaller groups moving through the systems, resulting in less data collision. At receiving, cattle may arrive untagged and move through the scanning alleys before retagging, therefore reducing read accuracy.
3. A 93% global read accuracy was achieved. However, daily reads were between 86 to 99%. Read rates fluctuate daily based on tags, environmental factors and animal behavior.
4. Single alley systems are the least expensive configuration. They had the highest read accuracy but the greatest impact on speed of commerce. Read accuracy ranged between 96 to 99%.
5. Dual alley systems are mid-priced and had a lower read accuracy than single systems. They also had less impact on speed of commerce. Read accuracy ranged between 86 to 93%.
6. Wide alley systems had a high read accuracy (96%) in smaller groups of 1 to 5 animals. As the group size increased to 6 to 10 the read accuracy decreased to 93%. These systems were located both before and after the sale ring and had little to no impact on the speed of commerce.
7. Each facility has a unique process flow and design. As such, each RFID system must be configured to fit within the cattle flow. This minimized the impact on speed of commerce and achieved a reasonable read accuracy.

Phase Two advanced the evaluation of RFID systems by integrating the tag collection and reporting software with the enterprise software. This integration enabled the tag numbers to be recorded on consigner and buyer invoices as well as settlement documentation. In some cases, it also provided age verification information to buyers. Two new RFID hardware configurations were added: the four-panel wide alley system and a dual alley multi-lane system along with a long-handled wand application. The project duration was 30 weeks from September 2010 to March 2011, scanning 107,423 groups with 393,474 head of cattle. The integrated systems were evaluated using three metrics:

1. Impact on speed of commerce (efficiency);
2. Software efficiency and effectiveness of capturing and reporting tag numbers; and
3. Weekly and global read accuracy (effectiveness).

Speed of commerce: The time it takes to complete one cycle in a business process—or the time it takes to complete an entire business process.
Efficiency: Improves business process, speeds business flow or minimizes errors/defects.
Effectiveness: Operates in a manner that meets the need for which it was implemented.

Further evaluation:

1. Identified if there was any potential for business value creation at the operational level.
2. Determined if RFID systems had the potential to cause employee and animal injury or illness.
3. Documented the capital, operating and ongoing cost of administration and maintenance associated with utilizing technology to collect and report RFID tag numbers to support traceability as per the Canadian Cattle Industry's National Animal Movement Plan for the livestock markets segment.

EVALUATION OF SOFTWARE OPTIONS

The variable in the RFID system is the type of software used to record and report the tag numbers. If the software does not align with business process and operating objectives, it will not be efficient or effective. As with the RFID hardware, the software is a critical component of a successful RFID scanning system but there is no one standard software solution. Three variations of tag recording software were evaluated. Option One reflects the processes used in Phase One, Option Two reflects the process from Phase Two and Option Three reflects of hybrid of both phases. It should be noted that the options presented in this study are not the only systems for scanning cattle; both Quebec and Australia have systems that support high read accuracy. The options evaluated are described as follows:

Option One and Three:

Software with basic functionality records the read accuracy by group/lot, then totals the read accuracy for the scanning day and creates a movement file for submission to the Canadian Livestock Tracking System. An alternative to scanning individual groups is to allow cattle to move through the scanners for 24 hours, recording the total number of head scanned and creating a movement report based on that total number. The software is called stand alone as it is not integrated with the enterprise software and does not link with invoices, statements or transactional data (settlement sheets). The software can run on any platform as it does not have to be linked to the enterprise servers. The RFID hardware can be linked to any computer through a serial hub and CAT5 cables. It is important that the computer that houses the software has access to the internet for transfer of the movement files.

Option Two:

Software with a broader functionality that is integrated with the enterprise software so tag numbers can be made available on invoices, statements and transactional data. This software is an add-on module to enterprise software so the entry of specific information (such as the name of the consigner) must be entered at the same time as the tag capture. Because it runs on the same platform and network as the enterprise software, the RFID hardware must be linked to the enterprise servers in order to communicate between the hardware and the software.

Option One **Stand alone software with third party entering information by group**	**Option Two** **Integrated software with site personnel entering information by group**	**Option Three** **Stand alone software with once daily input of total head handled by site personnel**
RFID hardware located either at receiving or sale ring: single, wide or dual lane scanning alley		
• Software to record and report tag numbers stands outside of business process • Information entry by a third party at the location of the system • No integration with enterprise software or operations processes	• Software that links with enterprise software to record and report tag numbers • Information entry by site personnel at the location of the system • Integration with enterprise servers, software and operation processes	• Software to record and report tag numbers stands outside of business process • Daily total entered by site staff • Software resides on administrative computers • No integration with enterprise software and operation processes
Software creates a report showing read accuracy for that scanning day and a converting spreadsheet data file (.csv) configured in the proper format for a movement file for submission to the CLTS.		
The movement file is submitted to the Canadian Livestock Tracking System		

IMPACT ON SPEED OF COMMERCE BY SOFTWARE

AUCTION MARKETS	Option One	Option Two	Option Three
At receiving	None	Negative: Between 30 seconds to five minutes per lot	None
Prior to the sale ring	None	Neutral to negative: from a few seconds to up to 20 seconds per sales draft	None
After the sale ring	None	Minimal: three seconds on regular drafts; up to one minute on show pens sales draft	None
BUYING STATIONS			
At Receiving	N/A	Neutral to negative: between zero to 10 minutes per lot	None

Option One

Was evaluated in Phase One. Due to the stand alone nature of the software, the features and issues of integrated software, as reported in Phase Two, did not apply.

Option Two

Was evaluated in Phase Two. The integrated systems impacted speed of commerce, at the auction markets, to varying degrees.

Systems at receiving had more impact as a result of entering data in a location that requires efficient movement of cattle. In order to enter consigner information at receiving, all incoming groups must be sorted by individual owner. The majority of cattle are delivered to auction markets on ground loading trailers, often with several owners' cattle on each load. Sorting the cattle by individual owner took between a few seconds to five minutes per group. The total impact at receiving from sorting and entering consigner data in the software was estimated to be 1.5 hours per receiving day. Five sites with systems either before or after the sale ring experienced a marginal impact of 10 to 20 minutes per sale as a result of the tag capture with the sales information. The system in Killarney was just prior to the sale ring; this facility experienced a 25% increase in the time to sell one draft as a result of the integrated software. The operator chose to switch to basic functionality software (Option Three) to reduce the impact on speed of commerce.

In order for the tag recording software to be linked with the enterprise software, the data entry devices must be networked through the enterprise servers. If the computers or software for recording tags fails, then the business process is also affected. This affect can be detrimental to the buyer, the market and the consigner.

Option Three

Was trialed in one market (Killarney)for six weeks in Phase Two. Killarney found that there was no impact on speed of commerce. The buying stations found that using software that did not integrate with their enterprise system did not affect their speed of commerce unless each draft was entered individually.

SOFTWARE EFFICIENCY AND VALUE CREATION

Option One: No impact

The business process did not change as a dedicated project person operated the software (the Field Research Associate worked for the project and not the test sites). There were no benefits to the test sites from the use of the RFID systems in Phase One because they were not linked with enterprise software. The software was effective as it recorded the tag numbers with minimal to no errors.

Option Two: Inefficient

The tag recording software introduced in Phase Two was found to be inefficient because it did not improve process flow, minimize errors, or add value. Some of the complaints from auction market operators included: software crashing and stalling or interrupting the sale, technical functionality issues requiring many hours on technical support, difficulties with communication between the hardware and software and negative impact on speed of commerce at all locations of the auction markets.

A number of test sites noted concerns over difficulties associated with being able to recruit and retain trained staff to use the software and the affect it would have on operations if these persons were unavailable on scanning days. As noted by the Ottawa market, "the important aspect of the system is a competent software operator who pays attention and doesn't make mistakes."

The two sites that found the systems to be efficient were Ottawa Livestock Exchange and Ontario Stockyards. Both of these sites deal in Quebec cattle with ATQ tags. Consigners get a rebate from ATQ when the tag is registered on the sales draft. As such, these sites both installed systems that were able to collect 100% of the readable ATQ tag numbers and report them on behalf of the customers. However, these systems are highly labor intensive and cannot process high volumes of cattle at one time. One facility said, "this is an efficient system because we are providing a service that has been requested by our customers." Both Ottawa Livestock Exchange and Ontario Stockyards noted that the benefit is to the consigner and buyer of Quebec cattle due to the recording and reporting of the tag number to ATQ for a rebate.

A few sites perceived potential benefits from being able to identify cattle that have moved out of the selling group or in situations where a back tag had fallen off. However, a common issue that detracted from value creation was that the data accuracy was not high enough to depend on. Further, a potential benefit was not met because the age verification numbers were low; between 7.8% and 42.4% of all head scanned. Most sites reported not seeing any value for operations in terms of the buyer or consigner now having the tag numbers available on all invoicing and settlement sheets.

Most sites found the software operated effectively and collected and recorded the tag numbers for movement reporting at a reasonable rate of accuracy. Yet, there were a few anomalies. Gladstone experienced a 12.8% error rate as a result of capture and recording of improper tag numbers and formats.

Buying stations were introduced in Phase Two and each site was equipped with multiple RFID alleys at the loading areas of the facilities. It was difficult to link into the enterprise software as a result of the unique business process. New stand alone software was developed that operated on a Windows-based protocol. This software supported recording both move in and move out. In some cases, the information was entered in the software in the office when time was available. There was no requirement to enter each group as it moved through the systems, although McCall Livestock did enter each load. The information was not available to the buyer or seller. Large groups of cattle would move through the system and be allocated to a vendor at a later time, therefore not requiring immediate attention from the yard staff. The buying station software is reflective of Option Three as the software was not integrated to operating software. As there was no immediate requirement to enter the data in a timely manner, this did not affect the speed of commerce on lots that were not tracked individually.

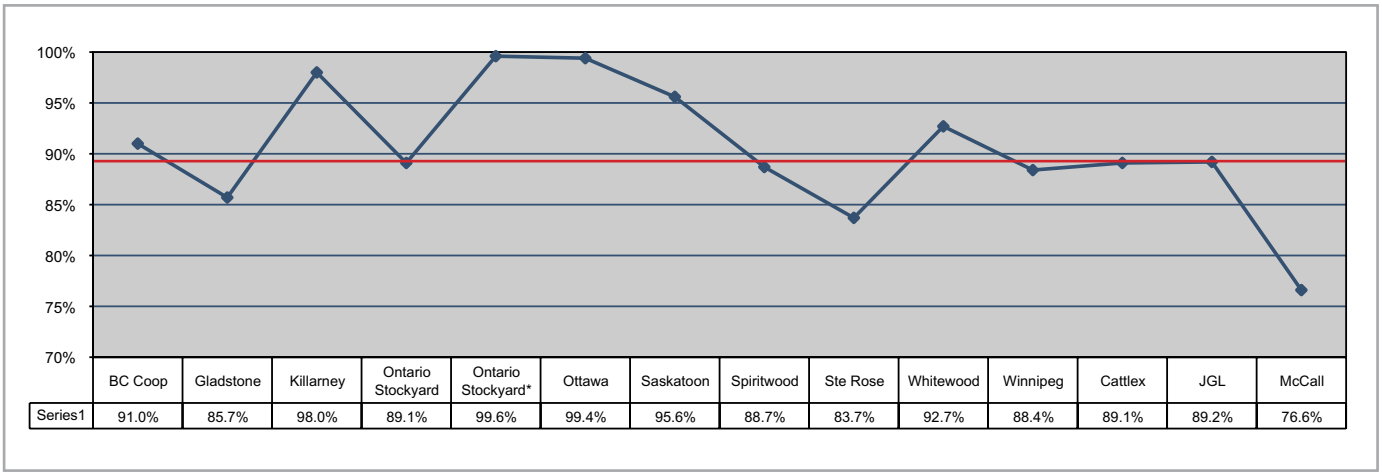
Option Three: Neutral

No change in the business process was required provided there was no intervention required for tags that are unreadable or cattle that are untagged. Data entry took place in the office where the staff were computer competent. Only minimal training was required as the software is not complicated; entering the total number of head handled throughout the day may take some time to complete, but the data itself only takes seconds to enter. As there was no integration with the business software, any technical difficulties did not affect sales transactions. Manifest manager software, by Viewtrak Technologies, was effective and efficient as it recorded the tag number with minimal to no errors.

Process efficiency of software options			
AUCTION MARKETS	**Option One**	**Option Two**	**Option Three**
At receiving	Neutral	Inefficient	Neutral
Prior to the sale ring	Neutral	Inefficient	Neutral
After the sale ring	Neutral	Inefficient	Neutral
BUYING STATIONS			
At Receiving	N/A	Neutral to inefficient	Neutral

READ ACCURACY

In Phase One, the global read accuracy was 93%, in Phase Two it dropped to an average of 89%. Three sites, Gladstone, Ste Rose and McCall brought the global average down with read rates of 85.7%, 83.7% and 76.6%, respectively. If these sites were not included in the calculation, the read accuracy would be 93%. As noted on the chart below, five of the 13 sites were above 90% plus Ontario Stockyards use of the wand on Quebec cattle which achieved close to 100%, three were at 89%, three were between 85% and 89% and two sites had low reads under 85%. The lower read accuracy rates are the result of numerous factors including: human error capturing tag numbers with software that was linked to enterprise systems, multiple systems in one facility that made it difficult to locate the source of error, panels on chutes with a width of 40 inches (therefore creating data collision), tag recording errors that may have affected the read accuracy calculation, and the difficulty in determining the weak link between the hardware, data connections, data entry device and the software. In Phase One, if the reads were low it was easy to locate the source of the problem and resolve it. In Phase Two, with the systems linked to the enterprise software, many more factors had to be considered, making it much more difficult to isolate the source of the issue. Only McCall Livestock and Gladstone Auction Market have yet to resolve the problems with low read accuracy.



	BC Coop	Gladstone	Killarney	Ontario Stockyard	Ontario Stockyard*	Ottawa	Saskatoon	Spiritwood	Ste Rose	Whitewood	Winnipeg	Cattlex	JGL	McCall
Series1	91.0%	85.7%	98.0%	89.1%	99.6%	99.4%	95.6%	88.7%	83.7%	92.7%	88.4%	89.1%	89.2%	76.6%

*Use of long-handled wand to collect tag numbers on Quebec cattle

Without a dedicated person to monitor the system, it can be several weeks before a read accuracy problem is discovered and addressed. Monitoring the systems includes evaluating the read accuracy reports, tuning the systems on scanning days, ensuring there is nothing introduced that can create electrical interference, and working closely with the vendors in the first few months to have the system set up to operate at the highest level of efficiency. A benchmark read accuracy should be set at that time and used as a baseline for evaluation.

Employee and animal health and safety

Although there were no employees injured during the project, the risk of injury to human or animal increases each time animals have to be moved or sorted. The systems had minimal affect on the overall health and safety of employees or animals. No employees were injured as a result of operating the systems in Phase One or Phase Two. Animal health can be affected if large animals are moved through the narrow (single) alleys and become wedged. The narrow alleys can also cause bruising on the animal's shoulders, ribs or hips. In all scanning alleys, employees are safer using cat walks down the sides of the alleys rather than following behind the animals inside the scanning alley.

In Phase Two, there was one additional factor of note: when consigner information is added to software at receiving, the groups had to be sorted into individual owner lots off the receiving trucks. The potential liability is created as the receiving area is not designed for this type of sorting. As such, employee safety may be at risk as a result of dealing with unruly animals in an area without proper design for safe handling for sorting animals.

COST ANALYSIS

The costs documented in this study are **based on one RFID system per facility** and **assume one movement report per site.** However, it must be noted that many facilities will require multiple scanning alleys to support traceability. The evaluations are based on actual costs of average installations from Phase One and Phase Two. These costs should not be assumed to be accurate in all auction market and buying station environments due to variable design, construction and provincial regulations.

It is important to note that an industry capital cost per head cannot be calculated because the volume of cattle handled at a facility does not equate to cost. Smaller volume sites require the same software and hardware as high volume sites. As such, the capital costs are not volume dependant.

CAPITAL COSTS

Option One and Three high costs are based on one wide alley eight-panel RFID system at receiving, using a laptop for data entry and basic functionality software. Option Two high costs evaluate the cost of one wide alley eight-panel RFID system at receiving, using a DT500 for data entry and software modules integrated with the enterprise software. With all options, the low cost is based on a single alley system.

Evaluation of capital costs	OPTION ONE		OPTION TWO		OPTION THREE	
	High	Low	High	Low	High	Low
VENDOR SITE ASSESSMENT	**$ 2,500**	**$ -**	**$ 3,700**	**$ 2,000**	**$ 2,500**	**$ -**
VENDOR ELECTRICAL INTERFERENCE TESTING	**$ 10,000**		**$ 10,000**		**$ 10,000**	
CAPITAL COSTS						
RFID Hardware includes vendor travel	$ 50,500	$ 13,000	$ 50,500	$ 13,000	$ 50,500	$ 13,000
Infrastructure changes & alley construction	$ 16,000	$ 5,000	$ 16,000	$ 5,000	$ 16,000	$ 5,000
Linking computers and hardware	$ 1,500	$ 250	$ 3,500	$ 1,500	$ 2,500	$ 1,500
Data entry devices	$ 1,500	$ 1,500	$ 7,900	$ 700	not required	not required
Software modules including training and install	$ 2,000	$ 2,000	$ 8,000	$ 2,000	$ 2,000	$ 2,000
Subtotal	**$ 71,500**	**$ 21,750**	**$ 85,900**	**$ 22,200**	**$ 71,000**	**$ 21,500**
PROJECT MANAGEMENT	**$ 7,150**	**$ 2,175**	**$ 8,590**	**$ 2,220**	**$ 7,100**	**$ 2,150**
EQUIPMENT AND SOFTWARE TOTAL	**$ 91,150**	**$ 23,925**	**$ 108,190**	**$ 26,420**	**$ 90,600**	**$ 23,650**
Potential additional costs at all facilities						
Travel costs for software install and train	not required	not required	$ 2,500	$ -	not required	not required
Booth to house data entry device at receiving	$ 2,500	$ 2,500	$ 2,500	$ 2,500	not required	not required
New computer systems	not required	not required	$ 16,600	$ -	not required	not required
Labour costs						
27 hrs x $18: tech support and process integration * LOW	not required	not required		$ 486	not required	not required
86 hrs x $18: tech support and process integration * HIGH	not required	not required	$ 1,548		not required	not required
8 hours of training and tech support-basic software	$ 144	$ 144			$ 144	$ 144
TOTAL COSTS	**$ 93,794**	**$ 26,569**	**$ 131,338**	**$ 29,406**	**$ 90,744**	**$ 23,794**

*This is the cost per person. In some cases there may be numerous people required. The average wage will vary from province to province.

As noted in Phase One, a critical aspect of any RFID system installation is the site assessment by both the hardware and software vendors. These assessments must be done by qualified individuals and assess site factors that can affect the read accuracy of the system as well as alignment with process flow. If electrical interference is identified in the initial assessment and it is deemed high enough to affect a read accuracy, an extensive noise assessment can be conducted. The hardware and infrastructure costs are based on Phase One research and actual costs for the RFID systems.

Option Two has the highest capital costs as a result of more expensive software, resulting in higher labor costs for technical support and training and the necessity of linking the RFID hardware to enterprise servers. In some cases, new servers will be required to support networking at a cost of over $16,000. Option Three uses basic functionality software installed on office computers, significantly reducing the costs of installation, computer systems and data entry devices.

A project manager is a key factor in the design of the system and the successful coordination of construction, hardware and software installations. Hardware that is properly aligned with business flow but not properly aligned with the software process will impact speed of commerce and affect process efficiency and effectiveness. The project manager must be able to assess hardware and software requirements and understand process flow.

OPERATING COSTS

Evaluation of operating costs without labour

ANNUAL OPERATING COSTS per facility	**Option One** Stand alone software with third party entering information by group	**Option Two** Integrated software with site personnel entering information by group	**Option Three** Stand alone software with once daily input of total head handled by site personnel
SUPPORT AND MAINTENANCE COSTS			
Hardware: Warranty and service agreements	$ 8,500	$ 8,500	$ 8,500
Service/repair costs for hardware and software	$ 5,000	$ 5,000	$ 5,000
Software: Additional license, maintenance and support	$ 500	$ 1,100	$ 500
Service and repair on alleys	$ 1,500	$ 1,500	$ 1,500
	$ 15,500	**$ 16,100**	**$ 15,500**
ADMINISTRATIVE COSTS: Insurance and one day of personnel training	**$ 644**	**$ 644**	**$ 644**
CAPITAL REPLACEMENT RESERVE: Hardware and alley	**$ 10,800**	**$ 10,800**	**$ 10,800**
	$ 26,944	**$ 27,544**	**$ 26,944**

System maintenance is required on a semi-annual basis to: ensure proper synchronization of the panels, evaluate any variance in frequency interference, update reader software and for tuning and general maintenance of the electrical connections and component parts. It is recommended that sites engage in warranty or service agreements with hardware vendors to ensure continuous high levels of read accuracy. The capital reserve is based on a five-year replacement of RFID hardware.

This table shows the high end of quotes received for each aspect of annual operating costs. The variance between Option One and Three with basic software functionality and Option Two with full software integration with enterprise systems is the cost of the annual software support. It is estimated that the lower fees for license, maintenance and support would reduce annual operating costs by $600. With all options, the same RFID hardware is installed and it is only the software and the data entry device that change. As such, the support and maintenance costs of the systems are the same regardless of volumes handled by a facility.

LABOUR

The variable operating cost factor is the internal labour costs for operating the systems on scanning days. Depending on the location in the facility, the scanning day will be either receiving or sale days. Systems at receiving have a higher cost than at the sale ring due to labour to assist with cattle movement through the alleys, additional time required during the day for all staff when the system is integrated with the enterprise software, and scanning for a few hours on sale day. There are a few instances that are not included in this analysis. For example, auction markets often hold cattle in-transit and these should also be scanned for proper traceability. These events are not calculated in the analysis below as they are not full scanning days. Even though the systems were installed at receiving at buying stations, the test sites did not identify the need for additional time or personnel because of the RFID systems. The number of scanning days used in the following table is based in the number of days the scanning system would be used in the test sites.

Estimated scanning days by volume

NUMBER OF SCANNING DAYS PER VOLUME	LOW # DAYS	HIGH # DAYS
Large volume auction markets	150	160
Medium volume auction markets	60	70
Small volume auction markets	45	55
Buying stations	300	350

Each of the following tables includes the annual operating costs, plus the estimated internal labor costs for operating the systems on scanning days.

ANNUAL OPERATING COSTS: AUCTION MARKETS AT SALE RING	Option one		Option Two		Option Three	
	Low	High	Low	High	Low	High
Large volume auction markets	$ 45,844	$ 47,154	$ 46,444	$ 47,704	$ 29,644	$ 29,824
Medium volume auction markets	$ 34,504	$ 35,814	$ 35,104	$ 36,364	$ 28,024	$ 28,204
Small volume auction markets	$ 32,614	$ 33,924	$ 33,214	$ 34,474	$ 27,754	$ 27,934

For systems at the sale ring, it is estimated that there will be six additional labour hours for data entry and one hour for RFID system maintenance and support; a total of seven hours per scanning day. The estimated labour cost per scanning day is $126 for Option One and Two and $18 for Option Three.

ANNUAL OPERATING COSTS: AUCTION MARKETS AT RECEIVING	Option one		Option Two		Option Three	
	Low	High	Low	High	Low	High
Large volume auction markets	$ 67,444	$ 70,194	$ 86,044	$ 89,944	$ 51,244	$ 52,864
Medium volume auction markets	$ 43,144	$ 45,894	$ 50,944	$ 54,844	$ 36,664	$ 38,284
Small volume auction markets	$ 39,094	$ 41,844	$ 45,094	$ 48,994	$ 34,234	$ 35,854

For systems at receiving, it is estimated that with all options there will be a requirement for one part-time person to facilitate cattle movement, additional labour for scanning days and a dedicated person to maintain and support the RFID system. With Option Two, there are additional labour hours for each receiving day to sort cattle into individual consigner groups prior to data entry. The estimated labour cost per scanning day is $270 for Option One, $390 for Option Two and $162 for Option Three.

ANNUAL OPERATING COSTS: AUCTION MARKETS AT RECEIVING	Option one		Option Two		Option Three	
	Low	High	Low	High	Low	High
	$ 64,744	$ 71,094	$ 65,344	$ 71,644	$ 32,344	$ 33,244

Labour costs at buying stations result from needing one dedicated person to maintain and support the RFID system, plus data entry throughout the sale day. The estimated labour cost per scanning day is $126 for Option One and Two and $18 Option Three.

In the evaluation of capital and ongoing annual costs, the least expensive option was clearly Option Three, with its basic functionality stand alone software that was not integrated with enterprise software. Although the tag numbers would not be linked to the buyer or consigner invoicing, traceability could still be supported at a low cost to the auction markets and buying stations. Option Three provides further benefits through a decreased reliance on labour, and in turn, lower stress on personnel, reduced recruiting and retention issues and fewer hours in the work day.

SUMMARY

After two years of evaluating RFID hardware and software and scanning close to 550,000 head of cattle at 13 test sites, it is concluded that the technology is not to the level that will enable 100% read accuracy in any of the environments tested. A deadline of full traceability by the end of 2011 is not reasonable at this time as many factors still need to be determined. The next step is for industry and government to establish a joint task force to move forward on some aspects of the NAFTS vision. These include the need for an integrated, responsive system that is able to react to challenges and seize opportunities. Beyond that, NAFTS will be built upon national standards. It has been recognized that each sector and individual user of the system has unique risks and opportunities, thereby requiring a phased approach to implementation.

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TERMS AND ACRONYMS

ATQ: Agri-Traçabilité Québec

CCIA: Canadian Cattle Identification Agency

CFIA: Canadian Food Inspection Agency

CLTS: Canadian Livestock Tracking System

CRT: Cathode- Ray tubes (used in computer monitors)

FRA: Field Research Associate

LMAC: Livestock Marketing Association of Canada

RF: Radio frequency

RFID: Radio frequency identification

RFID System: Automated tracing technology. Includes electronic panel antenna attached to the walls of a scanning alley, readers that collect data from the antenna and some sort of electronic process that collects the tag numbers into a report format.

Group: number of animals in a consignment (owner)

INTRODUCTION

Purpose of the study

Traceability requires the data capture and transfer of Canadian Cattle Identification Agency (CCIA) Radio Frequency Identification (RFID) tag numbers to the Canadian Livestock Tracking System (CLTS) through the use of electronic readers at each movement site. An RFID system is comprised of the hardware to scan the tag and record the electronic number and software to collect and disseminate that information.

Phase One of this multi-phase research project installed, operated and tested three commercially available RFID reader technologies at nine auction market test sites across Canada. The objective was to evaluate whether commercial technology for RFID hardware would scan RFID tags at a high level of accuracy. The first phase of the research was a proof of concept. As such, the RFID hardware was not linked to business software and therefore not integrated with business process. The project metrics were the impact on business process, speed of commerce, and animal and employee health and safety. The result of Phase One research is documented in a report submitted to Agriculture and Agri-Food Canada (AAFC) in April of 2010. The report is also available on the CCIA website at www.canadaid.ca under the tab for Applied Research Project. A copy of the executive summary from the Phase One study is attached in Appendix One.

Three buying stations were included as test sites in Phase Two as market neutrality is an industry concern. Both auction markets and buying stations will be regulated under traceability and it is important to evaluate the systems at both co-mingling sites.

The research finding from the final phase is presented in this business case. Using the same metrics as Phase One, the business case identifies the cot/benefit of implementing RFID systems at auction markets and buying stations across Canada in order to support a livestock movement tracking system. It is outside the scope of this research to identify how full traceability will benefit the industry at large and any associated economic value of those benefits.

National Agriculture and Food Traceability System (NAFTS)
Vision Statement

Better serve citizens, industry and Government with a secure National Agriculture and Food Traceability System. The system will provide timely, accurate and relevant information to enhance emergency management, market access, industry competitiveness and consumer confidence.

This study will help industry and government move forward on some aspects of the NAFTS vision such as having an integrated, responsive system able to react to challenges and seize opportunities. Beyond that, NAFTS will be built upon national standards. It has been recognized that each sector and individual user of the system has unique risks and opportunities requiring a phased approach to implementation.

In order for industry to be compliant with government regulations on traceability, there must first be clear and concise direction on what is required. The current regulatory framework is uncertain and therefore it is impossible to determine an exact cost for compliance.

Background

Key elements of a traceability system are animal identification, premises identification, and movement tracking. All three pillars are supported with the use of an approved Canadian Cattle Identification Agency (CCIA) approved radio frequency identification (RFID) ear tag and the Canadian Livestock Tracking System (CLTS).

In July of 2009, the federal, provincial and territorial Ministers of Agriculture held a meeting at Niagara-on-the-Lake, Ontario and agreed that a national traceability system for both livestock and poultry is critical for managing animal health and food safety as well as expanding potential market access and driving efficiencies. With the exception of Saskatchewan, it was agreed that a mandatory national traceability system for livestock be implemented by 2011.[1] It is estimated that there are more than 150 auction marts and 85 buying stations that may require the installation of RFID reader systems to collect and disseminate the tag numbers to the Canadian Livestock Tracking System (CLTS) database for movement reporting. These estimates do not include feedlots that buy cattle direct from producers or other feedlots, farm to farm sales, or order buyers who purchase direct but do not have buying stations.

"As a result of the first Canadian-born case of BSE reported in May 2003, over 30 countries, including the United States (US) placed trading restrictions on beef exports from Canada. In August 2003, the US began allowing whole-muscle cuts from Canadian cattle less than 30 months of age into their country. On July 13, 2005, the US border opened to Canadian ruminants under 30 months of age. The cost of BSE to the Canadian cattle industry is estimated to be $7 billion."[2] Canada must protect its reputation and export markets for high quality beef. Competitors such as Brazil and Australia have implemented traceability systems which will provide a competitive advantage in export markets such as Japan and Korea.

Animal identification is especially important for emergency management in the event that a trace back is required for cattle that have been co-mingled. Traceability is supported by the Canadian Food Inspection Agency (CFIA) as an important tool for emergency management in the event of disease outbreak. CFIA has detailed the following objective in its traceability concept paper:

> *"To create an enabling legislative and regulatory framework to support the management of animal and related human health issues, to facilitate a rapid response to emergencies resulting from disease outbreaks, natural and other disasters in the livestock and poultry sectors, and to enhance food safety by collecting, reporting, holding and sharing timely, accurate and relevant traceability information among authorized users."*[3]

To achieve full movement tracking, the third pillar of traceability, requires significant technological investment and infrastructure modifications at commingling sites. "Movement tracking requirements are significantly more challenging since the cost and impact on commerce are far more pronounced. Implementation of movement tracking should only proceed when justified by a cost/benefit analysis and at a rate that commerce and technology will allow without placing undue costs and burdens on the industry."[4]

PROJECT DEFINITION

Project objectives and metrics

1. Evaluate the issues, opportunities and performance in relation to the business process with integrated RFID systems in three areas:
   i. Impact on speed of commerce by the hardware and software (efficiency);
   ii. Software efficiency of capturing and reporting tag numbers; and
   iii. Weekly and global read accuracy (effectiveness).
2. Determine if the systems have the potential to cause employee and animal injury or illness.
3. Identify potential for business value creation at the operational level. This will include identifying if there is any benefit to the consigner, buyer or operation through automated age verification, inventory control or data reporting.
4. Document the capital, operating and ongoing cost of administration and maintenance associated with utilizing technology to collect and report RFID tag numbers to support traceability as per the Canadian Cattle Industry's National Animal Movement Plan for the livestock markets segment.

These metrics were chosen to ensure the implementation of RFID systems have been evaluated from a business perspective. Every auction market has unique design configurations and process flow. As such, the design of an RFID System must also be unique and take into account efficiency and effectiveness of business process. For the purposes of this study, those are defined as follows:

- **Efficiency** is deemed to be anything that improves business process, speeds business flow or minimizes errors/defects.
- **Effectiveness** is anything that operates in a manner that meets the need for which it was implemented.

Speed of commerce is identified as the time it takes to complete one cycle in a business process; the metric changes whether the system is at receiving or at the sale ring. **Software effectiveness** is defined by whether or not the software was able to accurately record and report the tag numbers from the RFID hardware. **Software efficiency** is defined as whether or not it had any impact on business by improving process flow or minimizing errors. **Read accuracy** is defined as the percentage of tags that were recorded based on the number of head that were run through the scanning alleys.

Phase One documented the cost of RFID hardware, scanning alleys and infrastructure changes for three brands of hardware installed in two areas within auction markets. Two of the installations in Phase One caused significant impact on speed of commerce; in Phase Two these systems were replaced with new hardware in new locations within the facility. As a result of recommendations from Phase One, the project installed and tested: multiple systems at receiving to evaluate the impact of multiple entry points, two wide alley systems with only four panels to evaluate reduced size and costs, and new hardware to replace the two three-year-old systems.

Phase Two introduced software that linked the RFID hardware with enterprise software. The buying stations required different configurations than auction markets as a result of the process flow. Numerous RFID systems were required to cover the intake areas at buying stations due their complicated business process. The Phase One full report is available at www.canadaid.ca on the pages for the Applied Research Study.

Phase One research plan

Phase One installed, operated and tested three commercially available RFID reader technologies at nine auction markets in four provinces across Canada. RFID hardware configurations were single, dual and wide alley; located both before and after the sale ring and at receiving.

Software was custom designed and operated on a project laptop with a Windows operating system. It did not link into the auction markets enterprise systems. At each test site, a project Field Research Associate (FRA) was accountable for recording the data, reporting to the CLTS, and maintenance on the RFID systems. There was no integration with the business process.

There were 31,376 groups/lots with 144,197 head scanned over eleven weeks between September and December of 2009. The executive summary from Phase One is located in Appendix One of this report.

Phase Two research plan

Phase Two took place in ten auction markets and three buying stations across four Canadian provinces. Two new RFID hardware configurations were added; the four-panel wide alley system and dual alley multi-lane system. There were 107,423 groups/lots with 393,474 head of cattle scanned over 30 weeks between September 5, 2010 and March 31, 2011.

At the auction markets, fully integrated RFID systems were evaluated. The RFID hardware was linked to enterprise servers and the tag recording software module was integrated with the enterprise software used for business processes. This integration enabled the tag numbers to be listed on the consigner and buyer invoices/settlement sheets. Site personnel entered the corresponding data such as consigner name and group size. Each test sites enterprise software vendor built the tag recording and capture module in order to fully integrate with the enterprise system. Integrating the systems required installing communication cabling and network boxes to enable the hardware to transfer data to the enterprise servers.

At the buying stations, it was difficult to align with the enterprise software process. New stand alone software was developed that operated on a Windows-based protocol. This software supported recording both move-in and move-out with multiple hardware systems located throughout the facility.

