National Applied Research Project:

Study of radio frequency identification systems at livestock auction markets across Canada

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Canadian Cattle Identification Agency

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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.

	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%**

* same as single alley

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.

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INTRODUCTION

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).

Animal identification is especially important for disease control when cattle from multiple premises come into contact or are commingled.[1] In order to achieve full movement tracking, the third pillar of traceability, it will require 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."[2] A nation wide initiative of this magnitude will have monumental impact on the industry. **"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."**[3] Government requirements must be based on an appropriate assessment of the costs and benefits associated with the collection of this information.[4]

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 market access and driving efficiencies. [5] It was agreed that a mandatory national traceability system for livestock be implemented by 2011. It is estimated that there are more than 150 auction marts and 170 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.

It has been well publicized that the Canadian beef industry suffered the loss of billions of dollars worth of export sales as a result of Bovine Spongiform Encephalopathy (BSE). 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. 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 essential factors to support full traceability in Canada: [6] A) information in the system is accurate and complete; and B) all identified livestock must be able to be located to a premises within 48 hours.

This national auction market applied research project installed, operated and tested numerous commercially available RFID reader technologies in multiple test sites across Canada. This research enabled a proper assessment of the challenges and cost of installing and operating RFID reader systems at auction markets as well as the preliminary assessment of the functionality of the technology to read and collect data from the RFID tags. The research has been funded through Agriculture and Agri-Food Canada through the Growing Forward Program.

PURPOSE OF THIS REPORT

This report details the findings of Phase One of the applied research project that took place in nine auction markets across four Canadian provinces. More than 145,000 head of cattle were scanned over 240 days in nine auction markets between October 1 and December 18, 2009.

OBJECTIVES OF THE RESEARCH

The purpose of this research was to identify the impact of implementing electronic RFID panel reader systems in operating auction markets to support traceability through animal movement.

A) Determine if RFID systems that are currently commercially available and functionally viable to support accurate and efficient RFID tag reads of cattle at auction market facilities. A target of 95 percent or higher was established for this research as a benchmark for high efficiency and accuracy by the project team. These systems were evaluated based on:

- The impact on business process efficiency and effectiveness
- The collection and dissemination of the RFID tag number to the CCIA database for movement reporting with a high level of accuracy and reliability
- The impact on the speed of commerce
- The impact on animal and employee health and safety

B) Identify the business case regarding feasibility and cost/benefit to industry and government for implementation of hardware and software to enable movement at the auction mart level as per the Canadian Cattle Industry's National Animal Movement Plan for the livestock marketing segment. The business case will:

- Deliver an opinion on the feasibility of the existing hardware/software supporting full traceability
- Identify the positives and constraints of each RFID scanning system
- Make recommendations for Phase Two of the applied research in regards to modifications to RFID systems to achieve maximum efficiency and accuracy

Assumptions and Constraints

1. This project makes the assumption that the technology and processes for the RFID tags and premises identification is widely used, accepted and in place.
2. The occurrences of poor retention and high failure rates of RFID tags provides a major constraint to RFID scanning.
3. Hardware/software must integrate with existing infrastructure: CCIA database, RFID tags, industry software.
4. Auction market participants must allow the project team full access to evaluate, renovate, install technology, and train staff. The project team must not interfere with the day to day operations at the markets.
5. There is a great degree of difference in the level of technology acceptance and integration within the auction markets.
6. Extensive metal in auction market facilities may impact the accuracy of the reader systems.

RESEARCH PROTOCOL

Auction Market Selection

The Livestock Markets Association of Canada (LMAC) sent a survey questionnaire to their members regarding business processes and use of technology. From those who responded, a second questionnaire was sent asking if they would be interested in becoming a test site. Based on a positive response, a short list was developed. The LMAC committee (Larry Witzel, Mike Fleury, Jim Wideman and Rick Wright) recommended sites based on a blend of small, medium and large markets; number of sales per week; annual volume; types of sales conducted; types of livestock sold; geographical location; type of facilities (modern or old, wood or steel); amount of existing technology; willingness to participate; and past experience with the owner/operators.

There was a total of nine sites that contributed data collection; eight markets had new RFID systems installed and one market had an existing system. This cross section enabled a broad spectrum of RFID system configurations and market conditions to be evaluated.

Ontario

LARGE VOLUME MARKET: Ontario Stockyards Inc., Cookstown, ON
MEDIUM VOLUME MARKET: Ottawa Livestock Exchange, Greely, ON

Manitoba

MEDIUM VOLUME MARKET: Ste Rose Auction Mart Ltd., Ste Rose du Lac, MB
SMALL VOLUME MARKET: Gladstone Auction Mart Ltd., Gladstone MB
MEDIUM VOLUME MARKET: Winnipeg Livestock Sales, Winnipeg, MB
SMALL VOLUME MARKET: Killarney Auction Mart, Killarney, MB

Saskatchewan

LARGE VOLUME MARKET: Saskatoon Livestock Sales, Saskatoon, SK
MEDIUM VOLUME MARKET: Whitewood Livestock Sales, Whitewood, SK
SMALL VOLUME MARKET: Spiritwood Livestock Sales, Spiritwood, SK

British Columbia

SMALL VOLUME MARKET: BC Coop Livestock Sales, Kamloops, BC

Data collection anomalies: Ontario Livestock Exchange in Waterloo, Ontario was originally selected to be part of the research project but due to technology issues, the data collected from the market was not integrated into these findings. Ottawa Livestock Exchange supported the data collection with weekly updates on total accuracy from their existing system. However, the Ottawa market did not have test software on-site so only the average accuracy is noted in the report findings.

Table 1: Summary of participating auction markets

Large volume markets 150,000 head per year	Medium volume markets 55,000 - 70,000 head per year	Small volume markets 30,000 - 48,000 head per year
Ontario Stockyards Inc.	Ste Rose Auction Mart Ltd.	Gladstone Auction Mart Ltd.
Saskatoon Livestock Sales	Winnipeg Livestock Sales	Killarney Auction Mart
	Whitewood Livestock Sales	Spiritwood Livestock Sales
		BC Coop Livestock Sales

Vendor Selection

Phase one of the applied research dealt with proof of concept; that the technology is commercially available for 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. The project was phased to ensure that the hardware configurations were operating at optimum level prior to the integration into business systems. The intent of the project was to evaluate as many configurations and types of systems possible. As such, all three types of systems- single alley, dual alley and wide alley – were incorporated into the project.

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:

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
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:

- **Destron Fearing**: Wide alley and dual alley
- **Allflex USA, Inc**: Single lane-two and four panel
- **Integrated Traceability Solutions (ITS) representing Aleis products**: Wide alley

The vendors were required to work with the project team to continually monitor, evaluate and make modifications to the systems to ensure the highest levels of accuracy and efficiency. The software used to collect and transfer RFID tag information was custom developed by Viewtrak Technologies Inc. to meet the specific needs of the research project.

Data Collection Methodology

At each test site an alley was constructed to which RFID panel antennas were installed (scanner alleys). As cattle move through the alley, the panel antenna reads the RFID tag number and transmits the data to a reader box. 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 running 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
5. Manifest Manager software created two files:
    a. A manifest list that detailed the group size and read rates which was used to evaluate the read accuracy for the markets overall
    b. A converting spreadsheet data file (.csv) configured in the proper format for a move in report (the software removed all redundant tag numbers)
6. The FRA sent the .csv file/move in report to the CLTS database via the internet.

Design of the RFID System

Choosing the best location for the installation of an RFID system can be challenging. Every auction market has different layout, construction and environmental conditions which can affect an RFID reader installation. The system must be designed to not interfere with the daily work at the livestock market.[7] The design must take into account the flow of cattle through the market, the volumes at the market, group sizes and the location for the system. Scanning alleys must be designed to accommodate a variety of animal behaviours, employee safety, group sizes, ages, breeds and temperament to ensure the highest read accuracy and the least impact on business. It is important to conduct site visits when evaluating the location and type of an RFID system to ensure all these factors are taken into account. Factors to consider when choosing the location for the RFID system:

1. The alley does not necessarily have to be covered but the reader boxes should be protected from the weather
2. The length of the scanning alley depends on the type of RFID reader system. It is important to have enough length before and after the alley to allow the cattle to funnel into and out of the system
3. A dedicated electrical line must run to the location of the RFID system to ensure there is no "noise" on the electric line that may interfere with the RFID readers
4. Should not be located in an area that requires the cattle to make a 90 degree turn into the alley
5. Should be constructed in an area where all the cattle move through in a normal business process flow
6. The location requires minimum infrastructure changes
7. Although not required, a covered alley decreases snow and ice build up inside the alley which can cause the cattle to slip

Infrastructure changes vary based on the location of the system. If pens are removed to install the alley, the costs for welding and labour can be much higher than if the system is installed within an existing alley. It is also critical that the scanning alley be built to the manufacturers specifications with the highest quality materials. The construction of the alley, based on plans provided by the vendors, is generally the responsibility of the market. In this project, some vendors prepackaged the alley system and installed it on-site. Other markets constructed their own alleys to specifications provided by the vendor. As a result, the cost and structural integrity of the alleys varies in each market.

Maintenance of the RFID Systems

The FRAs monitored the system and the read accuracy for inconsistency that may have been related to required maintenance. The vendors all provided telephone support and often the fix was as simple as turning the system off then on again to "reboot" the panels and clear the readers. On other occasions the vendors came to the site for maintenance and software upgrades. The equipment vendors are to be commended for their ongoing commitment of manpower, information and support for this project.

Integrated Traceability Solutions visited the markets with Aleis equipment three times over the course of the test to update system software, tune the systems and evaluate electrical interference. Compass Animal Health visited the sites with Destron equipment at least twice per site to evaluate and adjust panel height, electrical interference, and update system software. Allflex didn't visit the markets with their systems as there were no issues with the read accuracy.

The participation of the vendors in the first few months of the installation is critical to ensure the systems are located in an area with minimal electrical interference, the panel heights are correct for the size of cattle and the read accuracy is relatively consistent.

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.

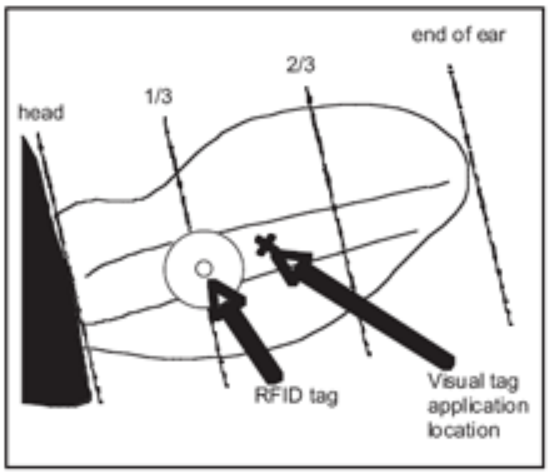
Overview of Issues with Tag Reads

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.

MARKET CONDITIONS

The research took place during the "fall run" of 2009 from October to December. The market conditions for the fall period were inconsistent with other years as it was one of the smallest fall volume seasons in recent history. Factors that influenced the unusual market conditions are as follows:

Volume of Cattle

Markets reported 20 to 50 percent fewer cattle delivered for sale depending on the area of the country. The drop was primarily a result of the contraction of the beef cow herd in Canada. Poor cattle prices since the BSE outbreak in 2003 along with high input costs have caused many producers to liquidate their herds and leave the business. With very few producers retaining heifers to breed, the basic cow herd has shrunk to the lowest inventory in the last 15 years.[8] Cattle numbers were down 1.3 percent compared to last year with beef cow inventory declining 1.4 percent. There were 20 thousand less beef heifers retained for breeding in 2009 and 160 thousand less than 2004.[8] The strong Canadian dollar and Country of Origin Labelling (COOL) deterred exports to the USA and put further pressure on the market prices and decreased deliveries.

Change in Sales Process

Marketers across the country, especially in the West, reported more producers selling direct to buying stations and feedlots in an effort to reduce expenses (commission, trucking and shrink). There was also an increase in sales through electronic means.

Weather

The fall weather in September and early October was unusual in comparison to a typical season which resulted in good pasture conditions. The bulk of the yearlings, off the grass, were sold prior to the research project. This is an important factor as these cattle are normally 800 to 1,000 pounds and are taller and larger framed than the calves that were processed in this research project. These pasture cattle are normally more wild than backgrounded cattle in the spring, thus moving faster and bunching up more at the chutes which could affect the read rates. Good pasture conditions kept the cow/calf pairs on pasture longer than normal as producers tried to put more weight on their calves in September and early October.

Typically, October has the largest volume for deliveries to the Manitoba and Saskatchewan markets. However, in 2009 the deliveries were reduced as a result of early winter like conditions in late October and early November. These are usually peak months for calf movement in Alberta. The weather in late November was exceptionally good, as winter conditions disappeared. Producers scrambled to complete fall work that was not completed in October and cattle movement was not a big priority. December was warmer than normal month with little snow in the first half of the month.

Summary

The volume of cattle at the auction markets during the research period was not typical. Industry suggests that there was an average of 30 percent less cattle sold by public auction in the fall of 2009 compared to 2008.

Weather conditions were drier and warmer than normal. There were very few days of extreme cold where the cattle were wet or covered in ice and snow. As such, the RFID systems were not tested in a long period of cold and wet that is typical of a Canadian fall.

READ ACCURACY

Protocol

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

> This data has been correlated and sorted from the manifest lists created by scanning RFID tags at the test auction markets in the research project. The data was received in the form of Excel spreadsheets. These were imported into a R statistical program.[9] Data was then validated with respect to consistency in terms of dates, etc. Comments were examined to assess the reasons for missed reads. The Spiritwood data provided some additional challenges since it did not provide information on the number of small groups. All data was then combined into a single file with information on the market, the date, the type and location of the system, the number of animals, the number read and the number of missed reads with and without identifiable cause. All further analyses were performed on subsets of this file.
>
> Analyses consisted primarily of computing appropriate averages for relevant subsets of the data. All weighted averages were calculated as the total number of animals scanned in the subset of interest divided by the total number of animals in the subset. Relevant subsets were: market, date (week), group size, type/location of system and manufacturer.

The data set includes the RFID tag scanning data from the eleven week test period (the first week in October to the third week in December). Anomalies in the data were dealt with to ensure data accuracy; obvious human error on data entry was deleted and double tags were adjusted back to 100 percent. The data was sorted into eight subsets of group sizes.

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.

Factors that affect the level of accuracy are: 1) human error entering the number of head in the group in the software; 2) cattle that aren't tagged; 3) dangle tags/bar code tags that do not have an RFID frequency; 4) early version of the software that did not record missed reads on single animals, which was adjusted six weeks into the project; 5) animal behaviour.

FRAs documented observable issues with tags. The number of observed incidents vary dramatically from day to day and market to market based solely on the observation by the FRA. The number of tags missed "with cause" cannot be statistically validated and therefore cannot be relied upon to present a valid picture of attainable read rate accuracy. Further study must be undertaken to assess the potential impact of the RFID tag on the failure of the RFID systems. The research study was performed for the following weeks:

Week	Date Range	Week	Date Range
1	Oct 5 - Oct 11	6	Nov 9 - Nov 15
2	Oct 12 - Oct 18	7	Nov 16 - Nov 22
3	Oct 19 - Oct 25	8	Nov 23 - Nov 29
4	Oct 26 - Nov 1	9	Nov 30 - Dec 6
5	Nov 2 - Nov 8	10	Dec 7 - Dec 13
		11	Dec 14 - Dec 20

Observable Causes of Misreads

FRAs were accountable for observing the cattle that moved through the scanner alleys to identify possible causes for missed reads of the RFID tags. There was a relative consensus among all markets as to the observable events:

1) Animal behaviour:
    a. With all systems, cattle running through the scanner alley at a fast pace reduces readability of the RFID tag.
    b. Shadows inside the alley, or bright sunshine at the end of an alley can spook the cattle and they won't move into the scanning alley.
    c. If the cattle are moving very quickly to the scanning alley entrance they may bunch up and back up prior to entering the alley.
    d. In a single and dual alley, it is important to keep them moving at a steady, quiet pace.
    e. In a wide alley with three cattle abreast at a fast pace reduced readability of the RFID tag.
    f. In wide alleys, the readability of an RFID tag improves with:
        i. Cattle that are penned in the alley for 5 - 20 seconds
        ii. The longer the cattle mill about in the scanning alley
        iii. Smaller groups, as a result of being able to move around
        iv. Room between the cattle versus cattle bunching together

2) Animal size:
    a. In a dual alley system, smaller animals were able to move through the alley side by side, therefore neither of the tags were read.
    b. Some systems were not designed for larger cattle as their heads were above the reader panels reducing the readability of the RFID tags.

3) Tags and tag placement:
    a. Tags placed too close to the base of the ear don't read as well because they are not in the correct orientation to the antenna for optimal read range.
    b. Defective tags simply didn't read or had to be moved in front of the panels several times to read.
    c. Bar coded tags do not have a radio frequency and cannot be read by RFID systems. These tags are still approved by CFIA and therefore will have an affect on read accuracy.

4) Cattle handling:
    a. Calm and steady movement of the cattle through the alleys is important.[10]
    b. Cooperation with the yard staff is critical for success.

5) Electrical interference:
    a. When the panel antenna is located close to the auction ring, the reads can be affected with the interference from the microphone, computers etc.
    b. Electrical appliances, motors, florescent lights and panel boxes can create/emit electrical noise which will interfere with the panels antennae and reduce the RFID systems ability to read the RFID tags.

IT MUST BE NOTED THAT THE READ ACCURACY RATE DOCUMENTED IN THIS RESEARCH IS THE PERCENTAGE THAT WOULD BE ACHIEVED IN AN OPERATING AUCTION MARKET IN THE CURRENT ENVIRONMENT. THERE WERE NO ADDITIONAL MEASURES TAKEN TO ENSURE THE READ OF THE RFID TAG AS THE CATTLE MOVED THROUGH THE SYSTEM.

EVALUATION OF SINGLE ALLEY SYSTEMS

Killarney Auction Market

Small Volume Market

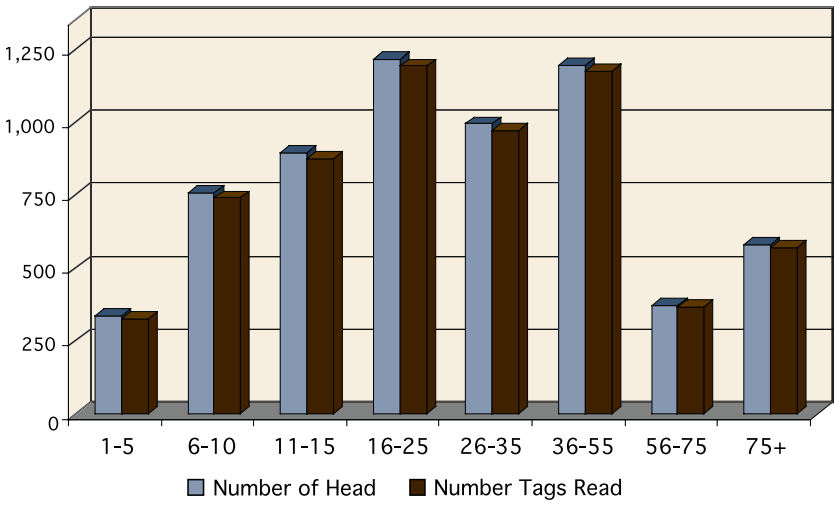
This market was equipped with a two-panel single alley system located in an existing alley that was used to receive cattle off semi-trailers only and was part of the normal animal flow on receiving days. Thee weeks were missed over the test period as a result of a lack of personal to operate the test software. The test period was eight weeks.

Table 2: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 25	82%	335	3,210	50%	3,138	98%
26 - 75+	18%	73	3,144	50%	3,085	98%
Summary	**100%**	**408**	**6,354**	**100%**	**6,223**	**98%**

The largest percentage of group size was from one to 25 at 82 percent. However, the number of animals is evenly divided between the two group sizes; under 25 and 26 to 75+. This is indicative of the RFID system being located at the receiving section of the market.

Chart 3: Summary of read accuracy by group size over test period



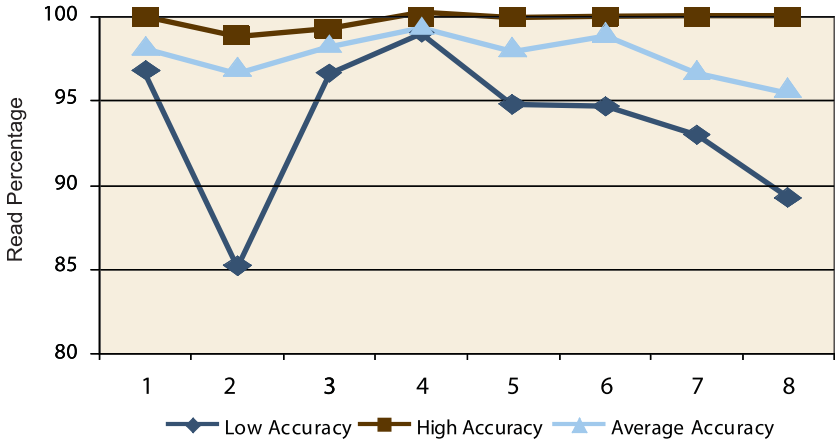
The largest volume of cattle were received in groups of 16 to 25, followed closely by 36 to 55. The average read accuracy, based on individual groups ranged from 97.3 percent to 98.5 percent in all group sizes with a mere 1.2 percent variance.

Chart 3: Data Table

Group size	# Animals	# Groups	Read Accuracy
1 - 5	336	109	97.3%
6 - 10	760	94	97.5%
11 - 15	896	71	97.8%
16 - 25	1,218	61	98.0%
26 - 35	995	33	97.7%
36 - 55	1,195	27	98.3%
56 - 75	373	6	98.1%
75+	581	7	98.5%
Summary	**6,354**	**408**	**97.9%**

Group Size	Ascending Read Accuracy
1 - 5	**97.3%**
6 - 10	**97.5%**
26 - 35	**97.7%**
11 - 15	**97.8%**
16 - 25	**98.0%**
56 - 75	**98.1%**
36 - 55	**98.3%**
75+	**98.5%**

Chart 4: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

High read accuracy showed little variance during the scanning period, staying consistently over 98.9 percent and often achieving 100 percent. The low accuracy fluctuated approximately 14 percent over the period and the average weekly accuracy varied 3.7 percent from 95.8 to 99.5 percent.

Table 5: High, low, average read rates by group size, ascending

Week	Group Size	Low Read
2	11 - 15	85.2%
9	26 - 35	89.35
8	1 - 5	93.0%
7	16 - 25	94.7%
6	6 - 10	94.8%
3	1 - 5	96.7%
1	11 - 15	96.8%
4	36 - 55	99.1%

Week	Group Size	High Read
2	56 - 75	98.9%
3	26 - 35	99.3%
1	1 - 5	100%
4	1 - 5	100%
6	1 - 5	100%
7	1 - 5	100%
8	75+	100%
9	6 - 10	100%

Week	Average
9	95.8%
8	96.8%
2	97.0%
6	98.2%
1	98.3%
3	98.5%
7	99.1%
4	99.5%

The highest rate was consistently 100 percent in group sizes from one to five. The lowest weekly read rate was 85.2 percent in a group size of 11 to 15 which was a result of two groups, with a total of 17 animals, where four of the cattle had bar code tags which are unreadable. In week nine, the read accuracy was 89.3 percent in two groups with a total of 56 animals. In these groups, the RFID tags were placed in close proximity to the dangle tags, which may have caused interference. The largest weekly variance occurred in week two with a 13.7 percent variance.

Chart 6: Average weekly read accuracy on all cattle

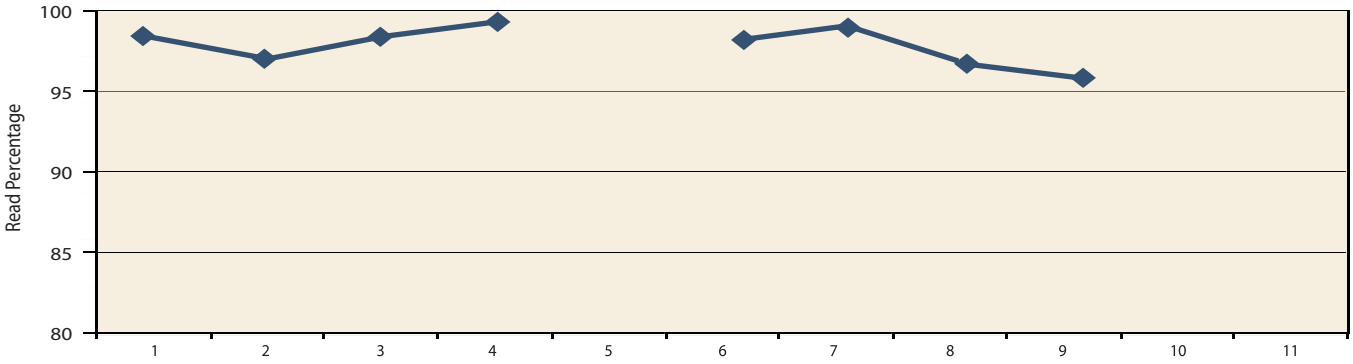


Chart 6: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	36	601	591	98.3%
2	41	1,029	998	97.0%
3	65	1,171	1,153	98.5%
4	62	938	933	99.5%
6	50	684	672	98.2%
7	43	426	422	99.1%
8	88	1,169	1,132	96.8%
9	23	336	322	95.8%

Ascending	
Week	Read Accuracy
9	95.8%
8	96.8%
2	97.0%
6	98.2%
1	98.3%
3	98.5%
7	99.1%
4	99.5%

As the average weekly chart indicates, during the eight weeks of scanning, the market maintained a consistently high read rate accuracy. This could be attributed to a higher than average number of animals with tags, as the system was located after the tagging station. It must also be noted that the alley width was three inches less than is standard industry specification for this type of system. Standard specification is 32 inches across the top; this alley was constructed by the vendor at 29 inches across the top. It is suggested that the narrow width of the alley may have contributed to the exceptionally high read rates.

Over the eight weeks of scanning, there were 106 missed reads that had an identifiable cause which would have adjusted the read accuracy by a mere 0.4 percent.

Ste Rose Auction Mart

Medium Volume Market

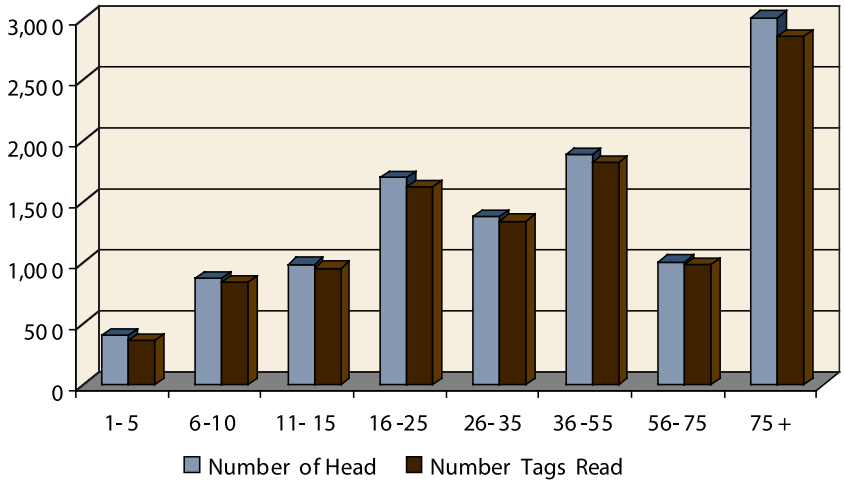
This market was equipped with a four panel single alley system located in an area that flowed the cattle from receiving to pre-sale penning. This system was originally intended for a dual alley but was converted to a single alley at the advice of the vendor; it therefore has double the number of panel antennae. The test period in this market was nine weeks as a result of lack of personnel to operate the test software. It must be noted that the volume of cattle on the two weeks that scanning didn't take place was well over 1,500 per day. Further, during the final three weeks of the test only 25 to 35 percent of the cattle were scanned as a result of the negative effect the system had on the speed of commerce which was creating undue hardship for the auction market.

Table 7: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 35	84%	443	5,313	48%	5,156	97%
36 - 75+	16%	85	5,876	52%	5,646	96%
Summary	**100%**	**528**	**11,189**	**100%**	**10,802**	**96.5%**

The highest percentage of groups are in the one to 35 range with 84 percent of the total. However, this group size reflects only 48 percent of the total number of animals. In this market, the number of cattle in groups of one to 35 is almost equal to the number of animals in groups of 36 to 75+. These group sizes are consistent with being located at the receiving area of the market.

