

## Progress Report: A Water Fountain Orientated Cattle Monitoring System

### A.S. Leaflet R2282

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#### Summary

An automated system for collecting in-pen drinking activity and weight gain was developed for group fed cattle using off-the-shelf radio frequency (RF) tags, RF readers, a ball-water fountain, floor scale and a wireless communications bridge. These items were coordinated using a custom software application and technical assistance provided by I.D.ology of Eau Claire, WI for the purpose of continually measuring in-pen weight gain and drinking behavior. These points of data collection then could be used to monitor animal health and development with minimal animal handling. This system has been installed at the Iowa State University – Armstrong research facility located near Lewis, Iowa. Initial data collection started in late fall 2007.

#### Concept

Attention to the individual animal is required to monitor health and fit cattle into preferred market windows. Cattle however, are managed in groups which make visual appraisal and handling of each animal a challenge. A system that allows for individual attention without disturbing the necessary routines of management was required. It seemed that the drinking fountain would be the easiest point of reference to build around since here cattle visit regularly and somewhat individually. To identify which animals approach this location, a commercially available, radio frequency, ear tag (RF tag) was placed in the left ear of each animal occupying the pen. The antenna and RF reader assembly used to read the tag would be mounted above the water fountain and this data would be sent to a central processing unit. The central processing unit serving as the indicator box would read floor scales. This would allow for combining the use of a floor scale to capture the weight of the animal along with its presence at the fountain.

Since it would be known what RF tags have been allotted to the animals in a given pen, the frequency of drinking of each animal can be then documented. Those animals / RF tags not being presented to the reader or infrequently presented to the reader would indicate a health problem based on the knowledge that sick animals drink less.

When animals do present themselves to the fountain, their placement relative to the fountain can then be controlled to a degree which allows a scale to be set in place and their live weight captured each time the animal would drink. This information can then be used to monitor weight gain and current live weight for marketing purposes. These data regarding visits and current weight would then be stored in the central processor until downloaded for evaluation. A further step can then be implemented as well that allows for sorting heavier or smaller cattle from the group by use of a paint marking system triggered by the central processor when the defined weight criteria is satisfied.

#### Equipment

Refer to the items, labeled as A, B, C, etc. regarding the physical components of the monitoring system in Figures 1, 2 and 3.

The water fountain (1-A) is a stock item made of polyethylene. It does not appear that this item needs to be made of any particular material since the antenna and RF reader are not contained within this unit. The only requirement is that the point of drinking access be limited in order to restrict more than one RF tag presented to the antenna at a given time.

The antenna (1-B) was embedded into the black board above the fountain. The antenna formed a 10 inch x 22 inch loop and was connected via a shielded cable (1-C) to the RF reader (2-A) located in the rafters of the building. The read range of this antenna system in this application was approximately 16 inches and capable of detecting either a full or half duplex livestock ear tag.

At the base of the water fountain a cement curb (1-D) was poured and a 5000 pound capacity B-Tek floor scale placed (1-E). A heavy piece of belting was placed over the top of this scale to protect the unit from manure and moisture. The scale and the reader assembly was connected to a 920i Rice Lake programmable indicator (3-A) equipped to handle eight stations using RS 232 serial communication protocol. This indicator contains a microprocessor which provides the controls for the system and hard drive for data collection and storage. Downloading data from the indicator is facilitated by utilizing the Maxtor RS232/485 bridging device. This device was connected to the scale head through a communication port and then housed in a water tight plastic box with line-of-sight proximity to all probable download locations. I.D.ology of Eau Claire, Wisconsin coordinated the technical communication protocols allowing for data capture, data recovery, system verification as well as assembling the RF antenna / reader system.

Software was then required to associate the weights from the scales with IDs from the reader. The software,

*S108363.cod - version 1.0*, was a custom application put together under a joint effort among the programming staff at Rice Lake Weighing Systems, I.D.ology and the Iowa Beef Center.