Assumptions and constraints

Assumptions

- There is a significant variance in the level of technology acceptance and integration within the auction marts and buying stations which will affect the success of the electronic integration throughout business process.
- For the purposes of read accuracy recording, any group of three of more with a zero tags read is assumed to be a failure of data input, tag failure or untagged cattle.

Constraints to achieving 100% read accuracy

- Failure rates of the RFID tag
- Tag placement
- Electronic interference causing low read accuracy

Scope

- It is outside the scope of this research to identify the economic benefits of full-scale traceability to the livestock industry as a whole.

Test site participants

All the auction markets that participated in Phase One continued onto Phase Two. Three buying stations were included in the test to ensure market neutrality.

Ontario:

LARGE MARKET: Ontario Stockyards, Cookstown, ON
MEDIUM MARKET: Ottawa Livestock Exchange, Greely, ON
MEDIUM BUYING STATION: McCall Livestock, Brussels, ON

Manitoba

MEDIUM MARKET: Ste Rose Auction Mart, Ste Rose du Lac, MB
SMALL MARKET: Gladstone Auction Mart, Gladstone, MB
MEDIUM MARKET: Winnipeg Livestock Sales, Winnipeg, MB
SMALL MARKET: Killarney Auction Mart, Killarney, MB
MEDIUM BUYING STATION: Cattlex, Hamiota, MB

Saskatchewan

LARGE MARKET: Saskatoon Livestock Sales, Saskatoon, SK
MEDIUM MARKET: Whitewood Livestock Sales, Whitewood, SK
SMALL MARKET: Spiritwood Livestock Sales, Spiritwood, SK
LARGE BUYING STATION: JGL Livestock, Moosejaw SK

British Columbia

SMALL MARKET: BC Coop Livestock Sales, Kamloops, BC

VENDOR SELECTION

Phase One was a proof of concept, concluding that technology is commercially available for relatively high levels of accurate RFID reads and transfer of that data to the CCIA database. The project did not integrate commercially available software for collection and dissemination of the RFID tag numbers to the CCIA database. Viewtrak Technologies designed and built the software, Manifest Manager, for test reporting with basic functionality.

In Phase Two, the RFID hardware was linked with enterprise software that integrated the RFID tag numbers into the enterprise software process. At nine of the 1O auction markets in this study, Viewtrak Technologies is the enterprise software vendor. Two test sites were offered new enterprise software from other vendors. In both cases they choose to continue with Viewtrak as they have customized their software, which was a significant monetary investment, and their staff is familiar with the software. The buying stations were provided with customized software by Viewtrak Technologies as their enterprise software process is complicated and aligning a software module did not provide the reporting functionality required.

The intent of the project was to evaluate as many configurations and types of systems possible. As such, all three types of systems; single, dual and wide alley were incorporated into the project, as was the use of a long-handled wand for pen scanning. Every auction market has a unique design and process flow, as such, it was important that various types of systems were installed to ensure that there was full coverage and evaluation for the analysis. The selection of the vendors was based on the following four criteria:

1. CCIA approved electronic RFID panel readers;
2. Documentation that shows the hardware has performed well in other installations;
3. The ability of the vendor to install the technology and provide training in test sites across Canada; and
4. Long term commitment and proven ability to maintenance and support of the hardware at the test sites.

The vendors of the RFID hardware systems are as follows:

- **Compass Animal Health** representing Destron Fearing: Four- and eight-panel wide alley and dual alley
- **Allflex USA, Inc**: Two- and four-panel single lane and four-panel dual lane
- **Integrated Traceability Solutions** (ITS) representing Aleis: Eight-panel wide alley, two-panel single alley and long-handled wands

The vendors were required to work with the project team to continually monitor, evaluate and make modifications to systems to ensure the highest levels of accuracy and efficiency.

An RFID system is a combination of RFID hardware (panels, antenna and readers) installed in a scanning alley, and software that collects the tag numbers from the readers and transmits those numbers to the CLTS for reporting.

DATA REPORTING PROTOCOL

Peter Ehlers, PhD, of StatCaR Calgary, consulted on the project to prepare the statistical data in the following manner:

The data set includes the RFID tags scanned over 30 weeks (the first week in September, 2010 to the end of March, 2011). Anomalies were dealt with to ensure data accuracy; data entries with obvious human error, any group of cattle with three or more head that recorded a zero read was eliminated based on the assumption this was a data entry error software issue. The data were received as comma-separated values (csv) files directly from the sites. The data were imported into the R statistical program[5] and were then validated with respect to consistency in terms of dates, etc. There were four different types of data:

1. Standard data reporting: single systems;
2. Ste Rose: multiple systems recorded by chute with summaries;
3. Ontario stockyards: multiple systems using a different software and therefore different reporting format; and
4. Three buying stations: Data recorded by chute and with notations for intake and load out.

These provided variables such as dates in different formats which were converted to a single consistent format. All reports were kept in separate files which were then combined and analyzed weekly (cumulatively). Time stamps of zero were eliminated, date formats were converted, and some cases of clearly incorrect dates and many cases of invalid time stamps were noted.

There were two different files presented by the software:

1. A tag report file that recorded the data by group, showing the number of head scanned, number of head read, and read accuracy; and
2. A file that listed the tag numbers by time read. The tag report file generated by the software had many errors and required an evaluation with the tag number file in order to verify read accuracy. The total number of head handled was taken from the tag report file, but the total number of head scanned was taken from the tag number file after data cleansing. "Data cleansing" dealt with two main issues as follows:
   i. Invalid and duplicate RFID tag numbers and
   ii. Groups of three or more with zero reads.

Invalid and duplicate RFID tag numbers

An invalid RFID tag number was anything recorded that did not fit the standard CCIA-approved tag format, that being: 15 digits, starting with 124 and ending with numbers above zero. All invalid and duplicate tag numbers needed to be detected and removed. Tag values were tested for invalid beginning/ending characters and for invalid tag length. It was important to handle the tags not as numbers but rather as labels (i.e., text values). The duplicated tags had to be detected and removed if they were considered to be double-reads. This was a challenging problem since there could be legitimate duplicates as long as they were not too proximal in terms of the time stamp. It was decided to remove entries if their time stamps were within a time window of given duration. Different time windows were assessed and it was determined that a 10-minute window for the buying stations and a 20-minute window for other sites were reasonable choices. Thus a duplicated RFID tag for which the time stamp difference exceeded the window value was not removed. A total of 1.9% of all tags had these errors.

Groups of three or more with zero reads

Phase One found it was rare that groups over three head recorded a zero read. An assumption was made that groups of three of more that reflected a zero read were likely human error in either entering the number of head, a scanning issue, or a group without ear tags. As a result, these groups were eliminated from the read accuracy data calculations. These groups were flagged and read accuracy was computed both with these cases included (unadjusted) and with these cases removed (adjusted). 1.2% of all groups were eliminated from the read accuracy calculation.

The global read accuracy is a weighted average of all numbers of cattle read divided by all the tag numbers recorded. As such, no one site influenced the outcome of the global read accuracy. The individual site global read accuracy was cleansed by adjusting the weekly reads so there was no read above 100% with the exception of Ottawa. Read rates in excess of 105% were deleted from the data set, and reads under 105% were adjusted to 100%. The influence this had was marginal as the only site with numerous reads over 100% was Ottawa.

The read accuracy is based on the number of RFID tags that were scanned by the animals passing through the scanner alleys of the RFID system. The read accuracy percentages identified in this research are not necessarily indicative of the failure of the panel reader hardware as there was no intervention when a tag did not record on the RFID system. Factors that affect the level of accuracy are:

1. Human error entering the number of head in the software;
2. Cattle that aren't tagged;
3. Animal behaviour; and
4. Tags that don't scan.

The technical factors that lead to low scanning rates are documented in Appendix Two: Technical Statement.

IDENTIFICATION OF OPTIONS FOR RFID SYSTEMS

The research project identified several options for configuring the RFID systems at auction markets and buying stations across Canada. Option One reflects the processes used in Phase One, Option Two reflects the process from Phase Two and Option Three reflects of hybrid of both phases. It should be noted that the options presented in this study are not the only systems for scanning cattle; both Quebec and Australia have systems that support high read accuracy.

Each alternative would use the same hardware tested in both phases; single, dual and wide alley scanners located at either receiving or before and after the sale ring. As cattle move through the scanning alley, the panel antenna reads the RFID tag number and transmits the data to a reader box. The software then records that tag number and disseminates it based on the level of integration with enterprise software.

It has been noted that the location of RFID hardware must align with business process so as to not impede the speed of commerce. The same is true for software; if the software does not align with business process and operating objectives it will not be efficient or effective. There is no one standard software solution; yet it is a critical component of a successful RFID scanning system. The variable in the RFID system is the type of software that will be used to record and report the tag numbers. Various software options are described as follows:

Option One and Three: Software with basic functionality records the read accuracy by group/lot, then totals the read accuracy for the scanning day and creates a movement file for submission to the CLTS. An alternative to scanning individual groups is to allow cattle to move through the scanners for 24 hours, then record the total number of head scanned and create a movement report based on that total number. The software is called stand alone as it is not integrated with the enterprise software and does not link with invoices, statements or transactional data (settlement sheets). The software can run on any platform as it does not have to be linked to the enterprise servers. The RFID hardware can be linked to any computer through a serial hub and CAT5 cables. It is important that the computer that houses the software has access to the internet for transfer of the movement files.

Option Two: Software with a broader functionality that is integrated with the enterprise software so tag numbers can be made available on invoices, statements and transactional data. This software is an add-on module to enterprise software so the entry of specific information (such as the name of the consigner) must be entered at the same time as the tag capture. It runs on the same platform and network as the enterprise software so the RFID hardware must be linked to the enterprise servers in order to communicate between the hardware and the software.

Table 1: summary of options for RFID systems

Option One **Stand alone software with third party entering information by group**	**Option Two** **Integrated software with site personnel entering information by group**	**Option Three** **Stand alone software with once daily input of total head handled by site personnel**
RFID hardware located either at receiving or sale ring: single, wide or dual-lane scanning alley		
• Software to record and report tag numbers stands outside business process • Information entry by a third party at the location of the system • No integration with enterprise software or operations processes	• Software that linked with enterprise software to record and report tag numbers • Information entry by site personnel at the location of the system • Integration with enterprise servers, software and operation processes	• Software to record and report tag numbers stands outside business process • Daily total entered by site staff • Software resides on administrative computers • No integration with enterprise
Software creates a report showing read accuracy for that scanning day and a converting spreadsheet data file (.csv) configured in the proper format for a movement file for submission to the CLTS.		
The movement file is submitted to the Canadian Livestock Tracking System		

Option One: Stand- alone software with third party data entry

Table 2: Location and type of system at Phase One test sites

TEST SITES	PHASE ONE: Location of System	PHASE TWO : Location of system
Cookstown; Ontario Stockyards	Wide alley before sale ring	Wide alley before sale ring
Gladstone Auction Mart	Dual alley at receiving	Four-panel wide alley at receiving
Kamloops; BC Livestock	Dual alley at receiving	Multi-Lane at receiving
Killarney Livestock	Single alley at receiving	Four-panel wide alley before sale ring
Ottawa Livestock	Single alley before sale ring	Single alley before sale ring
Saskatoon Livestock	Wide alley after sale ring	Wide alley after sale ring
Spiritwood Stockyards	Wide alley after sale ring	Wide alley after sale ring
Ste Rose Auction Mart	Single alley at back of the receiving area	Two single alley on intake chutes. One dual alley at receiving for ground loading trailers
Winnipeg Livestock	Wide alley at receiving	Wide alley at receiving
Whitewood Livestock	Wide alley after sale ring	Wide alley after sale ring
Buying Stations		
Cattlex; Hamiota, MB		Two single alley at receiving
JGL; Moosejaw, SK		Three single alley and one wide at receiving
McCall Livestock; Brussels, ON		Two single alley and one wide at receiving

Phase One business process

Nine RFID hardware configurations were tested; four systems at the sale ring (one before and three after) and five systems at receiving. Each location had only one RFID system. Manifest Manager, software with basic functionality was developed by Viewtrak Technologies that registered the RFID numbers from the readers and created reports for movement reporting to the CLTS. The software was not linked with business software used by the test sites, nor did it offer any alignment with invoicing, inventory, age verification or purchasing records.

A monitoring booth was installed which overlooked the scanning alley so the Field Research Associate (FRA) could easily observe the cattle moving through the system. The reader boxes were generally installed in the monitoring booth and connected to a project laptop, with a Windows operating system and Viewtrak Manifest Manager software. In general, the following steps occurred:

1. The yard personnel would tell the FRA how many cattle were in the coming group.
2. The FRA would use the Manifest Manager software to enter the number of head in the lot/group.
3. The cattle would move through the scanner alley.
4. Once all the cattle were through the alley, the FRA would click "end group" and enter their comments regarding observations of the animal behaviour and tag issues. At that point, the next group of cattle could enter the alley.
5. The FRA sent the movement file to the CLTS database via the internet and the group summaries to the project manager for research purposes.

Option Two: Integrated software with data entry by site personnel

Phase Two business process

Phase One verified the proof of concept that the RFID hardware could effectively collect and record tag numbers. The second phase of the project evaluated integrated business processes.

The RFID reader boxes were linked to the enterprise server in the administrative office by CAT5 cables and a digiboard (networking device). Software modules were developed and integrated with the enterprise (operating) software. Details of the transactions were entered by site personnel (i.e., consigner names, group size) at the location of the scanning alley using, thin clients with monitors, DT500s or office computers. For the purposes of this research, it is worth noting:

Viewtrak Technologies recommends the use of a DT500 at receiving. This is an operating system and software encased in a stainless steel box with a touch screen. These devices are built to withstand harsh and abusive environments and are well suited for operating in the cold weather or hot dusty environments.

A thin client is a computer, monitor and keyboard with no functionality unless networked to a server. A thin client must be in an enclosed environment such as a receiving booth, as it cannot be exposed to extreme temperatures or harsh environments.

The software modules were built by the same vendor as the enterprise software used at each site and linked into the software process based on the location of the system. Integrating the systems required installing communication cabling and network boxes (digiboards or serial hubs) to enable the hardware to communicate the tag numbers to the enterprise servers.

In all cases, the office staff submitted the movement files to the CLTS and the read accuracy reports were transmitted automatically to the project manager via email.

At receiving

The business process before the integration with the software was that cattle entered the facility on either semi-trucks or ground loading trailers. The receiving staff entered the consigner name and number of head on a receiving slip, one copy moved with the cattle through the facility, the other copy was entered by office personnel along with additional information to generate a sales lot linked to the consigner. In 90% of the cases, there is no electronic link between receiving and the administrative office. The administrative staff inputs information separately and invoices are printed. The consigner provides information on manifests when they exit; otherwise, the facility inputs the information.

With the integration of the software, the yard personnel had to first sort the cattle into individual consigner groups, document the receiving slips, then enter that information, plus all the other information that was generally entered in the admin office, using thin clients with monitors or DT500s at the receiving gate. Market staff at Gladstone and Winnipeg complained that the numerous mandatory fields were not required at receiving and therefore slowed the speed of receiving. It would have been beneficial to only enter the consigner name and number of head to increase the speed of data entry.

Ideally, the business process followed these steps:

1. The receiving personnel writes the consigner's name and number of head on a piece of paper and hands it to the receiving clerk.
2. The receiving clerk enters that information to the receiving module, in addition to check offs, breed, sex and billing address. This information would then be available in the office to continue entering the consigner loads.
3. The cattle move through the scanner alley and tag numbers were captured. The next group/lot could enter the alley once the first group was through.
4. The tag numbers were available on the consigner invoices.

Prior to the sale ring

At Killarney, before the installation of the software, the business process required that a ring clerk capture the weight of the animals on scales directly in front of the sale ring. That weight would be displayed in the sale ring and linked to the sales draft, which was eventually assigned to a buyer. With the integration with the software, that process changed to the following:

1. The ring clerk captured the tag numbers as the cattle moved through the scanners and then captured the weight.
2. Both the weight and the tag number/s were assigned to the sales draft which was eventually assigned to the buyer.
3. The next group could not enter the scanning alley until the tags from the first group were captured with the weights. There were numerous systems installed to notify the ring clerk that the cattle had moved out of the alley and tag capture could occur.
4. Tag numbers could be made available on the buyer invoices if requested.

At Ontario Stockyards in Cookstown, prior to the software integration, the ring clerk captured the weight on the scales that were directly before the sale ring, and that weight was then assigned to the sales draft. The consigner information was entered by the ring clerk from the paper that was transferred with the cattle. With the integration of the software:

1. A person trained on the software entered the consigner information and number of head on a laptop at the entrance to the scanning alley
2. The group of cattle moved out of the scanning alley onto the weight scale before the next group could enter the alley.
3. Tag numbers could be made available to the buyers if requested.

After the sale ring

Prior to the installation of the integrated software, data entry was finished as soon as the buyer information was entered by the ring clerk. With the integration of the software, the ring clerk waited to end the sale transaction until the cattle moved through the scanners so the tags were captured and aligned with the sales lot. Data entry took place on the sale ring computer. In sum:

1. The cattle moved out of the sale ring and through the scanning alley. Often they were held in the alley for a few moments awaiting the availability of a pen.
2. Once the cattle were through the alley, the ring clerk captured the tag numbers which recorded them on the sale documentation (settlement sheets).
3. The next group could not move out of the sale ring into the scanning alley until the tags were captured and the first group had moved out of the alley.
4. Tag numbers could be available on the buyers' invoices if requested.

Buying stations at receiving

Prior to the installation of the RFID system, information on the individual cattle loads were entered into inventory in the office by admin personnel based on receiving slips from the yard staff. If the cattle were received from an auction market, there was no need to re-weigh the group, so the group was entered into inventory as documented. If the cattle had not been purchased with an assigned weight, the cattle were weighed in advance of being entered to inventory.

After the installation of the RFID systems, the entry of three basic fields: consigner name, number of head and whether it was a load in or load out, took place on either a DT500 directly at the receiving gate, a thin client with monitor in the receiving booth, or on the office computers. The software at these facilities was designed for movement reporting more than integration with the inventory system.

1. As the cattle moved through the multiple scanning alleys, the software recorded the tag numbers by chute number.
2. Either the office or receiving personnel entered the consigner information and correlated that information to the tag numbers in the lots, identifying if it was a move in or move out event. It was not necessary to record the movement at the same time it happened as there was a buffer in the system that collected the numbers.
3. The software did not link to the enterprise software, so the tag number was not available on the consigner or buyer invoices.

Option Three: Stand alone software with data entry by site personnel

Option three business process

This option was developed as a hybrid of the business process from Phase One and a scenario that developed as a result of one test site capturing data at the sale ring, coupled with the experience of two buying stations in Phase Two. In Phase One, the software was not integrated with the enterprise systems and the data was entered by a project person at the location of the system. The business process, before and after the integration, is explained in the text on Option One. In Phase Two, the integration of the software with the business process affected the speed of commerce at one location to such an extent they were not able to continue with that process. The business process before and after the integration is explained in the text in Option Two, vis-à-vis the discussion of Killarney prior to the sale ring. As this site had participated in Phase One, the software program Manifest Manager was still installed on their Windows-based office computers. The RFID scanner was already linked to the office server. The office personnel opened the software at the beginning of a sale day on the office computers. With the software operational:

- The cattle moved through the scanner alley all day at the entrance to the sale ring.
- At the end of the sale day, the admin person entered the total head that were sold for the day and ended the group.
- The report did not record by group or consigner, just a total for the scanning day. However, the functionality existed to scan individual groups if required.
- The tag numbers were not available on the buyer or consigner invoices.

The three buying stations in Phase Two used software that was not integrated with their enterprise systems. In some cases, the information was entered in the software in the office when time was available. There was no requirement to enter each group as it moved through the systems, although McCall Livestock did enter each load. The information was not available to the buyer or seller. Large groups of cattle would move through the system and be allocated to a vendor at a later time, therefore not requiring immediate attention from the yard staff. The buying station software is reflective of Option Three as the software was not integrated to operating software. As there was no immediate requirement to enter the data in a timely manner, this did not affect the speed of commerce on lots that were not tracked individually.

PHASE TWO RESEARCH AND METRICS

In Phase Two, fully-integrated RFID systems were evaluated at the auction markets. The RFID hardware was linked to enterprise servers and the tag recording software module was integrated with the enterprise software used for business processes. This integration enabled the consigner and buyer settlement sheets (invoices) to have the tag numbers listed and age verification information available. Site personnel entered the corresponding data such as consigner name and group size. The software modules were built by the same vendor of the enterprise software used at each site and linked to the software process based on the location of the system. Integrating the systems required installing communication cabling and network boxes to enable the hardware to transfer data to the enterprise servers.

Buying stations were introduced in Phase Two and each site was equipped with multiple RFID alleys at the loading areas of the facilities. It was difficult to link into the enterprise software as a result of the unique business process. New stand alone software was developed that operated on a Windows-based protocol. This software supported recording both move-in and move-out.

Phase Two tested multiple RFID systems at the three buying stations and one auction market. All these systems were located at receiving; with single alley scanners installed on loading chutes to support intake from semi-trailer trucks.

The project documented specific metrics at each test site to summarize the impact integrated RFID systems would have on auction markets and buying stations. These metrics were:

1. Speed of commerce by the hardware and software;
2. Software effectiveness and efficiency of capturing and reporting tag numbers and impact on business process;
3. Weekly and global read accuracy;
4. Impact on animal health and safety, defined by the number of injuries or accidents caused by using the systems; and
5. Potential for business value creation.

Speed of commerce is identified as the time it takes to complete one cycle in a business process; the metric changes whether the system is at receiving or at the sale ring. **Software effectiveness** is defined by whether or not the software was able to accurately record and report the tag numbers from the RFID hardware. **Software efficiency** is defined as whether it had any impact on business by improving process flow or minimizing errors. **Read accuracy** is defined as the percentage of tags that were recorded based on the number of head that were run through the scanning alleys. The impact on **Animal and Employee Safety** was defined by injury or illness.

Individual Test Site Experiences Phase Two, pages 29 to 71, details the experience at each test site in Phase Two in relation to the project metrics. Most of the information was direct quotes from the test site operators, or generalizations of their experience and has been approved by the test site operator. As follows is a review of what the test sites reported in terms of their varying experiences with the installation and use of the RFID integrated systems.

Integration experience

Most sites found the hardware vendors to be professional and supportive with excellent technical support. The majority of RFID hardware installations went smoothly and there was little trouble with the operation of the scanning system. Both Compass Animal Health and Allflex attended their installations, at no charge to the project, and made amendments and changes to the RFID hardware to increase read accuracy. The biggest challenge the sites faced in the hardware installation was finding time to support the installation during the fall run, their busiest time of year. At JGL Livestock, a buying station in Moosejaw SK, extensive site modifications were required to link the four RFID systems located at receiving. McCall Livestock, Brussels, ON, required additional site visits from the hardware vendor to determine the cause of electrical interference that was creating low read accuracy. It was determined that the cause was the overhead lighting, which was resolved by installing inline filters. At Cattlex, Hamiota, MB, it took three months working with the hardware and software vendors to get the Aleis wand to link with the Viewtrak software. That prompted the market operator to comment that "the use of the wand did not create enough value for the amount it time it took to set up and get it working." Killarney, MB, required the installation of a crowding tub to support cattle movement into the scanning alley. Most sites were comfortably using their system within three weeks, while others were still having problems after three months.

Integrating the software with the enterprise systems created broader and more widespread problems. Some sites rated their satisfaction with Viewtrack, the software provider, as low due to the lack of support on installations and software training. Four operators complained that software crashes, as a result of the tag data capture, slowed or stopped sales. There were numerous technical software functionality and reporting issues that took a great deal to time for the test sites to sort out. These software technical issues were further exasperated by problems of communication between the hardware and software. The time spent on technical support ranged from 3 to 27 hours. The sites with new computer servers required the most technical support. Most sites found the staff learned the software in as little as a few hours but it took some time to get used to the additional step in the process. It could take up to one month before all staff was familiar with and comfortable using the new systems. Operators rated the level of technical competency to operate the software between 3 and 3.5/5 (with 5 being the highest level of competency).

Five of the sites requested revisions to the Viewtrak software modules in an attempt to mitigate the impact the software was having on speed of commerce. The modifications were to reduce the number of mandatory fields required at receiving, and to correct issues with recording duplicate tags and tags with invalid formats. Software modification costs ranged from $600 to $3,500. However, at Gladstone the software modifications never resolved the problems to the satisfaction of the operator.

Technical difficulties have plagued two sites, with resolutions still not in place. At Gladstone, the RFID numbers transfers from the Destron RFID panels to the Viewtrak software residing on the DT500. The number of tags recorded at this site with invalid formats was almost 13%; leading to a very low read accuracy rate. At this time, even with site visits from both hardware and software vendors, the cause of the tag recording errors has yet to be determined. At McCall Livestock, the RFID hardware has consistently had very low read accuracy since installation. Even with repeated site visits by the vendor Integrated Traceability Solutions, modifications to the lighting, panels and updating the DT500, the read rate remains exceptionally low by industry standards.

Speed of Commerce

The speed of commerce can be characterized in three ways: there was no impact; it slowed as a result of the software integration; or it slowed due to both the hardware and software.

The six sites with RFID systems before and after the sale ring found little to no impact on their speed of commerce as a result of the hardware. The integration with the software at Killarney increased the time to sell one draft by 25% (20 seconds), therefore affecting the speed of commerce to the extent they were not able to continue using the software. Other sites with systems at the sale ring experienced only a minimal impact of between 10-20 minutes over a whole sale. Whitewood found that the tag capture had a significant impact on presort days when the cattle are moving faster, adding almost one hour per day.

The facilities at receiving experienced the highest impact from both the hardware and software. Gladstone Auction Mart and Ste. Rose Auction Mart had to reduce the number of penning lanes to facilitate cattle movement through the scanning alleys. This increased their processing times by one to three hours per day. In order to enter consigner information at receiving, all incoming groups must be sorted by individual owner. This was a particular problem with ground loading trailers, where several owners often have cattle on one load. This was a time-consuming process that took between a few seconds to five minutes per group. Both Gladstone and Winnipeg complained the software had too many mandatory fields. The total impact at receiving from the software was estimated to be 1.5 hours.

Two of the buying stations did not find the hardware and software had any impact on speed of commerce. In contrast, McCall Livestock found an increase of 15 to 20 minutes per transaction as a result of entering individual move-in and move-out information.

Efficiency and Effectiveness of Business Process

All test sites reported that the integration of RFID hardware and software was inefficient because it added one more step in the business process (entering the data, tag capture and reporting to the enterprise software) without that additional step adding value. The way the tag numbers link to the drafts is not accurate enough to be relied upon, and the customers are not requesting the tag numbers on their settlement sheets.

The hardware at receiving created further inefficiencies. These occurred because of the time it took to unload cattle because of reduced penning alleys restricting process flow, the requirement to sort individual consigners on ground loading trailers, and too many mandatory fields on the software. This extra time created by the RFID systems created stress for producers waiting to drop off cattle.

Software technical issues created inefficiency at some facilities with the primary issues being::

1. The time spent on technical support and software crashes during sale days;
2. The inability of the hardware and software to work together as was the case at Cattlex with the Aleis wand and Viewtrak software; and
3. The Gladstone experience, with a 12.8% error rate as a result of capture and recording of improper tag numbers and formats.

A number of test sites noted concerns over difficulties being able to recruit and retain trained staff to use the software and the affect it would have on operations if these persons were unavailable on scanning days. As noted by the Ottawa market, "the important aspect of the system is a competent software operator who pays attention and doesn't make mistakes."

The two sites that found the systems to be efficient were Ottawa Livestock Exchange and Ontario Stockyards. Both of these sites deal in Quebec cattle with ATQ tags. Consigners get a rebate from ATQ when the tag is registered on the sales draft. As such, these sites both installed systems that were able to collect 100% of the readable ATQ tag numbers and report them on behalf of the customers. As one facility said, "this is an efficient system because we are providing a service that has been requested by our customers."

In most cases, the systems were effective as they collected and recorded tag numbers for movement reporting at a reasonable rate of accuracy. It was only McCall Livestock and Gladstone Auction Market that have ineffective systems, with low read accuracy, that have yet to be resolved.

Value Creation

Only two of the thirteen sites experienced benefits for their operations, buyers and consigners from the RFID systems. Both Ottawa Livestock Exchange and Ontario Stockyards noted that the benefit is to the consigner and buyer of Quebec cattle due to the recording and reporting of the tag number to ATQ for a rebate.

A few sites perceived potential benefits from being able to identify cattle that have moved out of the selling group or if a back tag has fallen off. However, a common issue that detracted from value creation was that the data accuracy is not high enough to depend on. Further, a potential benefit was not met because the age verification numbers were low; between 7.8% and 31.3% of all head scanned.

JGL Livestock noted in their comments, "We find value in the fact that our customers know we are concerned about the future of the cattle industry and that we are on the leading edge of any available systems or technology that is available. We also find value in the A/V (age verification) process as it pertains to tag numbers. We also believe that as industry goes forward this system will become of greater value."

Labour Requirements

Most sites reported that read range testing took only 10 minutes or less. Ste Rose Auction Mart had the highest read range testing time at half-an-hour due to managing three systems. Submission of the movement files to the CLTS took only five to 10 minutes unless data errors were encountered.

Sites with systems at receiving required extra staff to facilitate cattle movement through the systems. Gladstone Auction Mart required an extra three hours for their receiving clerk to enter data, which was handled by taking shorter and fewer breaks. Winnipeg Livestock needed one extra staff person for data entry and both Ottawa and Cookstown required an extra person to work the computers just prior to the sale ring. Saskatoon Livestock Sales needed a trained and skilled person to operate the wand for pen scanning.

Comments by Market Operators

BC Coop has been using an RFID system for three years so are comfortable with the process. Their read rates have increased with the new hardware and they will continue to scan cattle in support of traceability. Most of the problems they encounter are staff related in regards to not accepting the systems and not being able to use the software properly.

Gladstone Auction Mart manager Gerald McGowan said despite a slow down in the speed of commerce they will also continue to use the system if software is provided that does not require such extensive data entry. McGowan said the software could be improved, but communication between the software company and the livestock/auction operators is an impediment. Other aspects that need to be improved are the input of information from farmers, readability of different tag brands, system placement, scanner information transfer and modifications to the DT500.

JGL Livestock had a positive experience with what they called a user-friendly and cutting edge system with a high accuracy rate. They were one of the few businesses who found their customers appreciated their use of RFID. They said it showed they cared about the future of the industry.

Killarney Auction Mart found efficiency increased in the second phase due to moving the hardware to align with business process. In Phase One, there was a single alley system at receiving. It was replaced with a wide alley system prior to the sale ring. However, that was offset by the need to hire an extra person to move the cattle through the alley. They also stated that because there is no value added component for businesses, consumers or producers, the software should be used only for tracking and should not be tied to their existing business systems.

McCall Livestock said that to fully realize the benefits of traceability, the system has to be standardized in all sectors across Canada. Further, there needs to be a decision on how far through the value chain traceability will be implemented. They expressed concern over how government will support industry with financing, the readability of tags and/or the read accuracy of hardware.

Ontario Stockyards said they will continue to use the system, but would prefer simplified software and a reduction in the amount of required data. As they see no monetary value for using the system, they believe another entity should be responsible for operating scanning systems.

Michael Fleury of Saskatoon Livestock Sales reported "growing pains" in Phase Two, associated with expecting their scale personnel to take on another data entry step. Difficulties merging the hardware and software caused delays during auctions. Despite the challenges, they will continue to use the system as long as there are no additional costs. Before auction marts will be able to use the technology successfully, the technology needs to improve to allow large groups of cattle to be scanned. Tags also need to be improved to ensure they stay on the cattle and can be read.

Spiritwood Stockyards' owners, Pat and Brian Jacobsen, expressed concern over the cost of the system, duplication of existing systems and the stress on staff as a result of using the software. They cite the reliability of the reads, particularly due to the loss of tags, as a major problem. Requiring RFID reads could be crippling in the case of system failure and the Jacobsens question if they would have to shut down a sale in such a circumstance.

Ste Rose Auction Market said that even though their experience with RFID scanning improved in Phase Two, they will likely not continue using it if they have to continue with integrated software. Instead, they will use RFID scanning with basic software that records total group movement over a 24-hour period. The system needs to be self-operating and a separate entity needs to be on site to ensure proper tagging and locating lost tags prior to sale, they explain.
Whitewood Livestock Sales experienced extensive problems with the integration of the enterprise software and the scanners. This was primarily due to the installation of a new computer server to support networking. They stated that they will cease using the system if it cannot keep up. They also said the markets and auctions should not be footing the bill for this form of tracking and the government should pay for the system.

Winnipeg Livestock Sales hired a new staff member to operate the software and noted existing staff was put in danger by the way the cattle had to be handled. It was their experience that the system created a negative affect through reduced efficiency and effectiveness, increased labour costs and increased wait times for producers. They also said they needed more support from the software vendor for the installation of the new computer servers.

