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.

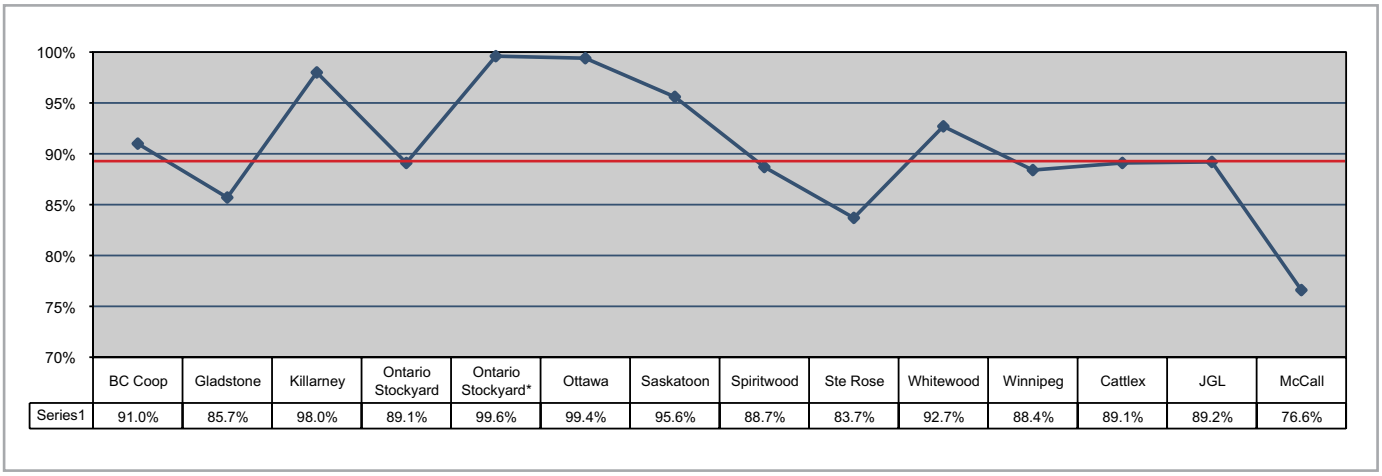
Option Three: Neutral

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.

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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REFERENCES

1. ***Agriculture and Agrifood Canada Website:*** *FPT MINISTERS OF AGRICULTURE TAKE ACTION TO STRENGTHEN SECTOR- NIAGARA-ON-THE-LAKE****, Ontario, July 10, 2009***
   http://www.agr.gc.ca/cb/index_e.php?s1=n&s2=2009&page=n90710a – Accessed April 2011

2. Government of Alberta Agriculture and Rural Development Website
   http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cpv8104 – Accessed on April 28, 2011.

3. Canadian Food Inspection Agency
   A Legislative and Regulatory Framework for Traceability - What It Means for Stakeholders - A Concept and Consultation Paper. June 2010.

4. Alberta Beef Producers: **Discussion on Traceability Issues October 2008**. Open letter to Cattle Producers of Alberta
   http://albertabeef.org.res/ABP%20Traceability%20Position%20final.pdf – Accessed March 2, 2010

5. R version 2.12.1. R Development Core Team (2010). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

6. Ontario Ministry of Agriculture Food and Rural Affairs **Reducing Cattle Shrink**;
   http://www.omafra.gov.on.ca/english/livestock/animalcare/facts/05-063.htm – Accessed March 2,2010

7. Canadian Cattle Identification Agency, National Applied Research Project: Study of RFID systems at livestock auction markets across Canada. Pg 56

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