A Rice Lake Weighing Systems software tool, *Interchange*, was acquired to simplify data download from the scale indicator to a PC. This program placed the logged data into spreadsheet form (see Table 1). The data was parsed into a record giving the animal's electronic tag identification number, the water fountain/scale number, the minimum recorded weight of the animal, the maximum recorded weight of the animal, the number of visits to the fountain, an indication if the animal was marked and a date-time stamp of the last visit. Provisions were made to collect reasonable weight and visit data in this application within the software. The first being that data records on a given animal would only be taken when a time lapse of at least 20 minutes occurred from the previous visit to the fountain. This addresses a common problem during warm weather where animals tend to congregate around the fountain for an extended duration or are moved out of place due to heavy traffic, but return quickly to finish drinking. Regarding weight measurements, the scale allowed for user defined minimum and maximum values to be entered, thus as cattle grow the minimum and maximum values could be adjusted upward. This feature was necessary to account for situations where more than one animal would be putting weight on the scale or in the circumstance where an animal only had one foot on the scale. The marking system likewise allowed for user defined weights to trigger the system, thus the user could indicate a minimum or maximum weight value and the system would mark those animals satisfying the criteria on the top of their neck when they drank.

The system itself was designed to monitor up to eight stations or 500 head of cattle. The data itself is compiled within the scale indicator's processor and the report can be downloaded via the *Interchange* tool into a spreadsheet.

### Special Design Considerations

A number of additional points deserve mentioning in terms of equipment design and software setup. This system requires limited animal access to a given water fountain to prevent two RF tags from being simultaneously read by a given reader. The ball-opening water fountain design naturally provides for this, however, construction of a stall (see Figure 1-F) was also done.

Electromagnetic interference (EMI), often referred to as "radio frequency (RF) noise" is always a concern when implementing any device that uses RF receivers. EMI is stray RF that can be caused by poorly grounded or shielded transformers, fluorescent lights, variable speed motors, etc. RFID readers are typically designed to

eliminate any unwanted "RF noise" received through the antenna. However, a source of EMI that has a frequency on or very near 134.2 KHz will adversely affect all ISO11784/ISO11785 RFID compliant systems to some degree. The effect on the RFID reader is increased as strength of the EMI is increased, the proximity between the RF reader and EMI source is decreased, or if the size (square area) of the receiving antenna is increased. Due to the nature of their operation, half-duplex RFID readers are much more sensitive to the affects of EMI than are full-duplex readers. Proper cable shielding and equipment grounding of existing electrical farm equipment and their power cables can reduce or eliminate the sources of EMI. The presence and "strength" of EMI at a given installation will vary with each location. Tests can be performed that can assess the amount and strength of potential EMI sources before system installation. However, the actual performance of a stationary RFID system with large antennas cannot be fully gauged until the system is placed into the operating environment.

Another necessary consideration regarding the RFID antennas is the physical proximity of the antenna to the water fountain access point in the adjacent pen. Since the antenna naturally collects the RF frequency in the shape of a bubble surrounding it, provisions were made to prevent the antenna from detecting RF tags in the cattle of the adjacent pen. This was done by using steel mesh hardware cloth on the backside of the antenna. Steel (such as pen rails/posts, head locks, etc.) that is physically too close to the read field of the antenna will "ground out" the power of the antenna's electromagnetic field. This will reduce the power of the antenna, thereby reducing the distance at which the reader will detect a transponder. In this application, steel mesh hardware cloth is used to shield areas from the antenna's receiving field.

The RS232 "point-to-point" serial communications somewhat restricts the current system. RS232 limits distances to the central processor to 75 feet or less. Also, due to the "point-to-point" communication of RS232, a communications port (PC card) had to be installed in the central processor for each RFID reader (for a total of 8). The use of a RS485 "multi-drop" serial communications between the central processor and the RFID readers would result in lower PC card cost and lower communications cabling costs. It would also extend the communication cable lengths to 300 feet.