Table 3: Summary of metrics from test site experience

	RFID alley configuration	Speed of Commerce Hardware	Speed of Commerce Software	Efficiency of software aligned with business process	Animal and Employee Health and Safety	Value created with process integration	Read accuracy High- Low Global
BUYING STATIONS							
Cattlex	Two single alleys on chutes	No affect as the system is on the chutes. Does not restrict cattle flow or change process flow	No affect as the data is being entered in the office by admin personnel	Entering data does add an additional step, with no added value, it is inefficient.	No affect	No benefits	Low 84% High 99% Global 89%
JGL Livestock	Two single alley on chutes, one single alley for ground loading, one wide alley	No impact as the systems are on the chutes and a wide alley support large volumes from the auction market	Entering data does not affect the speed of commerce as lots are not entered with each movement.	Entering data does add an additional step, with no added value, it is inefficient.	No effect	No benefits	Low 84% High 94% Global 89%
McCall Livestock	Two single alley and one wide alley all at receiving	No slow down in receiving, maybe a little slower loading, but only in the single alley system. Wide alley system has zero affect on cattle movement in either direction.	Entering the data from each lot increases the processing time from 10-20 minutes per transaction	Is not efficient as entering the data at the receiving location does not reduce the need to enter it again in the office.	No effect	No benefits	Low 63% High 90% Global 77%

Ontario Stockyards

JGL Livestock

Table 3a: Summary of metrics from test site experience – Labour Requirements

	RFID alley configuration	Speed of Commerce Hardware	Speed of Commerce Software	Efficiency of software aligned with business process	Animal and Employee Health and Safety	Value created with process integration	Read accuracy High- Low Global
AUCTION MARKETS AT RECEIVING							
BC Coop	Dual alley at receiving	Extra time to unload cattle results in an additional 40-100 minutes per day Restricts flow as cattle can be penned through only one lane	Have been using this process for three years. Staff is used to the system and it does not require any additional time.	More reports create a longer backup. Requires a trained person to operate the software.	No affect	No benefits	Low 81% High 112% Global 91%
Gladstone Auction Mart	Four-panel wide alley at receiving	Only one lane for receiving and penning cattle adds 1.5 hours per day for hardware only	Entering data requires an extra 0-5 minutes per draft/ 1.5 hours per day for software only	Highly inefficient with numerous errors recording the tag numbers Requires a trained person to operate the DT500 and software. Entering the data created longer waits for producers, causing stress	Sorting cattle off trucks to enter data by individual consigner may cause a problem because this area not designed for sorting.	No benefits	Low 77% High 95% Global 86%
Ste Rose Auction Mart	Two single alley on chutes, dual alley for ground loading at receiving.	No impact on the time to unload cattle through the systems. One receiving area was closed so all intake ran through the scanning alleys. That added 1-2 hours per day	Entering data on each consigner adds 30 seconds per group	Entering data adds an additional step, with no added value, it is inefficient. There have been many technical difficulties Requires a trained person to operate the software.	Sorting cattle off trucks to enter data by individual consigner may cause a problem because this area not designed for sorting.	No benefits	Low 66% High 113% Global 84%
Winnipeg Livestock Sales	Eight-panel wide alley at receiving.	Extra time required to move cattle through the alleys at 1.5-2 hours per receiving day.	Entering data on each consigner adds 0-5 minutes per group	Technical difficulties shut down the sale Entering the data created longer waits for producers, causing stress Requires a trained person to operate the software.	Sorting cattle off trucks to enter data by individual consigner may cause a problem because this area not designed for sorting.	No benefits	Low 66% High 148% Global 88%

Table 3b: Summary of metrics from test site experience – Labour Requirements

	RFID alley configuration	Speed of Commerce Hardware	Speed of Commerce Software	Efficiency of software aligned with business process	Animal and Employee Health and Safety	Value created with process integration	Read accuracy High- Low Global
AUCTION MARKETS BEFORE SALE RING							
Killarney Auction Mart	Four-panel wide alley prior to sale ring	No impact as the system is before the sale ring and has small groups that move into a wide alley	With the software integration, the affect was a 20-25% increase in the time to sell one draft. 2-4 extra hours on sale day	Highly inefficient with numerous duplicate tag numbers recorded	The catwalk along the side of the system may increase employee safety	No benefits	Low 97% High 100% Global 98%
Ontario Stockyards	Eight-panel wide alley at prior to sale ring	No affect on time for cattle to enter the sales ring	Entering the data does not affect the time for the cattle to enter the sales ring	Efficient as it links the ATQ tag numbers to the invoices	The catwalk along the side of the system may increase employee safety	No monetary value for having the system in place	Low 81% High 95% Global 89%
Ottawa Livestock Exchange	Single alley at sale ring entrance	No affect on time to sell on draft	Entering the data slows down the process if the tag has to be recorded manually	Efficient as it links the ATQ tag number to the invoices	No effect	The benefit is to the consigner and buyer of Quebec cattle	Low 96% High101% Global 99.5. %%
AUCTION MARKETS AFTER SALE RING							
Saskatoon Livestock Sales	Eight-panel wide alley after the sale ring	Time to move the cattle out of the sales ring was affected by 2-6 minutes per sale.	Entering the data at the sales ring slows down each draft by 2-3 seconds to a maximum of 20 minutes per sale day	Entering data adds an additional step, with no added value, it is inefficient. Created additional stress on personnel	The catwalk along the side of the system may increase employee safety	No Benefits	Low 86% High 100% Global 96%
Spiritwood Stockyards	Eight-panel wide alley after the sale ring	Additional 14 minutes over a sale day to move the cattle out of sale ring to pens	Entering data at sale ring is only a minimal impact; Except with show pens where the impact is up to 10 minutes per sale.	Entering data adds an additional step, with no added value, it is inefficient. Created additional stress on personnel.	No effect	No Benefits	Low 75% High 110% Global 89%
Whitewood Livestock Sales	Eight-panel wide alley after the sale ring	No impact on the time it takes to sell and pen one lot	Entering data on each sale adds 2 seconds, if the tag doesn't read, another 2 second to clear it. One hour on presort day	Entering data adds an additional step, with no added value, it is inefficient. Created additional stress on personnel. Data is not accurate enough to rely on	No effect	No Benefits	Low 70% High 110% Global 93%

Table 4: Summary of metrics from test site experience- Labour Requirements

The following table summarizes the labour requirements in each facility. Each metric is defined as follows:

- **Read range testing**: this is the process of taking a tag and moving it in front of the RFID panel. The space between the panel and the tag is the read range. This should be recorded on each scanning day to determine if there are potential issues with tag reads.
- **Report submission to the CLTS**: The electronic submission of the movement report to the CLTS for movement tracking. This is done through the internet by site personnel.
- **Technical and support training:** The time spent by site personnel with hardware and software technical support to manage technical issues and resolve problems.
- **Time spent integrating the systems with business process:** The amount of time it took to fully integrate the process of RFID hardware and software into the business process; including getting all the personnel working efficiently with the system and the system working efficiently with the business process.
- **Technical competency using computers:** The level of competency required by individuals using the software to capture the tag numbers. 5 is the highest level with 1 being a low level of competency.
- **Facility staff time:** Extra time spent by test site personnel, above normal business hours, to use the integrated system.

	Read Range Testing	Report submission to the CLTS	Technical Support & Training	Time spent integrating the system with business process	Technical competency using computers	Facility staff time
BUYING STATIONS						
Cattlex	10 minutes	A few minutes	9 hours- mostly related to wand software	Six days spent trying to the wand to work with the software, but weren't successful	3 out of 5	Admin person to enter data at seconds to few minutes per transaction
JGL Livestock	5-10 minutes per chute	A few minutes	3.5 hours	30-40 hours to set up an integrate	3 out of 5	Data entry done at receiving booth, by yard personnel. No extra time required
McCall Livestock	20 minutes for two systems	15 minutes	5 hours, plus three site visits by hardware vendors	20 hours of staff training, 50 hours to get operational	4.5 out of 5	Data entry done at loading area by yard personnel, extra time of 10-20 per load

Table 4a: Summary of metrics from test site experience- Labour Requirements

	Read Range Testing	Report submission to the CLTS	Technical Support & Training	Time spent integrating the system with business process	Technical competency using computers	Facility staff time
AUCTION MARKETS AT RECEIVING						
BC coop	10 minutes	2-5 minutes	3 hours to set up reports	Not required. Done this for 3 years	1 out of 5	1 part time person 3 hours on scanning day. 3 persons for 1 hour extra on scanning days
Gladstone Auction Mart	10 minutes	20-30 minutes due to a high number of errors	12 hours: numerous technical issues	Not much difference from last year, took a couple of weeks to get used to entering the data on the DT500	3 out of 5	Extra 1.5 hours for staff due to location of readers. 1.5 hours extra due to data entry at receiving.
Ste Rose Auction Mart	10 minutes per system	5 minutes	8.5 hours: due to technical issues	Up to one month for everyone to be comfortable with the process	4 out of 5	Two hours extra on receiving days for four staff members
Winnipeg Livestock Sales	Not recorded	A few minutes	13 hours: most as a result of new computer hardware	20 hours over 3 weeks before staff were fully engaged with the new process	3 out of 5	One computer competent trained person. Two extra hours for all staff
AUCTION MAKETS AT THE SALE RING						
Killarney Auction Mart	Few minutes per day	Few minutes, error checking takes longer	2 hours	3 hours spent with Viewtrak to determine process. Ended up changing process as a result of delays.	3.5 out of 5	One extra person to move the cattle through the alley: 6-14 hours on sale day
Ontario Stockyards	10 minutes	A few minutes	2 hours of software training, one day training yard staff	No change to the system they were accustomed to last year.	2.5 out of 5	Required an extra trained person to enter the data for the sale day (8-10 hours) as data was captured at the alley not the sale ring
Ottawa Livestock Exchange	Do not do read range testing	2-5 minutes	1.2 hours to get the reporting program running	3 hours to set up new reports	3 out of 5	No extra people required, but trained, computer competent people are needed in sale ring
Saskatoon Livestock Sales	A few minutes	A few minutes	11 hours: evaluate system setup and technical issues	High pressure position, took the ring clerk a bit of time to get used to the process	3 out of 5	No extra people required unless using the wand
Spiritwood Stockyards	15 minutes	15 minutes	14 hours with training	High pressure position, took the ring clerk a bit of time to get used to the process	4 out of 5	No extra people required, but trained, computer competent people are needed in sale ring
Whitewood Livestock Sales	10 minutes	A few minutes	27 hours: most as a result of new computer hardware	10 hours to get the staff used to the new system	3.5 out of 5	No extra people required, but trained, computer competent people are needed in sale ring

BC Coop Livestock Sales

RFID System

- Phase One hardware was a three-year-old dual alley system. The hardware was changed for Phase Two as a result of low read accuracy reported in Phase One.
  - New system Aleis multi-read dual alley at receiving
  - Alley configuration is approximately 6-feet wide with both alleys and six-feet long
- Software:
  - Viewtrak is the enterprise software. This site has always used the receiving program; the only modifications were to include the reports for the CLTS and research.
- Data entry device: This site has always used a DT500 for data entry and continued its use through this test

Integration experience

- The installation of the hardware was delayed for three months due to shipping and clearances from Australia
- Hardware installation went well as the system was located in the same area as the old system and utilized the same electrical lines and data entry device
- Total time spent on tech support with software vendor for set up issues was three hours
- Estimated technical competency to operate software; 1 out of 5

Impact on speed of commerce

- It was noted in Phase One that moving the cattle through the RFID system requires and extra 40 to 100 minutes a day, at peak times, as a result of using the software and only having one area through which to unload cattle

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The RFID system is not efficient:
    - Creates extra time to unload and pen cattle.
    - Restricts process flow because of only one alley to move cattle through.
    - Data doesn't provide value to the market or producer.
    - With increased reports, the system takes longer to back up than without reports.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - This system is effective with the small exception that the cattle still have problems moving through the single alleys.

Value creation

- There was no benefit for the market, the consigner or the buyer
- The number of age verified cattle was not significant

Labour requirements

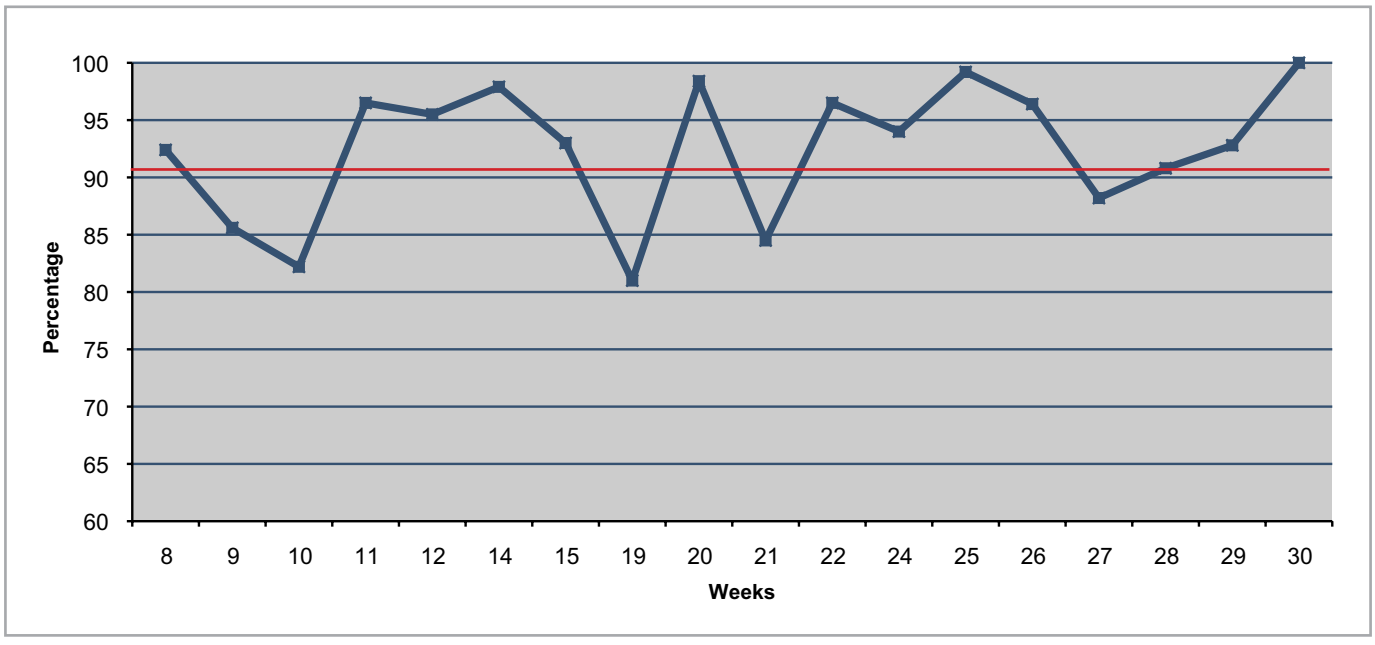
Two- Lane Multi Read System

- Moving cattle through the scanners requires the addition of one part time person per scanning day for a total of three hours
- Additional time for staffing on receiving days: one hour for three people
- Read range testing: 10 minutes
- Submission of movement files to the CLTS: two to five minutes

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors	% Age Verified
Phase one	11	656	12,405	87%		
Phase Two	19	525	9,315	91%	8	42.4%
Variance	8	(131)	(3.090)	4%		

Graph 1: Read accuracy for BC Coop Livestock Sales



Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and two?
   • Phase Two was easier and less time consuming because we didn't have the extra person there all the time.

2. Will you continue to use the system now the test is finished?
   • Yes, our read rates were good and we are used to the process now. We will continue to use the system.

3. Was there any value created for your business or your customers from having this system in place?
   • Helps to determine if there are cattle that are missing RFID tags.

4. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   • Most of the problems that we found are usually staff related; in regard to putting cattle through when the DT500 is on the wrong setting.

Cattlex Livestock Order Buyers

RFID System

- RFID hardware
  - Two Allflex single alley systems on the receiving chutes
  - Long-handled Aleis wand to scan cattle off ground loading trailers on the weigh scale
- Data Entry
  - Utilized office computer with a Windows operating system
  - Data entered by office personnel
- Software
  - Viewtrak is the enterprise software
  - Custom Windows-based software for this test developed by Viewtrak
  - Software enabled tracking of move in and move out, plus overnight loads
  - Software did not link into inventory or billing management

Integration experience

- Installation of the hardware went smoothly and on time. No technical issues with the hardware so no technical support required. Excellent follow up by hardware technicians

Single ally system on loading Chutes

- Installation of software in October, during peak season, created integration delays
  - Software vendor satisfaction rating: 4/10
  - On-site installation was done by salespeople, six hours on site and didn't accomplish much
  - No training on software provided or details on reporting requirements for movement files
  - Not responding in timely manner, not being able to solve the problems, low level of follow up
  - Numerous technical issues that took time to resolve, missed scanning days as a result
  - Estimate a minimum of 10 hours spent on technical support
- Initial site visit by project manager for software installation determined that the process of entering the data in the receiving area was not efficient and the data entry process should take place in the office
- Two weeks after this decision, the software was still not working in the office even after visits from Viewtrak technician. First scan was one month after first site visit and the software was still not capturing tag numbers properly
- Aleis wand
  - The tags captured from the scanning wand could not be transferred or captured in the software. This took many emails to the software vendor and a site visit from the wand vendor to rectify
  - It took three months to get the Viewtrak software working properly with the wand. When the software started working, the wand was not transmitting the tag numbers to the office software. As a result of numerous technical difficulties, the facility is still not using the wand to scan cattle.
  - The use of the wand did not create enough value for the amount of time it took to get it working
- Anticipate level of competency required to operate the software: 3 out of 5

Impact on speed of commerce

- Data entry is not affecting speed of commerce as it is being done in the office, leaving the yard staff to process cattle in the same manner as done previously

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - Data entry did add an extra step in the office process, but the time required was minimal, however, with no benefit it was inefficient.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The hardware operated effectively but the software had continual issues.

Value creation

- Have not seen any benefit or upside to the business or customers

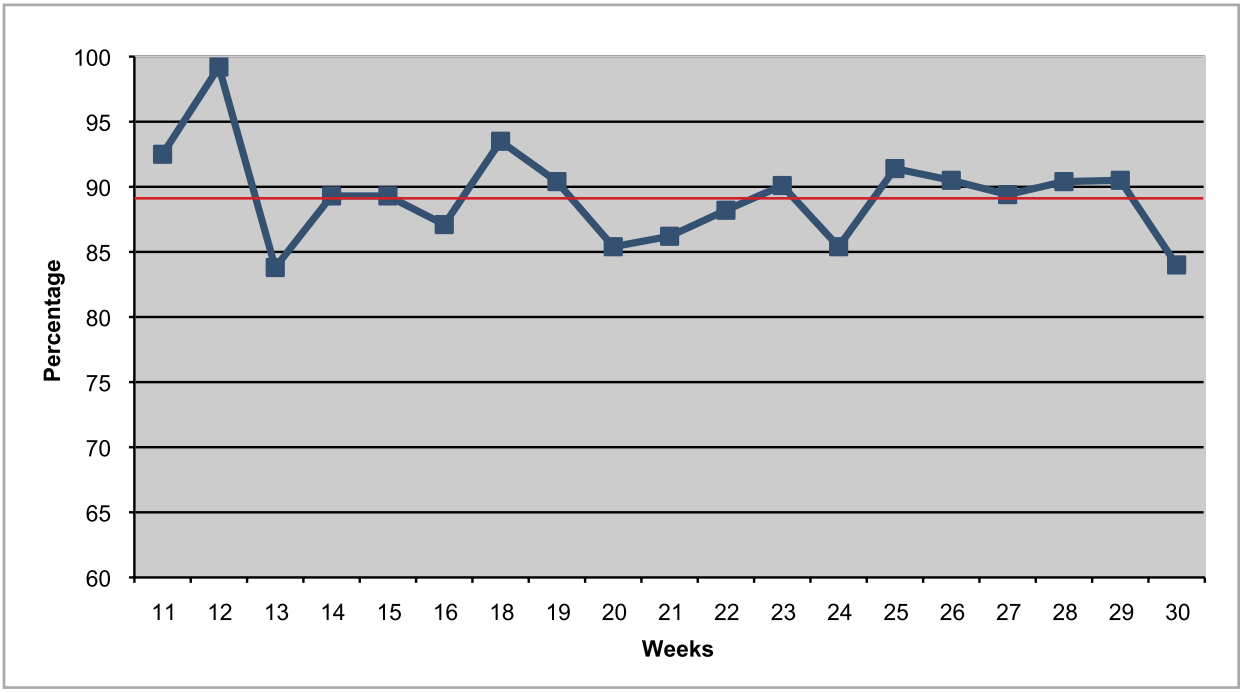
Labour requirements

- Read range testing: 10 minutes for two sets of readers
- Input of movement files to the CLTS**:** a few minutes

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	% Age Verified
Chute One: Single alley on chute	19	132	17,036	89%	
Chute Two: Single alley on chute	19	110	19,036	90%	23.1%
Global accuracy Phase Two	**19**	**242**	**36,072**	**89%**	

Graph 2: Read accuracy for Cattlex Livestock Orders Buyers



Comments by buying station operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - I guess the only change would be it has slowed down progress slightly and has really had no or very little benefit to us at this time.

2. Will you continue to use the system now the test is finished?
   - Yes absolutely, if the equipment is there we may as well keep up with things and stay in the loop for when the time comes that it is mandatory.

3. Was there any value created for your business or your customers from having this system in place?
   - As of right now there has been no value created.

4. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - In theory it sounds great but in practice it can be very difficult.

5. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - We found that the hardware side of things was great (other than the wand experience which has since been dealt with). But the hardware can be as good as gold but if the software and its people are not clicking, for lack of better words, the hardware is useless. I will add that Donna was great with the setup and coordinating everything and keeping us updated, Paul from Allflex was awesome, but the support and direction from Viewtrak and the first experience with Aleis was less than stellar.

Gladstone Auction Market

RFID System

- Phase One hardware was a dual alley system at receiving. The hardware was changed in Phase Two to a four-panel wide alley system, located in the same footprint as the dual alley.
  - New system Destron four-panel wide alley at receiving
  - Alley configuration is 5-feet wide x 10-feet long
- Software
  - Viewtrak is the enterprise software, modules for this test developed by Viewtrak
  - Software module linked to receiving, runs only on a DT500
  - Tag numbers were available on the seller consignment documents
- Data entry device
  - Vendor data was entered at receiving on a DT500, a custom machine proprietary to Viewtrak

Dual Alley System from Phase One

Four panel wide alley Phase Two same footprint

Integration experience

- The hardware was installed with no difficulties
- The installation of the DT500 with the software posed challenges. Viewtrak was contacted many times for support, when no one was available they had to shut down the system and wait about three hours for a response.
- The software crashed twice, which resulted in having to shut down the sale.
- DT500 required input of too many mandatory fields, which created a backlog in processing incoming cattle
- Software was modified once at a cost of $3,200, but it was never successfully completed to the satisfaction of the operator
- Ongoing issues with tag numbers being recorded in an invalid format created read accuracy issues
- There is a communication problem between the RFID panels and the DT500 as the tag numbers show properly on the RFID readers, but do not record properly in the DT500. CAT5 cables have been replaced, interference tests have been done (and some modifications made) the panels had a software upgrade. However, the problem persists.
- The system is still not working properly after repeated examinations by both the hardware and software vendors

- There was lots of interest from the producers about the collection of the tag numbers in the beginning but only a handful of producers showed any interest in using the information.
- Took a couple of weeks for the staff to get used to the process of entering the data at receiving on the DT500
- Time spent on technical support with Viewtrak to evaluate system errors: 12 hours
- Estimate the level of expertise to use the software: 3 out of 5

Impact on speed of commerce

- Prior to the installation of the RFID scanning alley, there were three lanes through which cattle were unloaded. Now all cattle have to move through the one lane to be scanned, adding 1.5 hours per receiving day
- Entering the data into the DT500 requires an additional 0-5 minutes per draft, or 1.5 hours a day. This impacts wait time for producers during peak delivery periods
- Total impact is 3 hours per day

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The RFID system is not efficient.
    - Changing the business process for cattle to only flow through one lane instead of three has increased handling time.
    - The entry of the data on the DT500 at receiving has added time to processing.
    - Sorting cattle coming off trucks is a problem as receiving area is not designed to be sorting area and may affect employee safety.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The system is not effective as there are numerous errors on the format of the tags recorded, although it has not been determined if this is a result of the software or hardware.
  - Both the hardware and software vendors have been on site several times to determine the cause of duplicate tags, numbers that are incorrectly transferred from the readers to the software and there has been no resolution. 12.8% of the tags recorded were incorrect formats or duplications

Value creation

- There was no benefit for the market, the consigner or the buyer
- Number of age verified cattle not significant at only 31.3% of the total

Labour requirements

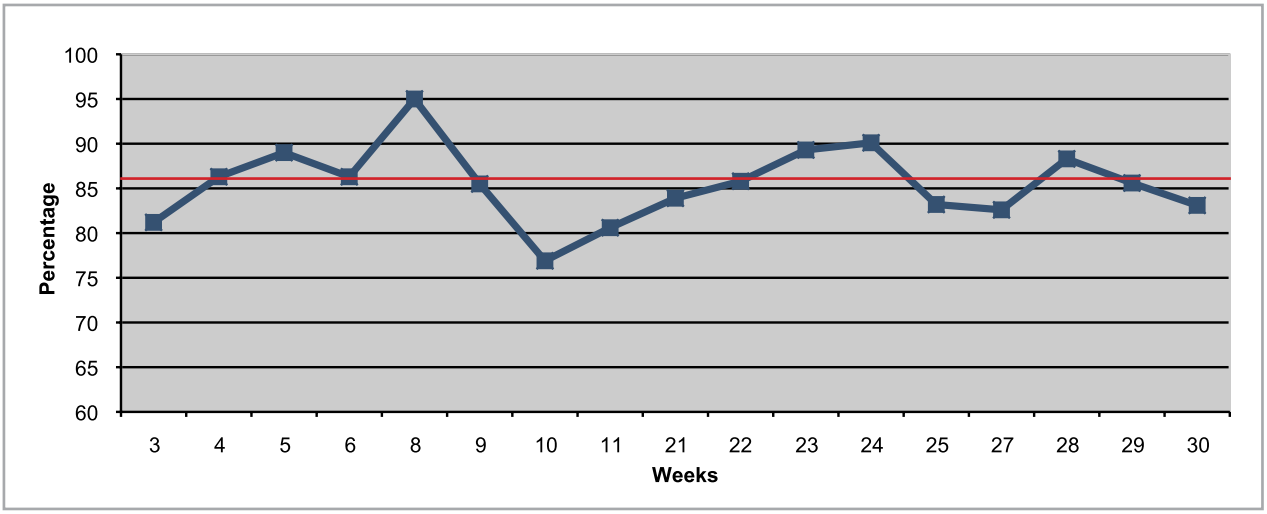
- Read range testing: 10 minutes per day
- Input of movement files to the CLTS: 20 to 30 minutes per session due to the number of tag errors created by the software
- Extra three hours per day for the receiving clerk to process and enter consigners. The total hours per day did not change because the staff took fewer and shorter breaks

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors	% Age Verified
Phase One	11	951	11,341	93%		
Phase Two	22	974	16,334	86%	1,989	31.3%
Variance	11	23	4,993	(7%)		

Data collected over seventeen weeks, but five of those weeks were not recorded as a result of extreme tag recording errors, software errors and computer malfunctions.

Graph 3: Read accuracy for Gladstone Auction Market



Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - The time lost by confining cattle from three lanes to one was the same in both phases. The time to process cattle through the DT500 was up to five minutes extra for each consignor in Phase Two. Phase Two created a slowdown in the speed of commerce.

2. What, if anything, will you require in order to continue scanning cattle and reporting the movement to the CLTS?
   - We will not continue to use the system as it works now with the data entry through the DT500, but we will continue to use the system with a simplified approach to software.

3. Was there any value created for your business or your customers from having this system in place?
   - No value added from having the system in place.

4. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - RFID systems may be feasible in the future, but there is a lot of work to do on every aspect of the system. (i.e., proper tagging by farmers, difference in readability rates of different brands of tags, transfer of information from scanners, placement of system within the mart, modifications to the DT500).

5. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - The DT500 was not too difficult to incorporate into our receiving process on the whole, but Donna (the project manager) and I both observed numerous things that could be changed to make the system more user friendly and more efficient.
     - Unfortunately, we had a hard time getting the changes we wanted made understood by the Viewtrak team. Numerous phone calls (some lengthy) and e-mails and we still did not get the modifications done successfully. Part of the issue is dealing with people and companies that do not necessarily understand what we do and how we do it. If the modifications had been completed it would have made a difference to the amount of time required per draft**.**

Jameson, Gilroy, and B and L Livestock

RFID System

- Destron equipment installed by Compass Animal Health, multiple systems installed at receiving
  - One eight-panel wide alley 5-feet x 32-feet to facilitate cattle flow from auction market next door
  - Two single alley systems on loading chutes for semi-trailer trucks
  - One single alley system for ground loading trailers
- Data Entry
  - Thin client linked to Windows-based server, located in receiving booth
- Software
  - Viewtrak is the enterprise software
  - Custom Windows-based software for this test developed by Viewtrak
  - Software enabled tracking of move in and move out, plus overnight loads
  - Software did not link into inventory or billing management

Integration experience

Single alley for ground loading

- Extensive site work required to support the installation of the systems. Wiring all four systems together with dedicated lines was expensive and time consuming.
- Hardware installation went smoothly and on time
- Estimate 30-40 hours to set up the system; including tech support, learning to use the software and get accustomed to the system
- Hardware vendor support was required at least three times on site as the read accuracy on one chute was low
- No on-site training by Viewtrak. The site was not told about the submission of the movement files to the CLTS
- Estimate level of competency to operate the software: 3 out of 5 (once everything is set up and operating effectively)

Impact on speed of commerce

- No impact on the speed of commerce

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The requirement to input data does take an additional step in the business process which is not efficient.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - This RFID system operates effectively as the read accuracy is high and the system performs with minimal impact on business process.

Value creation

- No benefits to the customer as they don't want or need the information and no benefit to the business

Labour requirements

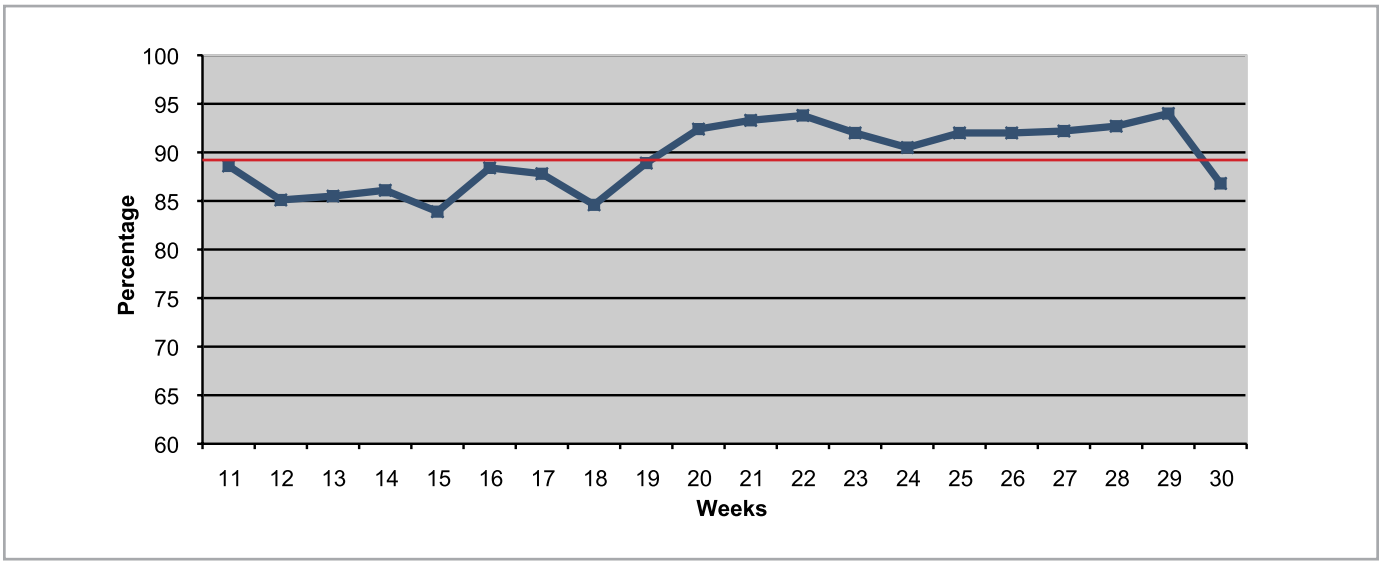
- Read range testing: five to 10 minutes per chute (four chutes)
- Input of movement files to the CLTS**:** a few minutes per file

Wide alley for cattle from neighboring auction market

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	% Age Verified
Chute One: Single alley on chute	20	321	31,878	88%	
Chute Two: Single alley on ground	16	41	627	91%	
Chute Three: Wide Alley	15	92	13,258	94%	
Chute Four: Single alley on chute	19	141	13,854	89%	
Phase Two	**20**	**595**	**59,617**	**89%**	**7.9%**

Graph 4: Read accuracy for Jameson, Gilroy, & B & L Livestock



Comments by buying station market operator

1. Will you continue to use the system now that the test is finished?
   - We will definitely continue to use the system. We have our people trained and the system is user friendly.

2. Was there any value created for your business or your customers from having this system in place?
   - Yes, we find value in the fact that our customers know we are concerned about the future of the cattle industry and that we are on the leading edge of any available systems or technology that is available. We also find value in the A/V process as it pertains to tag no. We also believe that as industry goes forward this system will become of greater value.

3. What are your comments on the feasibility of using RFID systems at buying stations markets to support traceability?
   - We believe with the right procedures it should work

4. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - We found the system, after some fine tuning to be very user friendly with accurate high percentage readings.

Killarney Auction Market

RFID System

- Phase One hardware was a single alley system at receiving. The hardware was changed in Phase Two as a result of the initial location (single alley) having an impact on the speed of commerce. A single alley system is not effective at the entrance to a sale ring prior to the weigh scale
  - New system is a Destron four-panel wide alley located at the entrance to the sale ring.
  - Alley configuration is 5-feet wide x 20-feet long
- Aleis long-handled wand was used for pen scanning.
- Software
  - Viewtrak is the enterprise software, all modules for this test developed by Viewtrak
  - Sale ring module to link RFID tag numbers with buyer lots on invoices
  - Module developed to transfer tag numbers collected with the wand to a buyer catalogue
  - Tag numbers and age verification data were captured by the ring clerk to align with the sale lot and available on the sales invoice if requested
  - Phase One software was used after six weeks
- Data entry device
  - When using the ring program software, the data was captured on the sale ring computer
  - When alternate software was used, the program resided on a Windows-based office computer

Integration experience

Four-panel wide alley system with catwalk to help with cattle movement

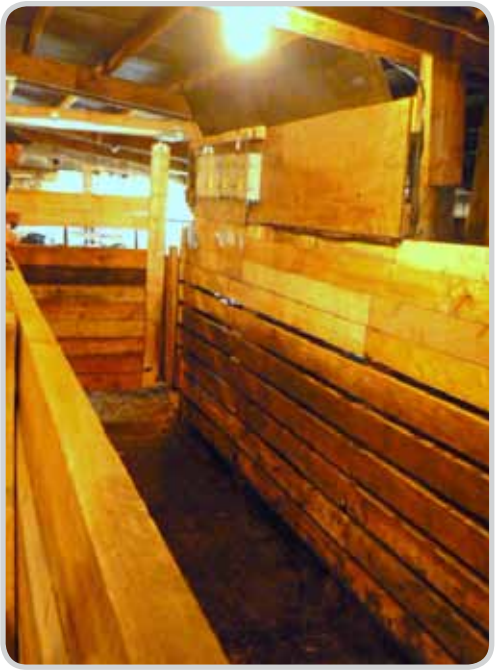
- Installation of hardware was efficient and completed in a timely manner
- Issues funneling cattle from the 12-foot alley into the 5-foot wide scanning alley. Installed a crowding tub which immediately solved the problem.
- Issues with the tags being captured at the sale ring, installed various systems and devices to notify the ring clerk that the cattle had moved through the scanners and could be captured in the software
- Ongoing issues with tags being recorded two and three times on each lot, total time spent on Viewtrak technical support: two hours
- Software was modified twice in an attempt to minimize problems with duplicate tag capture at a cost of $600
- After three weeks, it was evident that the impact on speed of commerce was too great to manage. Starting in week six, the market employed the software from Phase One. The software has a basic functionality that captured the tag numbers and created a movement file. The market operator recorded the total number through the sale at the end of the day and the software calculated the read accuracy. This solution did not have any impact on speed of commerce and was highly efficient and effective.
- Estimated a high level of technical competency to use the software: 3.5 out of 5

Impact on speed of commerce

- The RFID scanning alley did not have any affect on the speed of moving cattle into the sale ring or through the alleys. Using the ring program software had a severe negative impact on the speed of commerce. The time to sell one draft increased by 20 to 25%, adding two to four extra hours per sale. Previously, the time to sell was one draft was one to one and a half minutes which increased by 20 seconds using the software.
- No effect on speed of commerce using the simple software solution from Phase One.