Chart 8: Summary of read accuracy by group size over test period



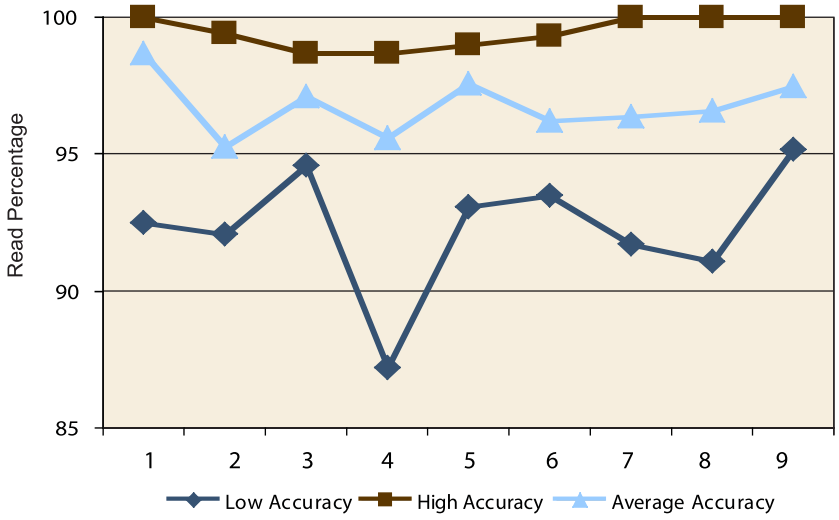
The largest volume of cattle were received in groups of 75+, followed by 36 to 55 and 16 to 25. The average read accuracy based on individual groups of all sizes had a 3.9 percent variance with accuracy ranging from 93.8 to 97.7 percent.

Chart 8: Data Table

Group size	# Animals	# Groups	Read Accuracy
1 - 5	401	122	93.8%
6 - 10	882	112	96.3%
11 - 15	980	77	97.7%
16 - 25	1,674	86	97.4%
26 - 35	1,376	46	97.7%
36 - 55	1,883	42	97.0%
56 - 75	1,001	15	97.6%
75+	2,992	28	95.0%
Summary	**11,189**	**528**	**96.5%**

Group Size	Ascending Read Accuracy
1 - 5	**93.8%**
75+	**95.0%**
6 - 10	**96.3%**
36 - 55	**97.0%**
16 - 25	**97.4%**
56 - 75	**97.6%**
11 - 15	**97.7%**
26 - 35	**97.7%**

Chart 9: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

High read accuracy showed little variance during the scanning period staying consistently above 98 percent and often achieving 100 percent. There was little variance in the weekly read accuracy with a variance of 3.4 percent between the high of 98.7 percent and low of 95.3 percent. The low reads showed the highest variance with an eight percent spread.

Table 10: High, low, average read rates by group size, ascending

Week	Group Size	Low Read
4	1 - 5	87.2%
10	75+	91.1%
9	1 - 5	91.7%
2	1 - 5	92.1%
1	75+	92.5%
5	75+	93.1%
7	1 - 5	93.5%
3	1 - 5	94.6%
11	56 - 75	95.2%

Week	Group Size	High Read
3	75+	98.7%
4	75+	98.7%
5	26 - 35	99.0%
7	56 - 75	99.3%
2	16 - 25	99.4%
1	1 - 5	100%
9	11 - 15	100%
10	36 - 55	100%
11	16 - 25	100%

Week	Average
2	95.3%
4	95.6%
7	96.2%
9	96.45
10	96.65
3	97.15
11	97.5%
5	97.6%
1	98.7%

The highest read rates were evenly distributed throughout the group sizes. The lowest weekly read rate was 87.2 percent in a group of one to five animals where in one group of five, four of the animals did not have RFID tags, and in another group of five, two of the tags did not read. In weeks 10 and nine the reasons for the missed reads were unidentified. The low weekly read rates are in the group sizes of one to five, which is easily attributed to a small number of missed tags, and the group size of 56 to 75+ in which the missed tags can be a result of the animals bunching in the alley due to the volume of animals.

Chart 11: Average weekly read accuracy on all cattle

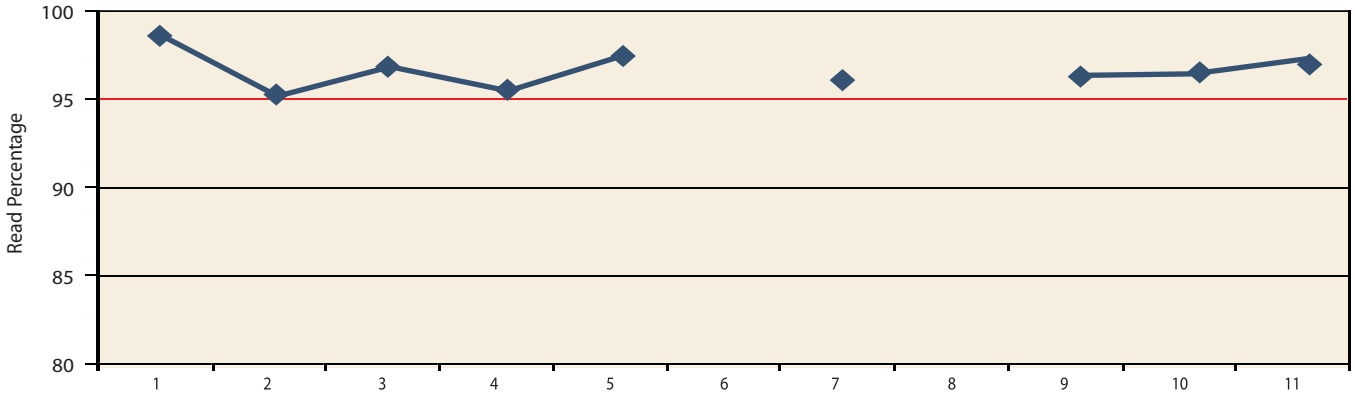


Chart 11: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	51	911	899	98.7%
2	88	1,979	1,885	95.4%
3	57	1,060	1,029	97.1%
4	64	1,513	1,446	95.6%
5	70	1,461	1,426	97.7%
7	82	2,246	2,161	96.2%
9	25	413	398	96.4%
10	50	887	857	96.6%
11	41	719	701	97.5%

Ascending	
Week	**Read Accuracy**
2	95.3%
4	95.6%
7	96.2%
9	96.4%
10	96.6%
3	97.1%
11	97.5%
5	97.7%
1	98.7%

The overall accuracy for all weeks was 96.5 percent with a variance of 3.4 percent. In nine weeks of scanning, there were only 41 identified issues with tags, which would have adjusted the accuracy by 0.4 percent overall.

Summary of Evaluation of Single Alley Systems

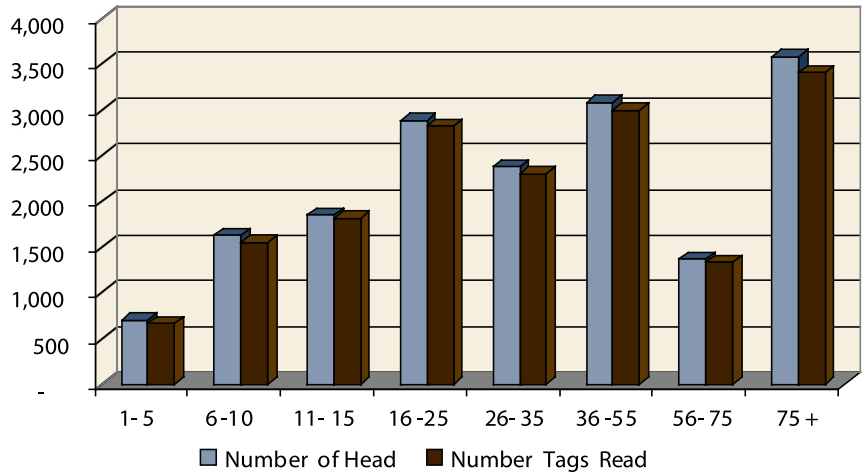
There were two single alley systems installed for this project: one system was a two panel system, the other was a four panel system. Both were located in an area that flowed cattle that were being received at the market. In total there were 17 weeks of data collected from both markets. In each of these markets the scanning took place the day before the sale.

Table 12: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 35	87%	811	9,518	54%	9,266	97%
36 - 75+	13 %	125	8,025	46%	7,759	97%
Summary	**100%**	**936**	**17,543**	**100%**	**17,025**	**97.0%**

The largest number of groups were in the one to 35 range, but the number of animals divided relatively equally between groups of one to 35 and 36 to 75+. This is indicative of these systems being located in the receiving area of the market.

Chart 13: Summary of read accuracy by group size over test period



The largest volume of cattle were received in the group sizes of 75+, followed closely by 36 to 55 and 16 to 25. There is only a 2.3 percent variation in read accuracy throughout the group sizes with a high of 97.7 percent and a low of 95.4 percent. The largest number of groups were one to five at 25 percent of all groups. This segment had the lowest read accuracy but that is not surprising as it had the highest number of groups.

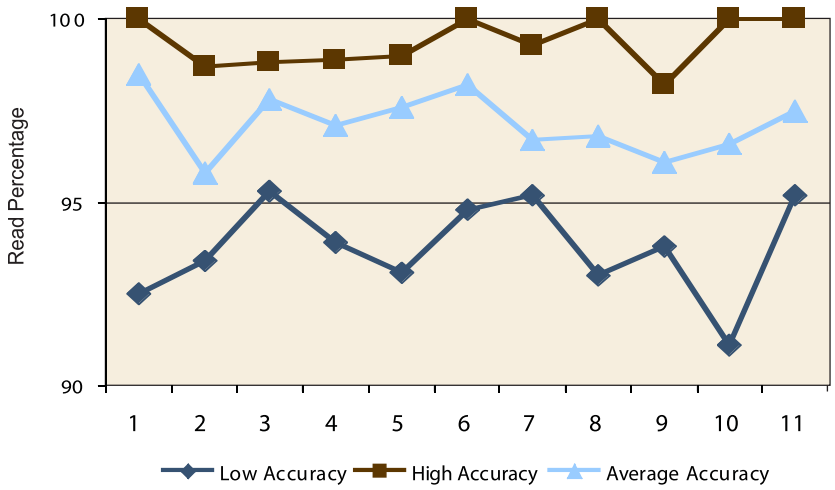
Chart 13: Data Table

Group size	# Animals	# Groups	Read Accuracy
1 - 5	737	231	95.4%
6 - 10	1,642	206	96.8%
11 - 15	1,876	148	97.7%
16 - 25	2,892	147	97.6%
26 - 35	2,371	79	97.7%
36 - 55	3,078	69	97.5%
56 - 75	1,374	21	97.7%
75+	3,573	35	95.6%
Totals/Ave	**17,543**	**936**	**97%**

Group Size	Ascending Read Accuracy
1 - 5	**95.4%**
75+	**95.6%**
6 - 10	**96.8%**
36 - 55	**97.5%**
16 - 25	**97.6%**
11 - 15	**97.7%**
26 - 35	**97.7%**
56 - 75	**97.7%**

Chart 14: High, low, average read accuracy weekly

High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.



High read accuracy of 100 percent occurred on 45 percent of the scanning days. The low reads were also relatively consistent with only a 4.2 percent range from 91.1 to 95.3 percent. The average also has a small variance of 2.7 percent week over week with a low of 95.8 percent and a high of 98.5 percent

Table 15: High, low, average by group size, ascending

Week	Group Size	Low Read
10	75+	91.1%
1	75+	92.5%
8	1 - 5	93.0%
5	75+	93.1%
2	1 - 5	93.4%
9	1 - 5	93.8%
4	1 - 5	93.9%
6	6 - 10	94.8%
7	75+	95.2%
11	56 - 75	95.2%
3	1 - 5	95.3%

Week	Group Size	High Read
9	11 - 15	98.2%
2	16 - 25	98.7%
3	26 - 35	98.8%
4	11 - 15	98.9%
5	26 - 35	99.0%
7	56 - 75	99.3%
1	1 - 5	100%
6	1 - 5	100%
8	75+	100%
10	36 - 55	100%
11	16 - 25	100%

Week	Average
2	95.8%
9	96.1%
10	96.6%
7	96.7%
8	96.8%
4	97.1%
11	97.5%
5	97.6%
3	97.8%
6	98.2%
1	98.5%

The spread of the high and low read ranges per group size does not show a definitive pattern as there was not one group size affected more than the other. The largest daily variance was in week 10 with an 8.9 percent spread between a low of 91.1 percent and a high of 100 percent. The highest weekly rate was 100 percent, 46 percent of the time, with an overall spread of only 1.8 percent. The weekly variance on low reads was 4.2 percent.

Chart 16: Average weekly read accuracy on all cattle

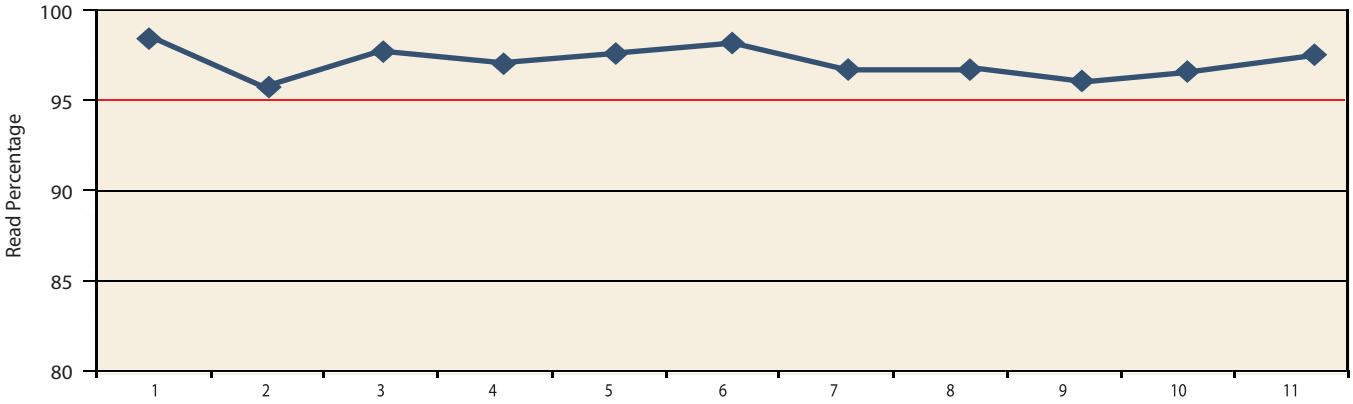


Chart 16: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	87	1,512	1,490	98.5%
2	129	3,008	2,883	95.8%
3	122	2,231	2,182	97.8%
4	126	2,451	2,379	97.1%
5	70	1,461	1,426	97.6%
6	50	684	672	98.2%
7	125	2,672	2,583	96.7%
8	88	1,169	1,132	96.8%
9	48	749	720	96.1%
10	50	887	857	96.6%
11	41	719	701	97.5%

Ascending	
Week	Read Accuracy
2	95.8%
9	96.1%
10	96.6%
7	96.7%
8	96.8%
4	97.1%
11	97.5%
5	97.6%
3	97.8%
6	98.2%
1	98.5%

The overall read accuracy was 97 percent with a weekly spread of 2.7 percent. Over 17 days of scanning, 13 percent (66) of the missed reads could be attributed to tag factors. This would have adjusted the overall accuracy by 0.4 percent.

SUMMARY

The single alley system at the receiving area of the market has an overall average of 97 percent in 17 days of scanning 936 groups with 17,543 cattle. The average weekly read accuracy had a 2.7 percent variance week over week. The system with the four panels had a marginally lower accuracy (96.5 percent) versus the system with two panels (98 percent). There could be many environmental factors that influenced this variation,in addition to one of the systems being constructed with two panels in an alley that was three inch narrower than the four panel alley.

	Low Read	High Read	Variance
By group size	95.4%	97.7%	2.3%
By week	95.8%	98.5%	2.7%
Throughout the day	91.1%	100%	8.9%

There is no correlation between low read accuracy and total number of head processed in one day. Some of the lower reads were on days of higher volume, but the variance in read accuracy is so low that there is no discernable pattern. The lowest read accuracy was in the groups of one to five, but this is not surprising as this segment has the highest number of groups. The single alley system was consistent with all group sizes as 54 percent of the animals were processed in groups of one to 35 and 46 percent in groups of 36 to 75.

The existing single alley system in the Ottawa market reported data that was not sorted by group and not verified with Viewtrac software. The read accuracy in 16 days of scanning over 7,275 cattle was 84 percent.

BC Coop - Kamloops, BC

Small Volume Market

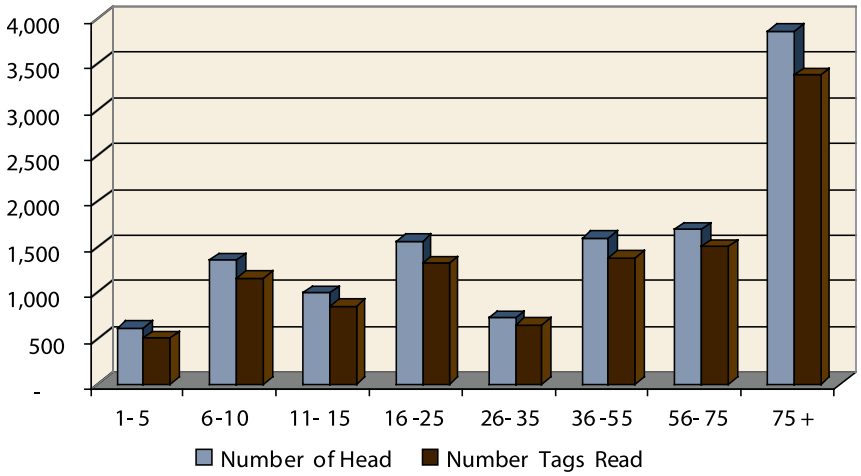
This market had a pre-existing three year old, four-panel dual alley RFID System. The RFID system is located at the receiving area of the market and scanning primarily took place the day before sale day throughout the eleven weeks.

Table 17: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 25	81%	530	4,529	37%	3,833	85%
26 - 55	9%	60	2,318	18%	2,029	88%
56 - 75+	10%	186	5,558	45%	4,891	88%
Summary	**100%**	**656**	**12,405**	**100%**	**10,753**	**87%**

The highest percentage of groups are in the one to 25 range, however, this accounts for only 37 percent of the cattle. The highest percentage of cattle enter the market (45 percent) in groups of 56 to 75+, which is indicative of being located at the receiving area.

Chart 18: Summary of read accuracy by group size over test period



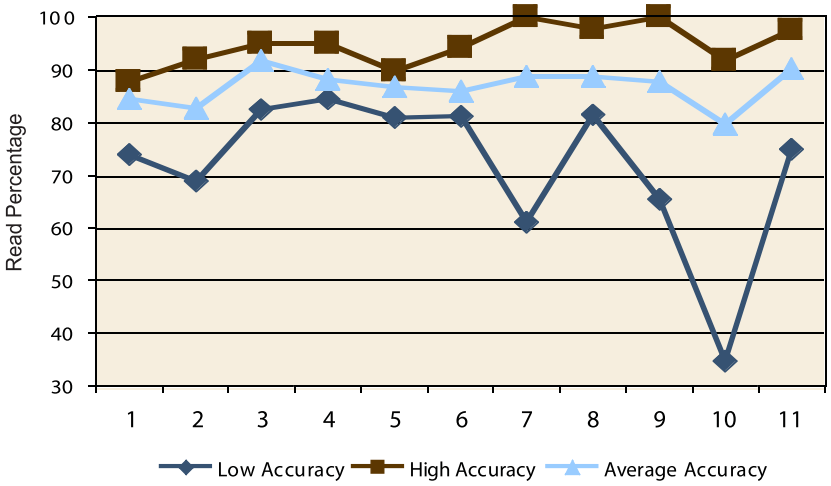
The highest volume of cattle was received in the group size of 75+ with other group sizes relatively equally distributed. The average read accuracy per group size ranged from 82 to 90 percent with an overall read accuracy of 87 percent. The smaller groups had the lowest read rates, but is not surprising as that segment accounts for 31 percent of the overall groups.

Chart 18: Data Table

Group size	# Animals	# Groups	Read Accuracy
1 - 5	616	202	82%
6 - 10	1,350	172	86%
11 - 15	999	78	85%
16 - 25	1,564	78	84%
26 - 35	719	24	90%
36 - 55	1,599	36	86%
56 - 75	1,697	26	89%
75+	3,861	40	88%
Summary	**12,405**	**656**	**87%**

Group Size	Ascending Read Accuracy
1 - 5	**82%**
6 - 10	**86%**
11 - 15	**85%**
16 - 25	**845**
26 - 35	**90%**
36 - 55	**86%**
56 - 75	**89%**
75+	**88%**

Chart 19: High, low, average read accuracy by week



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

There is a dramatic variance in the low read range of 50 percent. High read accuracy has a 12 percent variance between the low of 88 percent and the high of 100 percent. The average had a 12 percent variance between the low of 80 percent and the high of 92 percent.

Table 20: High, low, average by group size, ascending

Week	Group Size	Low Read
10	36 - 55	35%
7	16 - 25	61%
9	11 - 15	65%
2	1 - 5	69%
1	1 - 5	74%
11	11 - 15	75%
5	26 - 35	81%
6	16 - 25	81%
8	16 - 25	81%
3	6 - 10	83%
4	6 - 10	85%

Week	Group Size	High Read
1	6 - 10	88%
5	1 - 5	90%
10	26 - 35	92%
2	36 - 55	92%
6	11 - 15	94%
4	26 - 35	95%
3	11 - 15	95%
11	16 - 25	98%
8	26 - 35	98%
7	36 - 55	100%
9	26 - 35	100%

Week	Average
10	80%
2	83%
1	85%
6	86%
5	87%
9	88%
4	88%
7	89%
8	89%
11	90%
3	92%

All groups were affected by low read rates, no one group size more than others. The largest daily variance was in week 10 from a low of 35 percent to a high of 92 percent. The highest weekly rate was 100 percent in weeks seven and nine on groups of 26 to 55 animals. The lowest read is 35 percent in week 10 on groups of 36 to 55 animals; this was a result of 43 missing tags on the large group of 53 animals. In week seven, the cause of the low rate was primarily due to bar code tags.

Chart 21: Average weekly read accuracy on all cattle

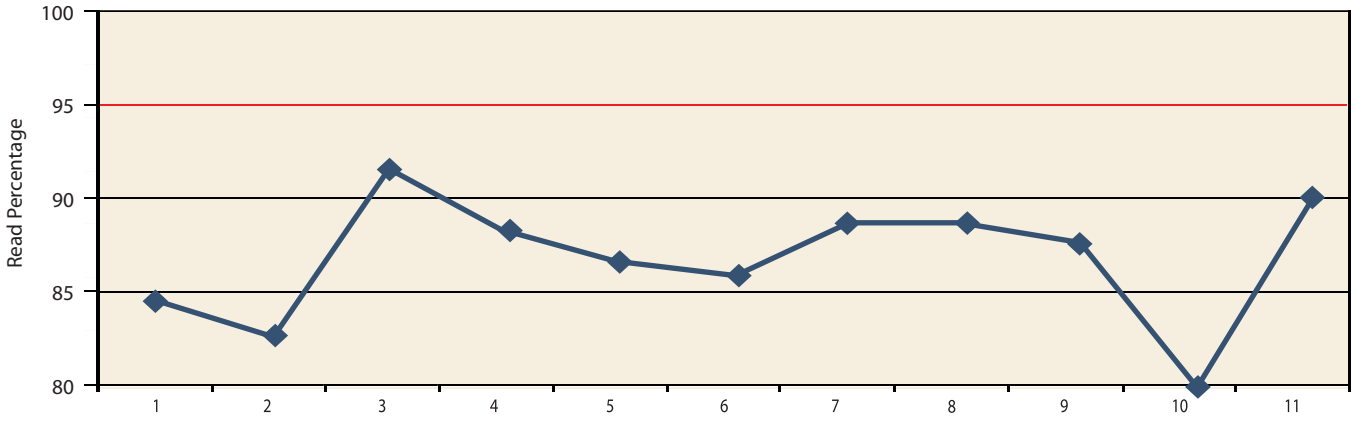


Chart 21: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	87	1,450	1,225	85%
2	88	1,526	1,262	83%
3	67	1,842	1,687	92%
4	70	1,580	1,395	88%
5	72	2,045	1,771	87%
6	62	1,089	935	86%
7	58	821	728	89%
8	46	646	573	89%
9	31	363	318	88%
10	49	789	630	80%
11	26	254	229	90%

Ascending	
Week	**Read Accuracy**
10	80%
2	83%
1	85%
6	86%
5	87%
4	88%
9	88%
7	89%
8	89%
11	90%
3	92%

The overall accuracy was 86.7 percent, with a 12 percent variance between the weekly highs and lows. Over the eleven weeks, 25 percent (411) of the missed reads were identified as tag factors which would have adjusted the read accuracy by 2.3 percent.

Gladstone Auction Market

Small Volume Market

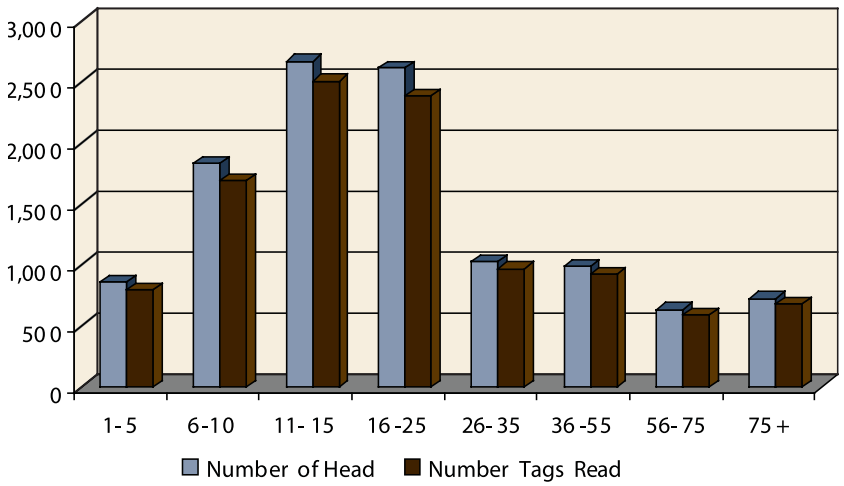
This market was equipped with a four panel, dual alley RFID System located in an existing penning area at the receiving area of the market. The scanning alley, built by the market personnel, was not quite to the vendor specifications. As such, the design may have had some influence on the read accuracy.

Table 22: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 25	92%	877	7,975	70%	7,380	93%
26 - 75+	8%	74	3,366	30%	3,157	94%
Summary	**100%**	**951**	**11,341**	**100%**	**10,537**	**93%**

The largest percentage of groups were of size one to 25. Thirty percent of the total cattle were in group sizes of 26 to 75+ skewing smaller as group size increased. This is consistent with the RFID system being located at the receiving area of the market.

Chart 23: Summary of read accuracy by group size over test period



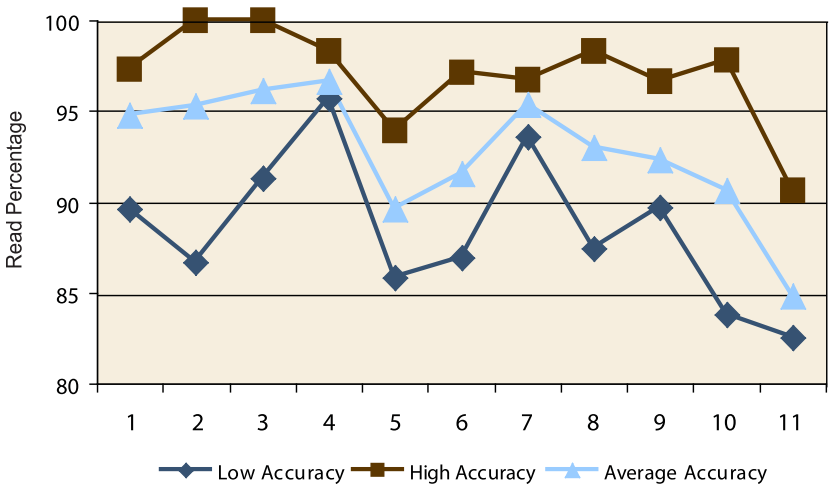
The highest volume of cattle was received in groups of 11 to 15, followed closely by 16 to 25. The average read accuracy had very little variance between the high of 94 percent and the low of 91 percent. The lowest read accuracy was in the highest volume segment of 16 to 25.

Chart 23: Data Table

Group size	# Animals	# Groups	Read Accuracy
1 - 5	856	305	93%
6 - 10	1830	230	93%
11 - 15	2675	209	94%
16 - 25	2614	133	91%
26 - 35	1,025	34	94%
36 - 55	985	22	94%
56 - 75	633	10	93%
75+	723	8	94%
Summary	**11,341**	**951**	**93%**

Group Size	Ascending Read Accuracy
16 - 25	**91%**
1 - 5	**93%**
6 - 10	**93%**
56 - 75	**93%**
75+	**94%**
11 - 15	**94%**
36 - 55	**94%**
26 - 35	**94%**

Chart 24: High, low, average read accuracy



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

High reads had a nine percent variance from a low of 91 percent to a high of 100 percent. Low reads ranged from 83 to 96 percent. The average weekly rate had a 12 percent variance from 85 to 97 percent.