Water tight connections are necessary to maintain component integrity and ensure accurate data collection. All items are sealed in water-tight enclosures and are not opened unless absolutely necessary, thus preventing unwanted dust or moisture from accumulating within the electronic enclosures.

This system while set inside a naturally ventilated steel building was protected from direct outside weather contact, but did not guarantee a moisture free, warm environment. Extremely cold (below 0 deg. F) or warm (above 140 deg. F) weather could create an operational problem. But in this system where a power feed was maintained throughout winter operation, an operating temperature was maintained preventing system failure. If the system must be operated in

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extreme cold or heat, heating or cooling devices can be added to the electronic enclosures (at extra cost) to compensate for extreme weather environments and guarantee proper system operation regardless of atmospheric temperature.

The wireless bridge has been a very good addition to the system since it is no longer necessary to physically open the indicator box and connect a communication cable to download data. This feature facilitates remote downloading which in turn allows the PC to be kept in a dust free area up to 750 feet away from the scale

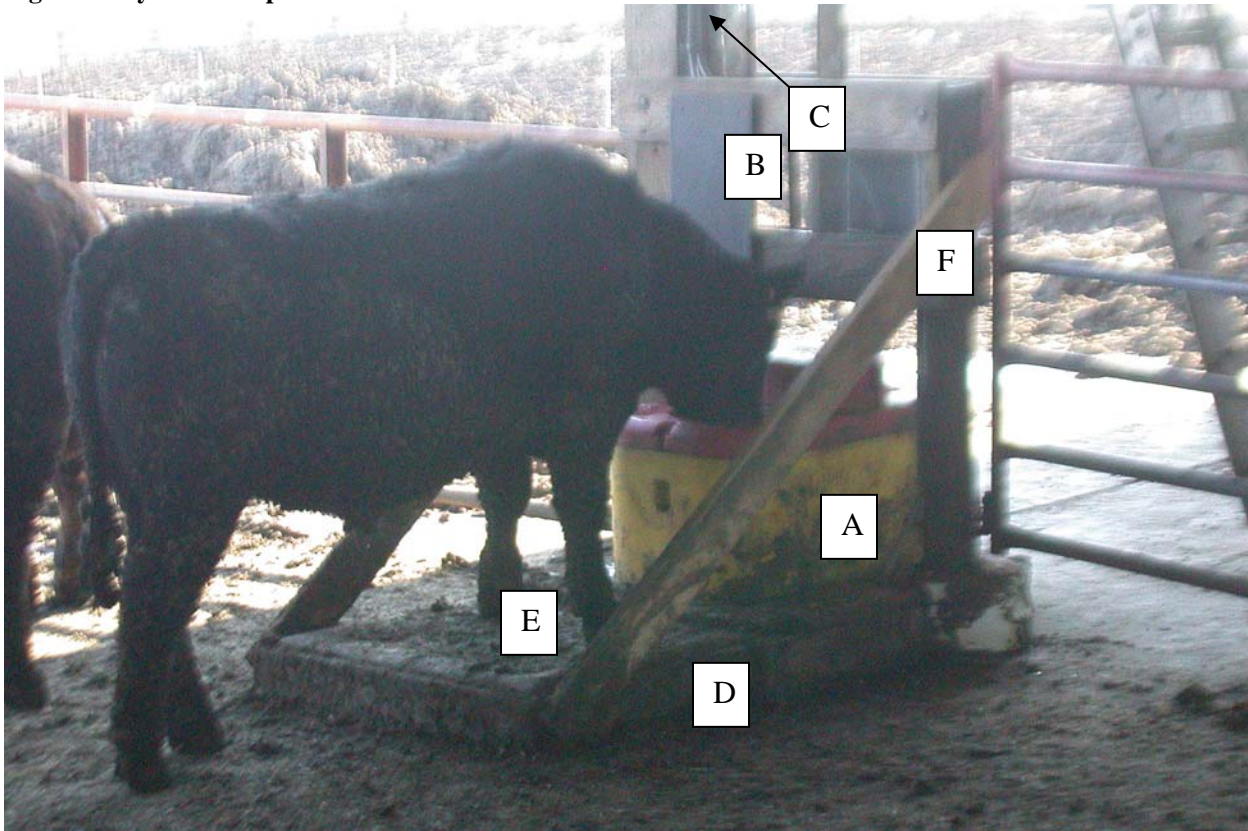
indicator-bridge assembly. This wireless bridge distance can be increased for additional costs.