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - Capturing the tags at the sale ring was not an efficient process as a result of time delays and numerous data errors. Various processes were implemented in an attempt to create efficiency but nothing was successful.
  - Utilizing the crowding tub to move the cattle through the scanning alleys was highly efficient as it improved process flow.
  - There was no reduction in the movement of cattle through the alley. It was thought the catwalk provided greater safety for the employees.
  - Pen scanning with wand reader worked well until the volumes increased at fall run.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The Viewtrak ring program for RFID tags was not effective as noted previously.
  - The software program from Phase One was highly effective as it created the movement files with no impact on the speed of commerce, high level of accuracy and developed the reports without duplication of tags.



Wide alley system: inside the alley

Value creation

- In the first few weeks of the project, the market operator created a buyer catalogue with lot sizes and age verification details. The buyers did not find value in this information
- The ring program software was not efficient or effective in this instance so was not used
- Could not link the tags to the drafts, nor could the age verification be relied on as accurate.
- As such, there was no value to either the buyers, producers or the market

Labour requirements

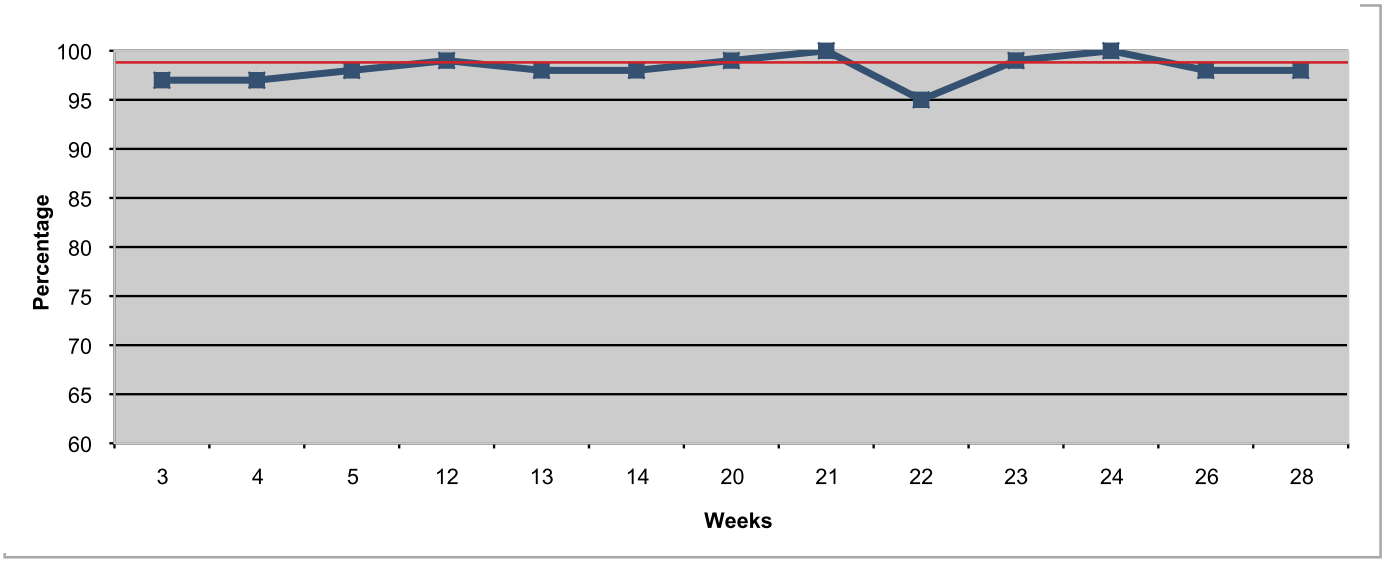
- Read range testing on the RFID panels: no more than a few minutes per scanning day
- Input movement files to the CLTS: a few minutes, error checking takes longer.
- One extra person on sale day required to move the cattle through the scanning alley, approximately six to 14 hours per sale

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy
Phase One	8	408	6,354	98%
Phase Two	12	N/A*	5,619	98%
Variance	4	n/a	(735)	No change

The software used by this market did not record the cattle by groups; it recorded the total head for the day.
The significance in this data is that Phase One was a single alley system, traditionally with very high read rates due to the proximity of the tags. In Phase Two, the hardware was changed to a wide alley system. To maintain the same high level of read accuracy is a testament to the four-panel wide alley system.

Graph 5: Read accuracy for Killarney Auction Market



Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - Change in process from Phase One operations to Phase Two increased business profitability for the market greatly by increasing speed of commerce. Negative impact was employing one extra person to run cattle through wide alley system.

2. What, if anything, will you require in order to continue scanning cattle and reporting the movement to the CLTS?
   - othing extra required to continue scanning and submitting.

3. Was there any value created for your business or your customers from having this system in place?
   - No value added from having the system in place.

4. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - Only feasible if aligned with business process, and if markets will not be required to finance costs of implementation, upgrades, and hardware/software repairs.

5. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - Software is not capable of creating added value for the market, buyers, or producers. Basic scanning software should be used independently from the Market Master systems, only for the purposes of meeting regulatory requirements.

McCall Livestock

RFID System

- Aleis equipment installed by Integrated Traceability Solutions, multiple systems installed at receiving
  - One eight panel wide alley 5-feet x 13-feet to facilitate cattle flow from ground loading and semi trailers
  - Two single alley systems to accommodate high and low intake from double-deck semi trailers
- Data Entry
  - One DT500 located at receiving
- Software
  - Viewtrak is the enterprise software
  - Custom Windows-based software for this test developed by Viewtrak
  - Software enabled tracking of move in and move out, plus overnight loads
  - Software did not link into inventory or billing management

Wide alley for ground loading and semi trailers

Integration experience

- Hardware installation went smoothly
- Software: disappointed in the lack of training provided by Viewtrak
- Anticipate 20 hours to train staff, 50 hours in total to have the system fully operational. This was difficult as it was September with high volumes and everyone is exceptionally busy
- Technical support issues with both the hardware and software vendor; not responding in timely manner, not being able to solve the problems, low level of follow up
- Anticipate level of competency to operate the software: 4.5 out of 5
- Ongoing technical difficulties causing low read accuracy
  - Within three weeks of installation, it was determined the read rates were very low as a result of interference from overhead lights
  - Filters were installed at a cost of $2,300
  - Read range on the panels remained high but read accuracy remained low
  - DT500 had software issues and needed to be sent back to Viewtrak for updates
  - Both hardware and software vendors on site to evaluate cause of low reads; the problem was determined to be the hardware. The software was performing well.

Impact on speed of commerce

- 15 to 20 minutes per transaction because of reading in and out. The amount of time per day varies with the number of loads.
- The hardware does not affect the speed of commerce at receiving. Maybe a little slower loading, but only in the single alley system. Wide alley system has zero affect on cattle movement in either direction.

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - Negative impact due to the DT500 at the receiving which takes extra time to set up and enter the data.
  - Does not create process efficiency as entering the data at this location does not eliminate duplicating the entries in the office.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - This system has not been effective due to the exceptionally low read rates in comparison with other similar systems by the same manufacturer.

Two single alley systems for double decker semi trailers

Value creation

- Have not seen any benefit or upside to the business or customers

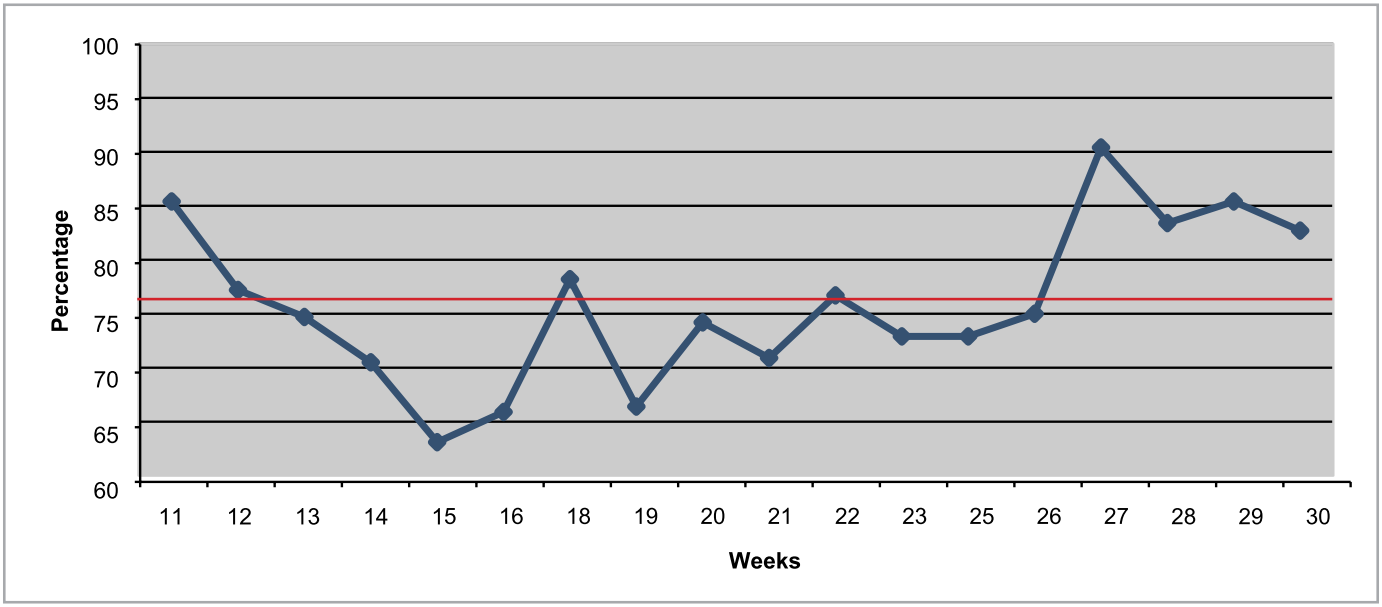
Labour requirements

- Read range testing: 20 minutes for two sets of readers
- Input of movement files to the CLTS**:** 15 minutes per submission

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	% Age Verified
Chute one: wide alley	18	359	17,494	75%	
Chute two: two single alleys on chutes	16	104	6,672	82%	15.8%
Global accuracy Phase Two		463	24,166	77%	

Graph 6: Read accuracy for McCall Livestock



Comments by buying station operator

1. Will you continue to use the system now the test is finished?
   - Yes, we intend to continue to use the system.

2. Was there any value created for your business or your customers from having this system in place?
   - No, we found no value to ourselves or our customers.

3. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - I'm sure there are many benefits for the Canadian cattle industry to realize from traceability, but there needs to be a standard protocol for all segments (e.g., assembly yards, auction markets, harvest facilities, etc.) of when the tags will be read to keep the traceability consistent across Canada. There also needs to be a decision on how far through the whole food chain we expect traceability to go as well as if the government is prepared to accept financial responsibility for traceability.

4. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - I think the software has the capabilities to do all the tasks required, but the hardware technology (readers and tags) needs to be further advanced. Tag retention and read rates need to be at a more dependable and consistent level.

Ontario Stockyards- Cookstown, ON

RFID System

- Primary system located at entrance to the sale ring
  - Destron eight-panel wide alley; no change from Phase One
  - Alley configuration: 5-feet wide x 32-feet long
- Secondary system located inside the small sales ring
- Destron panels attached to the walls of the sale ring
- This was an existing system, not installed by the project
- Software:
- Custom module developed to align with existing custom enterprise software
- Data entered at sale ring entrance: manifest number and number of cattle in the draft
- All tag numbers were listed with sale lots
- Tag numbers available on sales invoices
- Data entry device: Panasonic tough notebook with touch screen
- Aleis long-handled wand used to manually scan Quebec cattle in the scanning alley

Top view of wide alley system

Integration experience

- No problem with the software integration as it was developed by the same company that built the enterprise software
- Good alignment between scanning module and enterprise software
- Training on software was not an issue: two to three people use the software and picked it up very quickly
- There was one day when the computer completely froze and data could not be entered. In an operating environment, there should be a backup if one computer goes down. Being dependent on one piece of hardware is not effective.
- Required minimal technical competency to learn and operate the software: 2.5 out of 5

Impact on speed of commerce

- The speed of commerce moving cattle into the sale ring was not affected
- Occasional sale interruptions as a result of the computer stalling or freezing

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - Business efficiency was positively influenced by the collection of the ATQ tags for Quebec cattle. Prior to being able to collect 100% of the readable tag numbers with the wand, the process required manual reading and recording of the tags.
  - Entering the data at the sale ring requires one person be present at all times. This may require two people trained on the software so if one is not available, the other steps in. If there are not two people who can operate the system, either lots are moved into the ring without data being entered, or the sale is held up waiting for the data entry individual.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The integrated system was effective as it achieved the objective of linking tag numbers to enterprise software.

View inside wide alley system

Value creation

- It is important with Quebec cattle that 100% of the tag numbers are recorded and sent to ATQ so the producer receives the rebate. In Phase One, the speed of commerce (moving cattle into the sale ring) was affected by Quebec cattle. In order to obtain 100% reads, the cattle were moved back and forth inside the scanning alley numerous times. Now the long-handled wand is used to achieve 100% with only a minimal impact.
- The scanners are not accurate enough to add the tags to the settlement documentation for the buyer/seller.

Labour requirements

- Read range testing on the RFID panels: 10 minutes per scanning day
- Input movement files to the CLTS: A few minutes to prepare the file. Checking errors takes some time and is confusing
- One trained person on the computer for the entire sale day. Takes an extra 30 seconds per draft to input the data
- |One trained person needed throughout the sale day to use the long-handled wand, approximately one hour per sale

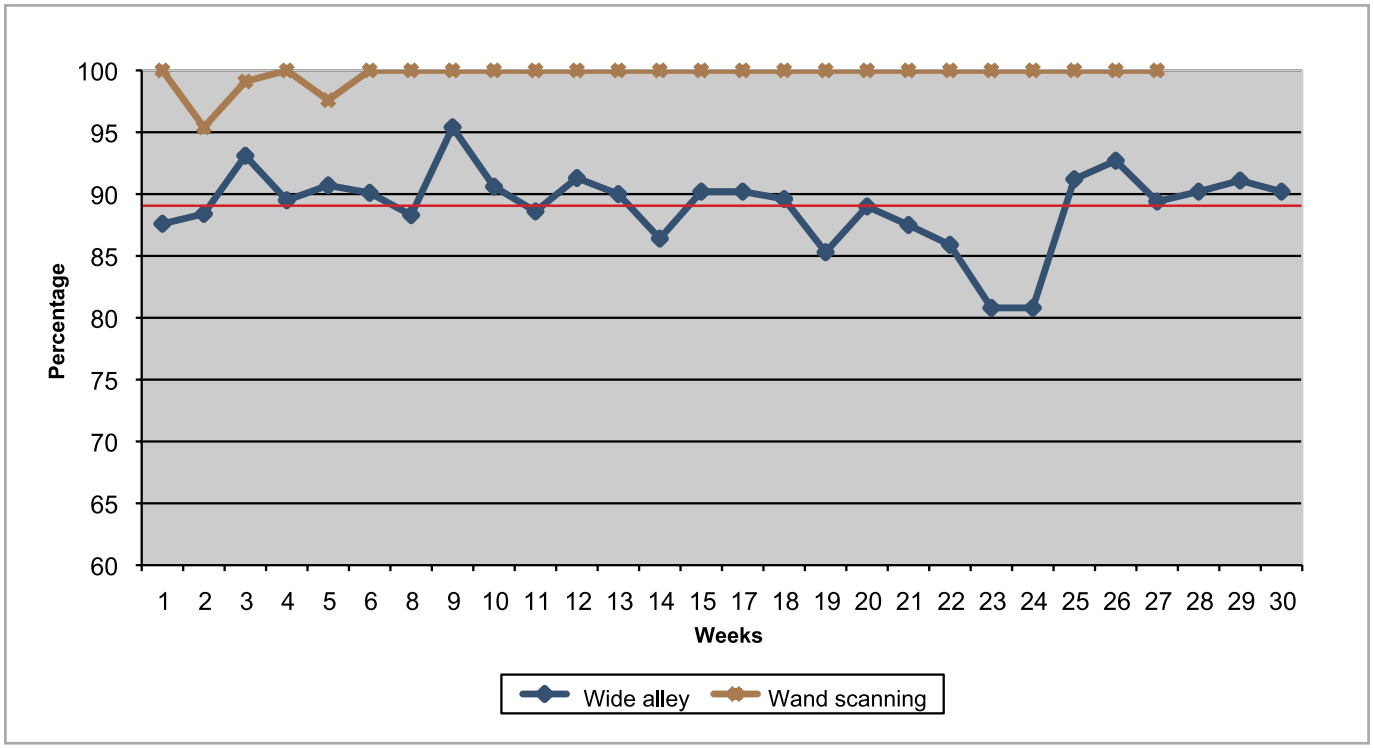
Read accuracy

Ontario Cattle: Scanning groups through the alleys				
	# Weeks	**# Groups**	**Total # scanned**	**Global read accuracy**
Phase One	11	4,220	14,575	94%
Phase Two	30	17,384	43,539	89%
Variance	19	13,164	28,964	(5%)

Quebec Cattle- Using Aleis long-handled wand				
	# Weeks	**# Groups**	**Total # scanned**	**Global read accuracy**
Phase Two	30	728	1714	99.6%

In Phase One, the cattle were held in the scanning alley for longer periods to attain the tag reads in order to collect the ATQ tag numbers. In Phase Two, the ATQ tag numbers were scanned with a long-handled wand. The variance in the read accuracy is a result of the cattle not staying in the alley and moving around for longer periods.

Graph 7: Read accuracy for Ontario Stockyards – Cookstown, ON



Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - In Phase One, there was a project person using the software. In Phase Two, we had to hire two additional people to capture the data.

2. Will you continue to use the system now the test is finished?
   - Yes, but not with the requirement to enter all the data on every draft. If we have a simplified software, we will use that.

3. Was there any value created for your business or your customers from having this system in place?
   - There is no monetary value for having this system in place.

4. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - The RFID system at Auction Markets should be owned, installed, operated and maintained completely independently of the auction market. Auction markets should not have to assume any responsibility for the data collected and transferred.

Ottawa Livestock Exchange

RFID System

- Phase One hardware was a three-year-old single alley system entering the sales ring that had a low read accuracy. The antennas were updated in Phase Two to increase the read accuracy.
- Software:
  - Viewtrak is the enterprise software. This site has always used the sale ring program, the only modifications were to include the reports for the CLTS and research.
- Data entry device: This site has always used a thin client data entry and continued its use through this test.

Integration experience

- This system has been operational since 2006 at this facility. The system was installed as a result of the demand from the clients with Quebec cattle as 100% of their tag number need to be read and reported.
- The process flow did not change as the hardware is coming directly into the sale ring in a narrow alley
- The important aspect of the system is a competent computer operator who pays attention and doesn't make mistakes.

Impact on speed of commerce

- No impact on speed of commerce as the cattle movement did not change. It only slows down if there is a mistake that needs to be adjusted.

Efficiency and effectiveness of business process

- Efficiency: anything that improves business process, speeds process flow or minimizes errors/defect.
  - The RFID system is efficient as it provides a service that is required by the customers with Quebec cattle.
- Effectiveness: anything that operates in a manner that meets the need for which it was implemented.
  - This system is effective as close to 100% of the tags are being recorded and provided to the consigner and buyer.

Value creation

- The benefit is to the consigner and buyer of Quebec cattle. Rebates are not paid unless the tag numbers are provided to ATQ. The tag numbers are linked to the invoices.
- Can track an animal if the back tag is lost

Labour requirements

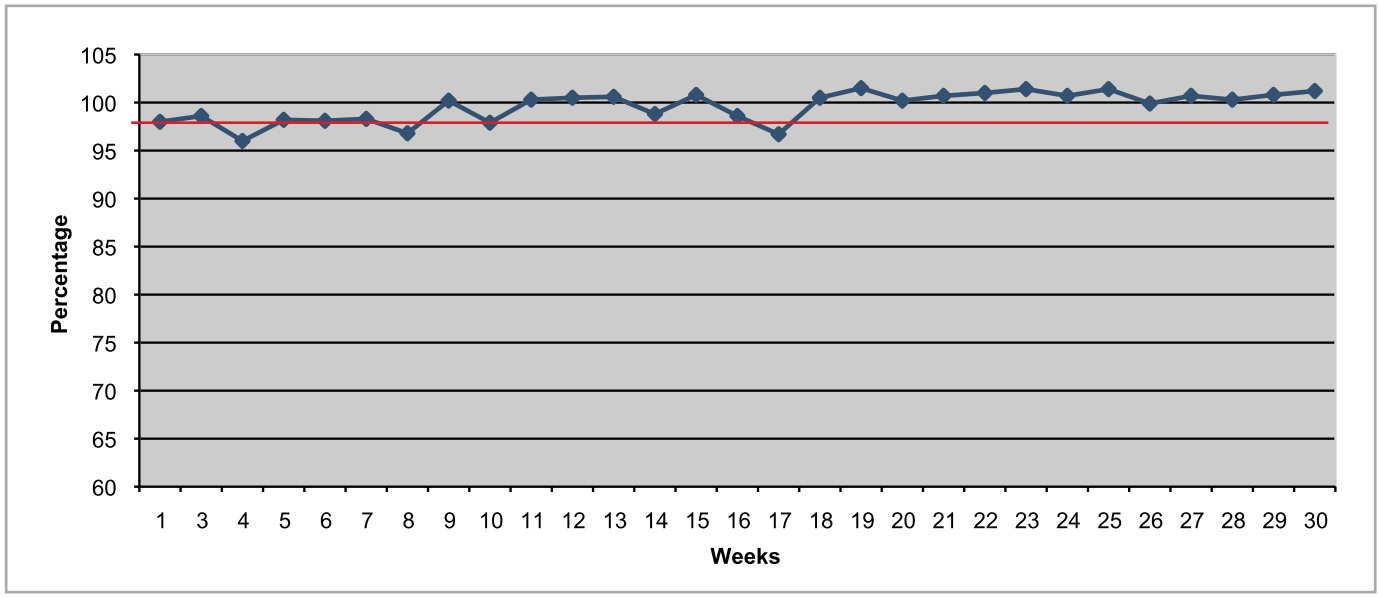
- Submission of movement files to the CLTS: between two to five minutes
- One additional person on the computer entering the data as the cattle move into the ring.

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors
Phase One	11		7,275	84%	
Phase Two	19	525	35,255	99.5%	8
Variance	8		27,980	15.5%	

At this facility, many of the cattle had more than one ear tag as ATQ tags are subsidized and there is a rebate to producers for tagging their cattle. This accounted for reads of over 100% in 16 of the 19 weeks. The weeks with reads in excess of 100% were reduced to 100% for calculation of the global read accuracy.

Graph 8: Read accuracy for Ottawa Livestock Exchange



This chart has a range above 100% because many of the Quebec cattle have more than one tag

Saskatoon Livestock Sales

RFID System

- Phase One hardware was not replaced:
  - Aleis wide alley eight-panel system
  - Located directly after the sale ring
  - Alley configuration is 5-feet wide x 13-feet long
- Software
  - Viewtrak is the enterprise software, modules for this test were developed by Viewtrak
  - Sale ring software module to link RFID tag number with buyer lots on invoices
  - Software module developed to transfer tag numbers collected by the wand to the sales invoice
  - Tag numbers and age verification data were captured by the ring clerk to align with the sales lot; available on the sales invoice if requested
- Data entry device
  - Tag numbers captured by the ring clerk using the sales ring computer
- Long-handled Aleis wand
  - Catwalk constructed in the area prior to the sales ring to facilitate pen scanning
  - Tag numbers transferred to sale lots through Viewtrak module created specifically for this purpose

Wide alley eight-panel system

Integration experience

- The software was not difficult to learn, but the extra step took time to adjust to
- Some technical issues with the software and hardware communicating
- Had to stop one sale because the computer froze as a result of the new software
- Built catwalks and infrastructure to support pen scanning using the long-handled wand
- Total time spent on Viewtrak technical support: 11 hours
- Estimated level of technical competency to use the software: 3 out 5

Impact on speed of commerce

- Phase One with hardware only, the impact was not material at two to six minutes per sale
- The integration of the software has delayed the sale of one lot by two to three seconds. On 300 to 400 lots per sale the time impact on a sale day is maximum 20 minutes

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The system is not efficient as the software introduces another step in the business process and does not provide any extra value for that time spent.
  - Biggest impact is on the scale person, having to align with the tag capture. This is a lot of pressure for one person
  - Wand scanning: It was determined that the wand scanning would not work efficiently prior to the sale ring. The reason is the cattle should be in an enclosed area and be stationary to get a good read. In the area prior to the sale ring were continually moving into the sale ring, and therefore it was difficult to capture the tag
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The hardware and software operate effectively to collect and disseminate tag information with a high read accuracy

Value creation

- No buyers have asked for age verification information. Only 13.6% of the tag numbers were recorded as age verified.
- There was no benefit for the market, the consigner or the buyer.

Wide alley eight-panel

Labour requirements

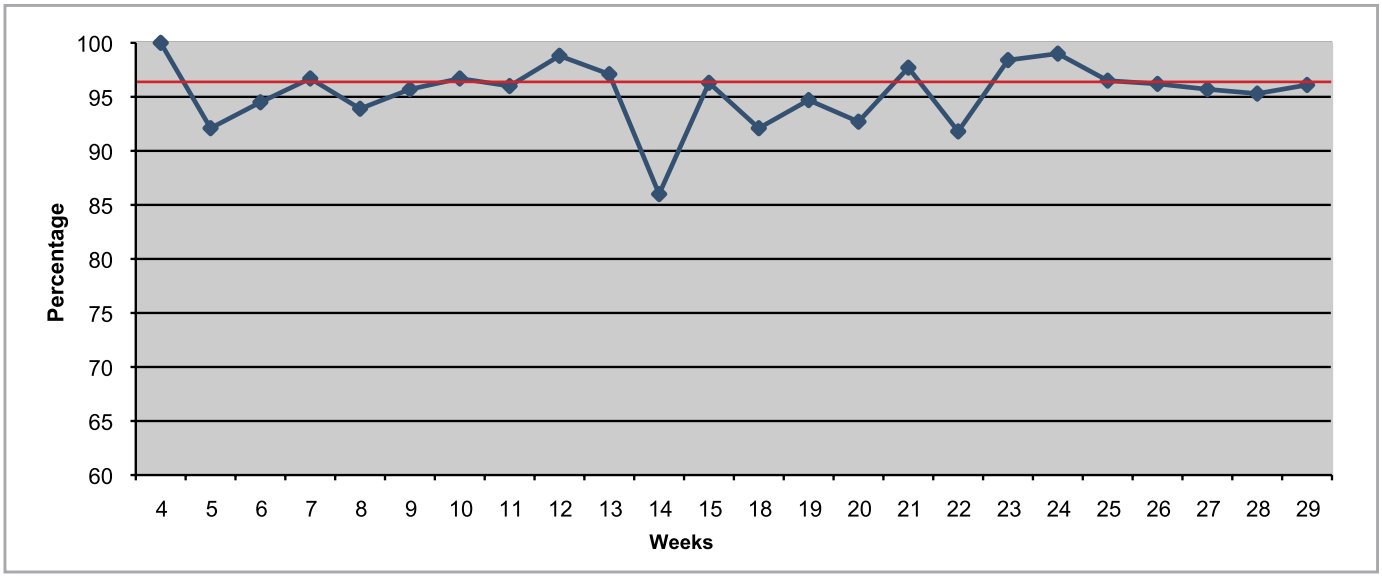
- Read range testing: No more than a few minutes per scanning day
- Submission of CTLS movement files: A few minutes without fixing the errors
- No extra personnel required to use the RFID scanners and sale ring software
- One extra person, who has been trained and is competent, required for the pen scanning

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors	% Age Verified
Phase One	11	16,525	44,382	93%		
Phase Two	25	25,860	67,605	95.5%	650	13.6%
Variance	14	9,335	23,223	2.5%		

The variance in Week 14 was a result of the software collecting and recording the tag numbers. This was not a hardware failure.

Graph 9: Read accuracy for Saskatoon Livestock Sales



Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - Phase One had minimal affect on the operation of our business primarily due to the location of the scanning alley. It was located directly behind the out- door of the sale ring. This location had the least amount of negative impact on the business. Any other location within our market would have had a substantial negative impact on our normal course of business. In Phase Two of the project, it took some time for the scale personal to become comfortable with the extra step of asking the computer to scan the cattle. This did slow the flow of the sale down somewhat do to creating another step. Once the scale person had gained more experience the procedure became more efficient. In Phase Two we experienced problems in merging the hardware with the software. This did interrupt the cattle auctions while trying to rectify the interface problems that were encountered. It seemed software was being developed by the programmers on the fly in order to fit the hardware. I believe the problems that were encountered were due to trying to merge together two different companies, a software company to a hardware company in a short period of time.

2. Will you continue to use the system now the test is finished?
   - Yes, only if the software is user friendly and does not create any extra labour, additional cost or ongoing costs to Saskatoon Livestock Sales.

3. Was there any value created for your business or your customers from having this system in place?
   - Saskatoon Livestock Sales Ltd did not experience any value by having this system in place, other than the perception may have been that SLS was participating in the state of the art technology when it comes to traceability and our customers may have envisioned us as leaders within our industry. As far as any operational benefits that would enhance the business of Saskatoon Livestock Sales Ltd, there was none. There was no direct value to the cattle producers that sold cattle at SLS. The buyers did not request age verification so there was no benefit to the producer. The buyers did not request any RFID numbers for their records as it may have pertained to inventories, invoices or age verification purposes, so there didn't seem to be any value to the buyer.

4. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - I believe that today's technology is not at a level where it needs to be in order to successfully operate RFID systems in an Auction Market environment with a 100% accuracy level. Traceability within the cattle industry can continue to go forward at the producer, feedlot, and packer level because we found that the technology is very accurate when cattle are physically caught in a head chute. This procedure is not an option in the Auction Market industry due to the nature of the business. When technology allows large groups of cattle to be scanned that are on the move down a 10- to 12-foot alley, with a 100% read rate, then the Auction Markets could be in a better position to participate in an RFID system.

5. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - We cannot overlook the fact that there is a huge tag issue, when it comes to retention and read ability. When we were wand reading we found that some tags just didn't read. If all tags were actually readable, then the scanning equipment read accuracy levels would have certainly been higher. The retention rate of the tag is going to be an on going problem due to the fact that a tag is not a permanent source of identification.

Spiritwood Stockyards

RFID System

- Phase One hardware was not replaced:
  - Aleis wide alley eight-panel system
  - Located directly after the sale ring
  - Alley configuration is 5-feet wide x 13-feet long
- Software
  - Viewtrak is the enterprise software, module for this test was developed by Viewtrak
  - Sale ring software module to link RFID tag number with buyer lots on invoices
  - Tag numbers and age verification data were captured by the ring clerk to align with the sales lot. Available on the sales invoice if requested
- Data entry device
  - Tag numbers captured by the ring clerk using the sales ring computer

Wide alley eight-panel system

Integration experience

- Software training was not difficult the ring clerk picked it up quickly; four hours to train all staff
- Had some technical difficulties where the software would not record any tag numbers but worked through this with the help of Viewtrak technical support
- Total time spent on Viewtrak technical support: 14 hours
- Estimated level of technical competency to use the software: 4 out 5

Impact on speed of commerce

- Phase One with hardware only was estimated to impact the speed of commerce by 14 minutes over an eight hour sale day
- Phase Two: if the software works properly there is just a slight hesitation in the sale of small groups. However, on show pens (large groups of cattle) it is estimated that capturing the tags with the software takes an extra 10 minutes per sale. This is a result of having to wait for the cattle to move through the scanning alley before the weight and data can be entered for the next lot.

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The system is not efficient as the software introduces another step in the business process and does not provide any extra value for that time spent.
  - Extra stress on the staff capturing the tags on the ring software, adds more steps to an already busy position.
  - Software requires a competent person to operate it, and with a reduced labour pool this makes it a difficult position to fill.
  - The software creates a lag in between groups/lots of show pen cattle. This in turn affects the flow and the momentum by which the sale moves along. A reduced momentum can affect price.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The system is effective for capturing tag numbers on smaller groups.
  - Ongoing issues with the hardware not capturing all tags on large lots.

Value creation

- There was no benefit for the market, the consigner or the buyer.
- The software isn't there yet to be relied upon to link the proper tags to the drafts.
- The number of age verified cattle recorded on the software was low at 7.8%.

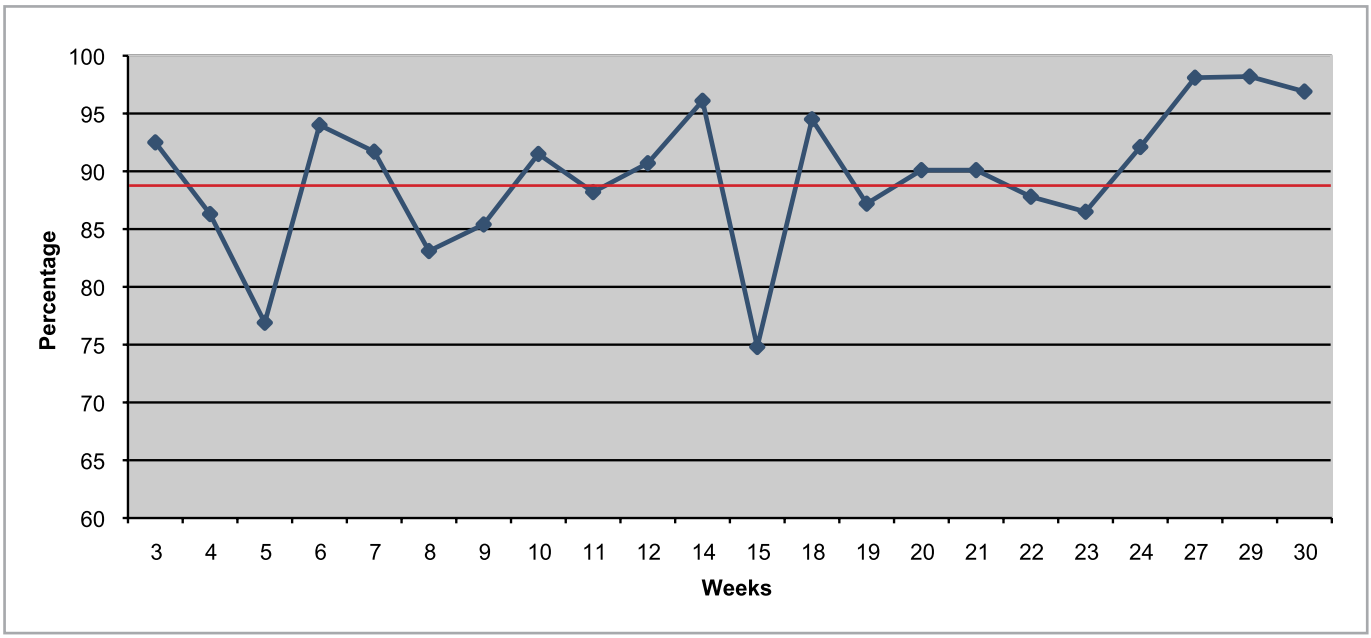
Labour requirements

- Rebooting the system on sale day: a few minutes maximum
- Submission of CTLS movement files: 15 minutes per sale
- Read range testing: 15 minute per day

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors	% Age Verified
Phase One	11	3,135	17,418	91%		
Phase Two	25	10,222	23,756	88.7%	14	7.8%
Variance	14	7,087	6,338	(2.3%)		

Graph 10: Read accuracy for Spiritwood Stockyards



The anomaly at this site was three scanning days in the last six weeks of the test that showed reads of well over 100%. This was a result of custom software that had been developed to align with their business process but was recording duplicate tags on show pens lots. The records from these three scanning days were eliminated from the data set.

Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - The difficulties that lie between Phase One and Two is that if experienced staff had not been available the market would not have been able to operate in a manner in which it is required to sell livestock. If experienced staff had not been available, sale time would have doubled and we would have lost many customers. The ability to run the sale program is difficult enough without the added stress of another program on top. We had two staff that could not even work up at the ring as they could not run the program to keep up.

2. Will you continue to use the system now the test is finished?
   - We will continue to run the system until we know what is going to happen as we feel it is good practice for our inexperienced staff to continue to learn. One has gotten better and is now able to manage, but we still have a very competent staff person who can't, she finds it too stressful. We don't have her work up there unless she asks.

3. Was there any value created for your business or your customers from having this system in place?
   - We did not find any value to the system for our stockyards; it upset the flow of our sale, caused undue stress on ring staff as well as auctioneers who had to pace themselves to the ability of the scanner to scan the cattle. Our customers don't know it's there unless they ask, and age verified cattle were not identified as the cattle were scanned after the sale. We don't believe there is any price increase for age verified cattle anytime, as buyers all try to buy cattle as cheap as possible.

4. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - We as a livestock market went into this project with an open mind, we asked lots of questions and questioned some of the information we were given, we know we were honest in the use of the equipment, we accepted every challenge to learn something new and tried to implement it as soon as possible. The feasibility of using RFID systems at auction markets is acceptable, if all you require is to report that this many cattle went through our market today and these are the tag numbers read. We have a major concern over the cost and maintenance of updating the systems as this information has not been made available yet. The cattle numbers have decreased in Canada. We as Stockyards will have that to deal with that, some of will survive and some will not. We make our living based on commissions. With lower commissions, where is the money going to come from to implement the requirements the government is laying down.

5. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - We feel that all the hardware and software is just a doubling up of a system we already have to identify ownership that follows the animal through our system. This new hardware and software is not as reliable and there has to be too much manual control, as tags are lost and tags are not captured by the readers. A manifest links line by line automatically with no effort other than its first data input. This system is already in place and is paid for. There is no extra maintenance of a machine; it's already built in. There is no stress involved in the operation and continuous data entry requirements aren't necessary. We found the system worked but it fluctuated between 0% reads (possible explanation, if ring person forgot to enter RT to scan) and low percentage reads (40 to 60%) in show pens and 0% reads to 100% reads in single animal units. But all reads of any kind had to be manually controlled by a ring person who already had a full-time job requirement prior to this phase of the project. Tag retention with RFID tags is a huge problem that we don't feel is being addressed in the industry. We feel scanning tags would have a huge affect on commerce if the government requires specifics and the system is down or we are having problems with it. Would we have to shut down our sale? Would we have to stop the sale and take time to fix the system, causing undo shrink on producer's cattle which would incur large losses for them? Why is it so important to read tags on animals that will not be in the food system for six months to a year later?

Ste Rose Auction Market

RFID System

- The RFID system in Phase One was a four-panel single alley system located at receiving. It was determined that the location of the system had a detrimental effect on the speed of commerce. Further, the single alley restricted the flow of cattle at peak processing times.
- A multiple RFID system was tested at receiving to cover all receiving ports
  - Two Allflex single alley systems on unloading chutes with two panels each
  - One Allflex dual alley system at receiving for ground loading trailers with four panels
- Software
  - Viewtrak is the enterprise software, modules for this test developed by Viewtrak
  - Software module linked to receiving to correlate tag numbers that aligned with each system
  - The tag numbers were available per consigner
- Data entry device
  - Thin client with monitor; linked to the Oracle server
  - Consigner data was entered in the office by the receiving clerk

Dual alley system for ground loading

Integration experience

- Installation of the hardware went smoothly and professionally
- Allflex technical support was excellent
- It is estimated that it took up to one month to train the staff and be comfortable with the integration of the process
- Technical issues included some of the panels not working in extreme cold and the digiboard ceasing
- Three site visits by the vendor to evaluate low read rates: replaced two panels three months after installation
- Software issues included not being able to scan more than 99 head in one group, software locked when scanning at least twice
- Entered data through the office due to the requirement to have a person who was competent with computers
- Installed a camera at receiving area and used radios to relay data to the office for entry
- Total time spent on Viewtrak technical support: 8.5 hours
- Estimated technical competency to operate the software: 4 out of 5

Impact on speed of commerce

- In Phase One, the location of the system added three hours per receiving day. The system was moved in Phase Two and has not impacted the speed of commerce.
- In Phase Two, one to two hours per day were added to the receiving day due to one area for ground loading trailers closed. These were closed to facilitate the movement of the cattle through the scanning systems
- The addition of the data entry into the software requires a minimum of 30 seconds per group

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The systems are not efficient as they are adding an extra business process without adding benefit.
  - There were many technical difficulties with the software and hardware.
  - Speed of commerce was affected by the process of entering consigner data to the software.
  - Multiple owners on one load must be sorted prior to entering data. Area not designed for sorting and that increases the wait time for consigners.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The system was effective as it covered numerous intake areas and recorded tag numbers.

Two single alley systems on

Value creation

- There was no benefit for the market, the consigner or the buyer
- As the tag numbers are confidential, the scanners cannot be used to locate the owner of a stray animal
- The number of age verified cattle was not significant at 18.1%

Labour requirements

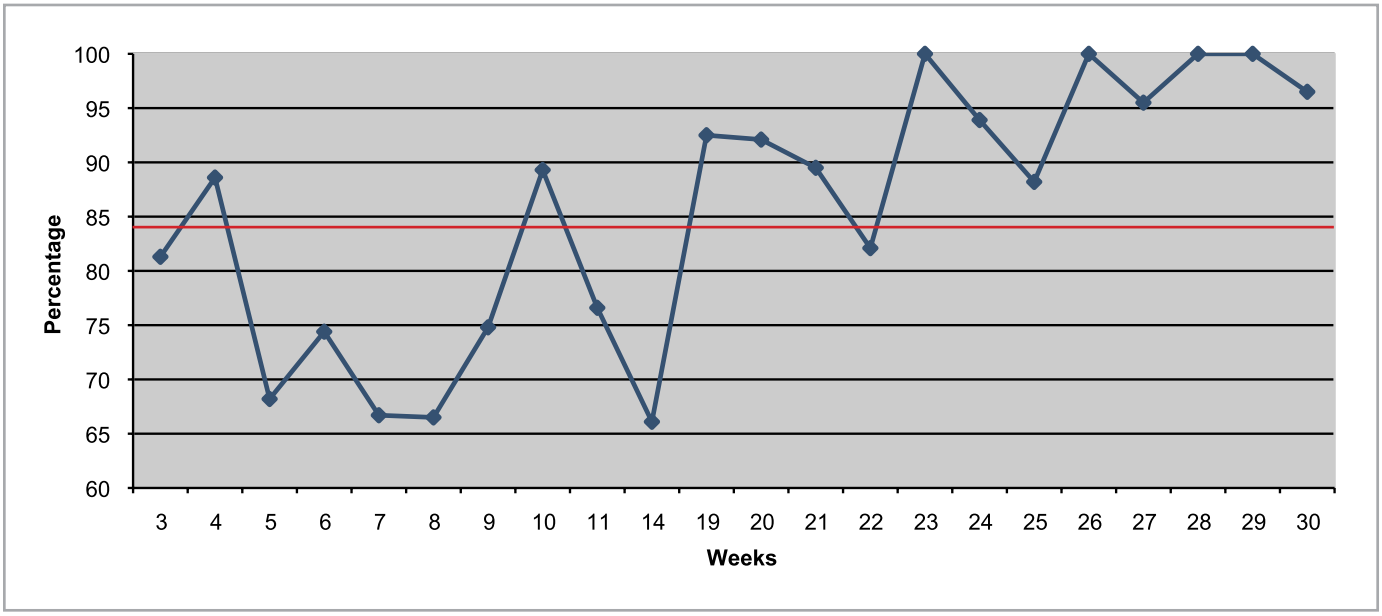
- Read range testing: half hour to do all eight panels
- Input of movement files to the CLTS: five minutes per submission
- Two extra hours for four staff members receiving day

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	% Age Verified
Phase One	**9**	**528**	**11,189**	**96.5%**	
Phase Two: Chute one	8	34	3,205	95.9%	
Phase Two: Chute two	3	7	591	91%	
Phase Two: Chute three	15	1,462	27,869	84.6%	
Phase Two: Global Accuracy	**23**	**1,503**	**31,288**	**83.7%**	18.1%
Variance	14	975	20,099	(12.8%)	

This test site had multiple systems at receiving. The primary alley was the dual alley system that serviced ground loading trailers. For the first 11 weeks, two of the panels were not working and the read accuracy was an average of 78%. Once the vendor switched out the panels, adjusted and tuned the systems, the read accuracy for the last 12 weeks was an average of 95%. This demonstrates the importance of paying attention to the read accuracy of the system so proper maintenance and tuning can be performed to keep the readers operating at the most efficient levels. For five of the 23 weeks, read accuracy exceeded 100% as a result of duplicate tag reads outside of the 10-minute time stamp used as a parameter for the project. These reads were adjusted to 100% when calculating the global accuracy. The global read accuracy of 83.7% is not indicative of the performance this system is capable of.

Graph 11: Read accuracy for Ste Rose Auction Market



Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - In Phase Two, the effect was on the positive side, we had less congestion, better "hands on" understanding of the read rates percentages.

2. Will you continue to use the system now the test is finished?
   - Not likely … if we still have to go through individual producers RFID numbers, but if we have a program where we turn it on in the morning, [it] collects data, and once all data is collect at a specific sale, then yes, I would use it.

3. Was there any value created for your business or your customers from having this system in place
   - Not at all.

4. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - This RFID system should be set up, where the auction markets just have to turn the scanners on, and let them do the work, (do not apply scanned tags to each individual consignor) and when the day is done, we simply upload the data to the main server at CCIA. This whole process has to be as simple as possible for it to work. And there should be a separate group, or business, that will be contracted out, from CCIA, to find any cattle not tagged, or tags lost, and tag them before the sale is to start.

Whitewood Livestock Sales

RFID System

- Phase One hardware was not replaced:
  - Aleis wide alley eight panel system
  - Located directly after the sale ring
  - Alley configuration is 5-feet wide x 13-feet long
- Software
  - Viewtrak is the enterprise software, module for this test were developed by Viewtrak
  - Sale ring software module to link RFID tag number with buyer lots on invoices
  - Tag numbers and age verification data were captured by the ring clerk to align with the sales lot; available on the sales invoice if requested
- Data entry device
  - Tag numbers captured by the ring clerk using the sales ring computer
- New computer system/server required in order to network the hardware with software

Integration experience

Inside view of eight-panel wide alley system

- The challenge was with the new computers and the software
- The new computer system shut down in the middle of a presort day and took at least four hours to sort out
- There were several technical flaws with the new computer hardware
- The ring clerk picked up the software program quickly, training was not significant
- Estimated 10 hours to train staff and integrate with business process
- Total time spent on Viewtrak tech support: 27 hours (most was related to the new computer hardware)
- Estimate technical competency to operate software: 3.5 out of 5

Impact on speed of commerce

- Phase One hardware only had no impact on the speed of commerce
- Phase Two integration with the software had an impact specifically on the presort days when the cattle flow faster than on a sale day. The extra step takes approximately two seconds, and if the tag doesn't read another few seconds to clear it. Using the software to capture the tag numbers can add up to one hour per presort day.

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The system is not efficient as the software introduces another step in the business process and does not provide any extra value for that time spent.
  - The way the tags link to the drafts is not accurate enough to rely on.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The hardware and software operate effectively to collect and disseminate tag information.

Value creation

- The data could be used to sort out an animal that moved out of its sale draft. However, the link between the tag capture and the draft is not accurate enough to rely on.

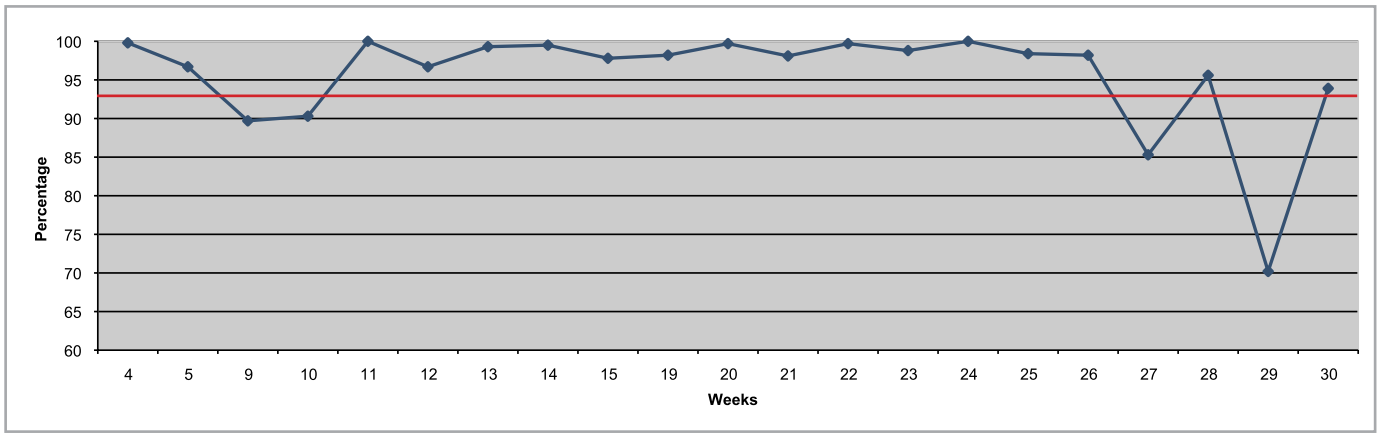
Labour requirements

- Testing the system prior to scanning day: 10 minutes
- Read range testing: a few minutes
- Using the software to capture the tag numbers can add up to one hour per presort day. With a staff if 22 to 25, that totals an approximate cost of $375 per day.

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors	% Age Verified
Phase One	11	3,658	12,053	96%		
Phase Two	22	14,499	27,787	92.7%	1,942	17.5%
Variance	11	10,841	15,734	(3.3%)		

Graph 12: Read accuracy for Whitewood Livestock Sales



This site had relatively consistent read accuracy in the high 90% range, with a few exceptions of extreme highs and lows. Note weeks 12 to 26 were close to 100% each scanning day. There were a significant number of tag recording errors as a result of duplicate tags recorded from the pre-sorts and then again on sale days. There were four days that recorded over 100% as a result of duplicate tags that could not be adjusted in data cleansing. The tag read accuracy on these dates has been adjusted to 100%

Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - We found many issues and problem going from the first phase to the second phase. We had a lot of issues with the new Viewtrak system after it was tied into the scanner. We had more computer freeze ups, in the first three months, than we ever had with our original system over a period of eight years. I found nothing that benefitted our business, only added expense.

2. Will you continue to use the system now the test is finished?
   - I guess we will continue to use it as long as it is working properly and not taking any extra time. If it can't keep up with us, I will not be using it.

3. Was there any value created for your business or your customers from having this system in place?
   - Really I see little to no added value for my customers and for ourselves. There is the possibility that in the case of a group of cattle getting mixed, we might be able to figure out which ones belong to who, however, that rarely ever happens.

4. What are your comments on the feasibility of using RFID systems at auction markets to support traceability?
   - Unless the government is willing to put up the majority of the startup cost, along with on going support and hardware upgrades and replacements in the future, I am not in favor of this program. I do not believe that any of the costs associated with traceability, should be put onto the markets or to producers. If the markets have to pay for equipment in the future, the reality is that the producers would end up paying for it. The added value was minimal to non-existent. As a market we are willing to work with government for the betterment of the industry, however we do not feel that it should be at our cost, or cost to the producers. I also believe that we are maybe a little ahead of the technology required to get the read rates that government is looking for. Possibly in the future the equipment and technology will advance and improve.

Winnipeg Livestock Sales

RFID System

- Hardware was not changed from Phase One
  - Destron wide alley eight-panel system
  - Alley configuration 5-feet wide x 32-feet long / situated in a 60-foot lane
- Software
  - Viewtrak is the enterprise software, modules for this test developed by Viewtrak
  - Software module linked to receiving
  - Tag numbers were available to the consigner until the dale date was changed in the software
- Data entry device
  - Thin client with monitor; linked to the Oracle server
- New computer system/server required in order to network the hardware with software

Integration experience

Inside view of eight-panel wide alley system

- The challenge was with the new computers and the software
- The software issues were extensive because after installation of the computer server and new software the technicians never stayed to test the system during a sale
- Software was modified, at a cost of $3,450, to reduce the number of mandatory fields; this reduced the time required to input the data
- Training people to enter the data was a challenge as this task required a person competent with computers
- Entering the consigner information at receiving slowed down the intake process enough employees were required to sort unruly cattle that had multiple owners on one truck prior to them moving into the scanning alley. As the facility was not designed to sort cattle in this small area, it put employee safety in jeopardy.
- Estimated time to train and integrate software with business process: 20 hours and approximately three weeks before the staff were comfortable with the new processes
  - Employing people that are computer and software competent was difficult. There was only one person who was trained to operate the software. If the designated person was not available to enter a new group, the cattle would have to be brought back later to be scanned. This created more cattle movement and time.
  - Software technical support was not an efficient process. Issues often arose after regular office hours and the market was forced to wait until the next day to fix the problems with processing the sale. One technical issue arose during a sale and caused painful delays; yet another occurred after a sale during invoicing and could not be fixed until the following Monday. These delays meant that the sales could not be handled and buyers were not able to pay for the cattle which were already arranged for transport.

- Total time spent on Viewtrak technical support: 13 hours (most calls related to new computer hardware as several key areas of the new system that were different from the old system)
- Estimate technical competency to operate software: 3 out of 5

Impact on speed of commerce

- Two hours per day added to receiving to support the input of data to the software. Estimate 0-5 minutes per consigner.
- Multiple owners on one load must be sorted prior to entering data.
- As a result of the extra time to input the consigner data, this facility had to stop scanning a few times because of consecutive loads that had to be sorted prior to scanning and the number of trailers waiting for processing became too large.
- Phase One noted an extra 1.5 hours per day to move the groups through the scanning alley.

Efficiency and effectiveness of business process

- **Efficiency:** anything that improves business process, speeds process flow or minimizes errors/defect.
  - The integration of the hardware and software had a negative effect on all business processes; both the process of receiving cattle and entering consigner data.
  - The extra time it took to process the lots created stress for the consigners waiting to bring in cattle.
- **Effectiveness:** anything that operates in a manner that meets the need for which it was implemented.
  - The system was effective as it collected and reported tag numbers with minimal errors.

Value creation

- There was no benefit for the market, the consigner or the buyer
- The number of age verified cattle was not significant at 14.1%

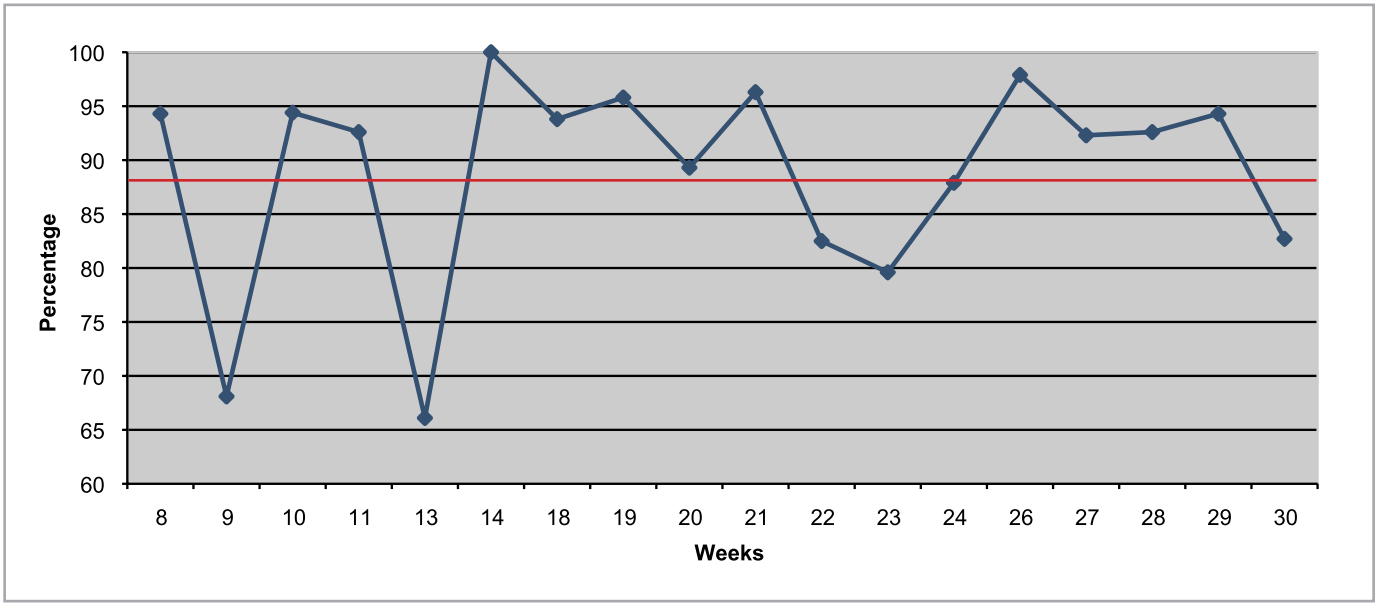
Labour requirements

- Input of movement files to the CLTS: a few minutes after the sale
- One extra person required for the entire receiving day to enter the consigner data
- Two extra hours for staff on receiving day

Read accuracy

	# Weeks	# Groups	Total # scanned	Global read accuracy	Tag recording errors	% Age Verified
Phase One	11	1,295	14,480	90%		
Phase Two	21	1,079	16,607	88.4%	46	14.1%
Variance	10	(216)	2,127	(1.6%)		

Graph 13: Read accuracy for Winnipeg Livestock Sales



There were three weeks with read accuracy exceeding 120% (weeks 12,15,25). This is an obvious error so the data set from those weeks has been eliminated. Week 14 recorded a read accuracy of 102% and this was adjusted to 100% for recording.

Comments by market operator

1. What was the affect on your business (either good or bad) by the change in the process between Phase One and Two?
   - In Phase One, there was no need to hire personnel to operate the software, but in Phase Two we had to hire a new person to operate the scanning equipment because the previous guys that worked receiving cattle did not have any computer skills to work it.

2. Was there any value created for your business or your customers from having this system in place?
   - As far as effect on business at Winnipeg Livestock Sales, it was far more negative than positive. Because of entering the consigner information at receiving, employees were in danger because they would have to sort unruly cattle fresh off the truck in an area that was often congested as cattle were being unloaded off gooseneck trailers and semis in a common area. As well, there was an increase in the time to unload cattle as a result of entering consigner data, sorting cattle into individual groups and the extra movement of the cattle through the alley.

3. Is there any other comment that you would like published in regard to your experience with the hardware and software in this study?
   - The hardware and software aspect involved about three weeks of growing pains which were to be expected. The only way this might have been made easier would be if the vendors could have provided better service at time of installation. This was made difficult mainly because of the geography of where the vendors were from.

ANALYSIS BASED ON TEST SITE EXPERIENCE

Introduction

This business case evaluates the advantages and disadvantages of three different configurations of software for RFID systems. The evaluation criteria mirror the objectives of the research project:

1. Evaluate the issues, opportunities and performance in relation to business process efficiency and effectiveness:
   i. The impact on speed of commerce by the hardware and software(efficiency);
   ii. Software efficiency and effectiveness of capturing and reporting tag numbers; and
   iii. Weekly and global read accuracy (effectiveness).
2. Determine if employee/animal injury or illness results from the use of the RFID systems.
3. Identify potential for business value creation at the operational level (efficiency).
4. Financial analysis of capital costs, operating costs, ongoing maintenance costs.

Efficiency: Improves business process, speeds business flow or minimizes errors/defects.
Effectiveness: Operates in a manner that meets the need for which it was implemented.
Speed of commerce: The time it takes to complete one cycle in a business process—or the time it takes to complete an entire business process.

Speed of commerce affected by hardware

The same RFID hardware configurations are used in all scenarios therefore the following evaluation is applicable to all options. Phase One determined that the greatest impact on speed of commerce is the location of the RFID system within the business process. Appendix Three notes the summary of the Phase One research in this area.

- At one test site, the system was placed at the back of the market to process cattle from receiving prior to pre-sale penning. The location of this system created a new leg in the business process as cattle were received on two sides of the facility and brought through the alley at the back for scanning. This extra step in the process to receive and pen cattle had a significant impact on speed of commerce increasing handling time by almost 60%.
- Markets with the RFID system at the sale ring, both before and after, experienced minimal to no impact on the speed of commerce. This is due to the systems being installed in an area that did not require any change in cattle movement.
- Markets with systems at receiving experienced an impact of between four to 10 minutes per group, with a total impact of one to two hours per receiving day. The impact was due to a change in cattle movement to facilitate unloading and penning through only one area. The buying stations in Phase Two did not experience an impact on speed of commerce with systems at receiving as there were multiple systems so the cattle didn't have to funnel into one area or change the process flow in any way.

Table 5: Impact on speed of commerce by hardware based on location in the market as documented in Phase One research

AUCTION MARKETS	Option One	Option Two	Option Three
At receiving	4-6 minutes per group/ 1-2 hour per day	4-6 minutes per group/ 1-2 hour per day	4-6 minutes per group/ 1-2 hour per day
Prior to the sale ring	No impact	No impact	No impact
After the sale ring	2-14 minutes per sale	2-14 minutes per sale	2-14 minutes per sale
BUYING STATIONS			
At Receiving	N/A	No impact	No impact

Determining the right alley configuration for the location within the facility is an extremely important consideration. A vendor site assessment will help determine the right hardware in the best location. A change in cattle movement will affect process efficiency through an impact on speed of commerce. In sum:

- Single alley systems, although having high read accuracy, are best located in an area where the cattle are already moving head to tail. These can be areas such as loading chutes or processing alleys, although not all facilities have single alley chutes coming off trucks. The drawback to this location is chutes are generally 40 inches wide so the cattle bunch up through the alleys. Numerous tags in the field create data collision and therefore lower read accuracy. A single alley system will have an impact on speed of commerce by potentially restricting flow in high volume areas such as receiving ground loading trailers.
- Dual alley systems were installed at receiving and it was determined that these are effective processing larger groups at this location. However, it is not thought these systems would be effective at the sale ring as the cattle may hesitate prior to the group moving through the alleys.
- Wide alley systems were installed both prior to and after the sale ring in five locations. The markets with these systems did not experience any impact on the speed of commerce. The wide alley scanners were set up in the 12-foot penning alley coming into and out of the sale ring. As the lot sizes moving into the sale ring are generally smaller (one to five cattle), there is little difficulty funneling these groups into a 5-foot alley. Two types of systems were tested: the eight- and four-panel wide alley. Both of these systems worked equally as well, and the four panel is half the cost and only requires a 16-foot alley.
- Pen scanning: Uses a long-handled wand to individually scan the tag numbers. Best suited to an area with a catwalk that enables the operator to be located above the cattle. Further, it is best used in an area where the cattle are stationary, such as in a pen. It is difficult to scan tag numbers on cattle that are moving as in an alley.
- Many auction markets have several receiving areas and reducing intake to one area affects speed of commerce, as was noted at Gladstone. A high percentage of deliveries on ground loading trailers contain cattle from multiple owners. Sorting these cattle by owner to enable software data entry by individual consigner creates not only a time delay, but a potential threat to employee safety as the receiving area was not designed for sorting cattle. At buying stations, a higher percentage of cattle arrive on semi trailers versus ground loading trailers so the issue of mixed loads is not as prevalent.

An important consideration in the determination of the location of the RFID system is the amount of additional handling required for the cattle. Reducing the stress placed on cattle in auction markets and buying stations is an important consideration when choosing the RFID system design and location within the market. The design of the system, the type of cattle and the amount of handling and movement will influence the amount of shrink. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) states that "shrink results from the stress cattle experience during processing, transporting and marketing, costing both the buyer and the seller." Stress reduces weight, which in turn reduces the value the cattle obtain in the auction ring. OMAFRA further states:

> *"Every 30 minutes spent moving cattle around in handling facilities will reduce their weight by 0.5 percent. Use quiet handling methods for moving and processing cattle to lessen this effect. Well-designed handling facilities will allow cattle to be processed quickly while experiencing minimal stress." 6*

Appendix Three has details of the full evaluation of the impact of the RFID hardware on the speed of commerce as documented in Phase One report.

Speed of commerce affected by software

Option One

In Phase One, the software was outside the business process and it was operated by a third party. There was no requirement to intervene if a tag did not read. The software did not have any affect on speed of commerce in Phase One.

Option Two

In order for the software to be linked into the enterprise system, the data entry devices must be networked through the enterprise servers. In four of the test sites, the business process of receiving and selling were interrupted as a result of the data entry device failing, and therefore shutting down the business process for several hours. If the computers or software for recording tags fails, then the business process is also affected. This affect can be detrimental to the buyer, the market and the consigner.

Auction markets at receiving: Negative impact

Test sites with systems at receiving were Kamloops, Winnipeg, Gladstone, Ste Rose. Before the integration of the tag recording software with the enterprise system, the cattle entered the market, the paper work was recorded by the yard personnel and then entered in the office by administrative staff to ensure data accuracy. With the integration of the software, the yard personnel added consigner information at the receiving gate using thin clients with monitors or DT500s was added to the process.

- Speed of commerce metric: time to unload and pen one group of cattle
- At all the markets, it was estimated the time to input the consigner information requires an additional 30 seconds to a five minutes per group/lot. This can add up to an extra two hours on receiving days.
- Extra time is required to sort cattle into groups assigned to individual owners for data entry. The receiving area is not designed for this type of sorting and creates time delays for cattle unloading.
- Wait times for the producers unloading cattle may increase at peak receiving times as a result of the delays caused by sorting and data entry.

Auction markets at prior to the sale ring: Neutral to negative

In Killarney, before the installation of the software, the business process was that the ring clerk would capture the weight of the animal and then link to the buyer. With the integration with the software, the rink clerk captured the tag number as the cattle moved through the scanners, then the weight, and then linked that information to the buyer. At Cookstown, the original process was that the ring clerk would capture the weight then align that with the buyer. With the integration of the software, there was a laptop at the alley entrance where the group size and some consigner data was entered prior to the weight scale and the sale ring.

- Speed of commerce metric: time to sort and sell one group of cattle through the sale ring
- Killarney: The time to sell one draft almost doubled, adding 20 seconds per draft to capture the tag number with the draft information. This facility ceased using the software as the impact was too great, adding at least two hours to a sale day.
- Ontario Stockyards: The data was entered on a laptop at the entrance to the alley by yard personnel. There was no impact on the speed of commerce because it only took a few extra seconds and the cattle were waiting for the next draft to move out of the sale ring.
- Ottawa Stockyards: The data is entered as the cattle enter the sales ring by a person dedicated to this task. It does not impact the speed of commerce as the cattle move primarily in singles or small groups. The next group/lot cannot move into the sales ring until the previous group/lot has sold.

Auction markets after the sale ring: Minimal impact

- Saskatoon, Spiritwood, Whitewood
- Speed of commerce metric: time to sell one draft and have the cattle to the penning area
- In all the markets, it was estimated the additional time to capture the tag number on sale lots is two to three seconds. The effect is between 10 to 20 minutes over the course of the sale, and an additional hour on presort days.
- Spiritwood found that the largest impact was up to one minute extra on sale of show pens (large groups of cattle) which accounted for up to 10 minutes per sale as a result of having to wait for large groups to move out of the scanners. The lag between lots created as a result of having to wait for the groups to clear the scanning alley before proceeding to the next group, reduces the momentum and flow of the sale which is important to maintain prices and interest.

Buying stations at receiving: Neutral to negative

- Speed of commerce metric: time to receive and process groups at receiving. Time to load cattle for delivery.
- McCall Livestock found an impact of an average of 10 minutes per transaction but could be up to 20 minutes as every lot was entered as the cattle came off trucks, or moved onto trucks. The difference was dependent on whether there were several trucks shipping and receiving in the same time frame while personnel were at the DT500 or whether they are going back and forth within the facility to enter the data.
- JGL and Cattlex did not find an impact on speed of commerce. The software had a buffer for collecting tag numbers that could be assigned to a consigner when time allowed. The data entry was either in the office or at a receiving booth.

Option Three

This system was only trialed in Killarney for six weeks in Phase Two. It was found that there was no impact on speed of commerce. The buying stations found that using software that did not integrate with their enterprise system had no affect their speed of commerce unless each draft was entered individually.

Table 6: Impact on speed of commerce by software

AUCTION MARKETS	Option One	Option Two	Option Three
At receiving	None	Negative: Between 30 seconds to five minutes per lot	None
Prior to the sale ring	None	Neutral to negative: from a few seconds to up to 20 seconds per sales draft	None
After the sale ring	None	Minimal: 3 seconds on regular drafts-up to one minute on show pens sales draft	None
BUYING STATIONS			
At Receiving	N/A	Neutral to negative: between zero to ten minute per lot	None

Software efficiency and value creation

Value creation is defined as benefits to the producer, buyer or facility from having the tag numbers recorded with the transactional information.

Option One: No impact

There were no benefits to the test sites from the use of the RFID systems in Phase One because they were not linked with enterprise software. The tag numbers were not available on consigner or buyer invoices.

- No change in business process required as there was no intervention for tags that did not read or cattle that were untagged.
- One dedicated person to operate the software (the FRA worked for the project and not the test sites)
- The software was effective as it recorded the tag numbers with minimal to no errors

Option Two: Inefficient

In all cases, the test sites reported that the RFID system did not have any benefit to the consigner, buyer or facility, except in the case of reporting ATQ tag numbers on Quebec cattle. The software provided the option of making the tag numbers available on the consigner and buyers invoices, but although this service was offered to customers very few requested that service as the information was not of value to them. In Killarney, the market used a hand-held wand to collect and record tag numbers to create a buyers catalogue on sale lots with age verification information. The buyers did not find value in this catalogue and the market stopped spending the time to produce it.