Table 25: High, low, average read accuracy by group size, ascending

Week	Group Size	Low Read
11	1 - 5	83%
10	16 - 25	84%
5	16 - 25	86%
2	16 - 25	87%
6	26 - 35	87%
8	75+	87%
1	36 - 55	90%
9	75+	90%
3	1 - 5	91%
7	6 - 10	94%
4	11 - 15	96%

Week	Group Size	High Read
11	36 - 55	91%
5	11 - 15	94%
9	56 - 75	97%
7	36 - 55	97%
6	56 - 75	97%
1	75+	97%
10	36 - 55	98%
4	56 - 75	98%
8	56 - 75	98%
2	6 - 10	100%
3	6 - 10	100%

Week	Average
11	85%
5	90%
10	91%
6	92%
9	92%
8	93%
1	95%
2	95^%
7	95%
3	96%
4	97%

Daily variance was 14 percent in week 10. The lowest weekly read rate was 83 percent as a result of 19 groups of 63 cattle, from which 11 didn't read but only four of which were due to identifiable issues. In examining all average read rates below 90 percent, the read accuracy was not always identified with a cause. The most extreme variance on weekly highs and lows occurred in week two with a low read of 87 percent and a high of 100 percent.

Chart 26: Average weekly read accuracy on all cattle

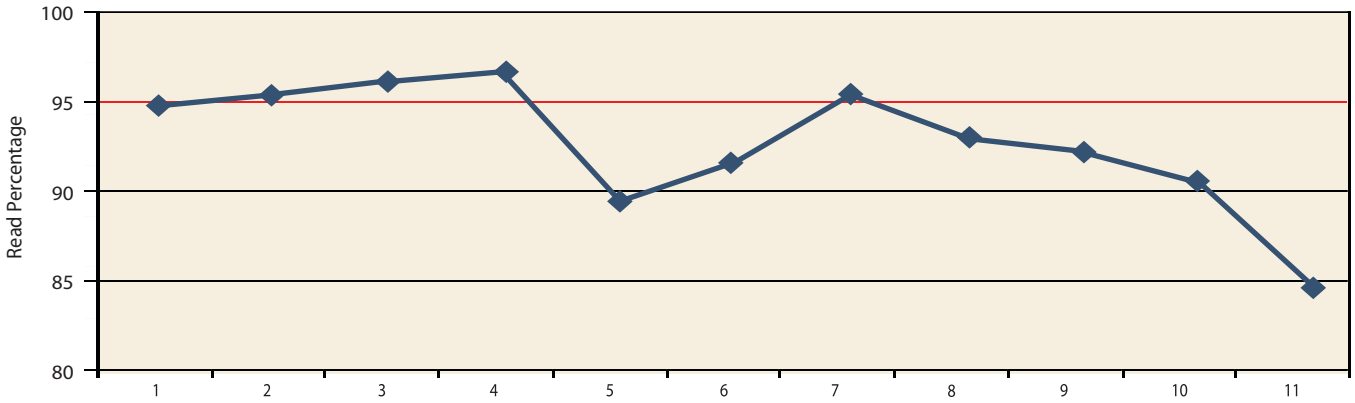


Chart 26: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	68	834	791	95%
2	85	1,202	1,145	95%
3	51	889	854	96%
4	82	951	919	97%
5	83	1,101	986	90%
6	85	1,222	1,119	92%
7	105	1,022	975	95%
8	112	1,237	1,151	93%
9	125	1,220	1,126	92%
10	96	1,050	951	91%
11	59	613	520	85%

Ascending	
Week	**Read Accuracy**
11	85%
5	90%
10	91%
6	92%
9	92%
8	93%
1	95%
2	95%
7	95%
3	96%
4	97%

The average weekly accuracy was 93 percent, with a spread of 12 percent from the weekly high to low. Throughout the 11 weeks of scanning .05 percent (47) missed reads were identified as a definitive tag issue. The identified causes would have adjusted the read accuracy by 0.4 percent.

Summary of Evaluation of Dual Alley Systems

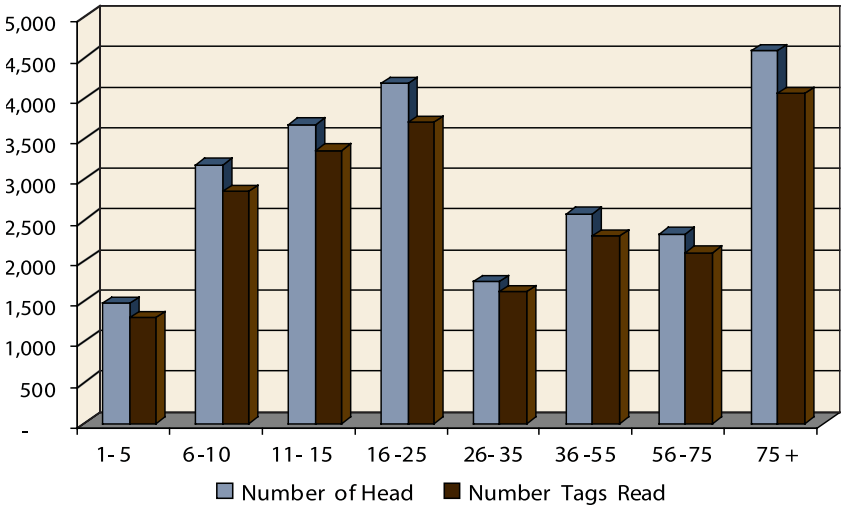
There were two dual alley systems in the test project; one was a pre-existing system the other was a new install. Both of these systems were located at the receiving area of the auction market. During the eleven week period both of these markets participated every week with scanning occurring once a week prior to sale day.

Table 27: Overview of accuracy by group sizes over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 25	88%	1,407	12,504	53%	11,213	90%
26 - 75+	12%	200	11,242	47%	10,077	90%
Summary	**100%**	**1,607**	**23,746**	**100%**	**21,290**	**90%**

These two dual alley systems processed approximately 26 percent more cattle than the single alley system. Although the largest number of groups were in the one to 25 range, the total number of cattle were equally distributed throughout all group sizes as noted in the following table. The high percentage of cattle in larger groups is indicative of the receiving area of the market.

Chart 28: Summary of read accuracy by group size over test period



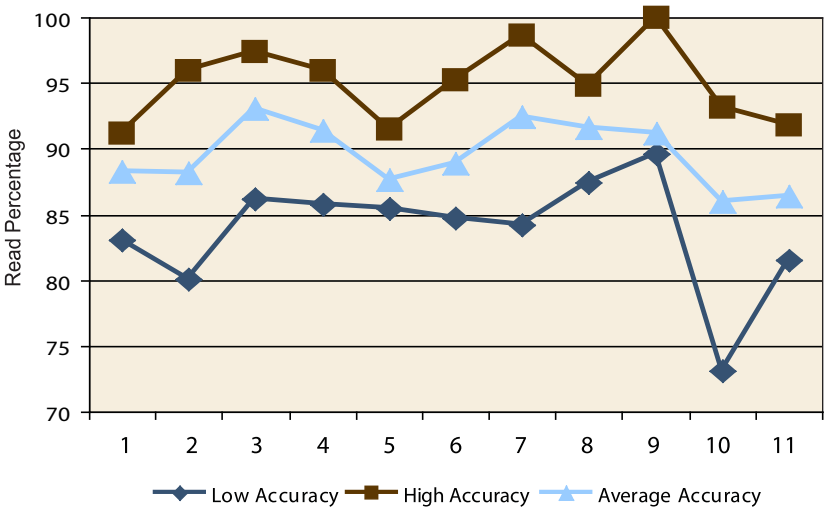
The largest number of cattle received in these two markets were in groups of 75+, followed by 16 to 25 and 11 to 15. The read accuracy was fairly consistent across all segments with a variance of five percent and with the lowest read accuracy in the segment with the highest number of groups. There is no definitive trend to the variations in group size read accuracy.

Chart 28: Data Table

Group Size	# Animals	# Groups	# Missing	Read Accuracy
1 - 5	1,472	507	173	88%
6 - 10	3,180	402	326	90%
11 - 15	3,674	287	316	91%
16 - 25	4,178	211	476	89%
26 - 35	1,744	58	128	93%
36 - 55	2,584	58	281	89%
56 - 75	2,330	36	231	90%
75+	4,584	48	525	89%
Summary	**23,746**	**1,607**	**2,456**	**90%**

Group Size	Ascending Read Accuracy
1 - 5	**88%**
75+	**89%**
16 - 25	**89%**
36 - 55	**89%**
6 - 10	**90%**
56 - 75	**90%**
11 - 15	**91%**
26 - 35	**93%**

Chart 29: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

Table 30: High, low, average by group size, ascending

Week	Group Size	Low Read
10	36 - 55	73%
2	75+	80%
11	26 - 35	82%
1	1 - 5	83%
7	16 - 25	84%
6	75+	85%
5	6 - 10	86%
4	75+	86%
3	1 - 5	86%
8	75+	87%
9	11 - 15	90%

Week	Group Size	High Read
1	6 - 10	91%
5	1 - 5	92%
11	36 - 55	92%
10	26 - 35	93%
8	26 - 35	95%
6	11 - 15	95%
2	26 - 35	96%
4	26 - 35	96%
3	11 - 15	97%
7	36 - 55	99%
9	26 - 35	100%

Week	Average
10	86%
11	86%
5	88%
2	88%
1	88%
6	89%
9	91%
4	91%
8	92%
7	92%
3	93%

All groups were affected equally in both the high and low read categories with no definitive trend emerging. The weekly average had a variance of seven percent ranging between 86 to 93 percent. The most extreme daily variance was in week 10 with a variance of 20 percent. The highest weekly rate was 100 percent in week nine, the lowest was 73 percent in week 10.

Chart 31: Average weekly read accuracy on all cattle

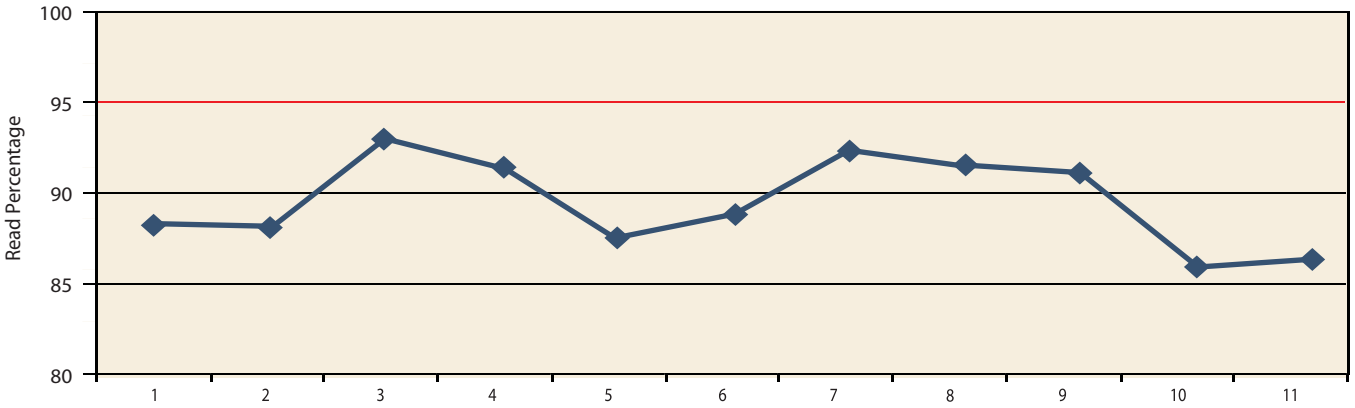


Chart 31: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	155	2,284	2,016	88%
2	173	2,728	2,407	88%
3	118	2,731	2,541	93%
4	152	2,531	2,314	91%
5	155	3,146	2,757	88%
6	147	2,311	2,054	89%
7	163	1,843	1,703	92%
8	158	1,883	1,724	92%
9	156	1,583	1,444	91%
10	145	1,839	1,581	86%
11	85	867	749	86%

Ascending	
Week	Read Accuracy
10	86%
11	86%
5	88%
2	88%
1	88%
6	89%
9	91%
4	91%
8	92%
7	92%
3	93%

The overall weekly accuracy is consistent in all group sizes, with a variance between 86 to 93 percent and an overall average of 90 percent. It must be noted that the Gladstone market, with the new RFID system, had an overall accuracy of 93 percent while the three year old existing system had an overall accuracy of 87 percent. Over 22 days of scanning, 18 percent of the missed reads (458) were identified as tag factors. This would have adjusted the overall accuracy by two percent.

SUMMARY

The dual alley system at the receiving area of the market has an overall average of 90 percent in 22 days of scanning 1,607 groups with 23,746 cattle. This read accuracy is slightly skewed due to an older system participating in the data collection. It is not known whether the cause of the lower read accuracy in British Columbia is a result of the age of the system or the quality of the reader panels. In 55 percent of the weeks the read accuracy was less than 90 percent, and in 45 percent of the weeks it was more than 90 percent.

There is no correlation between low read accuracy and number of head received during the day. There were several weeks of high intake numbers where the read accuracy was at the highest range for the test period (week two in Kamloops, week eight in Gladstone). The lowest read accuracy was in the groups of one to five, but this is not surprising as this segment has the highest number of groups.

Variations in read accuracy are as follows:

	Low Read	High Read	Variance
By group size	88%	93%	5%
By week	86%	93%	7%
Throughout the day	73%	93%	20%

This system has a relatively consistent read accuracy by group size as 46 percent of the cattle were in groups of less than 25, and 54 percent of the cattle were in groups of 26 to more than 75.

Winnipeg Livestock Sales

Medium Volume Market

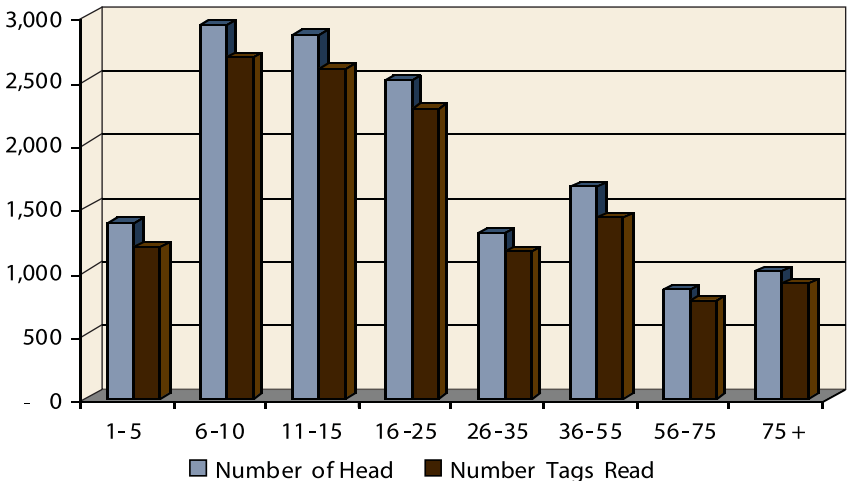
This market was equipped with an eight panel wide alley (five foot) RFID system, with a 32 feet scanning alley located in a 60 feet alley at the receiving area of the market. Scanning at this market took place in the days before the two major weekly sales and with participation throughout the 11 week test.

Table 32: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 25	92%	1,190	9,664	67%	8,740	90%
26 - 75+	8%	105	4,816	33%	4,256	88%
Summary	**100%**	**1,295**	**14,480**	**100%**	**12,996**	**90%**

The table indicates that the highest percentage of groups were in the one to 25 range. However, only 67 percent of the cattle were in this group size and eight percent of the groups equated to 33 percent of the cattle. This is consistent with being at the receiving area of the market.

Chart 33: Summary of read accuracy by group size over test period



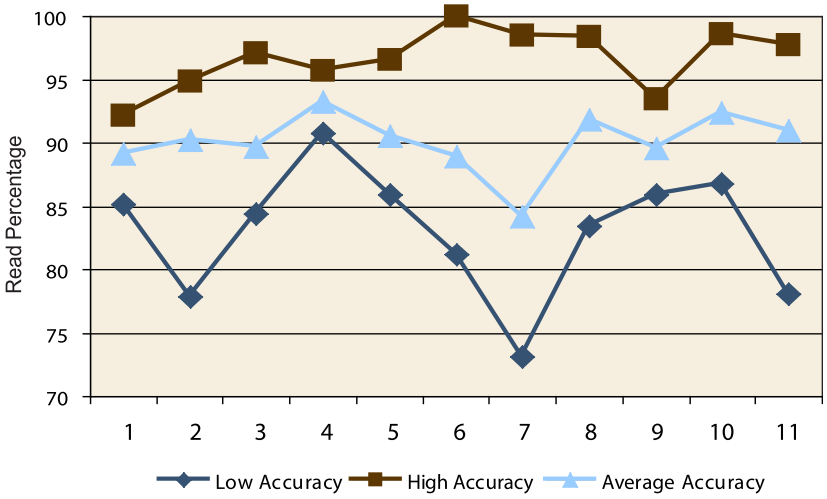
The highest volume of cattle was received in groups of six to 10, followed closely by groups of 11 to 15 and 16 to 25. The average read rate accuracy ranged from 86 to 91 percent with the highest level in groups of six to 25 at 91 percent (this is also the largest in terms of volume).

Chart 33: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	1,379	461	87%
6 - 10	2,935	372	91%
11 - 15	2,856	227	91%
16 - 25	2,494	130	91%
26 - 35	1,300	43	89%
36 - 55	1,662	39	86%
56 - 75	854	13	90%
75+	1,000	10	90%
Summary	**14,480**	**1295**	**90%**

Group Size	Ascending Read Accuracy
36 - 55	**86%**
1 - 5	**87%**
26 - 35	**89%**
56 - 75	**90%**
75+	**90%**
11 - 15	**91%**
16 - 25	**91%**
6 - 10	**91%**

Chart 34: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

This data averages four receiving days per week to allow for comparison with other markets with only one scanning day. Fluctuation in the average rate was nine percent, daily low rates varied 27 percent and highs varied eight percent.

Table 35: High, low, average by group size, ascending

Week	Group Size	Low Read
7	1 - 5	73%
2	36 - 55	78%
11	26 - 35	78%
6	36 - 55	81%
8	1 - 5	83%
3	11 - 15	84%
1	36 - 55	85%
5	36 - 55	86%
9	75+	86%
10	75+	87%
4	6 - 10	91%

Week	Group Size	High Read
1	16 - 25	92%
9	11 - 15	93%
2	11 - 15	95%
4	26 - 35	96%
5	1 - 5	97%
3	36 - 55	97%
11	36 - 55	98%
8	56 - 75	98%
7	56 - 75	99%
10	36 - 55	99%
6	75+	100%

Week	Average
7	84%
6	89%
1	89%
9	90%
3	90%
2	90%
5	91%
11	91%
8	92%
10	92%
4	93%

All group sizes were affected by low read rates, with 64 percent of the low reads in groups of more than 25. The lowest read rate was in week seven where there were 12 groups out of 37 that had a zero read rate without an identifiable cause. Weeks two and 11 also had low read rates without an observable cause. The largest variance was in week seven with a 26 percent variance over the course of one week with 1,711 animals and 144 groups.

Chart 36: Daily read accuracy

There was a total of four scanning days per week, two major scans before sale days and two minor scans on sale day. As noted in this chart, the daily accuracy skewed dramatically from a low of 65 percent to a high of 100 percent which were on small intake sale days of less than 15 animals.

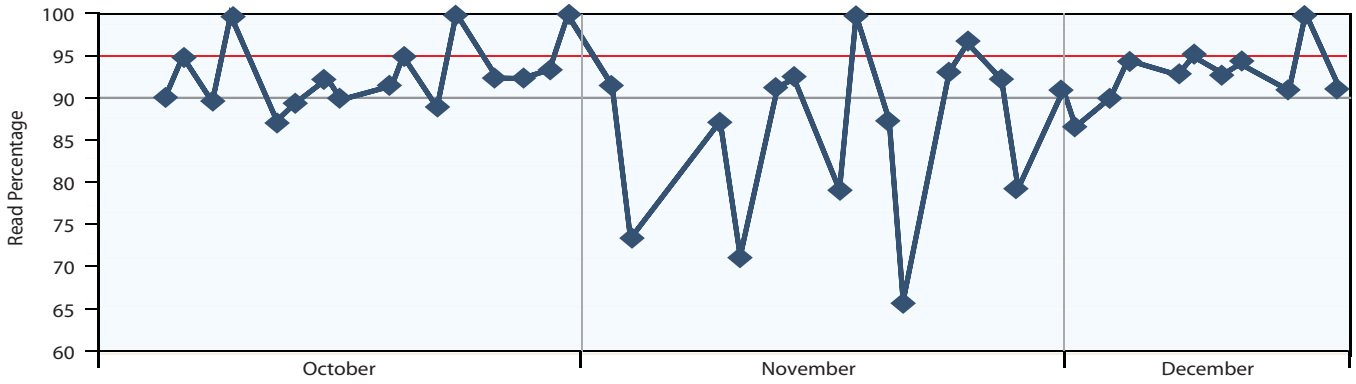


Chart 37: Average weekly read accuracy on all cattle

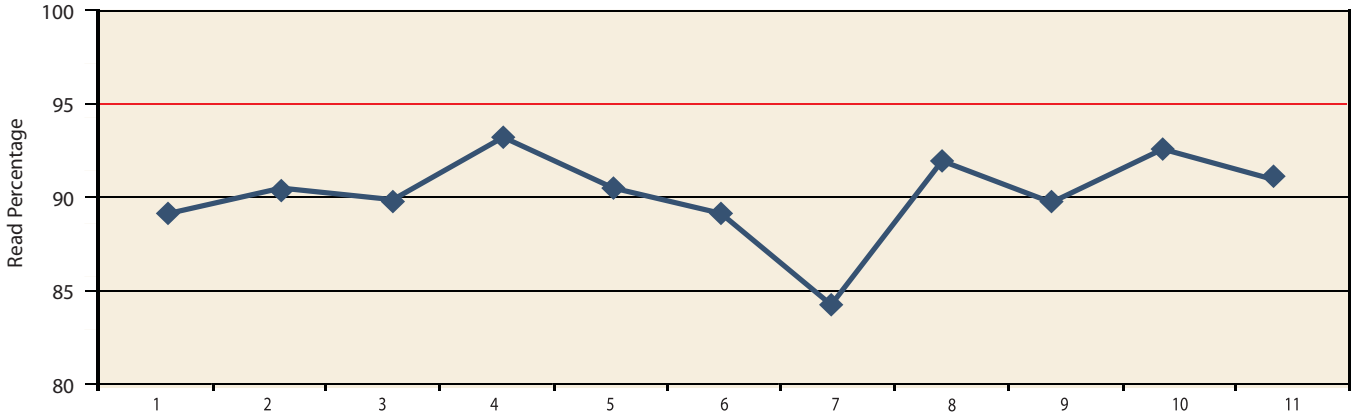


Chart 37: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	102	1,372	1,222	89%
2	129	1,468	1,324	90%
3	138	1,867	1,675	90%
4	81	939	875	93%
5	52	422	382	91%
6	134	1,607	1,429	89%
7	144	1,711	1,440	84%
8	166	1,670	1,533	92%
9	126	1,322	1,184	90%
20	141	1,426	1,317	92%
11	82	676	615	91%

Ascending	
Week	Read Accuracy
7	84%
6	89%
1	89%
9	90%
3	90%
2	90%
5	91%
11	91%
8	92%
10	92%
4	93%

Total overall accuracy was 89.7 percent with a variance of nine percent from the weekly high to low. Only 0.02 percent (32) of the missed reads were identified as a tag error. This would have adjusted the read accuracy by less than 0.003 percent.

Ontario Stockyards - Cookstown, Ontario

Large Volume Market

This market was equipped with an eight panel, wide alley (five foot) RFID system with a 32 foot alley at the entrance to the sale ring. Scanning took place two or three sale days per week over an 11 week period. The unique characteristic of this market is the sale of Québec cattle. These cattle have Agri-Traçabilité Québec (ATQ) tags and the sale of these animals must be registered with ATQ in order for the producer to receive the subsidy under the Québec provincial program. As such, extensive measures were taken to read as many of the ATQ tags as possible. As this is not an ordinary occurrence in the other test sites, the read on the Québec cattle has been removed from the test data. Twenty-four percent of the cattle sold during this test were Québec cattle.

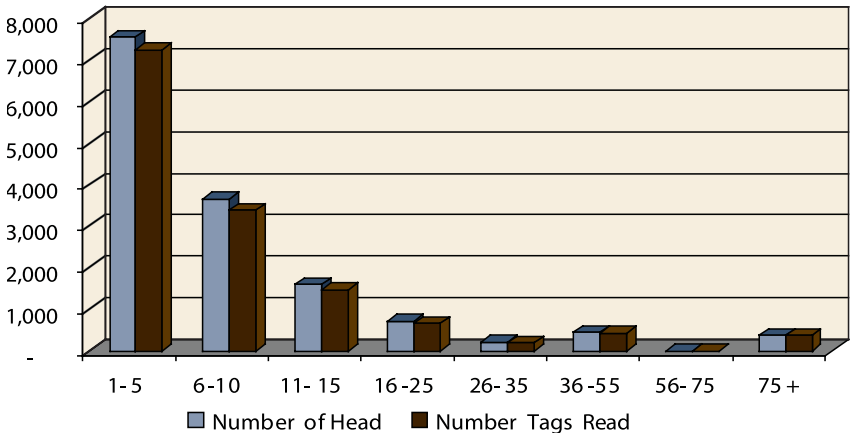
Ontario Cattle-Not Including Québec

Table 38: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 10	96%	4,033	11,209	77%	10,627	95%
11 - 75+	4%	187	3,366	23%	3,123	93%
Summary	**100%**	**4,220**	**14,575**	**100%**	**13,750**	**94%**

The largest percentage of groups were in the one to 10 range, equating to 77 percent of the total cattle. This is indicative of being at the sale ring as cattle are generally sold in small groups. Throughout the 11 week test period, there were only 166 groups between 11 to 25, accounting for .04 percent of the total, and 21 groups between 26 to 35 animals, which is a mere .005 percent of the total. This shows that group sizes over 10 are not a significant factor in this market.

Chart 39: Summary of read accuracy by group size over test period



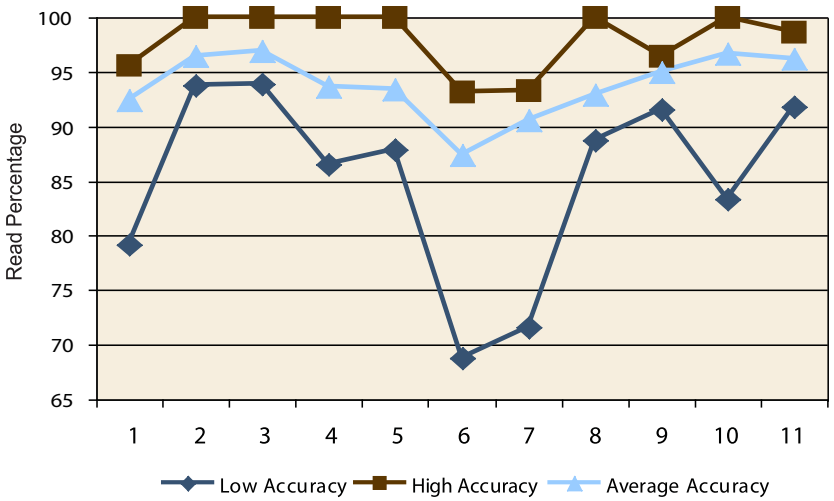
This market sells 52 percent of the cattle in groups of one to five and 25 percent in groups of six to 10. All other group sizes are relatively inconsequential overall. In these two groups, the read accuracy was high at 96 percent and 93 percent, respectively.

Chart 39: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	7,556	3,531	96%
6 - 10	3,653	502	93%
11 - 15	1,598	128	92%
16 - 25	724	38	91%
26 - 35	217	7	89%
36 - 55	455	11	95%
75+	372	3	99%
Summary	**14,575**	**4220**	**94%**

Group Size	Ascending Read Accuracy
26 - 35	**89%**
16 - 25	**91%**
11 - 15	**92%**
6 - 10	**93%**
36 - 55	**95%**
1 - 5	**96%**
75+	**99%**

Chart 40: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

The average weekly accuracy had a 10 percent variance between the low at 87 percent and the high at 97 percent. The low fluctuated dramatically from 69 to 94 percent, a 25 percent variance. High reads had a seven percent variance with 82 percent of the weeks registering 96 percent and above.