Only at Ontario Stockyards and Ottawa Livestock was there benefit to the customers with the collection and recording of the ATQ tag numbers for Quebec producers. The ATQ tag numbers must be provided with the invoices as there is a rebate back to the producer for the sale of the cattle. As such, both of the Ontario markets take extra care to record the ATQ tag numbers. At Ontario Stockyards, the long-handled wand is used while the Quebec cattle are enclosed in the scanning alley. Any tags that aren't readable are read and recorded by hand. In Ottawa, cattle stay in the single alley system prior to the sale ring until the number is captured. If the tag is unreadable, the number is recorded and entered by hand.

A few sites perceived potential benefits from being able to identify cattle that have moved out of the selling group or if a back tag has fallen off. However, a common issue that detracted from value creation was the fact that the data accuracy is not high enough to depend on. Further, a potential benefit was not met because the age verification numbers were low, between 7.8% and 31.3% of all head scanned.

Capturing tag numbers within the business process added an extra step which reduced efficiency. Several technical difficulties with the integration of the tag capture and reporting software were noted by the test sites. Numerous duplicate tags and incorrect tag formats were recorded. Over 5% of the tags recorded throughout Phase Two were either an incorrect tag format or a duplicate numbers. In one market that did presorts, the tag errors were almost 8% of the total head scanned as a result of duplication. In another, the system was recording only partial tag numbers and almost 15% of the numbers collected at that market were in an invalid format. In order to facilitate the research, this data had to be deleted from the data set using an alternate program prior to reporting.

Training market personnel is another important factor with this option. The test sites rated the level of competency to operate the software at between 3.5 and 4 out of 5 (5 being the highest level of competency). The issue lies in the ability to recruit and retain staff members who are competent with both computers and handling cattle. Labour shortages plague this industry, and adding the requirement of technical competence makes it even more difficult to find the right people. The Spiritwood Stockyard said it best "If experienced staff had not been available, sale time would have doubled and we would have lost many customers."

In Phase Two, the software was only moderately effective as a result of extensive technical issues leading to incorrect data recording.

Auction markets at receiving: Inefficient

- BC Coop has been using this system for several years and find that entering the data has a neutral effect. However, they are accustomed to the process.
- It was anticipated that entering the consigner data at receiving would eliminate the need to enter it in the office. This was not the case as too much time was required to enter the pertinent data, and therefore did not create time efficiency.
- One trained person to operate the software must be available throughout the day. It would be best to have two trained personnel.
- Extra time to unload and sort the cattle as a result of having to enter the groups by individual consigner.
- Wait times for producers were negatively influenced by the time delays.

Auction markets before and after the sale ring: Inefficient

- Extra time required for tag number capture on each draft
- Added stress on the ring clerk, adds another step to an already busy position
- The tags linked to the sales draft is not accurate enough to be relied upon for inventory control

Auction markets at the sale ring: Collected ATQ Tags Efficient

- ATQ requires that any market that sells ATQ cattle, must have a facility to record and report the tag numbers.
- 100% of tags are collected and recorded on invoices using a single alley system, a long-handled wand or manual reading and recording of the tags.
- This is efficient as there is a rebate back to the producer for submission of ATQ tags.

Buying stations at receiving: Neutral to inefficient

- As the tag capture software was not integrated with the business software, there was no requirement to ensure each lot was captured at the same time as the cattle moved through the facility. This reduced impact on time and resources.
- There were numerous tag recording errors as a result of the cattle moving in overnight and then back out in the morning before all the tags had been recorded as moved in.
- At McCall Livestock, when each group was recorded at the time of movement, there was a negative impact on speed of commerce of up to 20 minutes per group. Entering each group/lot is an inefficient process because of the time required to input and record the data.

Option Three: Neutral

- No change in the business process required: provided there is no intervention required for tags that are unreadable or cattle that are untagged.
- Data entry takes place in the office, where the staff is already computer competent.
- Minimal training is required as the software is not complicated.
- Entering the total number head handled throughout the day may take some time to acquire, but will only take seconds to enter.
- With no integration in the business software, any technical difficulties will not affect sales transactions.
- Manifest manager software was efficient as it recorded the tag number with minimal to no errors.
- The tag numbers will not be linked with enterprise systems so it will provide no benefit to the facilities.

Table 7: Process efficiency using software

AUCTION MARKETS	Option One	Option Two	Option Three
At receiving	Neutral	Inefficient	Neutral
Prior to the sale ring	Neutral	Inefficient	Neutral
After the sale ring	Neutral	Inefficient	Neutral
BUYING STATIONS			
At Receiving	N/A	Neutral to inefficient	Neutral

Read Accuracy

Read accuracy is related to the efficiency and effectiveness of the RFID hardware. Phase One found that all of the configurations of the RFID scanning alleys were effective as they were able to collect and record RFID tag numbers at varying levels of read accuracy as noted in the following table. Systems at the sale ring were more effective than systems at receiving as a result of higher read accuracy. This is due to smaller groups moving through the systems, resulting in less data collision. At receiving, cattle may arrive untagged and move through the scanning alleys before retagging, therefore reducing read accuracy.

Table 8: Read accuracy highs and lows by type of system and location in market as reported in Phase One [7]

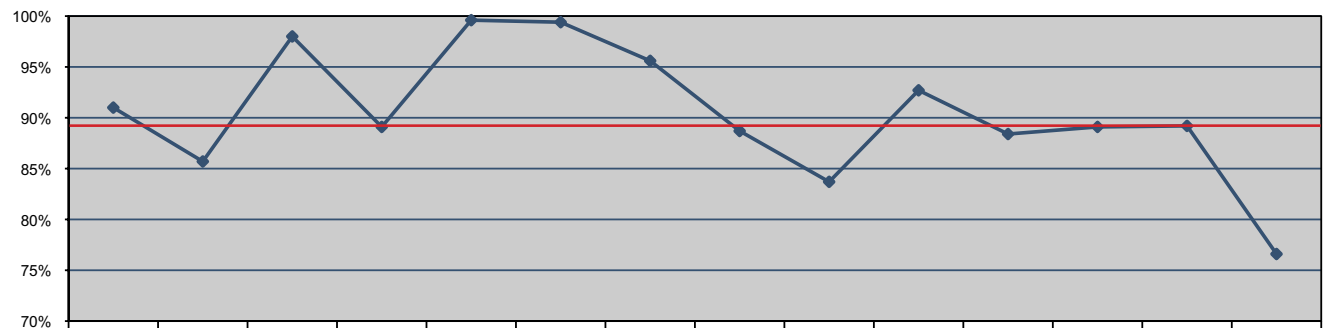
PHASE ONE	GROUP SIZE ACCURACY				WEEKLY ACCURACY				GLOBAL ACCURACY	
	Low Read	High Read	Variance	# Groups	Low Read	High Read	Variance	# Head	Average	% of Total Head
Single Alley	95%	98%	3%	936	96%	99%	3%	17,543	97%	12%
Dual Alley	88%	93%	5%	1,607	86%	93%	7%	23,746	90%	15%
Wide Alley	88%	96%	8%	28,833	90%	94%	4%	102,908	93%	72%
At Receiving	88%	91%	3%	2,902	88%	92%	4%	38,226	90%	26%
At Sale Ring	87%	95%	7%	27,538	92%	95%	3%	88,428	93%	62%
At other location*	95%	98%	3%	936	96%	99%	3%	17543	97%	12%
All cattle	90%	95%	5%	31,736	91%	94%	3%	144,197	93%	100%

* same as single alley

In Phase Two, the global read accuracy dropped to an average of 89%. Three sites, Gladstone, Ste Rose and McCall brought the global average down with read rates of 85.7%, 83.7% and 76.6% respectively. If these sites were not included in the calculation, the read accuracy would be 93%. As noted on the chart below, five of the 13 sites were above 90% plus Ontario Stockyards use of the wand on Quebec cattle which achieved close to 100%, three were at 89%, three were between 85% and 89% and two sites had low reads under 85%. The lower read accuracy rates are the result of numerous factors including; human error capturing tag numbers with software that was linked to enterprise systems, multiple systems in one facility that made it difficult to locate the source of error, panels on chutes with a width of 40 inches (therefore creating data collision), tag recording errors that may have affected the read accuracy calculation, and the difficulty in determining the weak link between the hardware, data connections, data entry device and the software. In Phase One, if the reads were low it was easy to locate the source of the problem and resolve it. In Phase Two, with the systems linked to the enterprise software, there were many more factors that had to be considered, making it much more difficult to isolate the source of the issue.

The lower read rates in Phase Two may also be due to the lack of a dedicated person to monitor and evaluate the RFID hardware. In Phase One, the FRAs were dedicated to this task, and if reads started to drop they were evaluating options to resolve the problem. In Phase Two, without this dedicated resource, it was often weeks before the problem was identified by the project manager and then weeks again before the vendors could get to the sites, resulting in several weeks of low read accuracy. This is an important lesson in the industry moving forward with RFID systems. Without a dedicated resource monitoring and evaluating the systems to ensure the highest levels of performance, the read accuracy could be far less than 90% on a global average.

Chart 14: Read accuracy by test site Phase Two



	BC Coop	Gladstone	Killarney	Ontario Stockyard	Ontario Stockyard*	Ottawa	Saskatoon	Spiritwood	Ste Rose	Whitewood	Winnipeg	Cattlex	JGL	McCall
Series1	91.0%	85.7%	98.0%	89.1%	99.6%	99.4%	95.6%	88.7%	83.7%	92.7%	88.4%	89.1%	89.2%	76.6%

* Ontario Stockyards use of long-handled wand for scanning tags on ATQ/Quebec cattle

Table 9: Read accuracy variances Phase One and Two

	Phase One		Phase Two		Variance Ph 1-2		
	# Head	Accuracy	# Head	Accuracy	# Head	Accuracy	Tag errors
BC Coop	12,405	87%	9,315	91.0%	(3,090)	4%	8
Gladstone	11,341	93%	16,334	85.7%	4,993	- 7%	1,989
Killarney	6,354	98%	5,619	98.0%	(735)	0%	na
Ontario Stockyards	14,575	94%	43,623	89.1%	29,048	-5%	na
Ontario Stockyards*			1,714	99.6%			
Ottawa	7,275	84%	35,255	99.4%	27,980	15%	21
Saskatoon	44,382	93%	67,605	95.6%	23,223	3%	650
Spiritwood	17,418	91%	23,756	88.7%	6,338	-2%	14
Ste Rose	10,802	97%	31,288	83.7%	20,486	-13%	146
Whitewood	12,053	96%	27,787	92.7%	15,734	-3%	1,942
Winnipeg	14,480	90%	16,607	88.4%	2,127	-2%	46
Cattlex			36,072	89.1%			1,263
JGL			59,617	89.2%			802
McCall			24,166	76.6%			554
	138,680	**93%**	**389,443**	**89%**			

• Ontario stockyards use of the long-handled wand to collect ATQ tag numbers on Quebec cattle
• The global average is based on a per head weighted average on the project as a whole

Gladstone: The dual alley system from Phase One was replaced with a four-panel wide alley system; consigner data was entered at receiving on a DT500. The read accuracy dropped from 93% in Phase One to 86% in Phase Two. The number of tag recording errors was 12% of the total number of head scanned, which certainly had an effect on the global read accuracy. Even after repeated evaluations by the hardware and software vendors, it has not been determined if it is a hardware and software problem. Ongoing evaluation at this site will include new software with basic functionality that can be tested directly at the alley (eliminating the cables and DT500 as the potential source of low read accuracy), then linking the laptop through the cables to evaluate if they are dropping data, and then finally setting up the new software on the office computer and spending one day evaluating the read accuracy and data collection. The read accuracy at this market is a testament to the importance of paying attention to read accuracies and having the vendors work to identify the issues in the first year.

Killarney: The single alley system at receiving was replaced with a four-panel wide alley system at the entrance to the sale ring. Originally, this facility was using a sale ring module linked to their enterprise system. As a result of a significant impact on their speed of commerce, the market switched to basic functionality software from Phase One. The software was set up on the office computers, turned on in the morning of the sale, the total number of head entered at the end of the day. The read accuracy was recorded 98% with no data errors.

Kamloops and Ottawa: In Phase One, both of these systems were at least three years old. In Phase Two the systems were updated and it is evident that the read accuracy increased with the newer technology. Kamloops was updated with a new dual lane system, the first of its kind in Canada and recorded 91%. The reason this rate is not higher is at this location in the market some groups enter the system and are not yet tagged. In Ottawa, the reader antennas were updated and the read accuracy jumped from 84% to close to 100%.

Ontario Stockyards: Phase One hardware was used, an eight-panel wide alley system. Phase One accuracy was 94% and Phase Two was 89%, a variance of 5%. In Phase One, there was more time spent reading each group, often moving them up and down the alleys to capture the tag numbers. In Phase Two, the market used a long-handled wand to capture tag

numbers on groups where 100% read was critical and did not make extra effort to capture the tag numbers on the other groups. This demonstrates the importance of keeping the animals in the alleys for a few more seconds to capture the tag numbers. Human error could be a factor with data entry on the number of head in a group.

Saskatoon, Spiritwood, Whitewood: All these markets have Phase One hardware; an eight-panel wide alley system located after the sale ring. The change in read accuracy was inconsequential (2%-3%) at all three sites with the tag number captured in the sale ring. Whitewood had over 7% tag errors as a result of the process of presorting and then the same cattle moving through the scanners on sale day. This was a software technical issue that should not have captured both movements. If the software is not used on presorts, the read accuracy will likely increase. Movement reporting only requires that the animal is identified as being at the facility, therefore, scanning on both presort and sale day is not essential.

Ste Rose: The single alley system from Phase One was replaced with three systems at receiving. Two single alleys on loading chutes and one dual alley for ground loading trailers. In the initial weeks of the test, there were both hardware and software problems, plus the digiboard failed (the device that converts the signal from the hardware to be read by the software) so no tags were being recorded from that chute for two weeks. The average read accuracy in the first 11 weeks was 79%. After the last site visit by the hardware vendor with changes made, the final 11 weeks showed a read accuracy of 95%. This again demonstrates the importance of continually monitoring the read accuracy of the system.

Winnipeg: The same hardware was used from Phase One, an eight-panel wide alley system. The read accuracy decreased marginally in Phase Two to 88%. However, there were some anomalies with the read accuracy in that many weeks showed reads of over 100% which compensated for lower reads in other weeks. The weeks showing over 100% were adjusted or eliminated from the data set. The last 12 weeks was more consistent with reads between 89 to 95%. Winnipeg did not scan all the groups of cattle at peak times as a result of the impact on speed of commerce and the increased wait time that producers faced as a result.

Buying stations: JGL, Cattlex, McCall

The buying stations were all equipped with multiple systems at receiving. The read accuracy was below 90% at all sites, specifically McCall. The number of tag recording errors, which were a result of duplicate tag numbers being recorded in the software, had an impact on the global read accuracy. At buying stations, often cattle are moved into the facility in the morning and back out in the afternoon through the same chutes where the scanners were located. The software vendor has been contacted to update the software to eliminate these errors. The experience at these sites highlights the importance of monitoring the read accuracy of the systems and taking action if the reads are below the benchmark set at installation.

At both JGL and Cattlex, the single alley systems were installed on the loading chutes which have a width of approximately 40 inches, which is industry standard. As was noted in Phase One research, single alley configurations should be approximately 32 inches to reduce crowding and multiple animals in the read field. There is a possibility that the lower read accuracy on the single alley configurations is a result of the width of the alley and data collision. To support the highest read accuracy, the chute should be narrowed to 32 inches where the panels are located.

JGL: Global read accuracy of 89.2% with 802 tag recording errors (approximately 1%). The read accuracy on the four systems ranged from a high of 93.7% on the wide alley, 91.2% on the single alley for ground loading trailers to lows of 87.6% and 88.5% on the single alleys installed on the loading chutes. The wide alley had cattle that arrived from the auction market next door so most of the cattle were already tagged.

Cattlex: Global read accuracy of 89.1% with 1263 tag recording errors (approximately 3.5%). Both single alley systems were installed on loading chutes. Chute One had over 5.6% tag recording errors and a global accuracy of 88.6%. Chute Two had only 1.6% tag recording errors, but still had a global read accuracy of only 89.5%.

McCall: Global read accuracy of 76.6%. The wide alley had the lowest rate of 74.8% with 2.9% tag recording errors. The other chute with two single alleys recorded with one data box had a global accuracy of 81.5% with tag recording errors of less than 1%. Over $4,300 was spent on site assessments to have the hardware and software vendors visit this site to determine the cause of the low reads after the equipment was installed. It has been determined that the cause is definitely the hardware being affected by electrical interference from overhead lights. An electrician installed ballasts in the lights and the vendor has installed inline filters on the reader power supply in attempts to eliminate the interference issues. Another $4,350 was spent at this facility in an attempt to resolve these issues, totaling over $8,650 in costs attempting to rectify the problems created by noise interference. The last four weeks of the test showed marginal improvement in the read accuracy after this work was done. Continued testing will include noise logging software and a visit by technicians from the manufacturer. This site demonstrates on the importance of including a basic evaluation of electrical interference prior to installing RFID hardware.

Factors affecting read accuracy

As noted in Appendix Two, there are several factors which can affect read accuracy. These being: data collision, electrical interference, tag orientation and tag failure. The change in read accuracy from Phase One to Two could be a result of several factors but is indicative of a real world environment where systems fail. Without a dedicated person to monitor the systems, several weeks can evolve before the problem is addressed. Monitoring the systems includes evaluating the read accuracy reports, tuning the systems on scanning days, ensuring there is nothing introduced that can create electrical interference, and working closely with the vendors in the first few months to have the system set up to operate at the highest level of efficiency. A benchmark read accuracy should be set at that time and used as a baseline for evaluation.

COST ANALYSIS

The costs documented in this study are based on one RFID system per facility and assume one movement report per site. However, it must be noted that many facilities will require multiple scanning alleys to support traceability. The evaluations are based on actual costs of average installations from Phase One and Phase Two. These costs should not be assumed to be accurate in all auction market and buying station environments due to variable design, construction and provincial regulations.

It is important to note that a capital cost per head to industry cannot be calculated because the volume of cattle handled at a facility does not equate to cost. Smaller volume sites require the same software and hardware as high volume sites, as such, the capital costs are not size dependant.

Capital Costs

Site assessments

It was noted in Phase One, and verified in Phase Two, that the placement of the RFID hardware within the facility has more impact on speed of commerce than the configuration of the system. As such, a thorough site assessment, by both the hardware and software vendors, is critical to the success of the system installation. Integrated Traceability Solutions charged the project $2,500 for site assessments, while others included those costs in the package price. Software vendors can charge up to $1,200 per day, plus travel expenses, for a business analyst to visit a site. Site assessments by software vendors are only required if the facility is going with Option Two. If the hardware and software vendors are familiar with the sites being evaluated then time spent at each facility will be substantially reduced.

If severe electrical noise is found on the initial site visit, an extended evaluation should be engaged. The cost of this is $10,000 and will ensure that the hardware is installed in an area free of electrical interference to operate at the highest level of performance. Had the original site assessment at McCall Livestock included a basic electrical interference test, it would have been evident that the overhead lights were creating too much electrical noise, and a more advanced test could have been undertaken to evaluate the potential location for reduced interference.

RFID hardware

RFID hardware consists of panels, antennas and data boxes to record the tag numbers picked up from the antennas on the reader panels. This hardware is installed in an alley specifically constructed for the purpose of scanning animals. The construction of a scanning alley requires modifications to the infrastructure at a facility. The cost of RFID hardware includes installation by the vendors. The following are excerpts from Phase One research report (p. 72):

Systems at receiving at auction markets

At receiving the penning/sorting alleys need to remain unencumbered so pens were removed to install the systems. The removal of pens requires extensive welding, reconfiguration of gates and often adding holding pens in another location. The cost of infrastructure changes, including labour, ranged from a high of $12,000 for a market that converted pens to a 60-foot alley to a low of $7,200. Scanning alley construction costs can be expected between $2,250 for dual and single alley systems to $4,000 for a wide alley system.

Systems at sale ring

The systems located after the sale ring had the lowest infrastructure modification costs because these were installed within an existing 10- to 12-foot alley. The cost of the modifications, including the electrical service, ranged from $750 to $2,000. All these systems were wide alley with a $4,000 cost to construct the scanning alley. One market built a longer alley coming off the sale ring to facilitate the flow of cattle. Infrastructure costs were affected and the total infrastructure price was $4,200.

In Phase One, there was only one system installed prior to the sale ring. That market had significantly higher infrastructure modifications as a result of removing pens to install the system coupled with the installation of a hydraulic gate to reduce the need for market personnel to enter the alley ahead of the cattle. The system could have been placed within the existing alley but was moved to create efficiency in process flow. In Phase Two, a new system was installed prior to the sale ring in Killarney and it was verified that costs at this location exceed costs of installation after the sale ring.

At the buying stations, RFID systems were installed at receiving to ensure the capture of all the cattle in the most efficient manner. At facilities with multiple RFID systems, the increased costs were primarily a result of more hardware. The software works off multiple systems and there is generally only one data device required. The costs of infrastructure changes and alley construction ranged from $9,000 to $31,000 in facilities with two to four systems. JGL had the highest costs as the facility is all outdoors and with four RFID systems at various locations throughout the site, the cost to run new dedicated electrical lines in conduits under ground was in excess of $14,000.

Aleis long-handled wands were used in three test sites for tag collection. At Ontario Stockyards, the wand is used on cattle that are penned in the wide alley prior to the sale ring so no additional infrastructure was required. At Cattlex, a catwalk was installed over the weigh scale, and in Saskatoon the catwalk was built prior to the sale ring. The use of the wand requires skilled personnel, adding additional costs for training and labour.

The scanning alleys were either constructed by the vendor and installed with the system, or constructed in advance by the market. There are pros and cons to each of these types of installations. The cost of labour provided by the market personnel for infrastructure modification and construction of alleys is included in these prices.

Table 10: Cost of RFID hardware by type

	Number of panels	Location of readers	Cost of RFID System	Cost of alley construction	Cost of infrastructure modifications	Total cost of systems
Wide alley 8 panel						
Wide	Eight-panel: Destron	Entrance to sale ring	$ 48,500	$ 4,000	$ 12,000	**$ 64,500**
Wide	Eight-panel: Destron	Receiving	$ 48,500	$ 4,000	$ 12,000	**$ 64,500**
Wide	Eight-panel: Aleis	Sale ring exit	$ 50,500	$ 4,000	$ 2,000	**$ 61,000**
Wide alley 4 panel						
Wide	Four-panel: Destron	Entrance to sale ring	$ 30,000	$ 4,000	$ 6,500	**$ 40,500**
Wide	Four-Panel: Destron	Receiving	$ 30,000	$ 4,000	$ 6,500	**$ 40,500**
Dual alley						
Multi-read* *	Four	Receiving	$ 47,000	Included**	$ 6,500	**$ 53,500**
Dual	Four	Receiving	$ 20,000	$ 2,250	$ 6,500	**$ 28,750**
Single alley						
Single	Two	Receiving- on two load in chutes	$ 15,500	$ 3,000	$ 2,000	**$ 20,500**
Single	Two	Receiving- through one alley	$ 13,000	$ 2,250	$ 6,500	**$ 21,750**
Wand	n/a	Receiving	$ 6,700	Not required	$ 5,000 ***	**$ 11,700**

* Systems supplied by Integrated Traceability Solutions, representing Aleis, include the cost of the scanning alley as they are prefabricated and delivered to the site.

** The Multi-read is a two lane system manufactured by Aleis and new to Canada. It is two attached single alleys with a concrete base and metal frame, the structure eliminates the need for alley construction and does not have the 30" island in the middle.

*** The use of the long-handled wand requires a catwalk to access the cattle from above. This cost is based on a 10-foot catwalk.

Computer hardware and data collection devices

In order for RFID reader hardware to communicate with the data accumulator (computer and software), the two pieces of equipment must be linked via a cable or network. Networking the RFID hardware and the computers requires the use of data network (CAT5) cables and some type hardware that links the two to support the flow of data from the hardware to the software (data link hardware, serial port or digiboard).

Computer Server

If the hardware and enterprise software are integrated as in Option Two, then the hardware must be networked with the enterprise servers. Of the 13 test sites in Phase Two, five of the computer systems (38%) were not able to support networking due to their age. New computer networks cost approximately $10,000 plus $6,600 for on-site configuration and installation, plus travel costs. The vendor did not provide any training with the on-site installation of the systems. It took an average of three days to complete the configuration and installation of the new systems. Software with basic functionality is used in Option One and Three and the software would reside on the office computers for data entry so there is no need for computer server or extensive networking options.

Linking the hardware with computers

An industry specification is that a CAT5 cable should not be run more than 300 feet between the hardware and the computer to ensure that data will not be dropped. If the RFID system is further away than 300 feet from the computer, a booster will be required to extend the signal. In some instances, the cables will have to be buried in a conduit if there is nothing to attach them to above ground. The cost of running the cables will vary based on the distance and whether or not they need to be buried. It is estimated that the cable installation for a 300-foot run will cost between $1,000 and $2,000. These cables should be run by a certified electrician to ensure that:

1. The run is within the specified distance suitable for the type of cable used;
2. The cable is finished on both ends with the proper connectors to attach to the hardware and software; and
3. The line has been tested for clean and accurate data transfer.

With Option One and Three, the only requirement for linking the RFID hardware with computer hardware is a CAT5 cable and some type of network switch. The data link boxes can be either a network switch, serial hub or a digiboard and will be dependent on the type of computer and operating system. The cost of these items is between $500 and $1,500.

Data entry devices

If it is the objective to track the lots by owner or assign a group of RFID tags to a buyer, as in Option Two, then a data entry device is required. The choice of data entry device must be based on the location of the system, the functionality required and the environment in which it will be required to operate. The following only refers to Option One and Two, with Option Three the software would be installed in the office so no other data entry device would be required.

Sale Ring

At three sites with systems after the sale ring and one system prior to the sale ring, no additional data entry devices were required as data is entered with the sale program on the computer at the sale ring. When the system at the sale ring is not tied into sale software, devices must be able to withstand harsh environments and be in an area that does not impede process flow. At Ontario Stockyards, a Panasonic Tuff Notebook with a Windows operating system was used on a swinging stand to enter the data on lots coming into the scanning alley. These notebooks are $5,900, have touch screens and are built to withstand harsh environments.

Receiving

When data is entered at receiving there must be some structure to house the data entry device. In Phase One, monitoring booths were constructed to house the computers and the field research associate at a cost of $2,500.

Viewtrak recommends the use of a DT500 at receiving. This is an operating system encased in a stainless steel box with a touch screen. These devices are built to withstand harsh and abusive environments and are well suited for operating in the cold weather or hot dusty environments. However, these devices cost $7,900 and cannot be used with any other software so have no further functionality than data entry. Three of these devices were used in the project, two at an auction markets and the other at a buying station. In Phase Two, the DT500 did not outperform the thin client computers in any of the test sites.

Alternatively, a thin client (computer, monitor and keyboard with no functionality unless networked to a server) are only $700. A thin client must be in an enclosed environment such as a receiving booth, as it cannot be exposed to extreme temperatures or harsh environments. Thin clients were used in three test sites, two at auction markets and one at a buying station with good results.

In one buying station, it was most efficient to enter the data in the office as it had close proximity to the chutes. The existing computer system was used for data entry.

Wand

The long-handled Aleis wands have a built in device that holds up to 100,000 tag numbers. These can be transmitted to software provided by the vendor through a USB connection, or it can send the data via Bluetooth to a computer device within a 100-foot range. Although a laptop could be used at the entry point, no additional device is required. This device is applicable to smaller applications and is not likely suitable as a single installation in a medium or large volume market.

Table 11: Computer Hardware and Data Entry Devices

Item	Low cost	High Costs
Computer Server	Not required	$ 16,600
Linking computers and hardware	$ 1,000	$ 2,000
Network devices to link computers and hardware	$ 500	$ 1,500
Data Entry Devices	$ 700	$ 7,900

Software

RFID hardware has a data collection box (reader boxes) that records tag numbers from animals moving past the panels. However, software is required to transcribe those tag numbers into a format that can be submitted to the CLTS for movement reporting. There are many brands of software with varying levels of complexity on the market today.

Manifest Manager is software with basic functionality that was developed for Phase One by Viewtrak Technologies. It recorded the RFID numbers from the readers and created reports for movement reporting to the CLTS. The software was not linked with business software used by the test sites, nor did it offer any alignment with invoicing, inventory, age verification or purchasing records. However, it had a high ease of use, low cost, easy installation and low cost for integration with RFID hardware. This software was used at one site in Phase Two where the RFID alley was prior to the sale ring. It was found to be highly efficient, effective and easy to operate without any impairment on the speed of commerce. Software with basic functionality is also available from Integrated Traceability Solutions. The cost of this software is approximately $2,000 per license with an annual maintenance cost of $300 to $500.

An objective of Phase Two was to integrate the recording and reporting of tag numbers, read by the RFID hardware, with the existing business software. Viewtrak Technologies was the enterprise software provider in 12 of the 13 test sites. Viewtrak software is designed to be customized in each facility to align with a unique business process. As a result of individual customization at each facility, integration was difficult, since additional modules had to be customized to fit with the existing software. This added costs that were not anticipated in the original budget. Prices for auction market software modules ranged from $3,500 at receiving to $6,800 for integration with sale ring software. Gladstone and Winnipeg, using software at receiving, found there were too many mandatory fields. This made data entry cumbersome which resulted in a negative impact on the speed of commerce. In order to reduce the number of mandatory fields, the software was modified at a cost of over $3,000. Custom software was developed for the buying stations at a cost of almost $10,000 per facility. This software had a Windows interface and provided effective project reporting.

Each facility has customized their business software to achieve the functionality required by their specific business process. Four of the 10 auction markets required further customization of the software modules to support their business process, reduce the impact on speed of commerce and increase efficiency and effectiveness. The cost of the customization was, in some cases, more than the original module with a minimum of $2,100 and a maximum of $4,000. Any additional development to improve software functionality bears a significant cost.

As the software for auction markets was an add-on to the existing business software, the new modules were delivered and integrated electronically at a cost of $1,200. Any additional visit by a software vendor employee was billed at $1,200 per day plus travel. In all cases, travel for site visits is not included in the quotes.

If a wand is used as the RFID hardware device there are several options for software. In one test site, the wand was used prior to the sale ring and software was developed to link with the sale ring modules at a cost of $1,800. One buying station used the wand as an RFID collection device and the custom software that was developed for the project included functionality to support the collection of tags from the wand. There is also software available from the manufacturer for recording tag numbers from the wand at a cost of $2,000. The software provided by the vendor has functionality for age verification as well as creation of movement files for submission to the CLTS.

As noted in the section on vendor selection, markets were offered new software packages and refused the upgrade, choosing to stay with their existing vendor and add a module that supported the integration of the tag numbers. As such, new versions of full software packages were not employed in this test. Four software companies were consulted on the costs of new enterprise software: Viewtrak, Ag2Networks, Reference Systems and Integrated Traceability Solutions (ITS). ITS would not provide a quote for publication in this study. Full software package prices range $20,000 to $65,000 including installation and training, but not including travel. The functionality of each package varies dramatically and some software is better suited to installations at various locations in the process flow. The costs of the full enterprise systems are not included in the capital cost evaluations as it was not a factor in setting up a RFID system but rather a business decision.

Even with the installation of a module that expands an existing business software system, installation and training is critical to effective use. In this phase, the project manager did the training for the buying stations and the software vendor provided telephone support for the auction markets. Ontario Stockyards was provided with on-site training from their software vendor. In only one instance did a Viewtrak representative attended an auction market to provide on-site training.

Table 12: Software costs

Item	Low cost	High Costs
Software with basic functionality	$ 2,000	$ 2,000
Software modules linking to enterprise	$ 3,500	$ 7,000
Customization of software modules	$ 2,000	$ 4,000
Software installation	$ 500	$ 1,200
Wand	$ 1,800	$ 2,000

Evaluation of capital costs

In Phase Two, the total capital expenditure in auction markets ranged from $47,000 to $95,000. At the buying stations, each with multiple RFID hardware installations, the capital expenditures ranged from $47,000 to $118,000. The costs on Table 13 include three markets with new computer servers, unique requirements to support process flow such as crowding tubs and hydraulic gates, vendor travel for software installation, and the labour costs to build the alleys. These totals do not include the cost of project management, training/tech support or integration as those costs were in-kind contributions in Phase Two.

The cost of the RFID system **is not volume dependent,** what determines the cost of the total system is the extent of infrastructure changes required. Two markets with the same system located after the sale ring, Spiritwood and Saskatoon, small-and large-volume facilities, respectively, are evidence of the variance due to infrastructure. Spiritwood total costs exceeded Saskatoon by $5,700.This resulted from having a longer alley which required the removal of more pens. Ste Rose installed three systems at receiving a cost of $58,500, whereas the cost of one system in Winnipeg at receiving was over $95,000. Winnipeg had significant infrastructure costs as a result of removing numerous pens and replacing them with a 32-foot alley. In contrast, Ste Rose installed two single alley systems on loading chutes with minimal infrastructure changes required. The physical configuration at JGL, with the whole facility out of doors without a roof, required over $14,000 in electrical costs to dig out concrete and run the wires through underground conduits. The variance in prices is generally related to the amount of infrastructure and computer equipment required. Vendor travel costs will vary based on the number of technicians any one company has in the province.

Table 13: Actual capital expenditures by test site

CAPITAL EXPENDITURES BY SITE - Phase Two	
Large volume markets: Over 150,000 head	**Total cost of system**
Ontario Stockyards	$ 85,600
Saskatoon Livestock Sales	$ 64,900
Saskatoon: cost to equip for wand use	$ 15,700
Medium volume markets: 55,000-70,000	
Ste Rose Auction Market: multiple systems	$ 58,500
Winnipeg Livestock Sales *	$ 95,250
Whitewood Livestock Sales*	$ 83,500
Small volume markets: 30,000-48,000	
BC Livestock Sales	$ 52,200
Gladstone Auction Mart	$ 57,300
Killarney Auction Mart	$ 47,350
Spiritwood Auction Mart	$ 70,600
Buying Stations: multiple systems	
Cattlex	$ 46,800
JGL Livestock*	$ 118,400
McCall Livestock	$ 106,200

* New computer networks at these facilities

Capital cost factors to consider

- Dual, single and wide alley systems can be used in combination at receiving. These systems can utilize the same software and data collectors reducing the overall cost of a multiple system installation.
- Single alley systems on load-in chutes do not require extensive infrastructure modifications as the panels are placed on the side of the existing chute and alley construction is not required. The estimated cost for labour and materials is $2,500 per chute.
- The use of a wand at receiving does not require a special scanning alley, but does generally require a catwalk to access cattle from above and an area where the cattle can be contained. A skilled person is required to operate the wand, therefore increasing labour and training costs.
- Multiple systems that are not in close proximity require extensive costs to tie the systems together in order to utilize one central data entry device. At JGL Livestock the cost of running the electrical to tie four systems together was over $14,000.
- With systems prior to the sale ring, the process flow required extra equipment to ensure the cattle moved quickly through the system and into the sale ring. These specialty items were hydraulic gates and crowding tubs at a cost of $3,500 per item.
- Installations require a dedicated electrical line to each RFID hardware location.
- CAT5 cable should not be run more than 300 feet between the hardware and the computer to ensure that data will not be dropped; anything further requires a data booster.
- If a facility is outdoors, electrical lines and CAT5 cables should be run in a conduit underground.

Integration of hardware and software

Project Management

Each facility has a unique business process and flow; integrated systems require integrated business process. Successful RFID system installations ensure an integrated process is developed and aligned with business flow.

A project manager is a key factor in the design of the system and the successful coordination of construction, hardware and software installations. Hardware that is properly aligned with business flow but not properly aligned with the software process will impact speed of commerce and affect process efficiency and effectiveness. The project manager must be able to assess hardware and software requirements and understand process flow.

The project manager should oversee the construction of the alleys and market modifications. Many test sites constructed their own scanning alleys. A few did not follow manufacturers specifications resulting in the dimensions not being within the defined building specifications which ultimately caused read accuracy issues. Further, some facilities made modifications to alleys that were not conducive to the movement of cattle into the alley, such as placing a 5-foot system in a 12-foot alley without gradual tapering. A project manager, working with the individual facility, will ensure that all construction is built to specification using the proper materials and supporting cattle movement through the alley.

Integrated Traceability Solutions (ITS) includes project management, alley construction and software with their package pricing. It is expected that other hardware vendors will provide these services for a fee of 10 to15% of the hardware and software costs.

Training and integration

For sites that were provided with modules linked to pre-existing software systems, the training component was minimal. Most auction markets said that the staff picked up the process of tag capture quickly. The buying stations were supplied with software outside the normal operating system. These sites were trained by the project manager and again, the training required was minimal. It is suggested that sites anticipate training on software systems that relate only to the capture of RFID tags to be approximately two to four hours.

Hardware manufacturers include training on maintenance and support of the RFID hardware with the installation package. A typical training session would take approximately one hour. The test sites reported there was minimal time spent on technical support with the hardware vendors.

All test sites reported spending a significant amount of time on software technical support to address bugs and correct issues. Between September and February Viewtrak reports there were 210 calls to the support line with a total 250 hours spent on technical support during the test period. The greatest amount of time was invested by sites with new computer hardware with approximately 27 calls each. The range of time was a low of four hours to set up reports and systems to a high of 31 hours for evaluating process errors, hardware data transfer errors and software corrections. The sites anticipated that it required between 20 to 50 hours to train the staff, work out the issues and get the systems integrated to business operations.

Table 14: Summary of labour for integration

Item	Low cost	High cost
Project Management: % of hard costs	10%	15%
Software training	2 hours	4 hours
Training on RFID hardware	1 hour	2 hours
Training staff on integration with systems	20 hours	50 hours
Technical support with integrated software	4 hours	31 hours

Evaluation of capital set-up cost

This section summarizes the previous sections and descriptions of costs for the various components of an RFID system. The highs and lows are for **one RFID system** including hardware, software and installation based on the costs and labour hours documented in the 2009/2010 research.

Option One **Stand alone software with third party entering information by group**	**Option Two** **Integrated software with site personnel entering information by group**	**Option Three** **Stand alone software with once daily input of total head handled by site personnel**
RFID hardware located either at receiving or sale ring: single, wide or dual-lane scanning alley		
• Software to record and report tag numbers stands outside of business process • Information entry by a third party at the location of the system • No integration with enterprise software or operations processes	• Software that linked with enterprise software to record and report tag numbers • Information entry by site personnel at the location of the system • Integration with enterprise servers, software and operation processes	• Software to record and report tag numbers stands outside of business process • Daily total entered by site staff • Software reside on administrative computers • No integration with enterprise software and operation processes

Full description of the process with each option is described in the section Identification of Options for RFID Systems.

The high cost is based on full integration with the business process, the most expensive hardware (an eight-panel wide alley), the most expensive data entry device being the DT500, incurring travel costs for vendors, a monitoring booth at receiving, new computer servers, and a full spectrum electrical noise evaluation. The low cost is based on a single alley system with none of the extra's added.

With Option One, data is entered by a third party so there is no integration with the business process, therefore, no labour costs. As the software is not integrated with enterprise software, there is no need for an expensive DT500 where a simple laptop could be used. With Option Three, the software would be installed in the office without integration to the business software. There would be no need for additional data entry devices, a booth at receiving, new computer servers or travel costs for the software vendor to install and train. Due to the basic functionality of the software, training and tech support would be a maximum of eight hours and there would not be any labour costs for training on the integration with the business process.

The volume of cattle through the market will have a significant influence on the labour hours required. The following table itemizes the costs detailed in previous paragraphs and do not include sales taxes.

Table 15: Evaluation of capital costs

	OPTION ONE		OPTION TWO		OPTION THREE	
	High	**Low**	**High**	**Low**	**High**	**Low**
VENDOR SITE ASSESSMENT	**$ 2,500**	$ -	**$ 3,700**	**$ 2,000**	**$ 2,500**	$ -
VENDOR ELECTRICAL INTERFERENCE TESTING	**$ 10,000**		**$ 10,000**		**$ 10,000**	
CAPITAL COSTS						
RFID Hardware includes vendor travel	$ 50,500	$ 13,000	$ 50,500	$ 13,000	$ 50,500	$ 13,000
Infrastructure changes & alley construction	$ 16,000	$ 5,000	$ 16,000	$ 5,000	$ 16,000	$ 5,000
Linking computers and hardware	$ 1,500	$ 250	$ 3,500	$ 1,500	$ 2,500	$ 1,500
Data entry devices	$ 1,500	$ 1,500	$ 7,900	$ 700	not required	not required
Software modules including training and install	$ 2,000	$ 2,000	$ 8,000	$ 2,000	$ 2,000	$ 2,000
Subtotal	**$ 71,500**	**$ 21,750**	**$ 85,900**	**$ 22,200**	**$ 71,000**	**$ 21,500**
PROJECT MANAGEMENT	$ 7,150	$ 2,175	$ 8,590	$ 2,220	$ 7,100	$ 2,150
EQUIPMENT AND SOFTWARE TOTAL	**$ 91,150**	**$ 23,925**	**$ 108,190**	**$ 26,420**	**$ 90,600**	**$ 23,650**
Potential additional costs at all facilities						
Travel costs for software install and train	not required	not required	$ 2,500	$ -	not required	not required
Booth to house data entry device at receiving	$ 2,500	$ 2,500	$ 2,500	$ 2,500	not required	not required
New computer systems	not required	not required	$ 16,600	$ -	not required	not required
Labour costs						
27 hrs x $ 18: tech support and process integration * LOW	not required	not required		$ 486	not required	not required
86 hrs x $ 18: tech support and process integration * HIGH	not required	not required	$ 1,548		not required	not required
8 hours of training and tech support-basic software	$ 144	$ 144			$ 144	$ 144
TOTAL COSTS	**$ 93,794**	**$ 26,569**	**$ 131,338**	**$ 29,406**	**$ 90,744**	**$ 23,794**

*This is the cost per person. In some cases there may be numerous people required. The average wage will vary from province to province.

The high cost of one RFID system (hardware, software and data entry device) could be upward of $131,000 with the Option Two scenario. The lowest cost would be in Option Three at $23,794. It is evident that the integration with enterprise systems is a significant cost. The high cost of Option Three is over $40,500 less expensive than the high cost of Option Two. The more extensive the integration with the enterprise software, the higher the cost becomes. Another option not considered on the previous table is using a wand to scan cattle with the data linked into existing software at a system cost of $19,000. A single wand is not an applicable system for a medium or large volume facility. Further, the use of a wand requires a skilled person, therefore increasing labour costs. The extent of the RFID system is anything in between these two variables and must be

evaluated at each facility to determine highest and best fit. Multiple RFID systems are required in some facilities, the cost of which is not a multiple of the costs quoted here as many of these costs extrapolate across multiple systems.

The cost of a full software package is not included in this evaluation as it is not a necessary component of the RFID system. However, operators may choose to evaluate whether or not their software system will support any value added functionality that may result from having the tag numbers linked to systems.

Operating costs

Support and Maintenance: Hardware and software

In order to ensure the highest level of read accuracy, functionality and efficiency- the systems **must** be maintained on a regular basis. Software functionality improves with updates and telephone support provided to users.

Hardware

RFID hardware systems are installed with a one year warranty that provides parts, labour and travel to diagnose and resolve any deficient equipment or performance. Training of site personnel on system maintenance is generally included at installation. A baseline level of read accuracy should be established at the time of install and site personnel must perform regular testing of the system to ensure continuing levels of performance.

Even with a warranty, there are some cases where there are additional costs incurred to get the systems operating at acceptable performance levels. Two of the three vendors in this research indicated that they include the cost of travel when visiting a site for warranty work. Only Allflex charges the customer for travel on warranty work. Integrated Traceability Solutions installed an Aleis system with one wide and two single alleys at McCall Livestock in Ontario. Within weeks of the original installation the vendor was asked to revisit the site to determine the cause of low performance. It was determined the cause was electrical interference from overhead lights. The problem persisted and the project requested both the hardware and software vendors send technicians for an evaluation of the total system. The software technical support was billed at $1,300 plus travel; the hardware technician charged $1,500. The costs for three site visits by ITS and one by Viewtrak plus materials and labour to resolve the problem was almost $8,650 and the performance is still not to a level of other systems of this configuration.

System maintenance is required on a semi-annual basis to ensure proper synchronization of the panels, evaluation of any variance in frequency interference, updating reader software, tuning and general maintenance of the electrical connections and component parts. The cost of service agreements varies with the hardware vendor but will range from $2,500 for a basic maintenance package to $8,500 per year for a service and extended warranty package.

Software

The added annual cost to the vendor license, maintenance and support for new reporting and integration software is estimated to be between $500 and $1,100. The level of support required is directly related to the level of functionality in the software. This will be in addition to the existing support packages offered by the software vendors. At Cattlex, the office computer crashed and Viewtrak software needed to be reinstalled on another computer. Viewtrak charged $200 per hour for installation that took over six hours, but only billed the project $400.

Replacement reserve

The long-term cost for replacement of the systems must be accounted for, and is calculated in the annual operating costs as a replacement reserve.

The scanning alleys should not require extensive upgrading and maintenance if they were properly constructed and built to specifications. Continual use, with thousands of cattle moving through the alleys on an annual basis, will have some affect on the structure. It is estimated that annual maintenance to replace worn boards and tighten systems to ensure longevity of the alley will be $1,500.

The optimal life expectancy of the panels, readers and antenna is 10 years. This term is greatly affected by environmental conditions such as how well the components are protected from the elements, exposure to wide ranges of temperatures and moisture (leading to condensation and corrosion issues) and the volume of animals handled and number of days used throughout the year. Proper maintenance of the system will extend its life, but these are also electronic items and subject to obsolescence and diminishing functionality. Based on the conditions in Canada, with harsh winters and large volumes of cattle during the fall, it is suggested a functional life expectancy is five years.

Labour to manage an integrated system

Ontario Stockyards

It was noted that in order for the systems to operate effectively, regardless of the location in the facility, a dedicated person is required. The importance of maintenance and continual evaluation of the hardware is critical to high read accuracy. One individual should be appointed to maintain the system, manage the reporting, perform ongoing evaluation of the read accuracy and work with the software and hardware vendors if something is not working. This is a semi skilled position as it requires some computer literacy and interest in the systems. System maintenance is required to extend the life expectancy of the equipment; this includes keeping it clean, inspecting for minor damage and periodic inspection of cables and cable ends. Read range testing must be performed each scanning day to evaluate the efficiency of the panels. The readers should be rebooted daily and read range tested prior to each day of scanning. Daily maintenance of the RFID system is estimated at 15 to 30 minutes per scanning day. It is anticipated this person will spend one hour per scanning day working with the systems and the reports. This labour component is applicable to all three options. It was evident from the experience at Ste Rose Auction Markets that without attention to read accuracy reporting, there can be problems that go undetected. At this facility, the first 11 weeks had low reads of 78%, the direct result of one system not scanning at all. The vendor attended the site and rectified the problem. The last 13 weeks have had a read accuracy of 96.5%. If there had not been a dedicated person evaluating the read accuracy reports, the global reads would have continued to be exceptionally low.

For Option One and Two, with the systems at receiving and the entrance to the sale ring, a person is required to enter data to the software. This position requires some training and is often compensated at a higher level than others. It is estimated data entry will take an average of six hours out of the 10-hour work day. Systems after the sale ring generally do not require additional personnel to support cattle flow or data entry.

Phase Two noted extended work days for personnel with systems at receiving as a result of sorting lots by consigner and data entry to the integrated software. It is estimated the extra time on receiving day was one to three hours per person during fall run. Estimating four persons affected by the extra time at $15 per hour, the cost to the auction market could range $60 to $180 per receiving day. Further is the requirement for additional part time staff to help facilitate cattle movement through the alleys at receiving as a result of fewer lanes to pen the cattle through. Submission of the movement file to the CLTS takes approximately five to 15 minutes per report. Correction of errors and resubmission can take another ½ hour if errors occur.

Evaluation of operating costs

The following table shows the high end of quotes received for each aspect of annual operating costs as described in the previous sections. The variance between Option One and Three with basic software functionality and Option Two with full software integration with enterprise systems is the cost of the annual software support. It is estimated that the lower fees for license, maintenance and support would reduce annual operating costs by $600. With all the options, the same RFID hardware is installed and it is only the software and the data entry device that change. As such, the support and maintenance costs of the systems are the same regardless of volumes handled by a facility.

The only component of the RFID system that has a capital reserve is the RFID hardware. This is due to the other components, such as the alley, only requiring annual maintenance and not full replacement. Costs for infrastructure modification are sunk costs required at the initial installation and not required again over the life of the system. The capital replacement is based on a five-year life expectancy of the technology for the RFID hardware. Although the vendors suggest the panels will last up to 10 years, technology changes will make the systems obsolete within five years. This was evidenced at both Kamloops and Ottawa with the three-year-old system performance in comparison to the new systems installed in Phase Two. The software annual license, maintenance and support fee should cover software upgrades.

Table 16: Evaluation of operating costs without labour

ANNUAL OPERATING COSTS per facility	**Option One** Stand alone software with third party entering information by group	**Option Two** Integrated software with site personnel entering information by group	**Option Three** Stand alone software with once daily input of total head handled by site personnel
SUPPORT AND MAINTENANCE COSTS			
Hardware: Warranty and service agreements	$ 8,500	$ 8,500	$ 8,500
Service/repair costs for hardware -software	$ 5,000	$ 5,000	$ 5,000
Software: Additional license, maintenance and support	$ 500	$ 1,100	$ 500
Service and repair on alleys	$ 1,500	$ 1,500	$ 1,500
	$ 15,500	**$ 16,100**	**$ 15,500**
ADMINISTRATIVE COSTS: Insurance and one day of personnel training	**$ 644**	**$ 644**	**$ 644**
CAPITAL REPLACEMENT RESERVE: Hardware and alley	**$ 10,800**	**$ 10,800**	**$ 10,800**
	$ 26,944	**$ 27,544**	**$ 26,944**

In Phase Two, costs were incurred that were not budgeted such as: costs of almost $8,650 for site visits to evaluate and modify overhead lighting in order to assist with read accuracy; and Viewtrack Technologies charging for every modification such as: updating the movement files to reduce errors at a cost of $4,200, an hourly cost of $200 to reinstall software on a computer that had crashed, and changing reporting notifications at a cost of $1,400. Other extraordinary expenses may include replacing panels that are not under warranty as a result of breakage due to animal behavior or accident. Even with warranties, there can be extra costs as Allflex charges customers for travel to complete warranty work. It is difficult to evaluate the extent each facility will experience some of these events, so a contingency of $5,000 per site has been included in the annual operating cost evaluation.

The variable factor is the internal labour costs for operating the systems on scanning days. Depending on the location in the facility, the scanning day will be either receiving or sale days. Systems at receiving have a higher cost than at the sale ring due to labour to assist with cattle movement through the alleys, additional time required during the day for all staff when the system is integrated with the enterprise software, and they will also scan cattle for a few hours on sale day. There are a few instances that are not included in this analysis; auction markets often hold cattle in-transit and these should also be scanned for proper traceability. These events are not calculated in the analysis below as they are not full scanning days. Even though the systems were installed at receiving at buying stations, the test sites did not identify the need for additional time or personnel because of the RFID systems. The number of scanning days used in the following table is based in the number of days the scanning system would be used in the test sites.

Table 17: Scanning days by volume

NUMBER OF SCANNING DAYS PER VOLUME	LOW # DAYS	HIGH # DAYS
Large volume auction markets	150	160
Medium volume auction markets	60	70
Small volume auction markets	45	55
Buying stations	300	350

Table 18: Labour and operating costs at Sale Ring

LABOUR COSTS PER SCANNING DAY: AT SALE RING	Option One	Option Two	Option Three
Labour for one dedicated person to support system @ $18/ 1 hours per day	$ 18	$ 18	$ 18
Labour for one individual to enter data @ $ 18/6 hours	$ 108	$ 108	not required
	$ 126	**$ 126**	**$ 18**

ANNUAL OPERATING COSTS NOT INCLUDING LABOUR	Option one		Option Two		Option Three	
	Low	High	Low	High	Low	High
	$ 26,944	**$ 26,994**	**$ 27,544**	**$ 27,544**	**$ 26,944**	**$ 26,944**
LABOUR COSTS TO OPERATE SYSTEMS: AT SALE RING						
Large volume auction markets	$ 18,900	$ 20,160	$ 18,900	$ 20,160	$ 2,700	$ 2,880
Medium volume auction markets	$ 7,560	$ 8,820	$ 7,560	$ 8,820	$ 1,080	$ 1,260
Small volume auction markets	$ 5,670	$ 6,930	$ 5,670	$ 6,930	$ 810	$ 990
TOTAL OPERATING COSTS AT SALE RING						
Large volume auction markets	**$ 45,844**	**$ 47,154**	**$ 46,444**	**$ 47,704**	**$ 29,644**	**$ 29,824**
Medium volume auction markets	**$ 34,504**	**$ 35,814**	**$ 35,104**	**$ 36,364**	**$ 28,024**	**$ 28,204**
Small volume auction markets	**$ 32,614**	**$ 33,924**	**$ 33,214**	**$ 34,474**	**$ 27,754**	**$ 27,934**

In all cases, Option Three is the least cost alternative as a result of the lower labour costs for data entry. The variance between Option Two and Three in a high volume large market is over $17,000 annually as a result of not having to have a person entering data per group as is required in Option One and Two. With Option Three, the only labour requirement is a trained person to maintain and support the RFID system for each scanning day. Although some days will only require 15 minutes to do read range tests and tuning, other days will require several hours of interaction with the vendors to resolve read accuracy issues.

Table 19: Labour and operating costs at receiving

LABOUR COSTS- PER SCANNING DAY AT RECEIVING	Option One	Option Two	Option Three
Labour for one individual to enter data @ $18/6 hours	$ 108	$ 108	not required
Labour for one dedicated person to support system @ $18/ 1 hours per day	$ 18	$ 18	$ 18
Additional labour hours per day: all staff 4 persons X 2 hours $15	not required	$ 120	not required
Labour for one part time person to assist with cattle movement 6 hours X $ 15	$ 90	$ 90	$ 90
Labour for scanning on sale day 3 hours X $18	$ 54	$ 54	$ 54
	$ 270	**$ 390**	**$ 162**

ANNUAL OPERATING COSTS: AT RECEIVING	Option One		Option Two		Option Three	
	Low	High	Low	High	Low	High
OPERATING COSTS: AT RECEIVING	**$ 26,944**	**$ 26,994**	**$ 27,544**	**$ 27,544**	**$ 26,944**	**$ 26,944**
LABOUR COSTS TO OPERATE SYSTEMS : AT RECEIVING						
Large volume auction markets	$ 40,500	$ 43,200	$ 58,500	$ 62,400	$ 24,300	$ 25,920
Medium volume auction markets	$ 16,200	$ 18,900	$ 23,400	$ 27,300	$ 9,720	$ 11,340
Small volume auction markets	$ 12,150	$ 14,850	$ 17,550	$ 21,450	$ 7,290	$ 8,910
TOTAL OPERATING COST AT RECEIVING						
Large volume auction markets	**$ 67,444**	**$ 70,194**	**$ 86,044**	**$ 89,944**	**$ 51,244**	**$ 52,864**
Medium volume auction markets	**$ 43,144**	**$ 45,894**	**$ 50,944**	**$ 54,844**	**$ 36,664**	**$ 38,284**
Small volume auction markets	**$ 39,094**	**$ 41,844**	**$ 45,094**	**$ 48,994**	**$ 34,234**	**$ 35,854**

The systems at receiving require additional personnel to move cattle through the alleys. These facilities have the ongoing maintenance and support costs as well as addition costs to facilitate cattle flow. In Phase Two/Option Two, an extra 1.5 hours was added to the work day as a result of having to sort cattle into individual consigner groups and enter the data at the receiving gate. Option Three is the lowest cost alternative, by over $37,000 at high volume in large markets, as a result of the reduced labour costs on scanning days to sort cattle and the elimination of one person for data entry.

Table 20: Labour and operating costs at Buying Stations

LABOUR COSTS PER SCANNING DAY AT BUYING STATIONS	Option One	Option Two	Option Three
Labour for one individual to enter data @ $ 18/6 hours	$ 108	$ 108	not required
Labour for one dedicated person to support system @ $ 18/ 1 hours per day	$ 18	$ 18	$ 18
	$ 126	**$ 126**	**$ 18**

ANNUAL OPERATING COSTS: BUYING STATIONS	Option one		Option Two		Option Three	
	Low	High	Low	High	Low	High
OPERATING COSTS	**$ 26,944**	**$ 26,994**	**$ 27,544**	**$ 27,544**	**$ 26,944**	**$ 26,944**
LABOUR COSTS TO OPERATE SYSTEMS	$ 37,800	$ 44,100	$ 37,800	$ 44,100	$ 5,400	$ 6,300
	$ 64,744	**$ 71,094**	**$ 65,344**	**$ 71,644**	**$ 32,344**	**$ 33,244**

The number of hours in a scanning day at buying stations varies dramatically from week to week. As an average, it was estimated that data would be entered for six hours per day. This could be lower if the data is entered by office personnel and not entered by individual group. The buying stations in the research study did not indicate the need for additional personnel to facilitate cattle movement. This may be due to having multiple systems installed primarily on loading chutes so there was no change to the loading or unloading process. As with the auction markets, the lowest cost alternative is Option Three, by over $38,000 in high volume times, due to elimination of personnel for data entry.

Summary of costs

Estimating industry costs for compliance is difficult as the requirements have not yet been clearly defined. This cost evaluation is based on one RFID system per facility. It assumes one movement event per facility and the ability to submit daily totals rather than by individual consigner.

Option Two has projected capital costs as high as $131,338 for a wide alley system at receiving; requiring a new computer system to network the hardware and software and using a DT500 for data entry. The low cost in option two could be almost $102,000 less at $29,406 for a single alley system located on receiving chutes. There is little variance between Option One and Three capital expenditures with a high of $93,794 for a wide alley system at receiving and $23,794 for a single alley on a receiving chutes. The only variance is the data entry device where in Option One there is a thin client or laptop at receiving requiring a receiving booth, and Option Three uses office computers.

Annual operating costs vary with the volume at a facility and the number of scanning days. The labour component is the critical factor that varies between options and market volumes. With all options, systems at receiving have a significantly higher annual operating cost as a result of additional personnel to facilitate cattle movement. Annual costs at receiving could be as high as $90,000 or as low as $36,000. Annual costs for systems at the sale ring could be as high as $48,000 or as low as $28,000. Option One costs are higher than Option Three as a result of having a dedicated person entering the data. Buying stations have higher operating costs than auction markets with systems at the sale ring, but lower costs then auction markets with systems at receiving. Annual costs at buying stations can be as high as $72,000 or as low as $33,000.

In the evaluation of capital and ongoing annual costs, Option Three with basic functionality stand alone software that was not integrated with enterprise software, was clearly the least expensive option. Although the tag numbers would not be linked to the buyer or consigner invoicing, traceability could still be supported at a low cost to the auction markets and buying stations. Option Three provides further benefits through a decreased reliance on labour, and in turn, lower stress on personnel, reduced recruiting and retention issues and fewer hours in the work day.

SUMMARY OF ANALYSIS

The research project identified that there are options for configuring RFID systems at auction markets and buying stations across Canada based on the type of software used to record and report tag numbers. Option one reflects the processes used in Phase One, Option Two reflects the process from Phase Two and Option Three reflects of hybrid of both phases. See the previous section Identification of Options for RFID Systems, pages 13 for full description of the business process for each option. The options were evaluated using the following metrics related to business process efficiency and effectiveness:

1. Speed of commerce (efficiency)
2. Weekly and global read accuracy (effectiveness)
3. Software efficiency and effectiveness
4. Identification of business value creation at the operational level (efficiency)
5. Employee and animal health and safety (effectiveness)
6. Capital and ongoing annual costs

Option One **Stand alone software, third party data entry**	**Option Two** **Software integrated with enterprise software, data entry by site personnel**	**Option Three** **Stand alone software, data entry by site personnel**
RFID hardware located either at receiving or sale ring: single, wide or dual-lane scanning alley		
Stand alone software with third party data entry	Integrated software with data entry by site personnel	Stand alone software with data entry by site personnel
• Software to record and report tag numbers stands outside of business process • Data entry by a third party at the location of the system • No integration with enterprise software or operations processes	• Software that linked with enterprise software to record and report tag numbers • Data entry by site personnel at the location of the system • Integration with enterprise servers, software and operation processes	• Software to record and report tag numbers stands outside of business process • Data entry by site personnel in the administration office • No integration with enterprise software and operation processes
Software creates a report showing read accuracy for that scanning day and a converting spreadsheet data file (.csv) configured in the proper format for a movement file for submission to the CLTS.		
The movement file is submitted to the CLTS		

Hardware: Speed of commerce

In all three options, the same RFID hardware is installed. A site assessment is critical to ensure that the system is aligned with business process in order to minimize the impact on process flow. Phase One was the proof of concept on hardware and the key findings were as follows:

1. Wide alley systems installed both before and after the sale ring had the least impact on speed of commerce with little to no time added to the time to sell and process one lot. Systems prior to the sale ring required no additional time, and systems after the sale ring could add up to 14 minutes to a sale as a result of cattle backing up into the ring on large lots.
2. Systems at receiving, both dual and wide alley, experienced the greatest impact on speed of commerce with an impact of between four to six minutes per group or one to two hours per scanning day for receiving and penning cattle as a result of moving all the cattle through one alley versus numerous lanes and the extra movement required to bring the cattle through the scanners and then back to the penning sites (as in Winnipeg).
3. The buying stations, with multiple systems at receiving did not find an impact on the speed of commerce to load in or out and process the cattle. Because there were scanning alleys on every intake chute, there was no need to funnel all the cattle through one area. Further, because the scanning alleys were attached to the chutes, no additional cattle movement was required.

Many auction markets have several receiving areas and reducing intake to one area affects speed of commerce, as was noted at Gladstone. Many of the ground loading trailers carry cattle from multiple owners. Sorting these cattle by owner to enable software data entry by individual consigner creates a time delay and presents a potential threat to employee safety as the receiving area was not designed for sorting cattle. At buying stations, a higher percentage of cattle arrive on semi trailers versus ground loading trailers so the issue of mixed loads is not as prevalent.

Process efficiency

1. Systems installed at receiving generally require additional staff to help move the cattle through the scanning alleys.
2. Markets with systems at receiving have reduced process flow as a result of moving the cattle through only one lane for scanning versus multiple lanes.
3. Advantages and disadvantages of the various alley configurations include:
    i. Single alley systems are highly effective when installed in an area where cattle are already moving in single file, such as on loading chutes. These systems generally have a high read accuracy. However, the width of a loading chute is generally over 40 inches, and the best width for single alley read accuracy is 32 inches.
    ii. Dual alley systems process higher volumes than the single alley, but may restrict cattle at peak processing times. These systems have a slightly lower read accuracy than the single alleys.
    iii. Wide alley systems (both four and eight panel) did not impede the flow of cattle in any environments where they were tested. The read accuracy on these systems was more variable than the other systems tested with high accuracy in smaller groups of one to five animals.
    iv. Pen scanning using a long-handled wand: Although this has a high read accuracy, it is highly labour intensive and therefore costly to operate. Further, the infrastructure required is a catwalk for access to the cattle from above, and an area where the cattle can be contained as it is not efficient to scan cattle that are moving.

Software: Speed of Commerce

With Option One and Three, there was no impact on speed of commerce as the software stands outside of the enterprise software. As such, the business process is not affected by entering the data and recording the tag numbers. This was the case in two of the buying stations where the data was not entered with each draft as well as the Killarney Auction Market where the total head count for the day was calculated on software with basic functionality. With Option Two, the integration of the software with the business process had a negative affect on the speed of commerce. The extent to which the data entry affected the business process was relative to the location of the system.

Systems at auction market receiving

- The impact at receiving was greater than at the sale ring as a result of entering the data into the software prior to allowing the next group to unload, the need for a trained individuals to operate the computer and the time required to sort ground loading trailers with multiple owners.
- The impact on speed to unload and pen cattle increased by between 30 seconds to five minutes per load. Adding up to two hours per receiving day

Systems after the auction market sale ring

- The impact after the sale ring was experienced through the need for trained personnel and the extra time to sell larger groups.
- The time to sell and pen one lot increased by between 30 seconds to one minute, for a maximum impact of 10 minutes per sale when selling show pen (large groups) of cattle.

Systems before the auction market sale ring

- The time to sell one draft of cattle was not impeded at Cookstown but there was a need for a well trained, computer competent person to operate the software.
- In Killarney, capturing the tag number in the sale ring created a delay in the time to sell one draft by up to 20 seconds, almost doubling the normal sales process time.

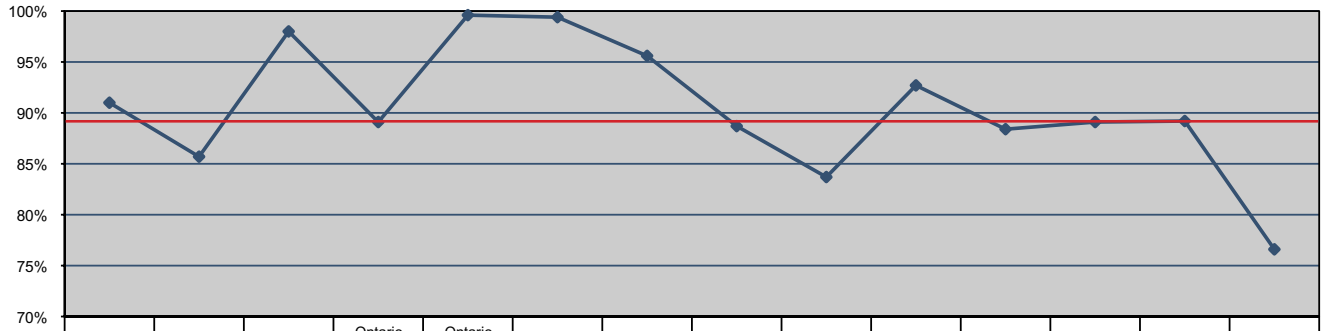
Systems at buying stations at receiving

- The only impact on speed of commerce was when each group was entered as they were loaded, taking 10 to 20 minutes per load. On groups that were entered when time allowed, facilitated through a buffer system in the software, there was no impact on the speed of commerce.

Read Accuracy

Phase One showed a global read accuracy of 93%, whereas Phase Two had a global read accuracy of 89%. Although the change at some test sites was marginal, others had a severe change in read accuracy. Gladstone dropped 7%, and it has yet to be determined if the problem is in the hardware, software or the manner in which the two communicate. As the chart below indicates, most test site had reads above the 89% global average. Three sites, Gladstone, McCall Livestock and Ste Rose brought the global average down with read rates of 85.7%, 76.6% and 83.7% respectively.

Chart 15: Read accuracy by test site in Phase Two



	BC Coop	Gladstone	Killarney	Ontario Stockyard	Ontario Stockyard*	Ottawa	Saskatoon	Spiritwood	Ste Rose	Whitewood	Winnipeg	Cattlex	JGL	McCall
Series1	91.0%	85.7%	98.0%	89.1%	99.6%	99.4%	95.6%	88.7%	83.7%	92.7%	88.4%	89.1%	89.2%	76.6%

* Ontario Stockyards use of long handled wand to individually scan Quebec/ATQ cattle

Software: Efficiency

The software was not effective as over 2% of the total tags were recorded as duplicates or invalid tag formats. The level of technical difficulties and technical errors encountered by sites in this test was substantial, with some spending up to 12 hours on technical support to sort out problems.

Training the market personnel to operate the software is another important factor. The test sites determined the level of competency to use the software was approximately 3.5 out of 5. In an industry plagued with staff shortages, it is a challenge to recruit people who are comfortable and competent using computers and able to handle cattle. Further, the data entry adds extra stress to an already busy position when at the sale ring.

Options One and Three do not require integration with enterprise systems and the software has basic functionality. Option three can be operated from the office computers. This reduces labour requirements, data entry errors and may increase accuracy of reporting. Both these options are deemed to be neutral in terms of software efficiency, having neither a positive or negative affect on business process.

Value Creation at an Operational Level

With the exception of the Ontario markets that sell Quebec cattle, in most cases, the sites were unable to identify an operational benefit to the business, the buyer or the consigner for the integration of the tag numbers with the business software.

A few sites perceived potential benefits from being able to identify cattle that have moved out of the selling group or if a back tag has fallen off. However, a common issue that detracted from value creation was that the data accuracy is not high enough to depend on. Further, a potential benefit was not met because the age verification numbers were low, at between 7.8% and 42.4% of all head scanned.

JGL Livestock noted in their comments, "we find value in the fact that our customers know we are concerned about the future of the cattle industry and that we are on the leading edge of any available systems or technology that is available. We also find value in the A/V (age verification) process as it pertains to tag numbers. We also believe that as industry goes forward this system will become of greater value."

Employee and animal health and safety

Although there were no employees injured during the project, each time animals have to be moved or sorted the risk of injury to human or animal increases. The systems had minimal affect on the overall health and safety of both employees and animals. No employees were injured as a result of operating the systems in Phase One or Phase Two. Animal health can be affected if large animals are moved through the narrow (single) alleys and become wedged. The narrow alleys can cause bruising on the animal's shoulders, ribs or hips. Employees are safer using cat walks down the sides of the alleys rather than following behind the animals inside the scanning alley.