Table 41: High, low, average by group size, ascending

Week	Group Size	Low Read
6	11 - 15	69%
7	26 - 35	72%
1	11 - 15	79%
10	16 - 25	83%
4	16 - 25	87%
5	6 - 10	88%
8	6 - 10	89%
9	6 - 10	92%
11	11 - 15	92%
2	11 - 15	94%
3	6 - 10	94%

Week	Group Size	High Read
6	1 - 5	93%
7	1 - 5	93%
1	1 - 5	96%
9	1 - 5	96%
11	16 - 25	99%
2	16 - 25	100%
3	75+	100%
4	26 - 35	100%
5	16 - 25	100%
8	36 - 55	100%
10	26 - 35	100%

Week	Average
6	87%
7	91%
1	92%
8	93%
5	93%
4	94%
9	95%
11	96%
2	96%
10	97%
3	97%

There were several occurrences where the high weekly rate was 100 percent on the larger group sizes. Eighty-eight percent of the low reads were in groups of six to 15. In week six, the average accuracy dropped significantly as a result of 14 groups of 129 animals with low read accuracy without an identifiable cause. However, in week seven, the tag factors that were observed would have adjusted the read accuracy up to 93 percent from 91 percent. The average accuracy fluctuated by 10 percent but there was only one week in 11 where the accuracy was below 90 percent.

Chart 42: Average daily read accuracy

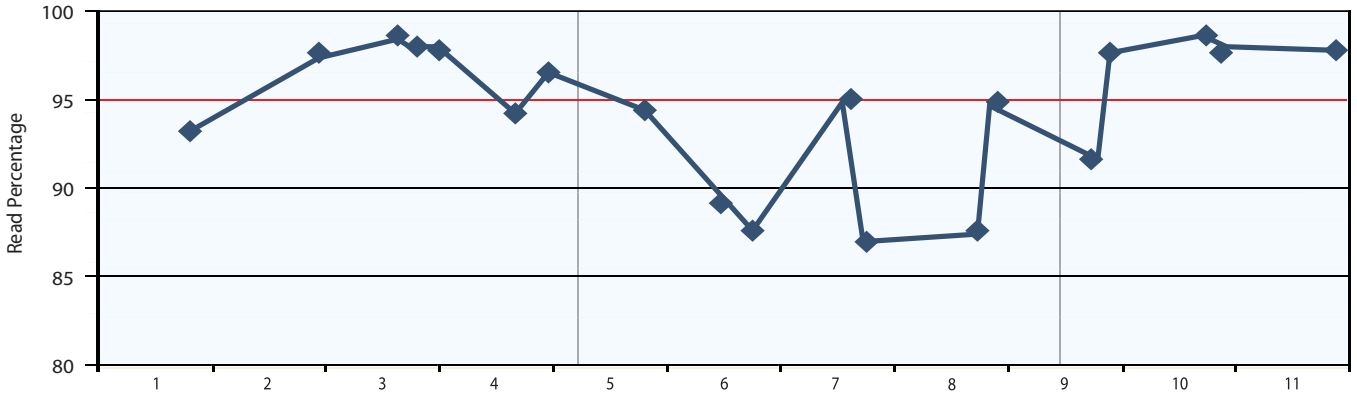


Chart 43: Average weekly read accuracy on all cattle

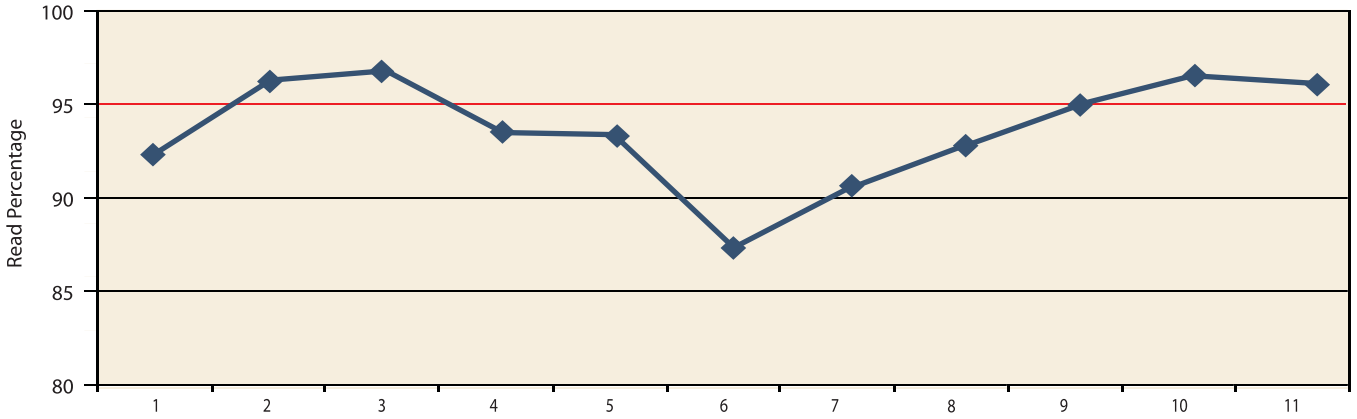


Chart 43: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	94	250	231	92%
2	307	894	862	96%
3	435	1,321	1,280	97%
4	600	2,275	2,130	94%
5	104	319	298	93%
6	137	389	340	87%
7	418	1,879	1,702	91%
8	589	1,771	1,646	93%
9	466	1,520	1,444	95%
10	559	2,157	2,086	97%
11	511	1,800	1,731	96%

Ascending	
Week	**Read Accuracy**
6	87%
7	91%
1	92%
8	93%
5	93%
4	94%
9	95%
11	96%
2	96%
10	97%
3	97%

The overall weekly accuracy was 94.3 percent, with a variance of 10 percent between the weekly high and lows. In eleven weeks of scanning, there was 24 percent (203) identified issues with tags. This would have adjusted the read accuracy by 1.4 percent.

Saskatoon Livestock Sales

Large Volume Market

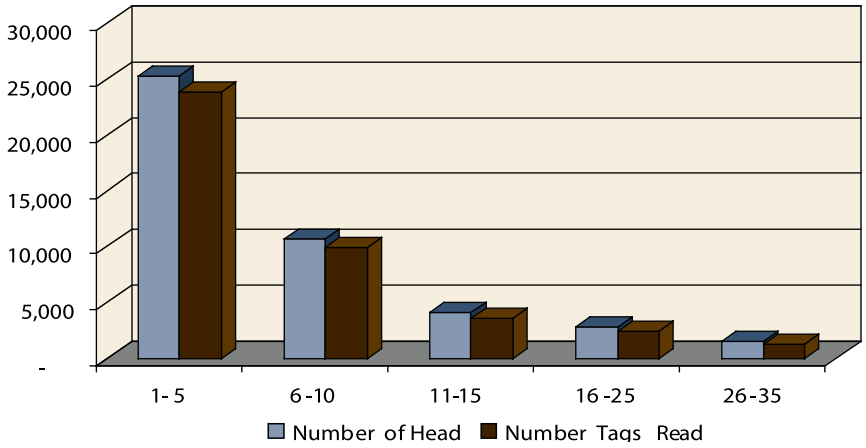
This market was equipped with an eight panel, wide alley (five foot) RFID system with an 18 foot alley at the exit from the sale ring. Scanning took place three days a week throughout an 11 week period and there were more cattle in this test than any other market.

Table 44: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 10	96.9%	16,008	35,978	81%	33,709	94%
11 - 75+	3.1%	517	8,404	3%	7,364	88%
Summary	**100%**	**16,525**	**44,382**	**100%**	**41,073**	**93%**

Almost 97 percent of the groups are less than 11 cattle, accounting for 81 percent of the total volume and 58 percent of all cattle are in groups of one to five. Throughout the test, which consisted of 33 days and 16,525 groups, there were only 39 groups of more than 26 animals.

Chart 45: Summary of read accuracy by group size over test period



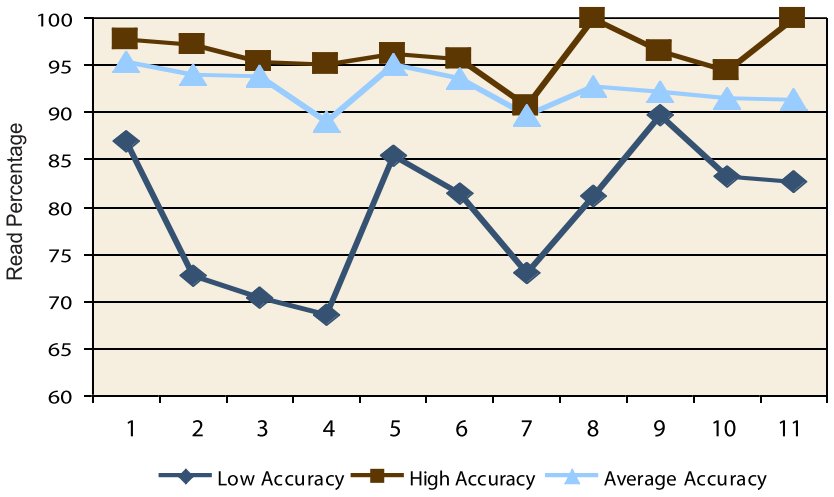
The highest number of animals sold in the market are in group sizes of one to five, with a distant following of groups of six to 10. This system had an average overall read rate accuracy of 93 percent and is consistent in small groups of less than 11. In groups of more than ten, the read accuracy drops to 90 percent and below, yet because this group size is such a small segment of the entire cattle population at the market, the average read rate stays high at 93 percent.

Chart 45: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	25,258	14,550	94%
6 - 10	10,720	1,458	92%
11 - 15	4,063	325	90%
16 - 25	2,860	153	86%
26 - 35	1,481	24	86%
Summary	**44,382**	**16,525**	**93%**

Group Size	Ascending Read Accuracy
26 - 35	**86%**
16 - 25	**86%**
11 - 15	**90%**
6 - 10	**92%**
1 - 5	**94%**

Chart 46: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

The average weekly accuracy fluctuated by six percent week over week from a low of 89 percent to a high of 95 percent with only one week below 90 percent. The high read had an accuracy variance of nine percent, yet in 73 percent of the weeks the read accuracy was 95 percent and over. The low had the highest fluctuation from 69 to 90 percent.

Table 47: High, low, average by group size, ascending

Week	Group Size	Low Read
4	16 - 25	69%
3	26 - 35	70%
2	26 - 35	73%
7	36 - 55	73%
8	16 - 25	81%
6	16 - 25	81%
11	16 - 25	83%
10	26 - 35	83%
5	36 - 55	85%
1	26 - 35	87%
9	56 - 75	90%

Week	Group Size	High Read
7	1 - 5	91%
10	36 - 55	94%
4	1 - 5	95%
3	1 - 5	96%
6	6 - 10	96%
5	1 - 5	96%
9	26 - 35	97%
2	1 - 5	97%
1	1 - 5	98%
8	36 - 55	100%
11	26 - 35	100%

Week	Average
4	89%
7	90%
11	91%
10	92%
9	92%
8	93%
6	94%
3	94%
2	94%
5	95%
1	95%

It must be noted that the largest group size in this market is the one to 10 with 97 percent of all groups and 82 percent of the animals. The low read rate was never in this group size throughout the test period, yet in seven of the 11 weeks, this group size was the highest read accuracy. The lowest read rates were recorded in weeks three and four and were a result of mechanical failure with variances from 69 to 95 percent and 70 to 96 percent. The weekly high and low accuracy by group size showed a 26 percent variance.

Chart 48: Average daily read accuracy

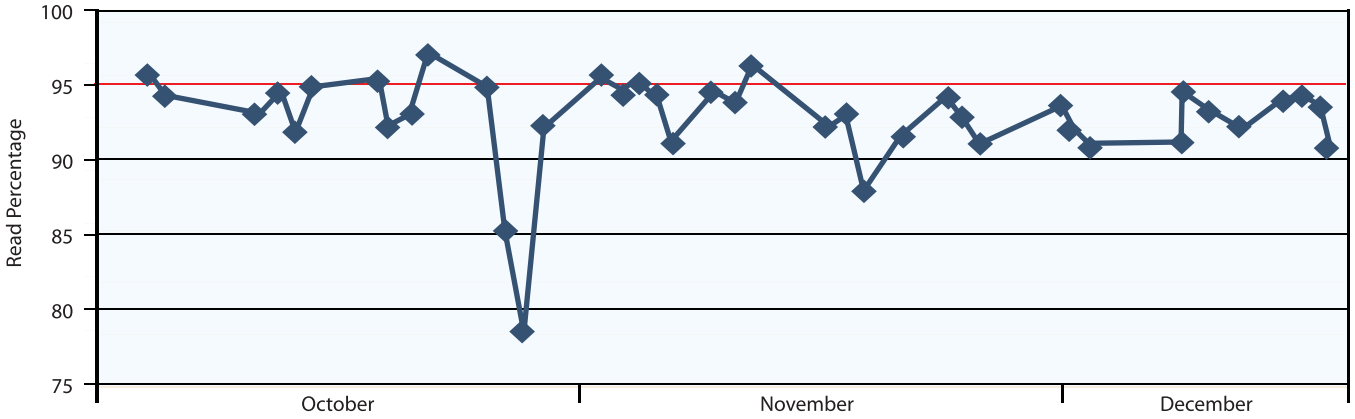


Chart 49: Average weekly read accuracy on all cattle

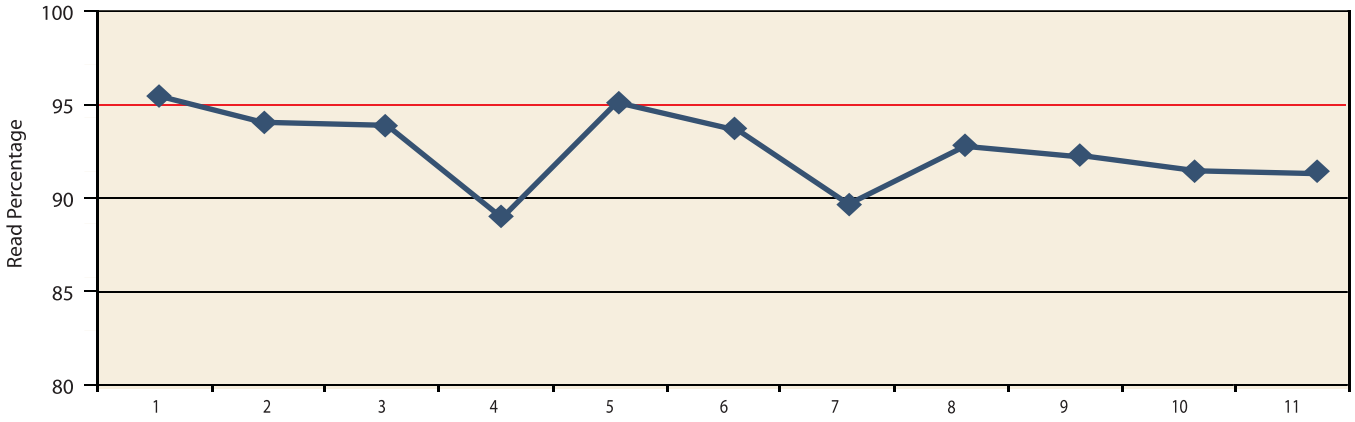


Chart 49: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	1,008	2,779	2,651	95%
2	1,747	5,246	4,931	94%
3	1,528	3,782	3,553	94%
4	1,450	3,663	3,261	89%
5	1,845	4,711	4,480	95%
6	867	2,526	2,368	94%
7	1,954	4,885	4,383	90%
8	1,473	3,678	3,415	93%
9	1,829	4,520	4,171	92%
10	1,775	5,721	5,235	92%
11	1,049	2,871	2625	91%

Ascending	
Week	Read Accuracy
4	89%
7	90%
11	91%
10	92%
9	92%
8	93%
6	94%
3	94%
2	94%
5	95%
1	95%

This market had at least three scanning days per week for the 11 week test period and had a 93 percent overall read accuracy. The drop in the accuracy in late October was a result of a loose connection to the read antennas. The November drop below 90 percent was because of higher than normal group sizes and a large number of bar code tags. Throughout the 11 weeks of scanning, 17 percent (548) of the missed reads were a result of tag factors. This would have adjusted the read accuracy by 1.3 percent.

Whitewood Livestock

Medium Volume Market

This market was equipped with an eight panel, wide alley (five foot) RFID system with an 18 foot alley. The system was located after the sale ring and scanning took place one day a week on sale day. Due to manpower issues, there was one week of scanning missed of the 11 in the test period.

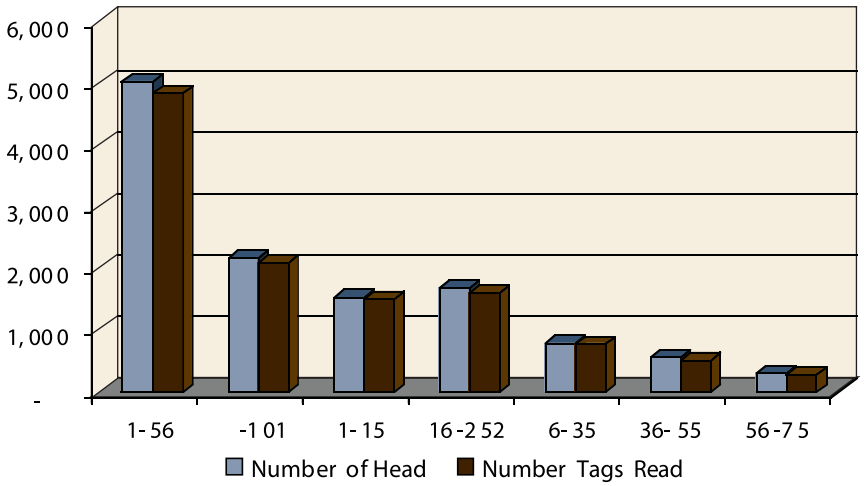
This was the only market in the research project that presorts and comingles groups of cattle the day before the sale. The cattle were processed through the RFID system on presort days and the number of tags read were collected from the readers. On sale days the cattle were scanned and the number of tags read from the same groups of cattle were compared day over day. There was an inconsequential difference on the read accuracy with a high variance of 0.4 percent which is approximately one to five tags.

Table 50: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 10	93%	3,409	7,187	60%	6,945	97%
11 - 75	7%	249	4,866	40%	4,655	96%
Summary	**100%**	**3,658**	**12,053**	**100%**	**11,600**	**96%**

Ninety-three percent of the groups in this market were in the one to 10 segment, accounting for 60 percent of the total animals. Throughout the test period there were only 18 groups with more than 25 animals.

Chart 51: Summary of read accuracy by group size over test period



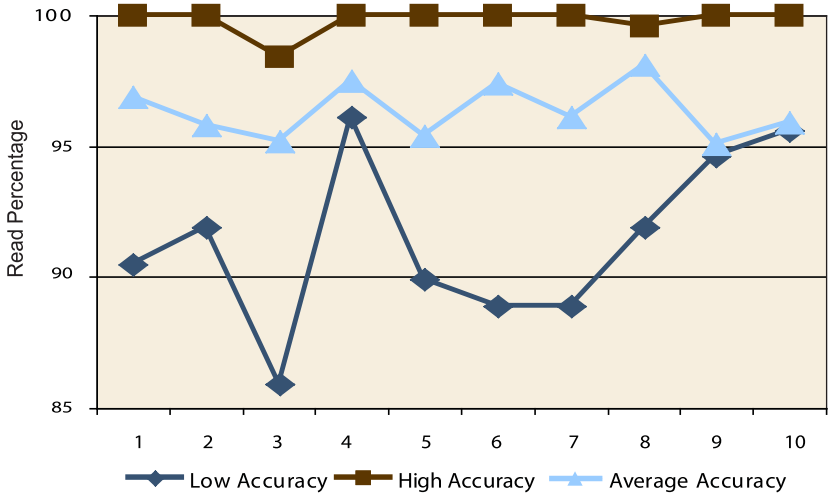
The one to five group size has by far the highest number of animals; other group sizes are less than half. The read accuracy was consistently high in all group sizes, with an average overall accuracy of 96 percent. The read accuracy drops slightly in groups of more than 35 animals. Due to the higher group sizes being such a small segment of the overall population in the market, the read rates stay high overall.

Chart 51: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	5,023	3,127	96%
6 - 10	2,164	282	97%
11 - 15	1,529	119	98%
16 - 25	1,691	85	94%
26 - 35	794	27	98%
36 - 55	547	13	92%
56 - 75	305	5	91%
Summary	**12,053**	**3,658**	

Group Size	Ascending Read Accuracy
56 - 75	**91%**
36 - 55	**92%**
16 - 25	**94%**
1 - 5	**96%**
6 - 10	**97%**
26 - 35	**98%**
11 - 15	**98%**

Chart 52: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

The average read accuracy only had a three percent spread from a low of 95 percent to a high of 98 percent. The high weekly read was almost consistently 100 percent, with only one day being 98 percent. The low read range fluctuated by 10 percent from a low of 86 percent to a high of 96 percent.

Table 53: High, low average read rates by group size, ascending

Week	Group Size	Low Read
3	56 - 75	86%
6	36 - 55	89%
8	36 - 55	89%
5	16 - 25	90%
1	16 - 25	91%
2	16 - 25	92%
9	36 - 55	92%
10	1 - 5	95%
11	1 - 5	96%
4	1 - 5	96%

Week	Group Size	High Read
3	11 - 15	98%
9	6 - 10	100%
1	26 - 35	100%
2	36 - 55	100%
4	26 - 35	100%
5	56 - 75	100%
6	16 - 25	100%
8	56 - 75	100%
10	16 - 25	100%
11	6 - 10	100%

Week	Average
10	95%
3	95%
5	95%
2	96%
11	96%
8	96%
1	97%
6	97%
4	98%
9	98%

Groups of one to 10 make up 93 percent of the total groups in this market. The low reads are primarily in group sizes of 35 to 75 but these groups also account for many of the high read rates over the test period. The low reads in week three were attributed to animal behaviour as a result of larger groups.

Chart 54: Average weekly read accuracy on all cattle

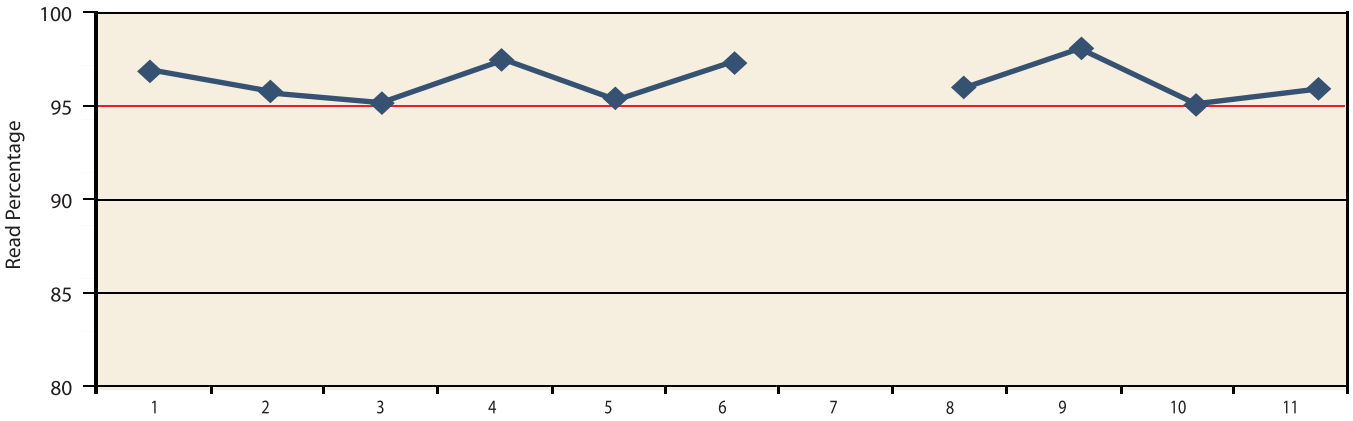


Chart 54: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	395	864	837	97%
2	300	1,243	1,191	96%
3	515	2,107	2,005	95%
4	342	1,070	1,043	98%
5	363	1,757	1,677	95%
6	151	643	626	97%
8	358	1,711	1,645	96%
9	435	1,524	1,495	98%
10	574	841	800	95%
11	225	293	281	96%

Ascending	
Week	Read Accuracy
10	95%
3	95%
5	95%
2	96%
11	96%
8	96%
1	97%
6	97%
4	98%
9	98%

The overall weekly accuracy was 96.2 percent, the highest of all the wide alley systems, with a weekly variance of three percent. Throughout the 10 week period, there were 13 percent (60) missed reads which could be attributed to a tag factor. This would have adjusted the overall accuracy by only .05 percent.

Spiritwood Stockyards

Small Volume Market

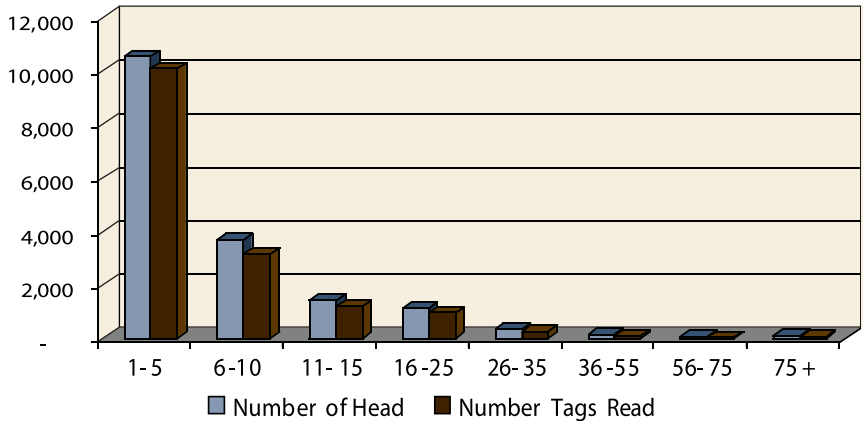
This market was equipped with an eight panel, wide alley (five foot) RFID system with an eighteen foot alley at the exit to the sale ring. The data on the number of groups in the one to five category is not accurate as a result of a data recording error.* Scanning took place on sale days throughout the 11 weeks of the research project.

Table 55: Overview of accuracy by group size over the test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 10	94%	2,945*	14,222	82%	13,212	93%
11 - 75+	6%	190	3,196	18%	2,581	81%
Summary	**100%**	**3,135**	**17,418**	**100%**	**15,793**	**91%**

The highest percentage of animals (82 percent) sold are in the one to 10 group size. This group also maintains a 93 percent level of accuracy. In the larger groups, with 18 percent of the total animals, the accuracy drops by 12 percent to 81 percent providing an overall accuracy of 91 percent. The small group sizes are indicative of the location of the RFID system after the sale ring.

Chart 56: Summary of read accuracy by group size over test period



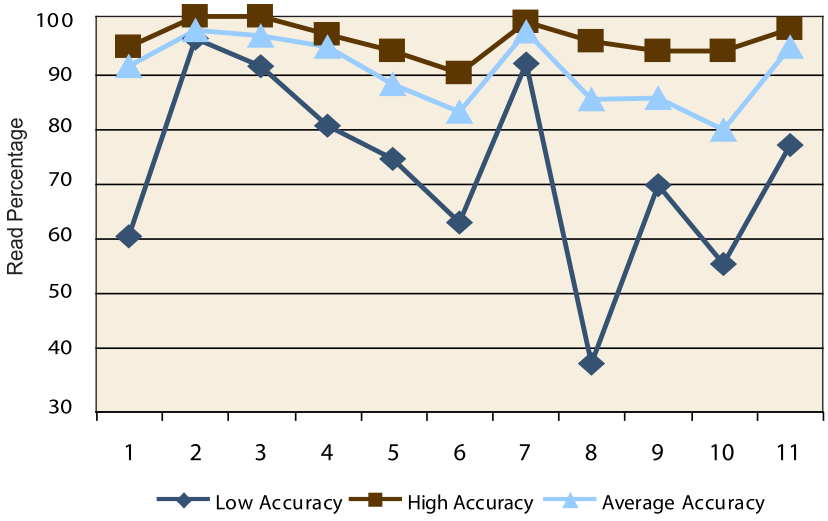
The largest volume of cattle were sold in groups of one to five, followed by groups of six to 10. The other group sizes are inconsequential. As indicated in the ascending read accuracy, the read accuracy is high in the lower groups of one to five but drops consistently as the group sizes increase. The reason for a 91 percent overall accuracy is the higher rates in the smaller groups, which make up the bulk of the animal population at the market.

Chart 56: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	10,547	2,453	96%
6 - 10	3,675	492	86%
11 - 15	1,438	114	83%
16 - 25	1,127	59	84%
26 - 35	324	11	80%
36 - 55	149	4	61%
56 - 75	61	1	69%
75+	97	1	55%
Summary	**17,418**	**3,135**	**91%**

Group Size	Ascending Read Accuracy
75+	**55%**
36 - 55	**61%**
56 - 75	**69%**
26 - 35	**80%**
11 - 15	**83%**
16 - 25	**84%**
6 - 10	**86%**
1 - 5	**96%**

Chart 57: High, low, average read accuracy weekly



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

The high read accuracy is relatively consistent with all but one week at 94 percent and above. The low read accuracy is what causes the dramatic fluctuations with a low of 39 percent and a 57 percent variance. The weekly average has an 18 percent variance from 80 to 98 percent caused by the dramatic shifts in the low read range.

Table 58: High, low, average by group size, ascending

Week	Group Size	Low Read
8	36 - 55	39%
10	26 - 35	56%
1	36 - 55	61%
6	16 - 25	64%
9	6 - 10	70%
5	6 - 10	75%
11	6 - 10	77%
4	36 - 55	81%
3	11 - 15	91%
7	26 - 35	92%
2	6 - 10	96%

Week	Group Size	High Read
6	1 - 5	90%
9	1 - 5	94%
10	1 - 5	94%
5	1 - 5	94%
1	1 - 5	95%
8	1 - 5	96%
4	1 - 5	97%
11	1 - 5	98%
7	1 - 5	99%
2	16 - 25	100%
3	26 - 35	100%

Week	Average
10	80%
6	83%
8	855
9	86%
5	88%
1	91%
11	95%
4	95%
3	97%
7	97%
2	98%

The highest reads were consistently in the one to five group size, but this could be a result of being the largest segment in the market. The low reads were primarily in the higher group sizes and had dramatic variances. In week one, there was a 34 percent variance high to low read accuracy for the day as a result of one group of 36 cattle with a 61 percent read. In week ten, there was a 38 percent variance as a result of a 56 percent read in one group of 32 cattle. None of these missed reads had an identified cause. This market had significant fluctuations in the weekly read accuracy, especially in higher group sizes. The cause of these missed reads has not been identified.

Chart 59: Average weekly read accuracy on all cattle

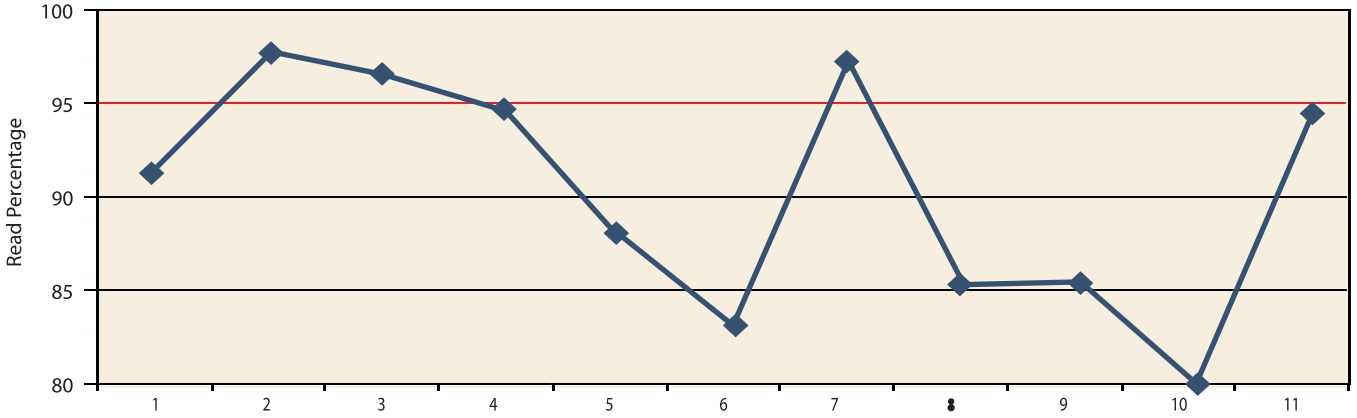


Chart 59: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	1,475	4,820	4,399	91%
2	458	1,318	1,286	98%
3	212	1,042	1,007	97%
4	175	1,370	1,297	95%
5	159	1,629	1,435	88%
6	112	961	800	83%
7	162	1,909	1,856	97%
8	138	1,760	1,501	85%
9	99	1,001	856	86%
10	98	1,132	906	80%
11	47	476	450	95%

Ascending	
Week	Read Accuracy
10	80%
6	83%
8	85%
9	86%
5	88%
1	91%
11	95%
4	95%
3	97%
7	97%
2	98%

The average overall read accuracy was 90.7 percent with the variance on weekly read accuracy of 18 percent. In 11 weeks of scanning, only .02 percent missed reads were identified as a tag factor. This would have not adjusted the overall accuracy.

Summary of Evaluation of Wide Alley Systems

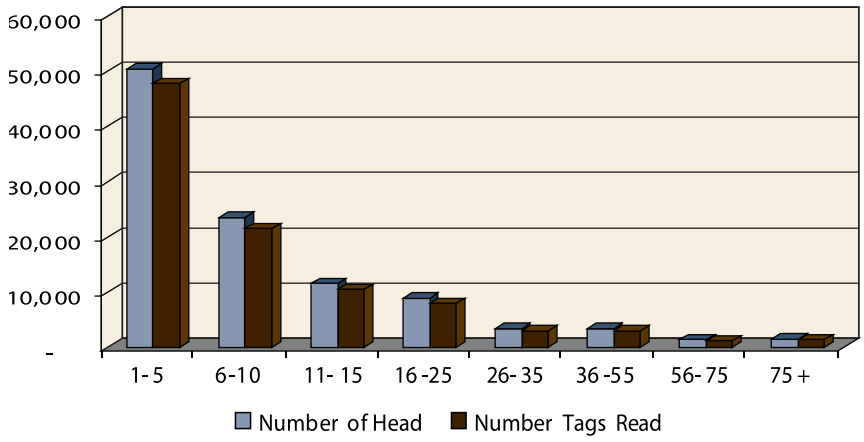
There were five wide alley systems in the research project; all systems had eight reader panels, three systems had alleys 18 feet long and two systems had alleys 32 feet long. Four of the systems were located at the sale ring (both before and after) and one system was at receiving. In total, there were 120 days of scanning. Please note that the number of groups in the one to five range are underestimated as a result of the data recording at Spiritwood; however, this will not have a significant impact on the accuracy of this group size due to the volumes at the other four markets in this segment. As such, the data recording errors in Spiritwood are not material to this data summary.

Table 60: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 10	95%	27,228	72,910	71%	68,369	94%
11 - 75+	5%	1,605	29,998	29%	26,843	89%
Totals/Ave	**100%**	**28,833**	**102,908**	**100%**	**95,212**	**93%**

The wide alley systems processed approximately four times more cattle than the dual alley systems and six times more than the single alley systems. With four of these systems located at the sale ring, and three of the largest volume markets, it is not surprising the highest percentage of animals was in the one to 10 range with more than 95 percent of the groups and 71 percent of the cattle. It is important to note that 49 percent of the cattle processed in this segment were in the one to five group size, followed by 23 percent in the six to 10 group size. The read accuracy in this group size was significantly higher than in the 11 to 75+ group size by a five percent variance.

Chart 61: Summary of read accuracy by group size over test period



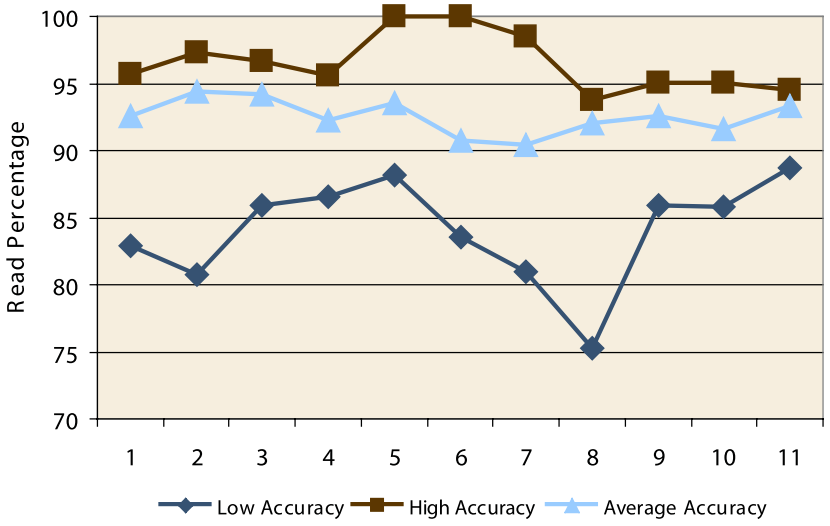
With a significant margin, most of the cattle were processed in groups of one to five, which also has the highest percentage read accuracy, followed by the six to 10 group size with the second highest read accuracy. Four of the five markets had inconsequential numbers in the 26 to 75+ group size. Variation in read accuracy by group size is eight percent. There is a definitive trend in higher read accuracy in the smaller groups with one to five group size at 96 percent, six to 10 group size at 93 percent and 11 to 15 group size at 91 percent.

Chart 61: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	49,763	24,122	96%
6 - 10	23,147	3,106	93%
11 - 15	11,484	913	91%
16 - 25	8,896	465	89%
26 - 35	3,371	112	90%
36 - 55	3,362	79	88%
56 - 75	1,338	21	89%
75+	1,547	15	90%
Summary	**102,908**	**28,833**	**93%**

Group Size	Ascending Read Accuracy
36 - 55	**88%**
56 - 75	**89%**
16 - 25	**89%**
26 - 35	**90%**
75+	**90%**
11 - 15	**91%**
6 - 10	**93%**
1 - 5	**96%**

Chart 62: High, low, average weekly read accuracy



High and low read accuracy is based on the read accuracy per one group for the day of scanning. The average read accuracy is based on the combined weekly totals of all groups.

The average weekly read accuracy varied only four percent from 90 to 94 percent. The high reads had a variance of six percent with all but one week more than 95 percent. Low rates, as always, had the highest fluctuation from a 75 to 89 percent.

Table 63: High, low, average by group size, ascending

Week	Group Size	Low Read
8	75+	75%
2	36 - 55	81%
7	36 - 55	81 %
1	36 - 55	83%
6	36 - 55	84%
10	26 - 35	86%
3	56 - 75	86%
9	75+	86%
4	16 - 25	87%
5	16 - 25	88%
11	16 - 25	89%

Week	Group Size	High Read
8	1 - 5	94%
11	1 - 5	95%
9	26 - 35	95%
10	56 - 75	95%
4	1 - 5	96%
1	1 - 5	96%
3	1 - 5	97%
2	1 - 5	97%
7	56 - 75	99%
5	56 - 75	100%
6	75+	100%

Week	Average
7	90%
6	91%
10	92%
8	92%
4	92%
1	93%
9	93%
11	93%
5	94%
3	94%
2	94%

It is not surprising that there were more high read rates in the one to five group than any other due to the volume of this group size in this segment. The low reads in larger group sizes indicates that these systems do not manage accuracy in large groups as effectively as in smaller groups. There was an 18 percent spread between high and low in week seven and a 19 percent spread in week eight.

Chart 64: Average weekly read accuracy on all cattle

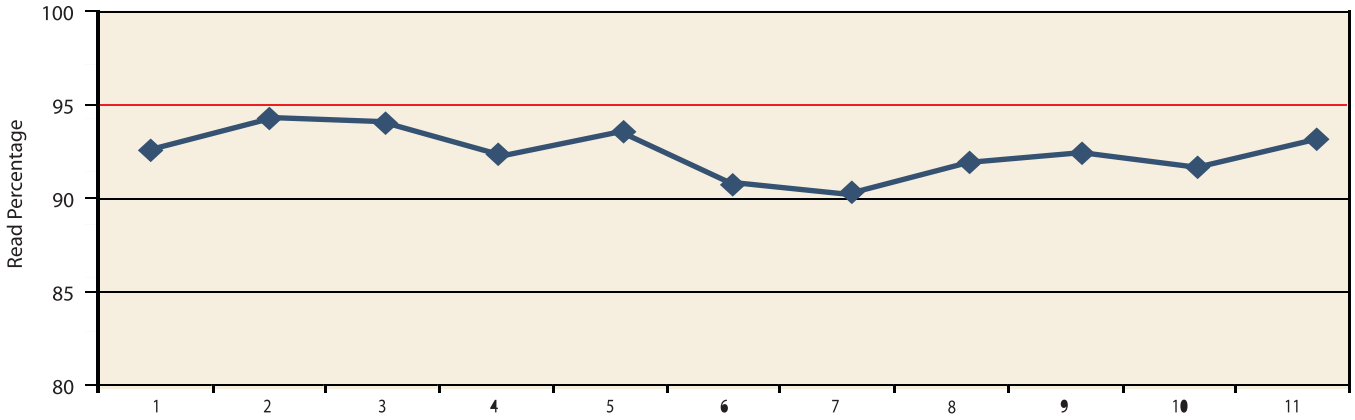


Chart 64: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	3,074	10,085	9,340	93%
2	2,941	10,169	9,594	94%
3	2,828	10,119	9,520	94%
4	2,648	9,317	8,606	92%
5	2,523	8,838	8,272	94%
6	1,401	6,126	5,563	91%
7	2,678	10,384	9,381	90%
8	2,724	10,590	9,740	92%
9	2,955	9,887	9,150	93%
10	3,147	11,277	10,344	92%
11	1,914	6,116	5,702	93%

Ascending	
Week	Read Accuracy
7	90%
6	91%
10	92%
8	92%
4	92%
9	93%
1	93%
11	93%
5	94%
3	94%
2	94%

The overall accuracy was 92.5 percent with a variance of four percent from weekly high to low. Throughout the total of 120 days of scanning, there were 11 percent (891) identified tag factors; this would have adjusted the overall read accuracy by one percent.

SUMMARY

The wide alley system achieved an overall read accuracy of 93 percent through scanning more than 104,000 cattle over 120 days. It is important to note that this read accuracy is skewed by systems at the sale ring where the cattle were processed primarily in groups of one to five animals (high accuracy of 96 percent and a low of 91 percent). Variations in read accuracy are as follows:

	Low Read	High Read	Variance
By group size	88%	96%	8%
By week	90%	94%	4%
Throughout the day	75%	100%	25%

There is no correlation between low read accuracy and total number of head in a week. Many of the high accuracy weeks processed more than 10,000 cattle. The most obvious trend is the lower average accuracy in the higher group sizes. It was noted that in the groups of one to five the read accuracy was 95 percent. Read accuracy dropped below 90 percent in groups of more than 16 and bottomed out at 87 percent in groups of 36 to 55. The exception was the 75+ group which had 90 percent accuracy but consisted of only two percent of all animals in 15 groups. The lower read accuracy in groups of more than 10 only accounts for five percent of the total groups; as such, read accuracy stays above 93 percent. This system has a high read accuracy at the sale ring in groups of less than six cattle with a 95 percent accuracy in groups of six to 10 at 92 percent accuracy decreased as the group sizes increased.

EVALUATION OF RFID SYSTEMS AT LOCATIONS WITHIN AUCTION MARKETS

RFID Systems Located at Receiving Area

There were five RFID systems located at the receiving area of the markets. Three were located in direct proximity to the unloading areas using wide and dual alley systems. The other two systems were located at the back of the market, but processed animals that were being received. This section only presents the data on the systems directly at the receiving area as there were a variety of systems utilized. The data on the other groups is exactly the same as the single alley system evaluation.

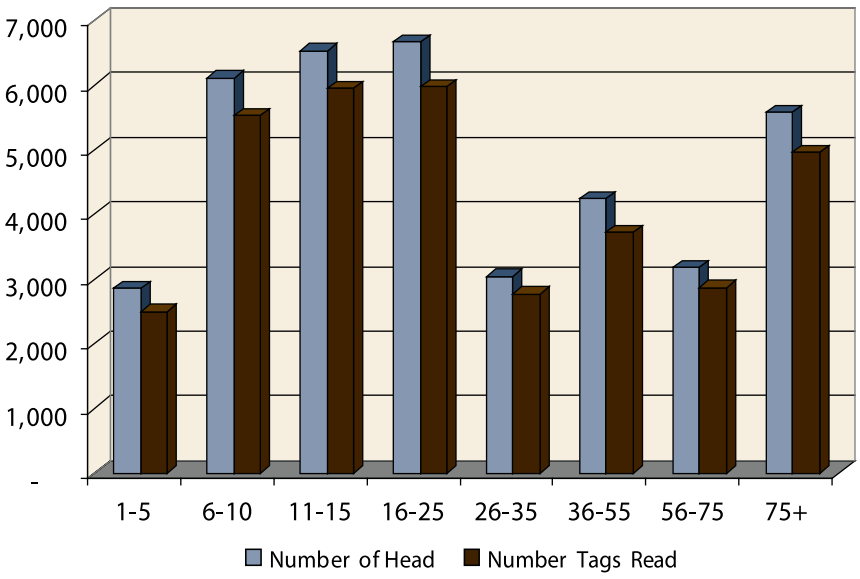
DIRECTLY AT RECEIVING ENTRANCE

Table 65: Overview of accuracy by group size over test period

Group Size	% Total Groups	# Groups	# Animals	% Total animals	# scanned	Read accuracy
1 - 25	90%	2,597	22,168	57%	19,953	90%
26 - 75+	10%	305	16,058	42%	14,333	89%
Totals/Ave	**100%**	**2,902**	**38,226**	**100%**	**34,286**	**89.7%**

As is consistent across the test project, the largest number of groups were less than 26 head, accounting for 90 percent of all groups. However, based on the receiving area of the market, the total number of animals is relatively equal with 57 percent in the one to 25 range and 42 percent in the 26 to 75+ range. The overall read accuracy varied little between the group sizes with an overall average of close to 90 percent. It is important to note that the three year old system in Kamloops is included in this group and it had the lowest overall read accuracy of 87 percent.

Chart 66: Summary of read accuracy by group size over test period



These systems are at the receiving area of the markets and, as such, the volume of cattle by group size is relatively evenly distributed across all categories. The variance on the read accuracy is only three percent across all groups. Groups of one to five have the largest number of groups, the smallest percentage of cattle and the lowest read accuracy of 88 percent.

Chart 66: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	2,851	968	88%
6 - 10	6,115	774	91%
11 - 15	6,530	514	91%
16 - 25	6,672	341	90%
26 - 35	3,044	101	91%
36 - 55	4,246	97	88%
56 - 75	3,184	49	90%
75+	5,584	58	89%
Summary	**38,226**	**2,902**	**90%**

Group Size	Read Accuracy
1 - 5	**88%**
36 - 55	**88%**
75+	**89%**
16 - 25	**90%**
56 - 75	**90%**
6 - 10	**91%**
11 - 15	**91%**
26 - 35	**91%**

Table 67: High, low and variance on read accuracy by processing

	Low Read	High Read	Variance
By group size	88%	91%	3%
By week	88%	92%	4%

Chart 68: Average weekly read accuracy on all cattle

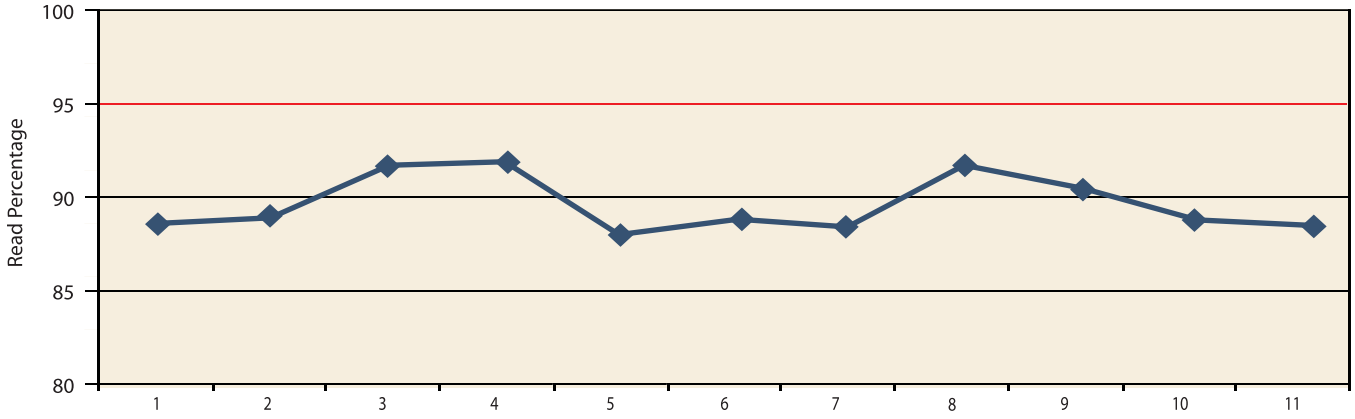


Chart 68: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	257	3,656	3,238	89%
2	302	4,196	3,731	89%
3	256	4,598	4,216	92%
4	233	3,470	3,189	92%
5	207	3,568	3,139	88%
6	281	3,918	3,483	89%
7	307	3,554	3,143	88%
8	324	3,553	3,257	92%
9	282	2,905	2,628	91%
10	286	3,265	2,898	89%
11	167	1,543	1,364	88%

Ascending	
Week	Read Accuracy
5	88%
7	88%
11	88%
1	89%
10	89%
2	89%
6	89%
9	91%
3	92%
8	92%
4	92%

The overall weekly average was 89.7 percent. The average weekly rate varied four percent overall from 88 to 92 percent, while 64 percent of the time there was a read accuracy of less than 90 percent. Of the missed reads 12 percent (496) were identified as tag factors, this would have adjusted the read accuracy by 1.3 to just over 91 percent.

SUMMARY

With 38,226 animals processed in 2,902 groups, the overall average accuracy was just under 90 percent. It must be noted that this segment presents the correlation of data on a new wide and dual alley system, plus a three year old dual alley system. The average read range on these systems was between 87 to 93 percent, a six percent variance. Had the older system not been included in the data collection the read rate would have exceeded 90 percent.

There is no correlation between total number of head and read accuracy, as some of the highest accuracy rates were in weeks with the highest number of animals and highest numbers of groups (week eight). Group size accuracy was relatively consistent, with a mere three percent variance, with no definitive pattern emerging.

There is a possibility that based on the animals being processed directly at the receiving area of the market, there may be a smaller percentage of animals that have RFID tags. This was noted by the Field Research Associates who attributed 1.3 percent of the missed reads to tag issues. Further, with group sizes roughly equally distributed among all categories, RFID systems at the receiving area must be able to continually support high read accuracy with larger group sizes.

RFID Systems at the Sale Ring

There were four, wide alley RFID systems located at the sale ring, three after the ring and one before.

Table 69: Overview of read accuracy over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 5	86%	23,661	48,384	55%	45,962	95%
6 - 10	10%	2,734	20,212	23%	18,531	92%
11 - 75+	3%	1,143	19,832	23%	17,723	89%
Summary	**100%**	**27,538**	**88,428**	**100%**	**82,216**	**93%**

It is evident that at this location, the majority of the animals are sold in groups of one to five. The actual number of groups is even higher than indicated due to the recording error in one market. As such, it is suggested that the percentage of total groups under five is closer to 95 percent. In this location groups of 10 and under are a significant driver of read accuracy. There is an overall read accuracy of 93 percent, with a high of 95 percent, dropping to 89 percent in group sizes of 11 to 75.

Chart 70: Summary of read accuracy by group size over test period

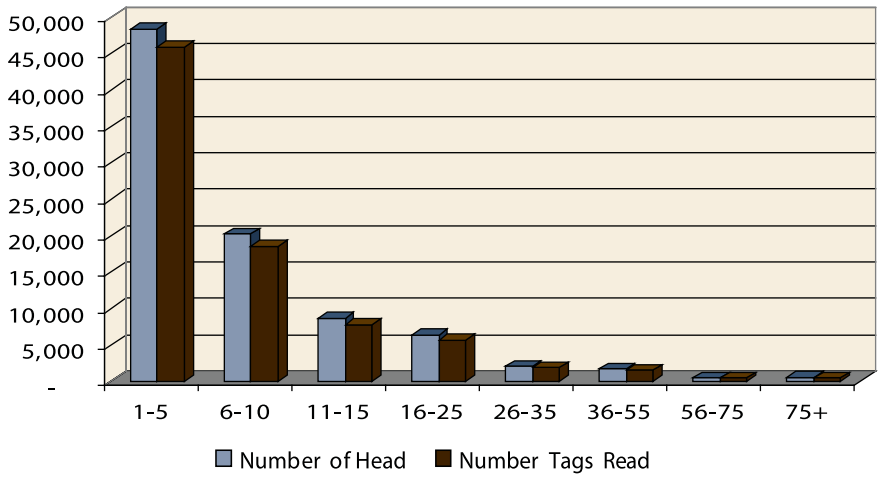


Chart 70: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	48,384	23,661	95%
6 - 10	20,212	2,734	92%
11 - 15	8,628	686	91%
16 - 25	6,402	335	88%
26 - 35	2,071	69	90%
36 - 55	1,700	40	88%
56 - 75	484	8	87%
75+	547	5	90%
Summary	**88,428**	**27,538**	**93%**

Group Size	Read Accuracy
56 - 75	**87%**
16 - 25	**88%**
36 - 55	**88%**
26 - 35	**90%**
75+	**90%**
11 - 15	**91%**
6 - 10	**92%**
1 - 5	**95%**

It is evident that the group size of one to five is the driver in this segment with 55 percent of the animals and 86 percent of all groups, followed by groups of six to 10 with 23 percent of all cattle. The group size of one to five have the highest accuracy at 95 percent followed by groups of six to 10 with 92 percent accuracy. Rates decrease with increased group size for a variance of eight percent. Groups of more than 10 constitute such a small percentage that their read accuracy does not materially affect the overall accuracy.

Table 71: High, low and variance on read accuracy by processing

	Low Read	High Read	Variance
By group size	87%	95%	8%
By week	92%	95%	3%

Chart 72: Average weekly read accuracy on all cattle

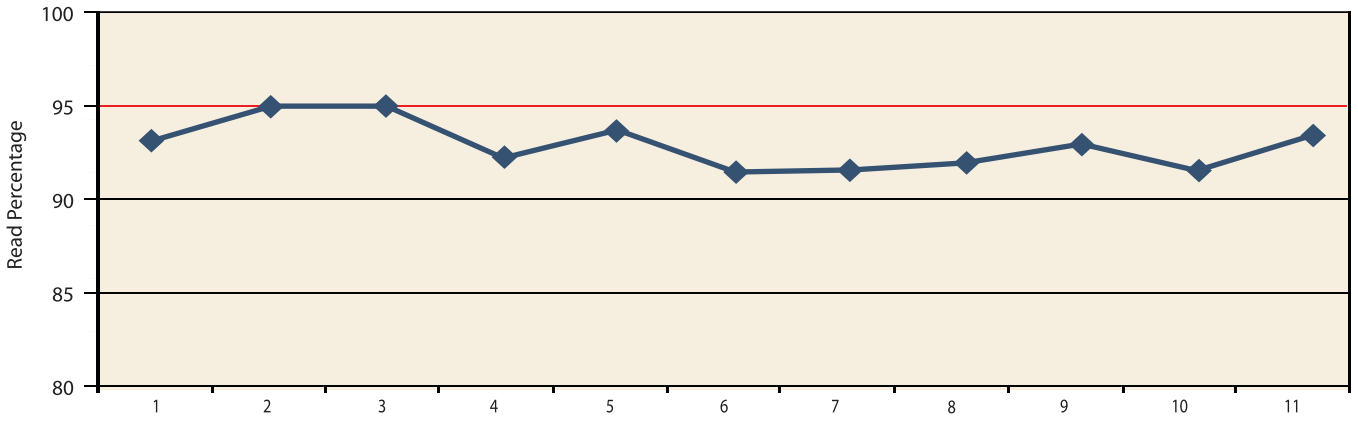


Chart 72: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	2,972	8,713	8,118	93%
2	2,812	8,701	8,270	95%
3	2,690	8,252	7,845	95%
4	2,567	8,378	7,731	92%
5	2,471	8,416	7,890	94%
6	1,267	4,519	4,134	92%
7	2,534	8,673	7,941	92%
8	2,558	8,920	8,207	92%
9	2,829	8,565	7,966	93%
10	3,006	9,851	9,027	92%
11	1,832	5,440	5,087	94%

Ascending	
Week	Read Accuracy
6	92%
7	92%
10	92%
8	92%
4	92%
9	93%
1	93%
5	94%
11	94%
2	95%
3	95%

The overall weekly accuracy was 93 percent, with a small three percent variance and a read accuracy from 92 to 95 percent.

SUMMARY

With 88,428 animals processed, this was the installation location with the largest segment of the research project. These systems had a 93 percent average weekly read accuracy, and only a three percent variance between the high of 95 and low of 92 percent. It is important to note that the individual, weekly, overall accuracy on the four systems in this location ranged from 90 to 96 percent.

There is no correlation between the number of head processed per week and read accuracy as one of the lowest weeks for total animals had a high read accuracy (week 11). Group size shows a definitive pattern indicating that larger groups have lower accuracy. Read accuracy drops three percent between groups of one to five and six to 10, followed by a further drop of five percent in the higher group categories.

There is a possibility that, based on these systems at the sale ring, there would be more animals with RFID tags. The Field Research Associates observed that 14 percent of missed reads were a result of tag issues. This would have affected the overall accuracy by less than one percent.