In Phase Two, there was one additional factor of note: when consigner information is added to software at receiving, the groups had to be sorted into individual owners off the receiving trucks. The potential liability is created as the receiving area is not designed for this type of sorting. As such, employee safety may be at risk as a result of dealing with unruly animals in an area without proper design for safe handling for sorting animals.

Capital costs

There are three options available for the installation of RFID systems at auction markets and buying stations in Canada. In all cases, site assessments are critical to the success of the installation. If placed in the wrong location, the system will have a negative impact on the speed of commerce. A site installation should include electrical interference testing in the area chosen for the RFID system. If there is a severe problem with electrical interference from something such as overhead lighting, a full noise level test should be conducted. Although these are expensive, they are worth the investment to determine if there are structural issues that will affect the system's performance. If the facility is integrating the hardware with business software, as with Option Two, then a site visit by the software vendor is also critical. A proper assessment by a business analyst to evaluate how the software should link with the hardware will save time and money post installation.

The options for RFID hardware are numerous and are detailed in the Phase One research study. The highest cost is for a wide alley system placed at receiving. The lowest cost would be using a wand and a catwalk to scan cattle in a pre-existing enclosed area (such as a weigh scale) or a single alley on an intake chute. Multiple systems in a close proximity can take advantage of economies of scale, utilizing the same amount of labour, dedicated electrical lines and data entry devices. Three systems at the same facility are not three times the price.

The extent of software integration with enterprise systems is the determining factor for many costs such as: computer server, data entry devices, and level of functionality in the software. If a basic functionality is selected, as detailed in Option Three, the overall capital and operating costs are significantly lower than the other options. Choosing the right software and functionality at the outset is cost effective as any software changes can almost double the original cost. The extent of training required is contingent on the extent of changes to the business process.

Each facility has a unique business process and flow; integrated systems require integrated business process. Successful RFID system installations ensure an integrated process is developed and aligned with business flow. A project manager is a key factor in the successful coordination of construction, hardware and software installations. The integration challenges in Phase Two identified this important factor. Without a dedicated project manager on each installation, the effective integration of systems is far more difficult and time consuming.

Capital expenditures are highest with Option Two and lowest with Option Three. The variance between these two options for a high end system is over $40,500 as a result of hardware, computers and labour. An RFID system could cost as much as $131,338 on the high side or $23,794 for a basic system, depending on the hardware, location in the facility, data entry device and software.

The volume of cattle handled in a facility does not determine the cost of an RFID system. The largest volume facilities, JGL Livestock and Ontario Stockyards, had the highest system costs. However, Saskatoon Livestock Sales, another high volume facility, had a lower capital cost than two of the small facilities and three of the medium facilities. Cattlex has two scanning alleys and a wand with a catwalk yet the capital expenditures were lower than all the small volume auction markets with only one installation. Once again, this evaluation proves that the type of RFID installation is totally contingent on process flow and location within the facility.

Operating Costs

Fixed annual operating costs for maintenance and support do not vary dramatically between the three options. The only variable is the cost of software support. In order to continue with optimum read accuracy from the RFID panels, antenna and readers, a capital reserve replacement fund should be established to replace the hardware. A five year straight line replacement fund is recommended to ensure capital replacement costs are not a financial burden to the facilities.

The variable factor for calculating annual operating cost is the amount of labour and the number of scanning days per facility. Buying stations will operate the scanning systems between 300 and 350 days per year, whereas small auction markets may only operate the systems 45 to 55 sale days per year. With all options, there are labour costs for a dedicated person to maintain the system. For Option One and Two, a person is required for data entry. Facilities with systems at receiving have a higher labour component as a result of needing assistance with moving cattle through the alleys and scanning for a few hours on sale days. Total annual operating costs for a large volume auction market could run as high as $90,000 for systems at receiving employing Option Two, to as low as $30,000 for systems at the sale ring employed Option Three.

It is important to note that throughout the test, there were occasions where costs arose from technical difficulties with the hardware and software that were not budgeted for or covered under service agreements. These costs highlight the importance of allowing some variance in the total budget to cover costs that cannot be estimated when the total system is being quoted.

CONCLUSION

This multi-phase research study evaluated the impact of specific RFID systems at 13 test sites across Canada. With the regulatory framework still undefined, this study has shown that system design, technology and software may require modifications to align with compliance requirements when they are determined.

When evaluating a single movement report without consigner or group information, it is evident that Option Three, stand-alone software not integrated with enterprise software, has the least impact and least cost to industry. This alternative system would not provide any value add components, such as age verification on invoicing, as a result of not being linked to enterprise systems. Option Three would be the most efficient and effective method for sighted events at auction markets.

All 13 test sites have agreed to continue scanning cattle and reporting movement to the CLTS in support of traceability at the conclusion of the research project. Two of the test sites will continue to use the integrated hardware and software they used before the research project. The three buying stations will continue to use the hardware and software provided in Phase Two as it stands outside the business process. Seven of the auction markets have agreed to continue scanning, only if they are provided with software with basic functionality that does not integrate with business process and does not require data entry and tag capture by consigner or sales lot. Only one of the test sites will continue to use the integrated hardware and software provided in Phase Two. This is evidence of industry's desire to support traceability with an RFID system that has minimal impact on their business.

After two years of evaluating RFID hardware and software and scanning close to 550,000 head of cattle at 13 test sites, it is concluded that the technology is not to the level that will enable 100% read accuracy in any environment tested. It is recommended that this research project continue to monitor and report the impact on read accuracy through implementing Option Three at the six test sites that have agreed to continue scanning with this software.

> It must be noted that the process studied in this research report for scanning cattle and reporting movement is not the only process that exists. Other systems both in Canada and internationally have been implemented with great success and high read accuracy. These include systems in Quebec and Australia and a hybrid of all.

The next step is for industry and government to form a joint task force to move forward on some aspects of the NAFTS vision such as having an integrated, responsive system able to react to challenges and seize opportunities. Beyond that, NAFTS will be built upon national standards. It has been recognized that each sector and individual user of the system has unique risks and opportunities requiring a phased approach to implementation

PROJECT OBSERVATIONS AND RECOMMENDATIONS

This section discusses key observation and recommendations as observed by the Project Manager (PM) over the two years of managing this project.

Timing

The hardware in Phase One was installed in August of 2009 and did not interrupt process flow as it was down time for the auction markets. The integrated systems were installed during the fall run, from September to October of 2010. This created extensive challenges as the site personnel are exceptionally busy and therefore training and changes to business process was difficult and stressful. In interviews with the test sites, all agreed that changes to business process required by new software or hardware in a location that changes process flow, must take place in the off season.

Recommendation

- Installations should take place in May/June or December to mid-January.
- This will enable site personnel to have the time to fully train and get used to the process prior to busy season.
- If additional labour is necessary, there will be time to recruit and train new people.
- If there are technical issues with any of the hardware or software, the impact is not as great as during fall run and the sites have the time to investigate the cause.

RFID Systems

Hardware

In all cases, the hardware was installed prior to the software being ready for deployment. The hardware vendors were all very professional and installed the systems on time without requiring extensive follow-up. Each took ownership of the installation and ensured site requirements were managed in the most efficient manner (such as dedicated electrical lines and the construction of alleys). The hardware installation is the easy part of the RFID system integration. All the test sites noted that this was the most efficient part of the installation, with generally no problems or concerns. Only one system was delayed as a result of shipping from overseas.

Recommendation

- Site assessments are critical. Determine in advance if the hardware vendor is charging for the site assessment and what is included.
- Determine if there are service technicians in the province where the system is being installed. Travel is expensive if the technicians are required on site to correct read accuracy problems or fix the systems.
- The hardware vendor should participate in the construction of the scanning alley to ensure it is built to the proper specifications.
- The vendor should establish a baseline read range on all panels at installation and test the system for read accuracy.
- On-site read range testing on scanning days is critical to ongoing performance of the readers. If the read range drops, the vendor must be contacted to evaluate the cause and possibly visit the site to rectify the problem.
- It is important that all costs are clearly stated in the original quote, including freight and travel.
- Extended service contracts are recommended to ensure ongoing maintenance of the systems.

- Each site must get a clear explanation of the warranty and service agreements. Define if vendor travel is included in the service agreements. The responsibilities of the site must be clearly identified so as to not void the warranty.
- Clarity is required of vendor obligations and performance clauses in contracts; this leads to lower costs for repairs and changes.
- The four-panel Destron system worked just as effectively as the eight-panel system, with less cost and less space required for installation.

Software

In Phase One, recording tag numbers was done by a third party using custom designed test software. That process stood outside the business process and operating software was not affected. In Phase Two, the objectives were to integrate the hardware and the software into the business process. Two sites rejected the offer of new operating software because the change that would be required in business process, the learning curve was too steep, and each facility had customized their software to align with their business process. A change to all new software was too much of a change in operating procedure.

Two things have been noted repeatedly throughout this research:

1. No two facilities are the same, each has a unique process flow and design; and
2. Site assessments are critical to ensure that RFID hardware is installed in an area that fits with process flow. It was recognized in Phase Two that facilities have customized their business software to fit with their unique process flow. Just as there is no "one size fits all" hardware design, there is no such thing as a standard software module for any of the operating processes. Viewtrak Technologies is the leading software provider to the industry and their software is designed to be customized for each site. Four of the 10 sites required additional customization of the modules that were purchased for their sites which, in most cases, doubled the cost of the software module.

The site personnel took responsibility for entering the data that correlated with the consigner or sales lot, and the challenges faced by the test sites were numerous. They included:

1. Expertise on the software (previous version before the integration of the new modules) is essential to assist with ensuring that alignment with the other business functions. The test sites estimated the level of technical competency required to operate the software was an average of 3.5/5.
2. Recruiting personnel to work at auction markets is a challenge. Adding the requirement of personnel who are competent and comfortable with computers, accurate in keyboard skills to enter data, and accepting of new processes add to the recruiting challenge. Some markets have hired additional people to enter the data because the existing personnel did not have these capabilities.
3. Facilities with data entry at receiving had greater problems than those with the system at the sale ring. This was due to the yard staff generally being less comfortable computers. Taking on the responsibility of computer data entry was outside of their area of competency and added stress to the day.
4. Retaining personnel at these facilities is also a challenge. Once an individual is trained on the systems, retention is even more important as that is now a skilled position.
5. The test sites noted that the data entry by site personnel in auction markets, whether at the sale ring or at receiving, was an added stress in an already busy position.

Most of the test sites complained about the lack of training provided by Viewtrak Technologies. The software was deployed electronically and there was no in-person training. At one facility with the system at receiving, Viewtrak was asked to send a person to train the personnel on the new system. The cost to the project was over $1,200, plus travel. Although it wasn't an onerous task to learn the new tag capture software, time spent on technical support was extensive in some facilities due to numerous technical and process issues. In the words of one test site operator, "we have Viewtrak tech support on speed dial." It should be noted that the auction markets, where software modules were linked with their existing business software, were

more satisfied with Viewtrak technical support than the buying stations that had new software that wasn't linked to their enterprise systems. The PM trained the buying stations on the new software as there was no training provided by Viewtrak.

There was extensive data cleansing required in Phase Two and numerous data errors recorded in the CLTS. This was a result of the movement files not having any software rules to scan out the recording of duplicate tag numbers or numbers with invalid CCIA formats. The issue with numerous data errors is that the read accuracy became skewed, and the administrator required additional time to review the errors in the CLTS.

Recommendation

- Integrated systems require integrated process. Yard personnel must work with software and this is generally not their level of expertise or competency.
- If facilities choose to have software that links into their business software, a site assessment by the software vendor is critical. This will ensure the software is designed to maximize efficiency within the specific business process and will also save expensive software modifications at a later date.
- Sites must determine if there is any value to them employing software that integrates with their business systems. If they do not perceive a benefit, choose basic functionality software that is not linked with enterprise systems.
- Internet access from the data entry device is important to enable the transfer of movement files to the CLTS.
- Install the software on a data entry device that can be operated by a competent individual in an environment that doesn't restrict process flow (receiving booth, office computers).
- When purchasing the software to document and report the tag numbers, ensure that training is included and offered on the day the scanners are being used.
- Ensure there is training on the submission of the movement file to the CLTS.
- Purchase a technical support agreement with the software vendor to ensure that technical issues, bugs and processes are provided free of charge.
- The software for submission of tag numbers to the CLTS should scan out redundant tag numbers and formats that are not aligned with the approved CCIA tag number protocol.

Data Entry Devices

In order to record the tag numbers on software for movement reporting, a data entry device must be used. In Phase Two, there were several systems employed; some performed better than others.

The Panasonic Tough Notebook, at a cost of $5,900, was sold with the promise that it could withstand harsh environments. It did not perform well in a sustained cold environment and shut down during data entry at the sale ring.

The DT500 was deployed at two sites, at a cost of $7,900 each, with Viewtrak Technologies as the vendor. The drawback to the DT500 is that software has to be customized to run on its operating system. Changes to the software are very expensive, and the device cannot be used to run any other software. It did perform well in cold and harsh environments, but the cost/benefit was not favorable.

Thin client computers with monitors, at a cost of $700, were used at receiving. Viewtrak warned against their use because they do not deem these the proper equipment for the location. However, it was determined that these $700 devices performed just as well as the $7,900 DT500 and the $5,900 Panasonic laptop. The key factor to their use is being housed in a protected environment such as a heated receiving booth.

Recommendation

- Choose the right data entry device for the location and protect it from the elements as much as possible.
- If basic functionality software is chosen, it can be installed on an office computer and therefore no additional data entry devices are required.
- The data entry device housing the software should be connected to the internet for ease of transmission of the movement files to the CLTS, and to facilitate online software training and technical support.

Integration of hardware and software

Phase Two identified challenges of integration of software and hardware given the different parameters in each facility, the different nuances of the enterprise software and RFID hardware, and the challenge of tying everything together. The time required to project manage the installations in Phase Two was more than double that of the installations in Phase One.

The budget challenges in Phase Two were a result of linking the hardware with the data entry devices. Neither the hardware or software vendors took ownership of this piece of the integration. As such, when the quotes were obtained for the hardware and software there was no mention of the cost to link the hardware with the data entry devices. This required extensive CAT5 cabling, installed by qualified electricians, with the ends specifically configured to align with the data specification of the hardware and software. There was also a requirement for electronic hardware to link the cables and convert the signal; in most cases a digiboard was used. The challenge was presented when the hardware was already installed, the software was ready to be deployed, but there was no cable or network box to link the two together. The hardware and labour for this piece of the integration cost almost $2,000 per site. This had not been budgeted and required significant time and coordination on the part of the PM. Viewtrak Technologies offered to manage the integration at the cost of $15,000 for nine sites. That offer was rejected as too expensive with minimum value.

Another challenge with integrated systems is determining whether the cause of failure is the hardware or software. When the software stopped recording the tag numbers, the first call was generally to the software vendor. In some cases, the PM requested the hardware and software vendors both visit a site to determine the cause of low reads, since the failure point was not evident with simple testing.

Recommendation

- In most installations, a dedicated project manager will benefit the installation of the system as there are many pieces that must come together in a coordinated and functional manner to be successful. These installations are technical and sites are best served to have a dedicated resource to ensure the coordinated efforts of all parties. The project manager can be the hardware vendor or an outside party.
- The decision on both the hardware and software vendors must be made in advance of any installation.
- The hardware has to link into some kind of software to document the tag numbers and create a movement file. The software should be installed first and tested prior to the installation of the hardware.
- The hardware vendors should be made aware of the choice of software, the location, and the type of data entry device. Linking the hardware and software with cables, network boxes and adapters should be done by the hardware vendor, in consultation with the software vendor, and that cost should be included in the installation quote.
- The hardware/software combination should be tested before the hardware vendor leaves the installation.

RFID systems operation

The integration of the software and hardware did not provide any benefit to the facilities, so use and maintenance of the system is purely for compliance purposes. The test sites in this multi-phased research study must be commended for their dedication to working with the project to evaluate the impacts on their sites.

In Phase One there was a dedicated project resource at each site, recording data, evaluating read accuracy and working with hardware vendors to maximize read accuracy, daily testing of the systems read ranges to evaluate hardware reliability, and generally attempting to attain the highest read accuracy possible without manual interference of the scanning process. Phase One was a proof of concept; as such, it was important to understand the variables of the hardware in the environment in which it was placed.

In Phase Two, the site personnel took over accountability for monitoring and maintaining the systems. The problem with this approach is that the site personnel are already fully engaged with responsibilities of their own. The receiving staff during peak times and the ring clerks during the sale, have to deal with high levels of activity and processes to complete their tasks without impeding the speed of commerce. Adding extra responsibilities in an environment where the staff is already exceptionally busy, adds stress and reduces commitment to working with the system. The PM asked one ring clerk if read range testing was done prior to each sale, her response was "it only takes about five to 10 minutes to do the testing and record the information, but how many extra five to 10 minutes do I have for all of these little jobs that need to be done on sale day?" The integration of the RFID system into the business process will have more impact on some business processes than others, but all will experience some degree of change.

In two markets, the read accuracy dropped dramatically after installation. It was only through monitoring the read accuracy report that this problem was determined. Hardware vendors were called to the site, made adjustments and read accuracy increased by almost 20% as a result of the modifications to the RFID hardware. Had the reports not been monitored, the system would have continued with low read accuracy, reducing the information available for traceability.

Recommendation

- In order for RFID systems to be effective in support of traceability at auction market and buying stations, there must be a commitment from the site to ensure the systems are working at optimum efficiency.
- One or two people, per site, must be accountable for working with the RFID system to ensure optimum performance of the readers and the software. This would include a commitment to:
  - Be fully trained on the use of the readers and the software
  - Conduct daily read range testing on scanning days
  - Ensure the RFID hardware is functioning to the highest level and that the readers and alleys are well maintained
  - Report inaccurate reads to vendors and trouble shooting
  - Evaluate reports on read accuracy to determine trends
  - Monitor the hardware to improve read accuracy; may require tuning, software updates, rebooting the systems
  - Evaluate the RFID system integration with business process to determine if there are more effective methods to integrate the system, reducing the impact on business
  - Evaluate the use of the RFID system to determine if there are any benefits available to the facility in the use of the tag collection data
  - Advise the software vendor on more efficient data collection methodology

RFID systems and traceability

A limited window on industry compliance for the installation of RFID systems will create a bottleneck. It will be difficult to equip the entire industry in one year. RFID system installation requires extensive coordination, assessment and lead time on installations. A short-term ramp up for compliance could increase the price of hardware and software due to supply and demand.

The systems, both hardware and software, are not technically capable of achieving 100% accuracy, however they are capable of reading at approximately 90%.

Of the 13 test sites in Phase Two, all the sites agreed to continue to scan cattle in support of traceability showing the dedication the industry has to supporting traceability. In sum:

- The three buying stations will continue to use the hardware and software provided.
- Two of the auction markets had integrated systems and will continue with those systems.
- One auction market will continue with the hardware and software provided in Phase Two.
- Seven auction markets will continue with the hardware, but only if they are provided with software that has a basic functionally, not requiring input of data by consigner or sales lots.

APPENDIX ONE: EXECUTIVE SUMMARY PHASE ONE RESEARCH

Executive Summary

In July of 2009, the federal, provincial and territorial Ministers of Agriculture held a meeting at Niagara-on-the-Lake, Ontario and agreed that a national traceability system for livestock is critical for managing animal health and food safety as well as expanding market access and driving efficiencies. It was agreed that a mandatory national traceability system for livestock be in place by 2011. Key elements of a traceability system are animal identification, premises identification, and movement tracking. The third pillar of traceability, movement tracking, will require significant technological investment and infrastructure modifications.

This applied research project was funded through Agriculture and Agri-Food Canada, Growing Forward program, to research the impact of implementation of RFID systems at livestock auction markets in Canada in support of movement tracking.

The project installed eight new RFID systems from three manufacturers at both the receiving area and the sale ring (both before and after) and collected data from one pre-existing system. Custom software was developed for the test environment that collected the tag numbers from the RFID readers for data evaluation and submission of reports to the Canadian Livestock Tracking System (CLTS). The RFID system configurations were: single alley, dual alley and wide alley. Data was collected throughout eleven weeks from October 5 to December 20, 2009 from 144,197 head of cattle in 31,376 groups.

Impact on Business Process Efficiency, Effectiveness and Speed of Commerce

Every auction market has a unique design configuration and process flow. The design of the RFID system must also be unique and located in an area that is well integrated with normal process flow in order to be efficient. It was found that the location of the system had more impact on business process than the design of the system. An effective system must take into account animal behaviours, employee safety, group sizes, cattle breeds and temperaments.

Systems that were installed outside normal business process flow had a significant impact on speed of commerce as a result of increased movement and handling. The installations at the receiving area also created a few challenges. Most markets have more than one unloading area, as such, some cattle had to travel an additional distance through the market to the one RFID system for scanning. Even with a small increase in processing time per group, at peak times during the day the producer may have a longer wait to unload cattle. Although there was no benchmark to measure this wait, it is known to be a critical factor to the market. Any additional handling increases the impact on animal health/safety, shrink and employee safety. In markets with the system well integrated with business process and located at the receiving area, speed of commerce was affected in increments of seven to 10 minutes per some groups and a few minutes on others.

Installations at the sale ring (both before and after) had the least impact on process efficiency as the cattle must flow through to the sale ring whether before or after. Therefore, systems at this location are perfectly integrated with business process without any additional movement or handling. The only minor change in cattle movement was at one market that installed a long curved alley which had an impact of 14 minutes over an eight hour sale. It was also noted that when selling larger groups, all the cattle may not fit into the alley and therefore back up into the ring. This caused a few seconds delay in the time to sell one draft and may result in an additional two to six minutes for a four to nine hour sale. Further, this location processed a high percentage of cattle in smaller groups which scanned with higher read accuracy.

Identify the Positives and Constraints of Each RFID Scanning System and Evaluate the Ability to Achieve a High Level of Accuracy and Reliability. The Project Team Established a Benchmark of 95 Percent or Higher as a High Read Accuracy.

It was found that the effectiveness of the systems varied from week to week and market to market. The same technology would provide highly consistent read accuracy in one market, but inconsistent read accuracy in another. This may be a result of numerous factors including: electrical interference, tags or tag placement, animal behaviour and size of cattle. Market volumes, time of year and size of groups processed will have an impact on the advantages and disadvantages of the system.

Single alley systems

The two new single alley systems processed the least amount of cattle with only three percent (936) of the total groups and 12 percent (17,543) of the total head. This system configuration had the lowest variance of only three percent with weekly averages between 96 and 99 percent, and had the highest overall read accuracy of 97 percent. The system had relatively consistent reads throughout all group sizes as a result of the single file processing through the scanner alleys. However, the narrow alley contributed to a reduced flow of cattle at high processing times, impacting speed of commerce. This design had the highest impact on animal health and safety as the narrow width could lead to larger cattle getting stuck, bruising as they push up against the side walls, cow/calf pairs entering side-by-side and small calves attempting to enter the alley in a group.

Dual alley systems

The project installed one new dual alley system and collected data from an existing three year old system. These systems processed five percent (1,607) of the total groups and 15 percent (23,746) of the total head. The variation in group size read accuracy was five percent from a high of 93 percent and a low of 88 percent. There was no definitive pattern in the group size read accuracy. The weekly accuracy ranged from 86 percent to 93 percent with a total accuracy of 90 percent, which was the lowest overall reading in the project and the highest day over day variance of seven percent. As a dual alley system is two single alleys with a narrow island in the middle, these systems had the same impact on animal and employee health and safety as the single alley systems.

Wide alley

There were five wide alley systems installed that processed 72 percent of the cattle, almost three times more than the other two systems combined. The variation in group size accuracy was the highest at eight percent (88 to 96 percent) showing a definitive trend of higher accuracy in smaller groups. The smaller groups had a read accuracy of 96 percent (one to five cattle) and 93 percent (six to 10 cattle) which is important as four markets has systems at the sale ring which processes 95 percent of the cattle in groups under 10 head. As group size increased the read accuracy dropped. The week over week accuracy only had a four percent variance with all weeks except one being over 90 percent. These systems, with five feet wide alleys, had the least amount of impact on animal heath and safety as all sizes of cattle could comfortably move through the system two to three wide with minimum to no stress and bruising.

Table 21: Read accuracy results from Phase One

	GROUP SIZE ACCURACY					WEEKLY ACCURACY				GLOBAL ACCURACY	
	Low Read	High Read	Variance	# Groups	% of Total	Low Read	High Read	Variance	# Head	Average	% of Total
Single Alley	95%	98%	3%	936	3%	96%	99%	3%	17,543	97%	12%
Dual Alley	88%	93%	5%	1,607	5%	86%	93%	7%	23,746	90%	15%
Wide Alley	88%	96%	8%	28,833	92%	90%	94%	4%	102,908	93%	72%
At Receiving	88%	91%	3%	2,902	9%	88%	92%	4%	38,226	90%	26%
At Sale Ring	87%	95%	7%	27,538	86%	92%	95%	3%	88,428	93%	62%
Other locations*	95%	98%	3%	936	3%	96%	99%	3%	17,543	97%	12%
TOTALS	**90%**	**95%**	**5%**	**31,736**	**100%**	**91%**	**94%**	**3%**	**144,197**	**93%**	**100%**

Identify the Business Case Regarding Feasibility and Cost/Benefit to Enable Traceability

This phase of the research project did not implement full commercial software or assess the viability of the computer networks at the auction markets to support integration of data collection from the RFID systems. Benefits of traceability need to be defined and assigned an economic valuation by government or industry agencies. As such, there is not sufficient cost data to support a full cost/benefit analysis at this time.

It was determined that there are approximately 150 auction markets in Canada that will require the installation of an RFID system. Based on the data from the research, it is suggested that all of the large volume markets and 90 percent of the medium volume markets would be best equipped with a wide alley system. 10 percent of the medium markets would be best supported with a dual alley system and the fifteen small markets could be accommodated with a single alley system. It was estimated that capital cost of the equipment would be $7,722,000 based on current market value of the hardware. Further, capital costs for infrastructure modifications, with 75 percent of the markets locating the system at the sale ring, is estimated to be another $860,000. The estimated total cost to equip the 150 auction markets in Canada, at this time with RFID system hardware, scanning alley construction and infrastructure changes is estimated to be $8,582,000.

It was determined that the auction markets will have additional operating costs as a result of implementation of RFID systems. These costs will result from administration and submission of the tag reporting to the CLTS, maintenance on the hardware and the likelihood of additional personnel. Total annual operating costs per market are estimated at $12,650. Extended warranty and maintenance agreements are recommended to ensure the equipment has the highest read accuracy. Two of the vendors provided estimates for these services at $6,500 annually for wide alley systems.

Annual operating costs for the industry, including maintenance and warranty, can be expected at almost $2.6 million. Approximately five million cattle were sold through auction markets in 2009. With operating costs and replacement of the electronic systems, the annualized cost per head equates to $0.51 not including capital expenditures, software or computer upgrades.

Delivers an Opinion on the Feasibility of the Existing Hardware/Software Supporting Full Traceability

It was determined that the RFID scanning hardware used in this test will provide a daily read accuracy between 86 and 99 percent. It is not reasonable to expect each system to perform at the same level of accuracy everyday, variances must be taken into account when determining an effective read accuracy rate for the industry. The global weekly read accuracy was 91 percent to 94 percent with an average of 93 percent. Based on the suggested configuration of systems in markets across Canada with 85 percent of the markets installing wide alley systems and 15 percent dual or single alley systems, the read accuracy rates would extrapolate to the same level as what was found in the test.

It must be noted that the systems tested were not able to reach, on a global average, this research target of 95 percent of the RFID tags. Any requirement for collection and reporting of RFID tags above the read accuracy documented in this research will impact auction markets speed of commerce and cost of labour to a level that may not be sustainable. This research is the basis by which industry and government can come to an agreement on an acceptable protocol for implementing and operating RFID systems at auction markets across Canada.

APPENDIX TWO: TECHNICAL DOCUMENTATION ON FACTORS THAT AFFECT TAG READS

Difference between HDX - FDX

The current standard for RFID in animals is ISO 11784/11785. ISO 11784 describes the code structure and content on transponders. Within the standard, there are two different technologies available: Half Duplex (HDX) and Full Duplex (FDX). Both protocols use a common carrier signal of 134.2 kHz to send data to the reader. HDX technology modulates the signal using Frequency Shift Keying (FSK). Digital information on the transponder is transmitted by changing frequency of the carrier wave. FDX technology uses Amplitude Shift Keying (FSK) where the amplitude of the carrier wave varies to communicate the digital information.

A common analogy compares HDX technology to a two-way radio conversation and FDX to a telephone conversation. Using a two-way radio, one party must listen whilst the other party speaks. In the telephone conversation, both parties can listen and both can speak simultaneously.

FDX transponders transmit their data to the reader as long as they are in the read field of the antenna. HDX transponders must recharge and wait until the reader is in listen-mode before the data can be received. FDX technology is a newer, faster technology whereas HDX technology tags have a longer read range for similar sized transponders.

Overview of Issues with Tag Reads

Tag Collision

Not all low frequency tags have anti-collision properties. Collision occurs when two or more transponders are in the same antenna read field. The reader has trouble discerning data from both tags. Depending on the rate of progression or movement within the field, one or both transponders may not communicate its unique identification data to the reader. Transponders with anti-collision properties are 'smarter' tags and communicate with the reader, taking turns sending their data so there is no collision. Although some low frequency tags have anti-collision capabilities, it is generally not used due to slower speeds of low frequency technology.

Orientation

Antennae on both transponders and readers radiate a uniquely shaped radio frequency (RF) field consistent with the design and shape parameters of the antennae. The shape of the field provides different areas of field strength which affects read range of the transponder. Aligning the antennae of both the transponder and the reader so they are in optimum orientation will give the maximum read range given the existing conditions. Moving the transponder to a non-optimum orientation will negatively affect the read range of the transponder in the field, and in some cases will reduce it to almost zero. Antennae design in reading systems can accentuate the orientation issue of transponders passing through the read field. Tags attached to animals are in constant motion and results in RF scanning systems giving inconsistent results with the same animal passing the same reader multiple times. Transponder orientation is difficult to control on the animal in motion. Superior antennae design can reduce the variability of orientation read issues in livestock systems.

What is Electrical Interference and How Does that Affect the Read Accuracy

RF interference is a critical parameter in the design and set up of animal RFID scanning systems. Electrical interference (RF noise) can be defined as unwanted radio frequency signals in a similar frequency spectrum reaching either the transponder or the reader antenna while the transponder is communicating with the reader. RF interference can reduce read range within the system to a point where it isn't functioning effectively. A number of factors that can affect read accuracy that are related to electrical interference or RF noise include: antenna size, antenna design as well as reader design and shielding. Common sources of RF noise can be CRT screens, overhead lighting systems, ballasts in fluorescent lights, electric motors, arc welding machines and switches. Reading systems should draw AC power directly from a panel box and should not be on a line with other electrical devices that can inject noise into the AC line where it can affect reader performance.

When tags and readers are communicating, noise can interfere or overwhelm the transponder communication preventing a successful read while the tag is in the read field. This missed read will negatively affect read accuracy.

APPENDIX THREE: SUMMARY FROM PHASE ONE ON THE IMPACT ON THE SPEED OF COMMERCE BY THE RFID HARDWARE

Summary of Business Process and Speed of Commerce

Introducing anything new into a business process will always require some modifications to the way things are done. In every market there were some adjustments made, from as small as the way a gate swung to as big as creating a new leg in the business process. In one market, having to find the most efficient place for the scanning alley actually led to an increased efficiency in the way the cattle moved to the auction ring. Yet in another, the RFID system created backlog, extra hours in the workday and frustration. Just as every auction market is unique, every business process will be affected in a different manner based on market volumes, time of year, size of groups and # of owners per group. The most important aspect of installing an RFID system is the decision on the location to integrate with normal process flow and business practice.

All of the markets with RFID systems at receiving had some affect on the speed of commerce as a result of taking longer to pen the cattle, ranging from two to three hours per day to a few minutes per group. On receiving days with high volumes, there was also increased wait time for producers unloading their cattle at peak times. The issue of shrink was a factor in all markets and more significantly in those with two receiving areas as there was only one RFID system, requiring the cattle to move through the market to be scanned. The financial impact was calculated to be between zero to $0.29 per head due to the requirement of additional man hours. When the process was aligned with business process, no additional man hours were added to the workday. The market with the existing system at the receiving area had hired one part-time person to assist with penning as a result of the bottle neck created by having all the cattle funnel through one area to pre-sale pens. Three advantages and six disadvantages were identified locating an RFID system at this location.

The research showed the systems located at the sale ring, either before or after, had the least impact on business process, shrink, and speed of commerce as well as the greatest number of advantages. The wide alley systems did not impede the small groups of one to five that are predominant at this location. The impact on speed of commerce was between zero to 14 minutes over a six to eight hour sale. There was no measurable financial impact or shrink on the cattle.

The disadvantages of a narrow alley, as are used in the dual and single alley systems, is the impact on bruising, the ability for two small calves to enter one alley and therefore miss one or both of those RFID tags and the possibility of larger cattle not being able to fit through. The single alley system was effective when aligned with business process and placed in a location that had an existing narrow alley, as was the case in the original configuration at the Killarney market. However, it was noted that the narrow alleys would be restrictive in locations requiring a high flow of large groups as in the case of at, or after, the sale ring. The dual alley system supported a high flow of cattle in large groups (Gladstone) as a result of the two lanes.

In each of the test markets, the yard personnel worked with the FRAs to identify methods to make the scanning alleys more efficient and the scanning process more effective. During this project, an FRA was at each site observing the cattle moving through the systems and using a laptop to monitor the read accuracy for research purposes. In an operating environment it is not reasonable, nor will it be necessary, to have a person at the scanning alley reading group accuracy. The FRAs were in contact with the vendors to discuss obvious read accuracy problems and were present when the vendors were on site doing maintenance. As a result, the FRAs learned to tune the systems and evaluate potential problems. The vendors supported the systems with many site visits for software upgrades, adjustments to the panels and recommendations for modifications. It is evident that the RFID systems will not operate at peak efficiency without some attention from personnel and an ongoing commitment from the vendors. Training will be required to keep the systems working at peak performance to ensure the highest level of read accuracy.

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Livestock Auction Markets and Buying Stations

BC Coop Livestock Sales - Tom Vickers
Cattlex Livestock - Andy Drake, Logan McGonigal
Gladstone Auction Mart - Dave Nickel and Gerald McGowan
JGL Livestock - Robin Gilroy, Scott Gilroy, Bill Jameson
Killarney Auction Mart - Scott Campbell
McCall Livestock - Lacey McCall, Ross McCall
Ontario Stockyards - Wayne and Sharon Small
Saskatoon Livestock Sales - Mike Fleury
Spiritwood Livestock Sales - Pat and Brian Jacobsen
Ste Rose Auction Mart - Myles Mason
Whitewood Livestock Sales - Rhett Parks
Winnipeg Livestock Sales - Scott Anderson

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