SUMMARY OF READ ACCURACY

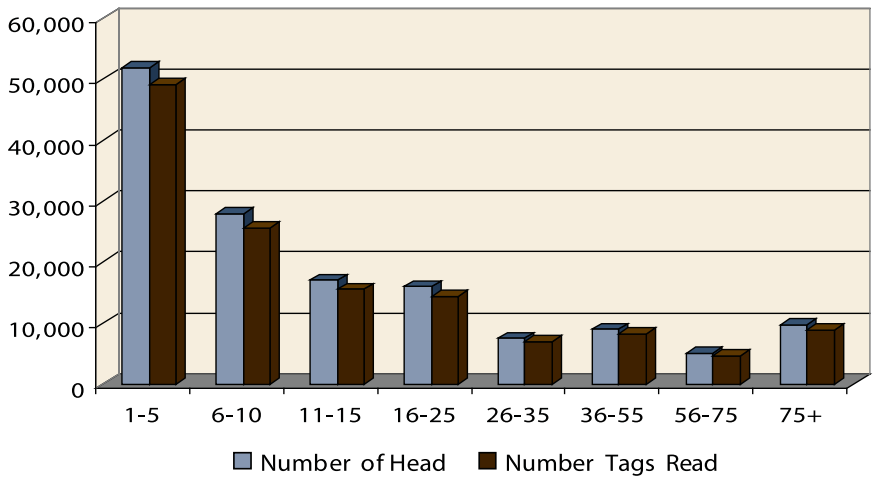
The objective for this segment of the research was to determine if RFID systems are currently commercially available and functionally viable to support accurate and efficient RFID tag reads of cattle at auction market facilities. The target of 95 percent or higher was set as a benchmark for a highly accurate read rate by the project team.

This project scanned more than 144,000 cattle in more than 31,000 groups throughout 11 weeks. This research found that commercially available RFID systems are not likely to support a consistent read accuracy of 95 percent or higher in an auction market environment without significant intervention. In this project, groups of cattle were only scanned once and that read accuracy recorded. There were not any additional measures taken to increase read accuracy in the groups recorded in this report.

Table 73: Overview of accuracy by group size over test period

Group Size	% of Total Groups	# Groups	# Animals	% of Total Animals	# Tags Read	Read Accuracy
1 - 5	79%	24,860	51,972	36%	49,159	94.6%
6 - 10	12%	3,714	27,969	19%	25,656	91.7%
11 - 75+	9%	2,802	64,256	44%	58,712	91.0 %
Summary	**100%**	**31,376**	**144,197**	**100%**	**133,527**	**92.6%**

Chart 74: Summary of read accuracy by group size



The systems located at the sale ring processed 61 percent of the cattle in the research project. As such, the group volumes skew to the lower sizes with seven percent of all cattle processed in groups of one to five. The read accuracy in that group size was the highest overall at 95 percent with a five percent variance in accuracy of all group sizes in the test. There wasn't a definitive pattern of read accuracy that emerged as groups of 16 to 25 had a read accuracy of 90 percent whereas groups of 56 to 75 had a read accuracy of 92 percent.

Chart 74: Data Table

Group Size	# Animals	# Groups	Read Accuracy
1 - 5	51,972	24,860	95%
6 - 10	27,969	3,714	92%
11 - 15	17,034	1,348	92%
16 - 25	15,966	823	90%
26 - 35	7,486	249	93%
36 - 55	9,024	206	91%
56 - 75	5,042	78	92%
75+	9,704	98	91%
Totals/Ave	**144,197**	**31,376**	**93%**

Group Size	Ascending Read Accuracy
16 - 25	**90%**
36 - 55	**91%**
75+	**91%**
11 - 15	**92%**
6 - 10	**92%**
56 - 75	**92%**
26 - 35	**93%**
1 - 5	**95%**

Chart 75: Average weekly accuracy: all cattle

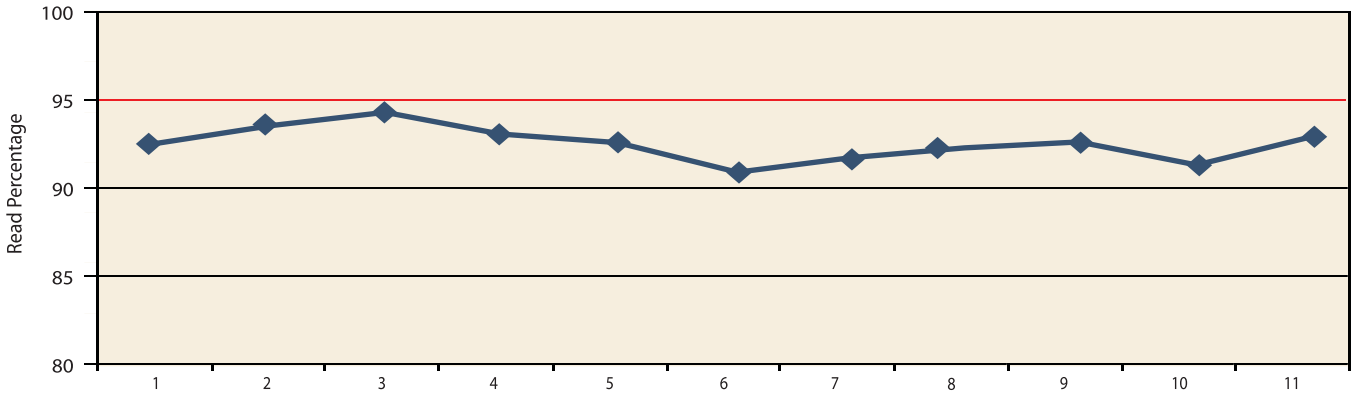


Chart 75: Data Table

Week	# Groups	# Animals	# Tags Read	Read Accuracy
1	3,316	13,881	12,846	92.5%
2	3,243	15,905	14,884	93.6%
3	3,068	15,081	14,243	94.4%
4	2,926	14,299	13,299	93.0%
5	2,748	13,445	12,455	92.6%
6	1,598	9,121	8,289	90.9%
7	2,966	14,899	13,667	91.7%
8	2,970	13,642	12,596	92.3%
9	3,159	12,219	11,314	92.6%
10	3,342	14,003	12,782	91.3%
11	2,040	7,702	7,152	92.9%

Ascending	
Week	Read Accuracy
6	90.9%
10	91.3%
7	91.7%
8	92.3%
1	92.5%
5	92.6%
9	92.6%
11	92.9%
4	93.0%
2	93.6%
3	94.4%

There wasn't a definitive pattern that could account for the 3.4 percent overall weekly variance over the eleven weeks of testing. It was originally thought that total volumes may have an impact. Yet, week three had the second largest volume of the test period and had the highest read accuracy. It was further considered that weather may be a contributing factor to low read accuracy. However, the coldest week of the test, week 11 (Dec. 14 - 20, 2009) had a read accuracy of 92.9 percent versus week one (Oct. 5 - 11, 2009) which had the warmest weather and a read accuracy of 92.5 percent. As follows are some specific temperature records and read accuracy for the week:

Kamloops

Read accuracy week 1: temperature 18C: read accuracy 85%
Read accuracy week 11: temperature -24C: read accuracy 90%

Whitewood

Read accuracy week 1: temperature 8C: read accuracy 97%
Read accuracy week 9: temperature -25C: read accuracy 98%

Saskatoon

Read accuracy week 3: temperature 5C: read accuracy 94%
Read accuracy week 8: temperature -27C: read accuracy 93%
Read accuracy week 11: temperature -30C: read accuracy 91%

Evaluation of All Systems

As is noted in the section on business process, each auction market is unique in its design, process flow and physical structure. It is not realistic to believe that any "one" configuration is the right system for RFID scanning at auction market facilities. This research project had the breadth and scope to predict RFID read accuracy in this multi-dimensional environment.

Table 76: Read accuracy highs and lows by type of system and location in market

	GROUP SIZE ACCURACY				WEEKLY ACCURACY				GLOBAL ACCURACY	
	Low Read	High Read	Variance	# Groups	Low Read	High Read	Variance	# Head	Average	% of Total
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%	17,543	97%	12%
All cattle	90%	95%	5%	31,736	91%	94%	3%	144,197	93%	100%

* same as single alley

The highest read accuracy was achieved with single alley systems with a 97 percent overall. The accuracy was relatively consistent across all group sizes and had a mere three percent variance week over week. One of the single alley systems had been constructed (by the vendor) three inch narrower than the standard specification which may have increased the read accuracy.

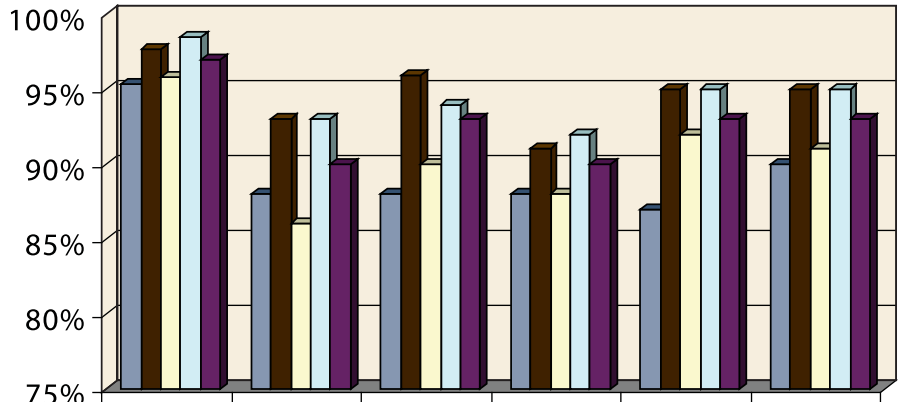
The second highest read accuracy was the wide alley systems that processed 72 percent of the total cattle in the test and achieved an overall accuracy of 93 percent with a four percent variance week over week. These systems had the highest variance per group size with eight percent low to high reads on 28,833 groups. There was a definitive trend that indicated high read accuracy in smaller groups (96 percent in groups of one to five) with accuracy decreasing as group size increased to more than 10.

The dual alley systems had the lowest read accuracy in the project with 90 percent overall with the largest weekly variance of seven percent. It must be noted that this group included one RFID system that was three years old. There wasn't any definitive trend that accounted for the five percent variance in read accuracy by group size.

The average read accuracy in each environment was more than 90 percent with an overall project read accuracy of 92.6 percent. It is important to note that read accuracy was not consistent in any of the markets, with highs and lows fluctuating by group, daily and weekly.

Variations in the high and low accuracy fluctuated based on the type of system by group at 10 percent and 13 percent weekly. On average the overall test fluctuated four percent by type of system and three percent based on where the system was located in the market. The variables on each system and location obviously drive the overall accuracy that the RFID systems will be able to achieve in an auction market environment.

Chart 77: Read accuracy highs and lows by type of system and location in market



	Single Alley	Dual Alley	Wide Alley	At Receiving	At Sale Ring	All animals
Group Low Read	95.40%	88%	88%	88%	87%	90%
Group High Read	97.70%	93%	96%	91%	95%	95%
Weekly Low Read	95.80%	86%	90%	88%	92%	91%
Weekly High Read	98.50%	93%	94%	92%	95%	95%
Average	97%	90%	93%	90%	93%	93%

If RFID systems are installed in auction markets outside a test environment, the data may be collected and disseminated electronically. As such, the read accuracy will be based on the total number of cattle processed over the course of one day; group size will not be relevant.

It must be noted that all of the equipment in this research project, with the exception of one dual alley system, was new and fully supported by the vendors. The levels of read accuracy achieved in this project may not be available in the market place without technical support and maintenance of the equipment on an ongoing basis. The FRAs were able to identify 13 percent of the missed reads attributable to tag issues, this would only have affected read accuracy by 0.6 percent.

In summary, it is not feasible to achieve a consistent read accuracy of 95 percent based on the unique characteristics in each market and multi dimensional environment in which they operate. Based on the equipment configurations in the test markets, this research summarized that global read accuracy of all animals, in all markets, equated to 90.9 to 94.4 percent over each week of the eleven week test period for a total accuracy of 92.6 percent.

BUSINESS PROCESS

Every auction market has a unique design configuration 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.

- 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.

As a result of site visits with the project manager, the vendors and market operators it was determined that three of the new installations would be prior to the sale ring, one would be after the sale ring and four would be at the receiving area. However, the vendors and market operators had further discussions and changed the configuration to: three systems after the sale ring, one prior to the sale ring and four at receiving. These selections were based on an area that required the least amount of structural change. Every effort was made to find a location that integrated with the normal flow of the cattle, yet this was not possible in all markets.

The Ontario Ministry of Agriculture, Food and Rural Affairs states that "Shrink results from the stress cattle experience during processing, transporting and marketing, costing both the buyer and the seller." [13] Stress reduces weight, which in turn reduces the value the cattle obtain in the auction ring.

"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 AFFECT. WELL-DESIGNED HANDLING FACILITIES WILL ALLOW CATTLE TO BE PROCESSED QUICKLY WHILE EXPERIENCING MINIMAL STRESS."[14]

Reducing the stress placed on the cattle in the auction market is an important consideration when choosing the RFID system design and location for the system 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.

Single Alley System

Single scanning alleys are 12 to 16 feet long and generally 30 inches to 32 inches wide, requiring the cattle to flow through single file. There are two to four panels depending on the length of the alley (See Appendix One). The scanning alley requires a significant amount of space in advance of the system to allow for funneling the cattle into the narrow alleys. If the market has a high volume of large cattle, this system may have a negative impact on the flow of the cattle through the system. Although the narrow alley has a high read accuracy, the single file system would not be efficient at a location at the sale ring due to the restrictive nature. This system can also lead to bruising as a result of hip-lock and the cattle pushing against the sides of the narrow alleys.

Dual Alley System

This system has two single alleys 30 to 32 inches wide and 12 feet long with a 30 inches wide island in the middle. There are two panels per alley for a total of four (See Appendix One). It requires a significant amount of space in advance of the system to allow for funneling the cattle into the narrow alleys. Cattle entering the alley two at a time decreases tag readability as the readers can only read one tag in the field at a time. This system may not be effective at a sale ring due to the amount of space required to funnel the cattle into the scanner alley and the restrictive nature of the single alley design. Dual alley systems can also lead to bruising as a result of hip-lock and the cattle pushing against the sides of the narrow alleys.

Wide Alley System

This system has five feet wide scanning alleys that are 18 to 32 feet long and are very effective in areas that require a high flow of cattle. Each side has four panels for a total of eight (See Appendix One). The width will allow cattle two to three wide depending on size. All sizes of cattle generally flow through these systems without impairment. However, read accuracy is affected in larger groups. The disadvantage to these systems is the cost and the amount of space required to construct the scanning alleys and the level of read accuracy on larger groups. The length of the alley can be a factor in selecting a location at the sale ring.

Location of the RFID System

Systems Located at the Sale Ring

All systems located at the sale ring were wide alley; one system was located prior to the sale ring and three directly off the sale ring. The following are the advantages and disadvantages at this location:

ADVANTAGES

1) At this stage in the process flow most cattle have RFID tags
2) This area is part of normal flow
3) Additional shrink is not a factor as the cattle do not have to move any further or have additional handling
4) Group size is generally smaller (one to five cattle per group) so read rates are higher
5) Cattle are often held in the scanning alley five to 10 seconds waiting for a pen to be chosen or the sale to complete. This behaviour will assist with higher read rates
6) Cattle are generally moving slowly through this area so they move into the scanning alley more efficiently
7) This area requires the least amount of infrastructure modification. The alleys entering or exiting the sale ring are generally 10 feet to 12 feet wide with sufficient length to funnel the cattle both in and out of the scanning alleys
8) In most cases, this location will not require additional personnel

DISADVANTAGES

1) If animals are not tagged at this stage there is little opportunity to tag them and resend them through the scanners without affecting the speed of commerce
2) The alleys require a significant amount of length which may be at a premium in this location
3) Single or dual alley systems at this location would likely slow the speed of commerce. However, these systems were not tested in this area of the market

Systems Located at the Receiving Area

Installations in this market location consisted of one wide alley and one dual alley system. The existing system is also located at the receiving area of the market. Pens were removed to construct the scanning alleys which allowed the main penning and sorting alleys to remain accessible. Additional holding pens were created to reduce potential delays for unloading cattle. The following are the advantages and disadvantages at this location:

ADVANTAGES

1) Cattle that have not been tagged can be moved to a tagging station before entering the scanning alley
2) If located directly at the receiving gates the process flow is not affected
3) Single or dual alley systems may support cattle flow at this location based on volumes

DISADVANTAGES

1) There is often more than one unloading area in the market to facilitate semi-trucks and ground-loading trailer trailers. With only one RFID system, the cattle need to be moved through the market to the scanning alley which requires additional manpower and also creates shrink
2) May impact the time it takes for a producer to unload cattle due to wait time inside the market penning cattle
3) The group sizes at receiving are larger which may lead to lower read accuracy in wide alley systems
4) If the producer does not identify the cattle as needing RFID tags, the cattle move through the alley with low read accuracy
5) May require additional personnel as penning can only be facilitated through one alley
6) May slow down receiving at peak times, with single and dual alley systems, due to the cattle moving through a narrower alley

Other Locations

In two markets, the system was located at the back of the market to scan the cattle from receiving to pre-sale pens. The systems were not directly at the receiving area.

DISADVANTAGES

1) These systems created a new leg in the business process due to not being integrated with normal process flow
2) Shrink became a major factor with the extended movement and handling of the cattle
3) Extensive additional man hours were required to move the cattle through another leg in the process flow

SPEED OF COMMERCE

Speed of commerce *is defined as: the time it takes to complete one cycle in a business process – or – the time it takes to complete an entire business process.*

RFID Systems Located at the Receiving Area

Killarney Auction Mart

The single alley RFID system was installed in an existing alley that is used to receive cattle off semi-trailers only (See Figure 1). The majority of cattle received arrive via ground load trailers at the other side of the market. This area was chosen to align with normal process flow as the cattle were moved to this area to be back tagged and processed prior to pre-sale penning. The single alley system required cattle to move in single file, which wasn't a problem in the original process configuration as the alleys were designed for single file.

Figure 1: This drawing is not intended to be an exact replica of the barn area and is not to scale.

The process flow was changed in the middle of the research project. The cattle were no longer back tagged and therefore didn't need to flow to the back of the market. With the system located in the receiving area, 50 percent of the groups were between one to 25 cattle and 50 percent of the groups were between 26 to 75+. The larger group sizes were encumbered by funneling into a narrow alley.

It must also be noted, due to this alley being constructed by the vendor to a width of only 29 inches, there were several larger cows and bulls that had to be backed out of the system as they would not fit through. There was a high risk of injury to cattle as a result of the narrow alley.

Before change in business process

Speed of commerce metric	Time from receiving to penning
Metric not moving through scanning alley	6.1 minutes per group
Metric moving groups through the scanning alley	6.1 minutes per group
Impact on speed of commerce	None
Financial impact	None

After change in business process

Speed of commerce metric	Time from receiving to penning
Metric not moving through scanning alley	2.3 minutes per group
Metric moving groups through the scanning alley	6.1 minutes per group
Impact on speed of commerce	Increased process time by 4.2 minutes per group Average 37 groups per day = 2.5 hours per day
Financial impact	7.5 man hours per day = $85 Average number of head per day 800 = $0.10 per head

The experience in this auction market displayed the importance of aligning the RFID system within a normal business process. Process changes to create efficiency should be evaluated prior to the installation of the RFID system.

Ste Rose Auction Mart

This single alley RFID system was installed in an existing alley at the back of the market in the middle of the process flow (See Figure 2). Cattle were received on both sides of the market and brought through the scanner at the back prior to the pre-sale penning inside the barn. One unloading chute was shut down to accommodate the flow through the scanners. There are twelve people that work penning cattle at this market.

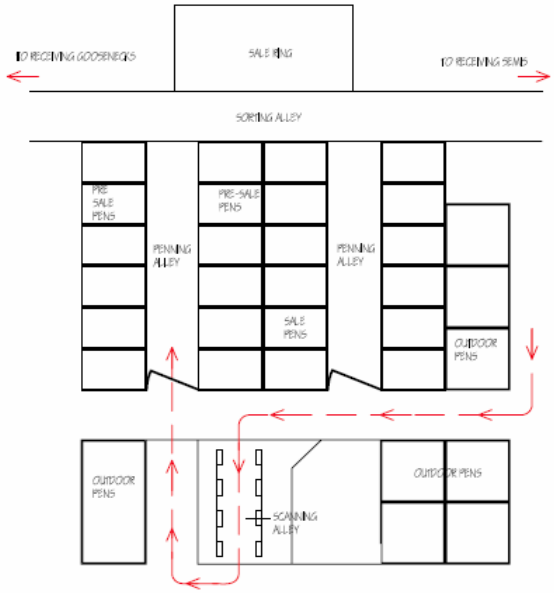


Figure 2: This drawing is not intended to be an exact replica of the barn area and is not to scale.

As a result of the single alley system, the cattle had to funnel from an alley that was 10 feet wide into an alley that is 32 inches wide. This system was located at receiving, therefore 84 percent of the groups were between one to 35 and 16 percent between 26 to 75+. The flow of larger groups was encumbered by the narrow alley. During the last two weeks of the test, only 25 to 35 percent of the cattle were scanned as a result of the negative impact on speed of commerce and the resulting financial impact on the market.

The factor that has not been evaluated, due to an insufficient benchmark and metric, is the waiting time producers faced due to the decommissioning of one of the unloading chutes that was required to facilitate a smooth flow of cattle through the scanning alleys.

Speed of commerce metric	Time from receiving to penning
Metric not moving through scanning alley	2.8 head per minute
Metric moving groups through the scanning alley	4.5 head per minute
Impact on speed of commerce	Increased process time by 60% = 3 hours per day
Financial impact	36 man hours per day = $432 Average number of head/1,500 per day = $0.29 per head

BC Coop Livestock Sales

This three year old, pre-existing, dual alley RFID system was located at the end of an incoming alley at the receiving area of the market (See Figure 3). This area was chosen to integrate with normal business process. Prior to the system installation the cattle could have been penned through several alleys. After the scanning system installation the cattle all had to flow through the scanner alley.

The market estimates that one part-time person is required two days a week to facilitate the movement of the cattle through the scanner alleys as a result of the bottleneck created by only having one access to pre-sale penning. As this is a dual alley system, only flow of the larger groups were encumbered.

The factor that has not been evaluated due to an insufficient benchmark and metric is the waiting time producers faced due to the slightly longer processing time on groups from ground-loading trailers.

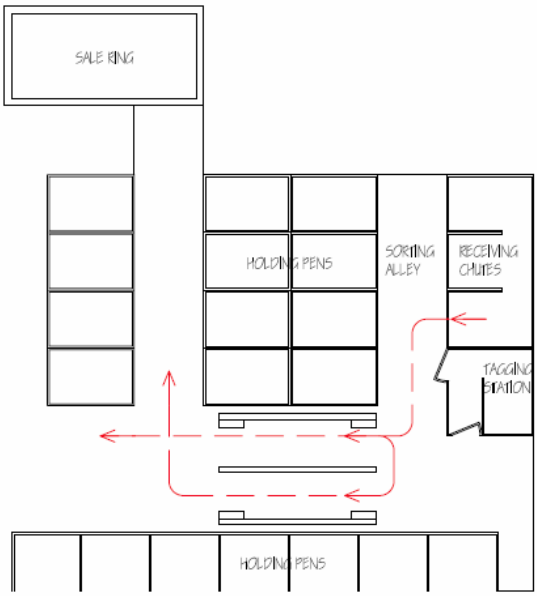


Figure 3: This drawing is not intended to be an exact replica of the barn area and is not to scale.

Speed of commerce metric	Time from receiving to penning
Metric <u>not</u> moving through scanning alley	7 - 10 minutes less on groups of 75+
Impact on speed of commerce	0 - 10 groups per day of 75+ cattle 7 - 10 minutes per group = maximum impact is 100 minutes per day On most days the impact would be 0 to 4 groups = 0 to 40 minutes per day
Financial impact	One part time person 2 days per week = $240 per week Average # head per week 1,120 = $0.21 per head

Gladstone Auction Mart

Holding pens were removed to install this dual alley, RFID system at the receiving area for ground loading trailers and trailers at the front of the market (See Figure 4). The receiving area for semis is at the back of the market. The area at the front was chosen, as the greatest number of cattle are received in this area and it integrated within business process.

The only change to business process was the cattle received on semi-trucks had to come through the market to be scanned. That process required coordination with the cattle being received at the front area of the barn to avoid collision in the main sorting alley. A maximum of three groups per day were received on semis.

Although there was additional time required to move the cattle through the scanners, the time was absorbed into the day and no additional hours were required.

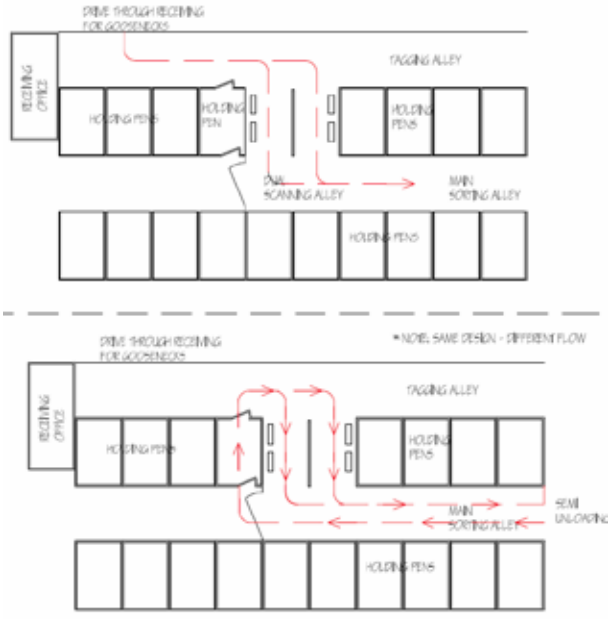


Figure 4: This drawing is not intended to be an exact replica of the barn area and is not to scale.

The factor that has not been evaluated due to an insufficient benchmark and metric is the waiting time producers faced due to the slightly longer processing time on groups from ground-loading trailer.

Speed of commerce metric	Time from receiving to penning
Metric not moving through scanning alley	1.67 minutes per group
Metric moving groups through the scanning alley	2.89 minutes per group from goosenecks 7 minutes per group from semi-trucks
Impact on speed of commerce	1.22 minutes per group x 86 groups = 105 minutes 7 minutes per group x 3 groups = 21 minutes Total of 126 minutes over a 9 - 12 hour day
Financial impact	None: no additional time was required for the day

Winnipeg Livestock Sales

Pens were removed to install this wide alley RFID system at the receiving area of the market that serves both ground loading trailers and semi-trucks (See Figure 5).

Ninety percent of the groups moved through the scanner alley and then back around to pre-sale penning. The entire alley is 60 feet long, requiring the cattle to move an additional 120 feet which is estimated to take an additional minute (30 seconds to 1.5 minutes). There were almost 1,300 groups through the course of the eleven weeks, with two sales per week. The highest number of groups on one day was 166. With ninety percent of those cattle having additional movement that would equate to over 2.5 hours over the course of one, nine to 12 hour day. The impact of this additional time would be felt during peak periods throughout the day when there were line ups for unloading.

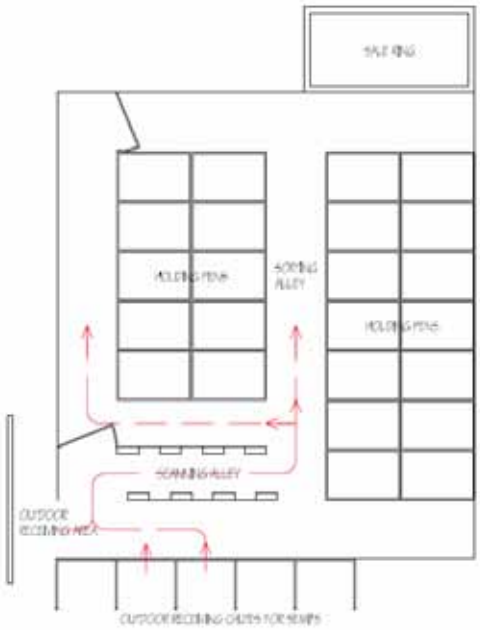


Figure 5: This drawing is not intended to be an exact replica of the barn area and is not to scale.

Speed of commerce metric	Time from receiving to penning
Metric moving through scanning alley	Additional one minute per group
Impact on speed of commerce	Maximum group number = 166 150 groups x 1 minute = 150 minutes over a 9 - 12 hour day
Financial impact	None: no additional time was required for the day

Summary of Impact on Speed of Commerce at Receiving Area

As was evidenced in the Killarney and St Rose auction markets, it is critical that the RFID system be located to align with business process flow. In both these cases, the RFID system created a new leg in process flow which dramatically affected the speed of commerce, shrink on the cattle and financial impact to the market. In both of these markets, extra personnel were required and the work day was extended by two to three hours to accommodate scanning the cattle through the RFID system.

In all markets with the RFID system at receiving, the groups took longer to pen when using the scanner alleys ranging from one minute per group to seven to 10 minutes for groups of more than 75 head. If a market has more than one receiving area, having only one RFID system creates another leg in the business process to move the cattle all through one system. The financial impact of the additional processing time is estimated to be between zero to $0.29 per head.

On receiving days with high volumes, there were times the cattle were penned rather than being brought through the RFID system to support efficient unloading. Additional handling always results in increased stress on the cattle and increased man hours. As a result of the extended time to pen the cattle, there were periods when the producers had to wait longer than normal to drop off the cattle in markets with single and dual alley systems. It is difficult to measure that impact without benchmarks and metrics but it is a viable concern for the markets that cannot be underestimated.

Shrink was a concern in markets where the cattle had additional handling as a result of moving further through the markets to pre-sale pens. This varied from a significant impact as in Ste Rose, to a minimal impact in the other markets. In markets where there were more than one receiving area, the impact on shrink was greater as cattle had to move a greater distance to be scanned before penning.

It was only in the markets where the system was integrated with business process that there were no additional hours added to the work day. It was only in Killarney and Ste Rose that additional staff were required as a result of the RFID system. Kamloops had an existing three-year-old system and had determined that one additional part-time person was required for the two days of receiving as a result of bottlenecks created by the RFID system.

RFID Systems Located at the Sale Ring

Ontario Stockyards

Unused pens were removed to install this wide alley, RFID system that ran parallel to the original alley leading directly to the sale ring (See Figure 6). A hydraulic gate was installed at the scale entrance to eliminate the need for a person opening and closing the gate at the end of the scanning alley. The system was completely integrated with business process flow as the cattle had to move through the alley to the sale ring.

As a result of the installation of the system, the market hired one additional person to support safety and the speed of commerce. The speed of commerce, time to sell one draft, was not affected on all cattle other than those from Quebec.

This market is unique in that it sells cattle from Québec that are registered with the Agri-Traçabilité Québec (ATQ) program. The ATQ program requires that all tags must be recorded to align with the buyer and seller. The market utilized the RFID system to capture and track the tag numbers from the Quebec producers. Cattle were held in the scanning alley for several minutes and moved up and down the alley in an attempt to capture 100 percent of the RFID numbers. There were several days when read accuracy was as high as 100 percent on these groups, but the overall total was 92 percent.

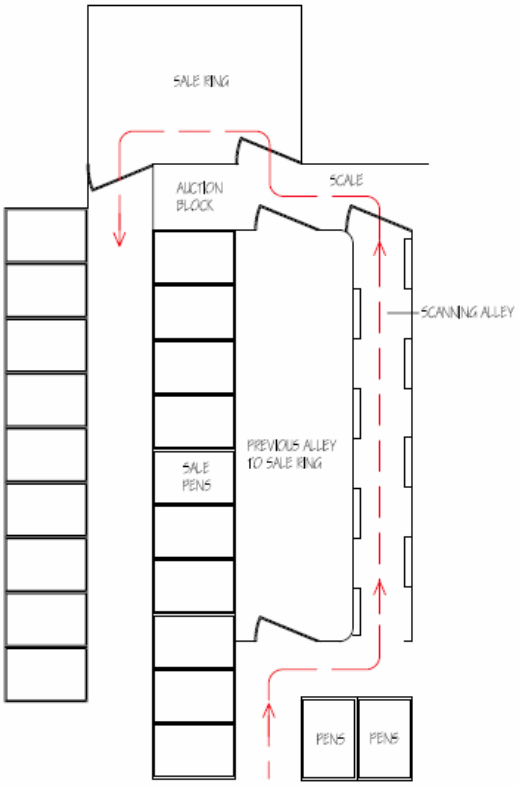


Figure 6: This drawing is not intended to be an exact replica of the barn area and is not to scale.

The metrics for this research project only record the non-Quebec cattle as there were unusual measures to capture the ATQ, RFID tag number.

Speed of commerce metric	Speed of sale: time to sell one draft
Metric moving through scanning alley	No change in time to sell one draft
Impact on speed of commerce	None
Financial impact	One additional full time person: $1.00 per head

Saskatoon Livestock Sales

The wide alley, RFID system was installed in the alley that ran directly off the sale ring at the exit to the outdoor pens (See Figure 7). This location was obviously well integrated with business process as nothing changed in the movement of the cattle. The difference was the reduction of the width of the alley coming out of the sale ring from 10 feet to five feet wide.

There was minimal impact on the speed of commerce. In the case of large groups, the effect was four to 10 seconds as all the cattle could not all fit into the alley and backed up into the sale ring.

It was noted that ring men could no longer safely enter the holding pens after the sale ring. As such, they depended on yard staff to push cattle back into the sale ring to be sorted. Whereas before the installation of the RFID system, the ring man had the option to sort splits in the ring or holding pens located after the ring.

The impact may have been two to six minutes over a three to nine hour sale which is not material.

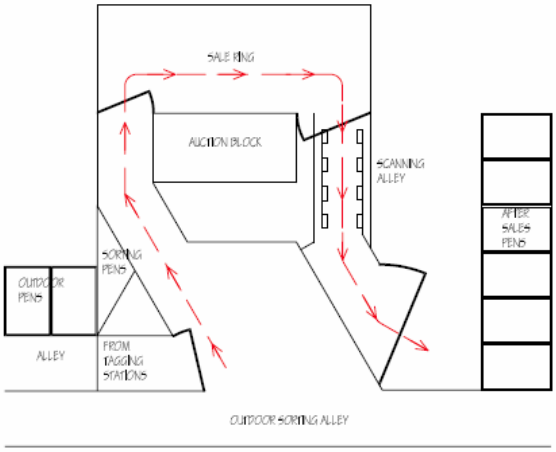


Figure 7: This drawing is not intended to be an exact replica of the barn area and is not to scale.

There were no metrics for the speed of sale prior to the installation of the RFID system. As such, the data on impact was measured by the FRA at the market based on observations of events.

Speed of commerce metric	Speed of sale: time to sell one draft
Metric moving through scanning alley	Minimal change in time to sell one draft/ Minimal impact on time from sale to penning
Impact on speed of commerce	2 - 6 minutes per sale day
Financial impact	None

Whitewood Livestock Sales

The wide alley, RFID system was installed in the alley that ran directly off the sale ring at the exit to the outdoor pens (See Figure 8). This location was obviously well integrated with business process as nothing changed in the movement of the cattle. Even with the reduction in the alley width from 10 feet to five feet, there was no impact on the sale. The location chosen for this system allowed enough room for the cattle to fully move out of the sale ring before moving into the scanning alley. As such, the sale was not affected by cattle backing up.

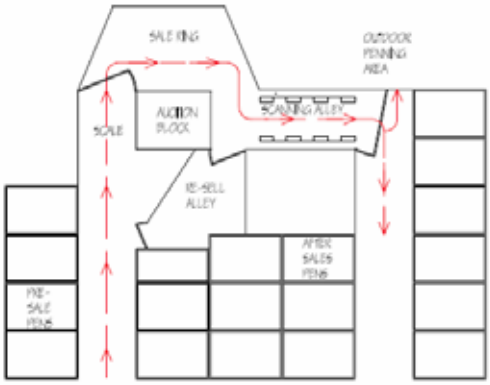


Figure 8: This drawing is not intended to be an exact replica of the barn area and is not to scale.

Speed of commerce metric	Speed of sale: Time to sell one draft
Metric moving through scanning alley	No change in time to sell one draft
Impact on speed of commerce	None
Impact on shrink	None
Financial impact	None

Spiritwood Stockyard

The wide alley, RFID system was installed in a side alley that ran parallel to the main alley off the sale ring (See Figure 9). The scanning alley in this market was unique in that it curved slightly and had quite a distance from the sale ring to the reader panels. The system was well integrated with process flow. Nothing changed in the movement of cattle other than the very minimal extra distance in the curved versus straight alley. It is suggested that the extra time to move the cattle through the scanner was a result of the longer alley. This market sold groups of show pen cattle that accounted for six percent of the total groups.

The speed of sale metric was not used in this market as there wasn't any benchmark to evaluate against. It is estimated that the maximum impact on speed of commerce was 14 minutes over the course of an eight hour sale.

Figure 9: This drawing is not intended to be an exact replica of the barn area and is not to scale.

Speed of ommerce metric	Speed of sale: Time for one group to exit sale ring to penning
Metric without moving through scanning alley	Larger groups: 11.2 seconds Smaller groups: 12.4 seconds
Metric moving through scanning alley	Larger groups: 20.3 seconds Smaller groups: 14.3 seconds
Impact on speed of commerce	Larger groups: 9.1 seconds x 17 groups = 3 minutes Smaller groups: 1.9 seconds x 350 groups = 11 minutes Total impact = 14 minutes per sale day of 1,500 head
Financial impact	None

Summary of impact on Speed of Commerce at Sale Ring

As evidenced in markets with the system immediately after and before the sale ring, the speed of commerce was not materially affected as the RFID systems were integrated directly with business process. It is important to note that these were all wide alley systems which supports the unencumbered flow of cattle. Further supporting an efficient flow of cattle was the result of being located at the sale ring, 86 percent of the groups were between one to five and 10 percent were between six to 10. It is evident that smaller groups move through a scanning alley more efficiently than larger groups with higher read accuracy.

Shrink was not a factor with these RFID system locations as the flow of cattle did not change. The only variance was the width or length of the alley the cattle moved through on the way to or from the sale ring. The length of alley had some impact on the time it took to process the groups at Spiritwood, but the overall sale day was not impacted as a result.

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.

SUBMISSION OF RFID NUMBERS TO THE CLTS

Traceability requires that individual animal identification is registered within a database that tracks their movement. To enable traceability, the tag identification numbers are collected by the RFID system at an auction market and must be transferred to software that will disseminate these numbers into a file format that can be submitted and recognized by the CLTS database. This is most often a comma separated value (csv) format.

The custom test software used in this research created a csv file that correlated all of the scanned RFID numbers into a report that the FRAs submitted to the CLTS. It took between five and 30 minutes to transfer the file to the CLTS through the internet. Dial up internet connections created some challenges as the connections were slow and often timed out so the file had to be resent.

Reports with tag or formatting errors would be returned as unrecorded but with notes of the lines with the errors. If the report is rejected, it can be resubmitted once the line errors have been deleted. The cause of many of the tag errors are as follows:

1) The tags had not been registered to the producer prior to the report being submitted. This often happened if the tag was sold the day of the sale.
2) The tags were not registered with the distributor, so therefore could not be registered to the producer.
3) Unrecognized tag numbers: these could be tags that were registered in the United States, or a tag that was not cross-referenced.

Any installation of an RFID system must have a software package that collects and disseminates the tag numbers into a report that is accepted by the CLTS. Further, it will be necessary for an individual to check the submission of the report and ensure it was accepted without errors.

COST ANALYSIS

The cost of equipping an auction market with an RFID system depends on the business needs and the amount of infrastructure modifications required. The following are cost factors:

- Each market required the installation of a dedicated electrical line to the RFID location
- The cost of the RFID system included the installation by the vendors
- The cost of the labour provided by the market personnel is included in these prices
- These costs do not include a computer or software to collect and record the RFID tag numbers
- Infrastructure changes include the costs to improve the flow of the animals through the RFID system, including the installation of cat walks
- The 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 volume of cattle through the market will have a significant influence on the labour hours required
- The costs estimated in this section are correlated from the research project only and should not be assumed to be accurate in all auction market environments
- All costs evaluated in this section assume one RFID system per market, which may not be feasible in all cases

Table 78: Depicts the costs of the systems installed in this test

Type of Alley	Number of Panels	Location of Readers	Cost of RFID System	Cost of Alley Construction	Cost of Infrastructure Modifications
Large					
Wide	Eight	Entrance to Sale Ring	$48,500	$4,000	$6,800
Wide	Eight	Sale Ring Exit	$50,500	$4,000	$750
Medium					
Wide	Eight	Receiving	$48,500	$3,000	$9,500
Wide	Eight	Sale Ring Exit	$50,500	$4,000	$1,850
Single	Four	Receiving	$21,500	$2,500	$5,700
Small					
Wide	Eight	Sale Ring Exit	$50,500	$4,000	$1,200
Dual	Four	Receiving	$20,000	$2,500	$6,500
Single	Two	Receiving	$13,000	$2,250	$6,600

Systems at Receiving

It is evident that the infrastructure changes are more expensive when the system is located at receiving. In this location, the penning/sorting alleys need to remain unencumbered, as such, 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 ranged from a high of $9,500 for a market that converted pens to a 60 feet alley to a low of $5,700. Scanning alley construction costs can be expected between $2,250 for dual and single alley systems to $4,000 for a wide alley system.

System at Sale Ring

The systems located after the sale ring had the lowest infrastructure modification costs because these were installed within an existing 10 feet to 12 feet alley. The cost of the modifications, including the electrical service, ranged from $750 to $1,850. All these systems were wide alley with a $4,000 cost to construct the scanning alley.

There was only one system 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.

Labour Costs

Each of the markets in this test project was staffed by a Field Research Associate (FRA) under contract to CCIA. This individual used a project laptop to monitor and track groups of cattle through the RFID systems for the purposes of this research. In an operating auction market, there will not be a need for an individual dedicated to watching the cattle move through the systems. However, it is not reasonable to expect the RFID systems to operate without the intervention and attention of personnel. The processes that will have to be addressed are:

1) The preparation and processing of the tag number report to the CLTS. Also required is the administration of the reports to ensure acceptance by the CLTS, removing errors and resubmitting
2) Ensuring all tags sold the day of the scanning have been registered with the CLTS prior to submitting the scanning reports
3) The daily evaluation of the RFID readers to ensure that all the panels are operating. This requires tuning, daily evaluation of read ranges, evaluating the read accuracy based on total numbers processed through the system and occasional monitoring to ensure that the tags are being recorded by the readers
4) Participation by yard personnel in continuous improvement meetings to support higher levels of speed of commerce and increased safety for animals and staff

At least one administrative person will require training on the submission of the tag report to the CLTS. Each market should have two individuals that are accountable for maintaining and evaluating the read accuracy of the RFID systems. These individuals will require training by the vendors to ensure a high level of confidence in the operating procedure for the systems. In this project, the FRAs contacted the vendors on several occasions when read accuracy had dropped for no apparent reason and were instructed on how to implement solutions. It is possible that personnel that have been trained to support the RFID system may request a higher wage as a result of the added responsibilities.

In some of the test markets an extra person was required to support the movement through the scanning alleys. This was a result of safety, the length of the alleys and the change in the movement through the markets. Based on the location of the RFID system in the market, it is possible that one part-time yard person will be required to assist with the scanning of the cattle through the RFID system.

Additional Equipment

This research evaluated the read accuracy of the RFID systems at various locations in the auction markets through the use of a project laptop linked to the systems readers. In an operating auction market, depending on the location, either a laptop computer or terminal with software will be required to collect and disseminate the tag numbers from the RFID readers. Linking the system to the auction market computer system will require cabling, hardware and software upgrades. The determination of these costs was not included in the scope of this project.

Warranty and Maintenance

In order to ensure the highest level of read accuracy and efficiency of the RFID systems the vendors will need to participate. It is recommended that the vendors provide on-site service for the first three months of installations to ensure the systems are operating at peak efficiency. Further maintenance is required at least twice a year for the installation of new software for the readers, ensuring proper synchronization of the panels, evaluation of any variance in frequency interference, tuning and general maintenance of electrical connections and component parts.

In addition to the one-year warranty, two of the vendors will provide a three-year maintenance and service agreement. Through these extended maintenance agreements, the markets can be assured that the systems will be operating at the highest levels of efficiency at all times. Both Compass Animal Health, representing Destron Fearing and Integrated Traceability Solutions, representing Aleis have indicated that their warranty can be extended to a full three years, service of the system will be provided through telephone consultation and on-site technicians if required. The cost of these agreements is estimated to be $6,500 per year for wide alley systems.

Replacement of the Panels and Readers

Data was collected on site from eight new installations and a three-year-old dual alley system. The new installation of a dual alley system had a read accuracy, throughout the course of the project, that averaged 93 percent, processing 950 groups totalling 11,300 cattle. The existing system had a read accuracy of 87 percent, processing 656 groups totalling 12,400 cattle. Both of these markets had the RFID system installed at the receiving area.

The market in Ottawa provided weekly data on the accuracy of their three year old single alley RFID system. In 15 weeks of scanning, the read accuracy was 84 percent on 7,300 cattle. It must be noted that the market was not monitored by a FRA or the reads recorded by test software so the data cannot be validated. The two new installations of single alley systems in this project showed read accuracy of 97 percent on 935 groups totaling 17,500 cattle.

Based on these observations, it is possible that the RFID systems may reduce read accuracy over time. This research is not definitive and more testing should be done to determine if this is true. However, it should be considered that the electronic components of the RFID systems be replaced every three years to ensure the highest level of read accuracy. Replacement costs of the key components of the RFID system include:

- Panel reader box: $3,500
- Panel antenna: $1,000
- Power supply: $1,200

Cost Tables

The following table itemizes the cost of an RFID system installation in various locations within an auction market. It is once again important to note that all markets have a unique business process and design. Each auction market should have a site assessment to determine the most appropriate location and type of system for installation. These costs are approximate and do not include software or computer terminals. The vendor site assessment is estimated at $2,000.

Table 79: Estimated Capital Cost of RFID Hardware

RFID System	Site Assessment and Construction Supervision	System Including Installation	Scanning Alley	Cost of Man Hours for Training Personnel	Total Costs
Wide Alley	$2,500	$50,000	$4,000	$350	$56,850
Dual Alley	$2,500	$20,000	$2,500	$350	$25,350
Single Alley	$2,500	$13,000	$2,000	$350	$17,850

	At Receiving and Before Sale Ring	After Sale Ring
Infrastructure Modifications	$6,500	$1,500

Table 80: Estimated daily labour costs for use of RFID systems

Administrative Activity	Hours	Cost Per Hour	Total Daily Cost
Correlating data for submission to CLTS	0.5	$20	$10
Submitting CLTS report	0.5	$20	$10
Checking accuracy of transmission and cleansing data if required	1.0	$20	$20
Personnel Responsible for the RFID System			
Daily tuning of system	.25	$20	$5
Daily evaluation of panel read ranges	.25	$20	$5
TOTAL DAILY LABOUR COSTS			**$50**

It was also noted that one part-time person may be required at markets with the system located in the receiving area to assist with penning cattle on receiving days. The cost of this part time labour is estimated at six hours per day at $15 per hour for a total of $90 per day.

Table 81: Estimated overhead costs for RFID system operation

Activity	Cost	Total Cost
Administrative overhead for computers, internet, telephones for transfer of reports to the CLTS	$20 per report x 2 per week x 10 months	$400
Annual insurance on the RFID system	$1,000	$1,000
Monthly electrical costs to operate the system	$75 x 10 months = $750	$750
TOTAL ESTIMATED ANNUAL OVERHEAD COSTS FOR OPERATION OF RFID SYSTEMS		**$2,150**

Estimated Costs to Equip Auction Markets in Canada

Based on a document researched by Agriculture and Agri-Food Canada[15], there are an estimated 150 auction markets across Canada outside of Québec: 42 percent of those are large markets with volumes more than 100,000 head per year (63 markets), 48 percent are medium markets with volume between 30,000 and 99,999 head per year (72 markets) and 10 percent are small markets with less than 30,000 head per year (15 markets).

It is anticipated that only the small markets will be able to install the single alley systems without an effect on the speed of commerce. The large volume markets and 90 percent of the medium volume markets would require a wide alley system. The balance of the medium size markets would be suitable for a dual alley system. It is expected that 75 percent of the markets will locate at the sale ring, with 80 percent of those before the ring and 20 percent after the ring, and 25 percent at receiving. Further, some of the larger markets will have more than one ring to equip.

Table 82: Estimated total cost for Canada wide installation of RFID Hardware

Market Size	Number of Markets	Type of System	Cost of System	Total Cost
Large	63	Wide alley	$56,850	$3,581,550
Medium	65	Wide alley	$56,850	$3,695,250
Medium	7	Dual alley	$25,350	$ 177,450
Small	15	Single alley	$17,850	$ 267,750
				$7,722,000
Infrastructure Changes				
At receiving	37		$6,500	$240,500
After sale ring	23		$1,500	$ 34,500
Before sale ring	90		$6,500	$585,000
				$860,000
TOTAL COST TO EQUIP AUCTION MARKETS WITH RFID SYSTEMS				**$8, 582,000**

The total cost of approximately $8.6 million is the initial cost to equip the auction market industry, but does not include software or computer terminals for the collection and dissemination of the RFID tag numbers.

Operating Costs for RFID Systems

It was found that three-year-old systems had a lower read accuracy than the newer systems. As such, the following operating cost analysis is taken over three years, with replacement of the reader boxes and panel antennas at the end of that period. The warranty and maintenance agreements cover a three year period with full warranty during that time.

Table 83: Estimated three year operating costs

Per Market Costs	Annual Cost	3 Year Cost
Warranty and maintenance agreement	$6,500	$19,500
Labour costs per sale day: Average 2 sales per week x 40 weeks per year = 80 sales per market at $50 per sale	$4,000	$12,000
Overhead costs	$2,150	$ 6,450
TOTAL ANNUAL OPERATING COST PER MARKET	**$12,650**	**$37,950**
TOTAL INDUSTRY OPERATING COST: ALL MARKETS	**$1,897,500**	**$5,692,500**

Replacement of Reader Box and Panel Antenna:		
128 wide alley systems with 8 panels	1,024 panels	$1,024,000
7 dual alley systems with 4 panels	28 panels	$ 28,000
15 single alley systems with 2 panels	30 panels	$ 30,000
Reader boxes: one per system	150 reader boxes	$ 525,000
TOTAL COST OF REPLACEMENTS IN THREE YEARS		**$1,607,000**
THREE YEAR OPERATING COST		**$7,299,500**

In markets with the system located at receiving, the annual labour cost could increase by $3,600 as a result of a part-time person to assist with penning. It was estimated that 25 percent of large/medium markets would locate the RFID systems

at receiving with a total annual labour cost of $133,200. This would increase the three year operating cost to $7,699,100, annualized at $2,567,000.

It was estimated that five million cattle were sold in 2010 through the 150 auction markets across Canada[16] (with the exception of Quebec). With all other factors being equal and assuming the volume remains consistent over three years, the annualized operating costs would equate to $0.51 per head of cattle sold at the auction markets. This cost does not include software, computers, the capital cost of the equipment or any additional increased staffing costs.

Summary of Cost Analysis

The cost of equipping an auction market with an RFID system can only be determined once a site assessment has been completed to ensure the system aligns with the unique needs of the market. The costs evaluated in this section are a reflection of the eight new installations in this research project. It is estimated that there are 150 auction markets outside of Quebec, across Canada: 42 percent of those are large markets with volumes of more than 100,000 head per year (63 markets), 48 percent are medium markets with volume between 30,000 and 99,999 head per year (72 markets) and 10 percent are small markets with less than 30,000 head per year (15 markets).

All costs assessed in this report assume only one RFID system per market, which many not be feasible in all cases. Costs for RFID system installations include site assessment, the construction of the scanner alleys, installation of hardware and some training. The cost of software and computer hardware is not included in these calculations. Eight panel, wide alley systems have an average installed cost of $56,805, dual alley systems with four panels averaged $25,350 and a single alley system with two panels is estimated to be $17,850. It was determined that markets with the installations at receiving and before the sale ring had higher infrastructure costs as a result of the removal of pens to ensure the penning/sorting alleys stayed unencumbered. Construction costs related to infrastructure modifications to install systems at receiving was an average of $6,500. The systems located after the sale ring had the lowest infrastructure changes as a result of the system being installed inside an existing 10 to 12 feet alley. Costs at this location were approximately $1,500.

As with the integration of any new business process, there will have to be some degree of participation in the maintenance, upkeep and reporting. It is estimated that there will be a daily labour cost of $50 when scanning and an annual overhead cost of $2,150. In order to ensure the systems be maintained at the highest level to achieve accurate read rates, it is recommended the systems are supported with extended service and warranty agreements. The vendors of the wide alley systems provided estimated costs for these agreements at $6,500 annually.

The test project evaluated eight new systems and two existing systems. It was found that the existing systems, both were three years old, had significantly lower read accuracy than the new systems. As such, it is recommended the panel antenna and reader boxes be replaced every three years to ensure the highest level of read accuracy. The cost of these replacements could be more than $1.6 million every three years.

The cost to install RFID systems in all markets across Canada was based on the configuration of all large markets and 90 percent of the medium sized markets installing wide alley systems and the balance of the markets installing either dual or single alley systems. The total capital expenditure is estimated to be $8,582,000. Annual operating costs for the industry, including maintenance and warranty agreements, 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 of cattle equates to $0.51 not including the capital expenditure or potential increased labour.

BENEFITS

This phase of the research was not able to identify any direct benefits to the auction markets in the research project as a result of having the RFID system operating at the market. It is outside the scope of this report to identify benefits to the Canadian cattle industry and consumers in regard to traceability in the cattle industry in Canada.

IMPACT ON ANIMAL AND EMPLOYEE HEALTH AND SAFETY

Animal

The systems had a minimal affect on the overall health and safety of the animals.

- The narrow alley systems will cause bruising as a result of pushing against the side and hip lock if more than one animal attempts to move through the alley at the same time. The wide alley system had minimal affect on bruising.
- The narrow alley may restrict large cows and bulls, causing injury if they move into the scanning alley and get stuck or fall. Extraction of an animal may be difficult in a narrow alley.
- In markets without cover over the scanning alleys, ice and snow builds up which causes the cattle to slip and fall. This could result in bone fractures, breaks and certainly increased stress and bruising.
- In narrow alley systems, there were some incidents where cattle did not fit into the alley and needed to be backed out. This could result in serious injury to the animal.

Employee

There were no reports of injury incidents as a result of the RFID systems.

- There is potential for injury as a result of the height of the scanner alley walls and length of the alleys.
- In the wide alley system: if an employee was in the alley and the cattle turned back, it would be difficult for the employee to get out of the alley as there are not any footholds to move up the walls. It was unsafe for staff to enter the alleys to move the cattle that may have turned.
- In some markets, safety was increased by installing cat walks down the side of the wide alley systems so the staff had access to the cattle from above. These catwalks were highly regarded as the reason for reduced injury. It would also be beneficial to install a safety railing to prevent personnel from falling backwards.
- There were some comments that the systems may have increased employee safety because the cattle have to move at a slower pace.
- In any process that requires more handling of cattle, there is a potential for increased risk of employee injury.

ASSUMPTIONS AND CONSTRAINTS

This section addresses the impact that the assumptions and constraints had on the outcomes of read accuracy and speed of commerce.

1. This project is making the assumption that the technology and processes for the RFID tags and premises identification is widely used, accepted and in place.

   In most cases, RFID tags are commonly used. However, CFIA has approved the continued use of the bar code dangle tag which does not have a radio frequency and therefore cannot be scanned with an RFID system. The continued use of the bar code tag will have a negative affect on read accuracy.

2. The occurrences of poor retention and high failure rates of RFID tags provides a major constraint to RFID scanning.

   The research project did not evaluate the impact of this one factor. Further research should be done to evaluate the actual failure rate of tags and retention issues.

3. Hardware/software must integrate with existing infrastructure: CCIA database, RFID tags and industry software.

   Only CCIA approved hardware was purchased for this project. The software was custom developed to align with the research requirements.

4. Auction market participants must allow the project team full access to evaluate, renovate, install technology, and train staff. The project team must not interfere with the day-to-day operations at the markets.

   The support and cooperation of the auction market personnel made it possible for the FRAs to collect and disseminate the data.

5. There is a great degree of difference in the level of technology acceptance and integration within the auction marts.

   That statement was found to be very true. However, as the FRAs were responsible for reviewing the systems and correlating the reports, the market personnel didn't have much interaction with the actual RFID systems or the reporting.

6. Extensive metal in auction market facilities may impact the accuracy of the reader systems.

   This was proven to be an inaccurate assumption. In markets with a high degree of steel structure, the systems were installed with minimum clearances and the use of aluminum shielding. Even in markets that were 100 percent metal, there was no variance in read accuracy than those markets that were significantly wood.

CONCLUSION

This applied research project took place throughout eleven weeks. The project installed eight new RFID systems from three manufacturers at both the receiving area and the sale ring (both before and after). A 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 CLTS. The system configurations were: single alley, dual alley and wide alley. The data from 31,376 groups of cattle totalling 144,197 head was correlated to report on objectives discussed as follows:

DETERMINE IF RFID SYSTEMS ARE CURRENTLY COMMERCIALLY AVAILABLE AND FUNCTIONALLY VIABLE TO SUPPORT ACCURATE AND EFFICIENT RFID TAG READS OF CATTLE AT AUCTION MARKET FACILITIES. A TARGET OF 95 PERCENT OR HIGHER WAS ESTABLISHED FOR THIS RESEARCH AS A BENCHMARK FOR HIGH EFFICIENCY AND ACCURACY BY THE PROJECT TEAM.

The Impact on Business Process Efficiency and Effectiveness

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. However, the design of the system must also take into account animal behaviours, employee safety, group sizes, cattle breeds and temperaments if it is to be effective.

Two markets installed systems in locations that did not align with process flow and their speed of commerce suffered substantially as a result. In one market the system was originally installed to integrate with existing process flow. However, in mid season they changed the flow to increase efficiency and found that the system no longer aligned and therefore tripled the processing time.

Installations at the sale ring had the least impact on process efficiency as a result of not having to change the way the cattle flowed. Further, this location processed a high percentage of cattle in smaller groups which scan with higher read accuracy. The minimal impact on speed of commerce at all markets was not material over the course of a four to nine hour sale. No additional persons were required at markets where the system was located after the sale ring.

The installations at the receiving area 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. Any additional handling increases the impact on animal health/safety, shrink and employee safety. Further, even with a small increase in processing time per group, at peak times during the day, the producer may have a longer wait as a result of the increased time to pen the cattle. Although there was no benchmark to measure this wait, it is known to be a critical factor to the market.

In order for the systems to be effective, the right alley configuration must be chosen to coordinate with the location in the market and the group sizes processed. Site assessments are critical to choosing the right system for the right location to ensure and maximize efficiency and effectiveness.

Collection and dissemination of RFID tag numbers to the CCIA database for movement reporting with a high level of accuracy and reliability with a minimal impact on the speed of commerce and animal/ employee health and safety

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 configuration had the lowest group size read accuracy variance of only three percent with weekly averages between 96 and 99 percent, and had the highest overall read accuracy of 97 percent. The two systems were not constructed to standard specifications as one was constructed by the vendor at 29 inches wide, which is 3 inches narrower than a minimum industry specification of 32 inches. The other had four panels versus the standard two panel design, again reconfigured by the vendor. Each of these factors may have had an affect on increasing the read accuracy. The system had relatively consistent reads throughout all group sizes as a result of the single file processing through the scanner alleys. The lowest read accuracy was in groups of one to five at 95.4 percent, but this is not surprising as there were more groups in this segment than any other. The read accuracy by group size was not definitive enough to show a pattern.

Both of these systems were installed at a location that processed cattle being received by the market. However, the systems were not ultimately aligned with normal process flow. As such, the speed of commerce was dramatically affected at both markets as a result of the scanning system creating a new leg in process flow. It was noted that the narrow alley design did constrict large groups of cattle and consequently affected process flow. Shrink was a factor in the location of the system as it was outside business process and therefore the cattle required more handling and movement.

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. The single alley systems didn't have any negative impact on employee health and safety.

DUAL ALLEY SYSTEMS

The project installed one new dual alley system and collected data from a 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 width of the alleys in this study ranged from 30 inches to 38 inches. The minimum industry standard specification is 32 inches wide.

The variation in group size read accuracy was five percent from a high of 93 percent and a low of 88 percent. No definitive pattern emerged in the group size read accuracy. It was found to be equally distributed between groups of one to 25, accounting for 53 percent of cattle, and 26 to 75 which was 47 percent of the cattle. 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 with the highest day over day variance of seven percent. It must be noted that the newer system had a read accuracy of 93 percent whereas the older system had a read accuracy of 87 percent. There was only an eight percent variance in the total head that were processed in each market but the newer system processed 31 percent more groups than the older system.

Both of these systems were installed at the receiving area of the market and were well aligned with business process. The only exception was in one market where semi-trucks were unloaded in one location and ground trailers at another. Moving cattle through the market created another leg in the process flow as there were two unloading areas and only one was equipped with an RFID system. Speed of commerce was affected in both markets by a maximum of 100 to 126 minutes per day in increments of 7 to 10 minutes per some groups and 1.7 minutes on others. 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. Shrink was a factor only in the market that had two unloading areas as there was more movement and handling through the market to the one scanning alley.

The design of a dual alley system is two singles with a narrow island in the middle. The impact on animal health and safety as a result of the narrow alley width is also applicable to the dual alley systems. Bruising, hip lock and two smaller animals entering at one time are still factors that affect the cattle. The difference is that although the narrow alley requires single file,

there are two alleys which doubles the number of cattle over a single alley system that can be processed at one time. The dual alley system didn't have any negative impact on employee health and safety.

WIDE ALLEY

There were five wide alley systems installed, more than double that of the other configurations. These systems processed 72 percent of the cattle, almost triple 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 of one to five and six to ten. The smaller groups had a read accuracy of 96 percent and 93 percent respectively, 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. Due to the small numbers of groups over 10 head, the read accuracy showed 93 percent overall because of the minimum impact of the larger groups on the totals. The week over week accuracy only had a four percent variance with all weeks except one being over 90 percent.

Of the four systems installed at the sale ring, one was installed prior and three directly after. This was found to be the most efficient location in the test project as it had the least impact on speed of commerce and shrink. 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. 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.

One system was installed at the receiving area of the market that served both the ground trailers and semi-trucks. The vast majority of cattle were required to move an additional 120 feet up and back through the scanning alley. This created a maximum impact on speed of commerce of 2.5 hours over a nine to twelve hour day. The highest impact was felt by producers waiting to unload cattle at peak times during the day as each group required an additional 30 seconds to 1.5 minutes. Additional shrink was also a factor as a result of the additional movement and handling.

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. There were no incidents that affected employee safety. However, it could be improved by the installation of catwalks with safety rails to enable the staff to move the cattle through the alley without having to actually enter the alley. Further, a safe emergency exit from the long alley and high walls would be beneficial.

	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%
At Other Location*	95%	98%	3%	936	3%	96%	99%	3%	17543	97%	12%
All cattle	90%	95%	5%	31,736	100%	91%	94%	3%	144,197	93%	100%

* same as single alley

It must be noted that the individual characteristics and design of the RFID systems will influence the impact of speed of commerce and costs to the markets

CLTS DATABASE SUBMISSIONS

The test software created an electronic file from the scanned tag numbers that was recognized by the CTLS as a move in report. The FRAs identified that the electronic submission of the file took between five to 30 minutes depending on the internet connection speed. At this time, the CLTS rejects any file with tag number errors, which could be a result of an unregistered tag (either to distributor or producer) or a random number scanned from some other object. It is critical that tags are registered, throughout the chain, in a timely manner to avoid tag errors on movement reports.

More training needs to take place to educate the producers, distributors and markets on the importance of tag registration and movement reporting. This project did not incorporate commercial software systems as the data was being collected in a specific format for research purposes. It must be noted that the RFID hardware is not an effective tag number collection method without the integration with proper software to correlate the tag numbers into an electronic file. It is also critical that the electronic file submission is checked to ensure it was accepted by the database, and if not, errors corrected and resubmitted.

IDENTIFY THE BUSINESS CASE REGARDING FEASIBILITY AND COST/BENEFIT TO INDUSTRY AND GOVERNMENT FOR IMPLEMENTATION OF HARDWARE AND SOFTWARE TO ENABLE TRACEABILITY AT THE AUCTION MART LEVEL AS PER THE CANADIAN CATTLE INDUSTRY'S NATIONAL ANIMAL MOVEMENT PLAN FOR THE LIVESTOCK MARKETING SEGMENT.

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 total cost to equip the 150 auction markets in Canada, at this time, is estimated to be $8,582,000.

Table 82: Estimated total cost for Canada wide installation of RFID Hardware

Market Size	Number of Markets	Type of System	Cost of System	Total Cost
Large	63	Wide alley	$56,850	$3,581,550
Medium	65	Wide alley	$56,850	$3,695,250
Medium	7	Dual alley	$25,350	$ 177,450
Small	15	Single alley	$17,850	$ 267,750
				$7,722,000
Infrastructure Changes				
At receiving	37		$6,500	$240,500
After sale ring	23		$1,500	$ 34,500
Before sale ring	90		$6,500	$585,000
				$860,000
TOTAL COST TO EQUIP AUCTION MARKETS WITH RFID SYSTEMS				**$8, 582,000**

This project relied on the vendors to support the systems in order to achieve the highest read accuracy possible. In order to ensure the hardware is maintained to the highest level, it is suggested that each system have an extended warranty and maintenance agreement. Both Compass Animal Health representing Destron Fearing and Integrated Traceability Solutions representing Aleis products provided the details and costs of such agreements at an average of $6,500 annually for a wide alley system.

The read accuracy data showed that the markets with older systems had lower read accuracy percentages. It is suggested that the reader boxes and panel antennas be replaced or upgraded every three years to ensure the most accurate read percentages possible. The cost of these replacements could be over $1.6 million every three years.

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 an additional part time person in some markets where the system is located at the receiving area. Total annual operating costs per market is estimated at $12,650. It was estimated that 25 percent of the large/medium markets would located the RFID system at receiving with a total annual labour cost of $133,200. This would increase the three year operating cost to $7,699,100, annualized at $2,567,000.

Table 83: Estimated three year operating costs

Per Market Costs	Annual Cost	3 Year Cost
Warranty and maintenance agreement	$6,500	$19,500
Labour costs per sale day: Average 2 sales per week x 40 weeks per year = 80 sales per market at $50 per sale	$4,000	$12,000
Overhead costs	$2,150	$ 6,450
TOTAL ANNUAL OPERATING COST PER MARKET	**$12,650**	**$37,950**
TOTAL INDUSTRY OPERATING COST: ALL MARKETS	**$1,897,500**	**$5,692,500**

Replacement of Reader Box and Panel Antenna:		
128 wide alley systems with 8 panels	1,024 panels	$1,024,000
7 dual alley systems with 4 panels	28 panels	$ 28,000
15 single alley systems with 2 panels	30 panels	$ 30,000
Reader boxes: one per system	150 reader boxes	$ 525,000
TOTAL COST OF REPLACEMENTS IN THREE YEARS		**$1,607,000**
THREE YEAR OPERATING COST		**$7,299,500**

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.

It must be noted that these costs are estimated for one RFID system per market. This will not be feasible in all cases. This phase of the research project did not implement full commercial software for the collection and dissemination of the RFID tag numbers to the CLTS database. It also did not assess the feasibility of the computer networks at the auction markets to support integration of data collection from the RFID systems. Further, the benefits require an economic valuation from government or industry agencies. As such, there is not sufficient cost data to support a full cost/benefit analysis at this time.

Identifies the Positives and Constraints of Each RFID Scanning System

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.

The location of the system will affect the potential value added attributes from collection of the RFID tag numbers (age verification). The installation of the system after the sale ring may have fewer value added benefits (age verification). Market volumes, time of year and size of groups processed will have an impact on the advantages and disadvantages of the system. As follows is a summary of advantages and disadvantages that was determined by the research:

SYSTEMS LOCATED AT THE SALE RING

ADVANTAGES

1. At this stage in the process flow most cattle have RFID tags
2. This area is part of normal flow
3. Additional shrink is not a factor as the cattle do not have to move any further or have additional handling
4. Group size is generally smaller (one to five cattle per group) so read rates are higher
5. Cattle are often held in the scanning alley five to 10 seconds waiting for a pen to be chosen or the sale to complete. This behaviour will assist with higher read rates
6. Cattle are generally moving slower through this area so they move into the scanning alley more efficiently
7. This area requires the least amount of infrastructure modification. The alleys entering or exiting the sale ring are generally 10 feet to 12 feet wide with sufficient length to funnel the cattle both in and out of the scanning alleys
8. Most markets will not require additional personal to operate the system in this location

DISADVANTAGES

1. If animals are not tagged at this stage there is little opportunity to tag them and resend them through the scanners without affecting the speed of commerce
2. The alleys require a significant amount of length which may be at a premium in this location
3. Single or dual alley systems at this location would likely slow the speed of commerce. However, these systems were not tested in this area of the market

SYSTEMS LOCATED AT THE RECEIVING AREA

ADVANTAGES

1. Cattle that have not been tagged can be moved to a tagging station before entering the scanning alley
2. If located directly at the receiving gates the process flow is not affected
3. Single or dual alley systems may, based on smaller volumes, support the flow at this location in the market

DISADVANTAGES

1. There is often more than one unloading area in the market to facilitate semi-trucks and ground loading trailers. With only one RFID system, the cattle need to be moved through the market to the scanning alley which requires additional manpower and also creates shrink
2. May impact the time it takes for a producer to unload cattle due to additional time for penning cattle
3. The group sizes at receiving are larger which may lead to lower read accuracy in wide alley systems
4. If the producer does not identify the cattle as needing RFID tags, the cattle move through the alley with low read accuracy
5. May require additional personnel as penning can only be facilitated through one alley
6. May slow down receiving at peak times, with single and dual alley systems, due to the cattle moving through a narrower alley

Single		Dual		Wide	
Pro	**Con**	**Pro**	**Con**	**Pro**	**Con**
Consistent read accuracy with all group sizes	Narrow alleys may restrict the flow of cattle	Good read accuracy in larger groups		High read accuracy in small group sizes	Low read accuracy in high group sizes
Scanner alleys can be constructed in as little as 12' long and 40" wide	Are not efficient in areas requiring a high flow of cattle	Scanner alleys can be constructed in as little as 12' but require eight foot width	Narrow alleys may restrict the flow of cattle	Does not restrict process flow	Requires a 20 - 35' for the scanner alley with a eight foot width
	The narrow alley width may cause bruising		The narrow alley width may cause bruising	The alley width supports movement 2 - 3 animals wide so there is little to no bruising	
Least expensive of the systems		Mid range cost for the hardware			Most expensive of the systems

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

This phase of the research project only installed commercial hardware. It is expected the second phase of the project will incorporate commercial software to collect and disseminate the RFID tag numbers to the CLTS.

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 every day, variances must be taken into account when determining an effective read accuracy rate for the industry. Scanning 144,197 cattle throughout eleven weeks showed a global weekly read accuracy of 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% of the RFID tags due to reasons specified in this document. 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.

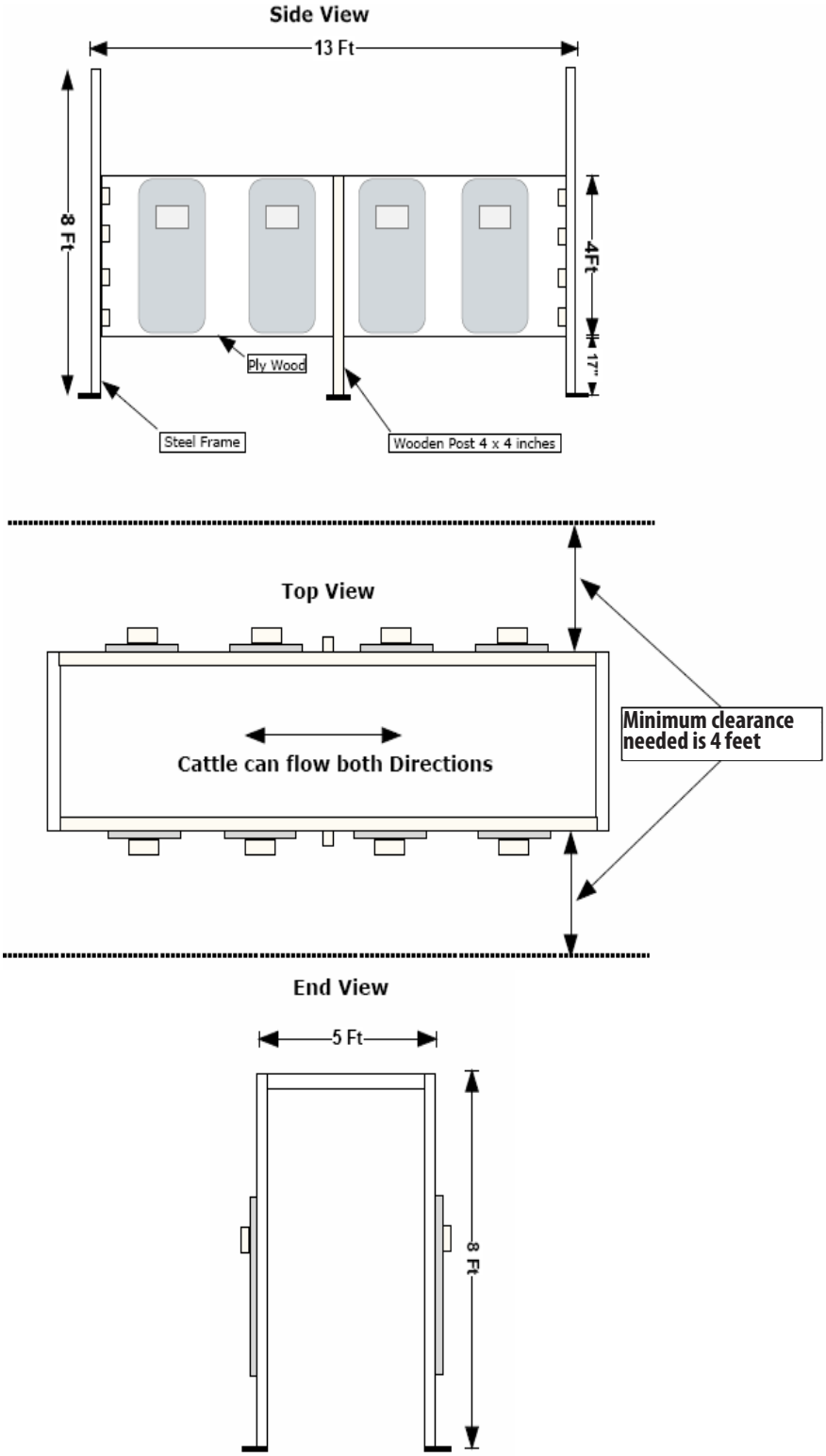
RECOMMENDATIONS

It is recommended that further research take place in order to evaluate the impact of traceability in all segments of the cattle industry:

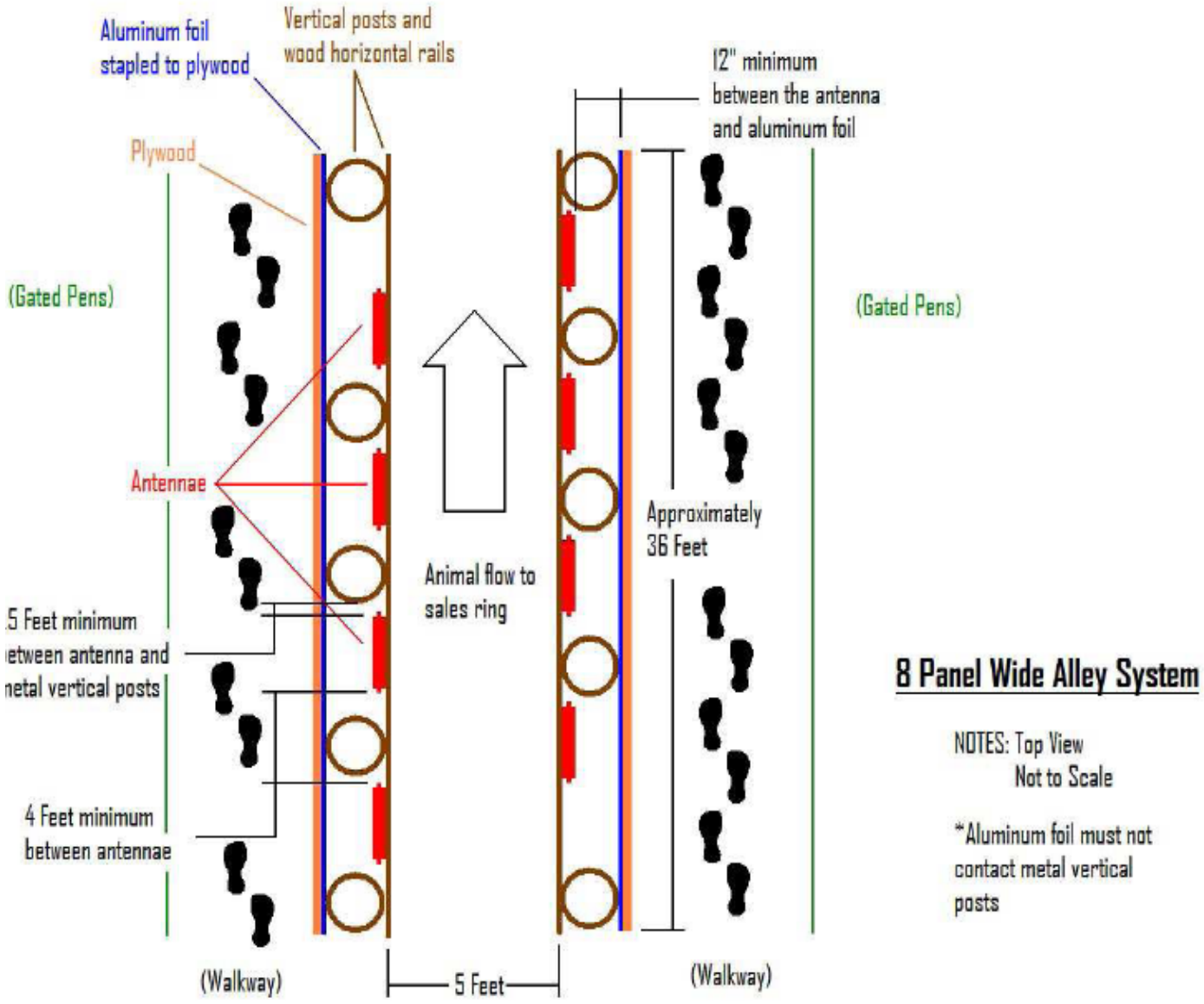
- Evaluate the read accuracy when using commercial software to collect and disseminate RFID tag numbers to the CLTS.
- Evaluate the impact on the auction markets for the administration and maintenance of the RFID system.
- Evaluate any potential value added attributes for the auction markets with the integration of the systems.
- Evaluate causes of missed reads.
- Evaluate the impact of shorter scanning alleys for wide alley systems before and after the sale ring.
- Evaluate market neutrality: no company is advantaged or disadvantaged by the implementation of traceability. Study the impact of RFID systems at feedlots, assembly yards, buying stations and electronic sales.
- Communications plan to educate producers and the importance of tag placement and traceability.

APPENDIX ONE: Drawings of RFID Scanning Alleys

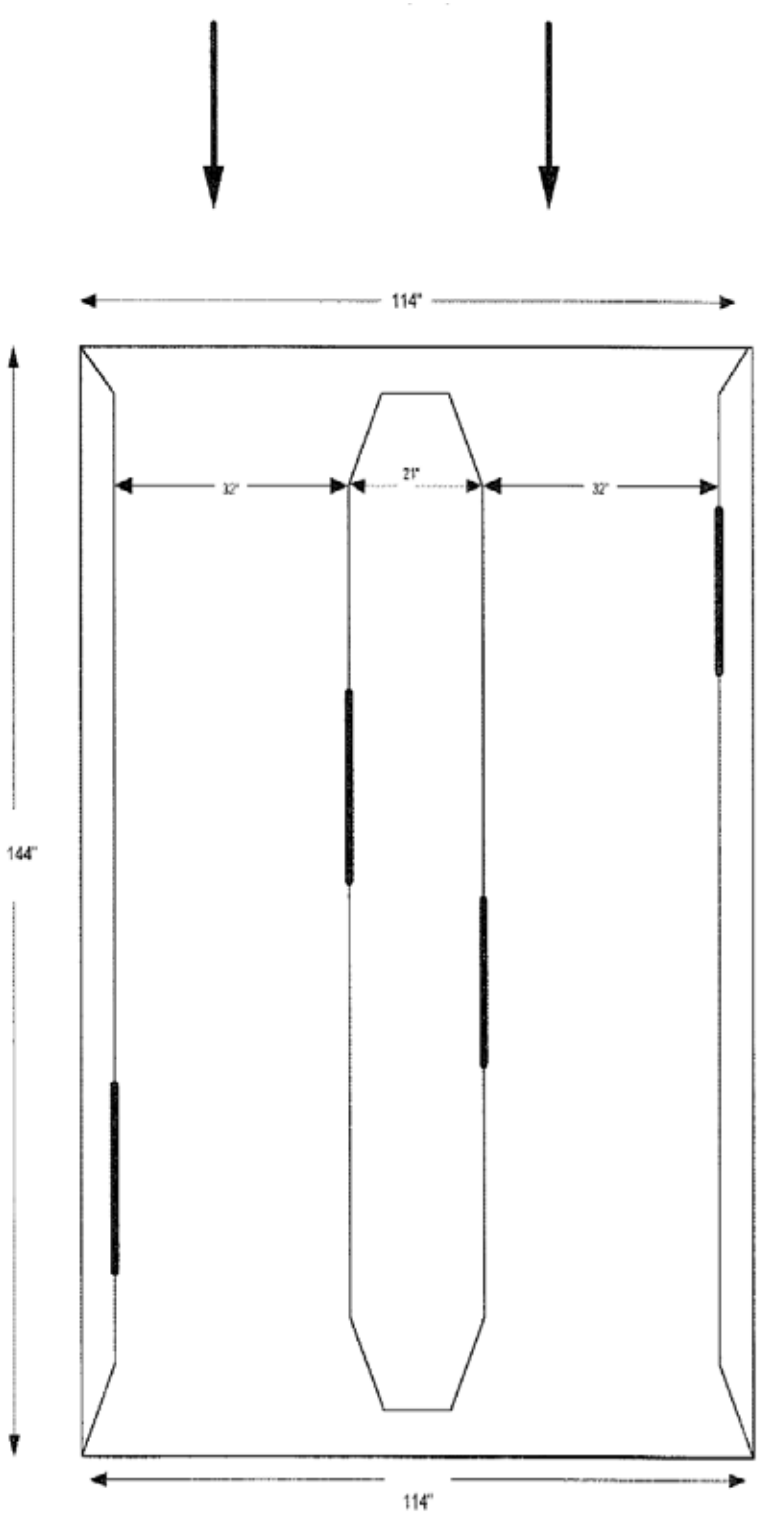
Drawing of Aleis Wide Alley System



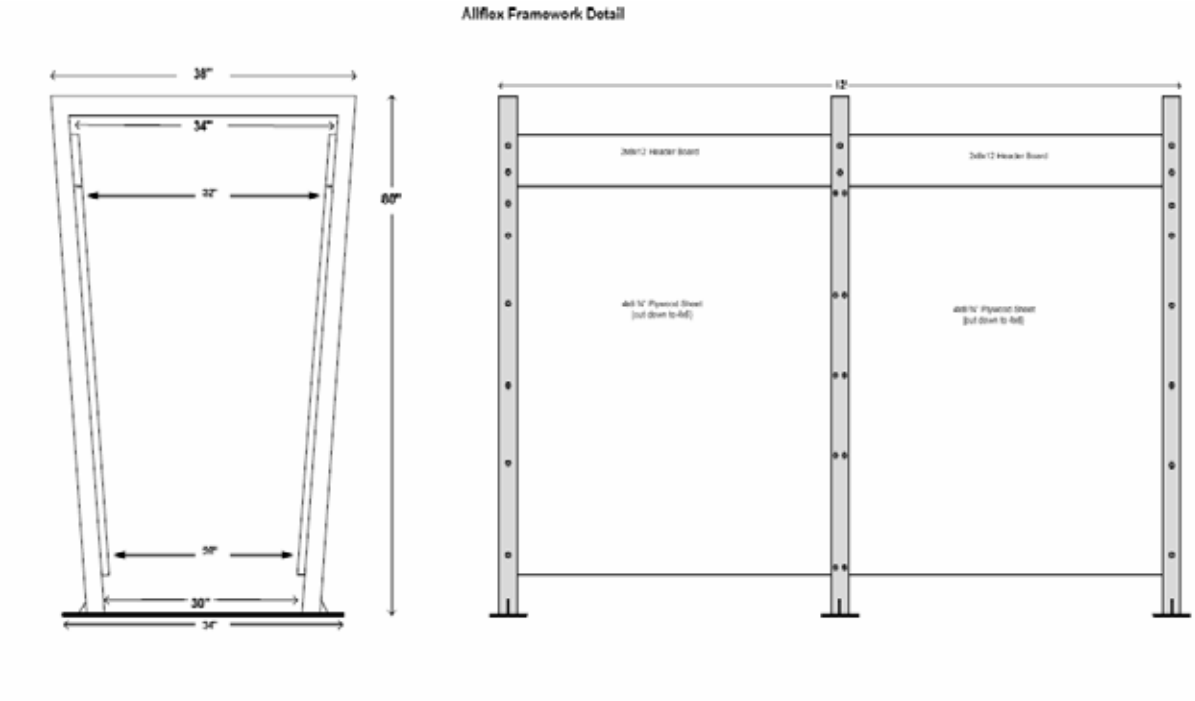
Drawing of Destron Wide Alley System



Drawing of Dual Alley System



Drawing of a Single Alley System



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)

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