### **Acknowledgements**

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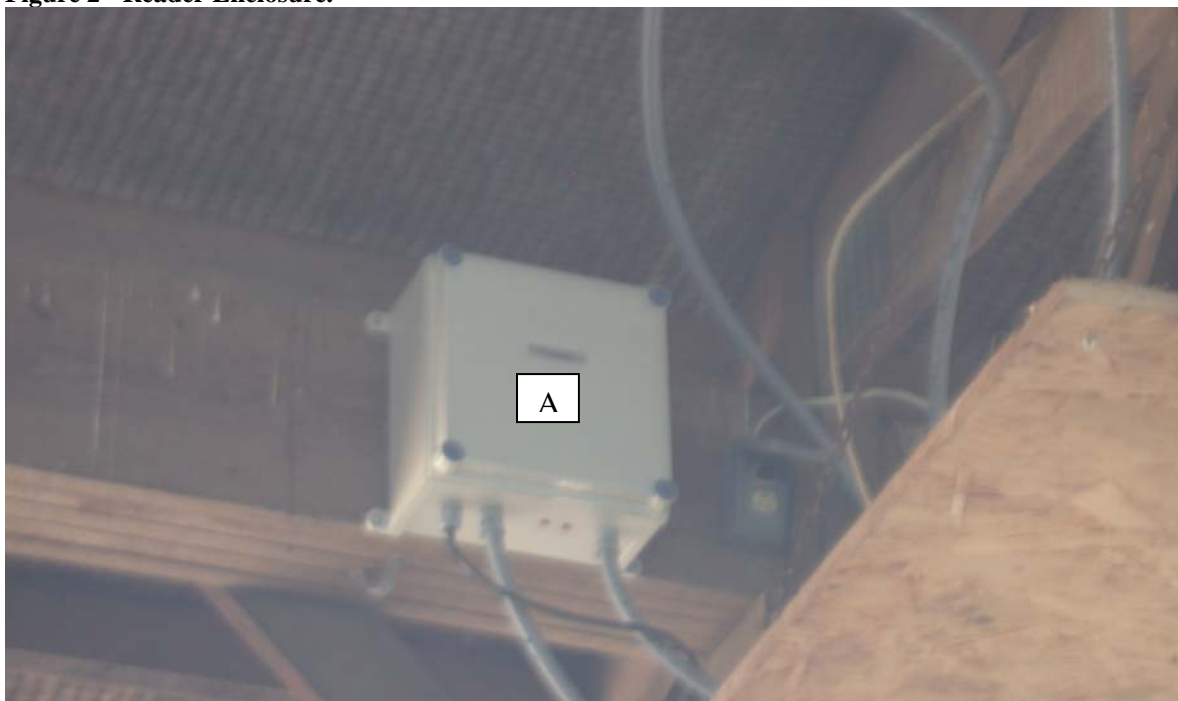
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**Figure 1 - System Components.**



Key to labels: A=Stock Ritchie water fountain, B=RFID antenna, C=shielded antenna, D=cement curb, E=B\_tek floor scale, F=constructed stall

**Figure 2 - Reader Enclosure.**



Key to labels: A=RFID reader

**Figure 3 Indicator.**

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Key to labels: A=920i Rice Lake programmable indicator

**Table 1 - Data Collection Example.**

Scale Number	E- ID	Number of visits	Low weight recorded	High weight recorded	Time of last drink	N= not paint marked H= marked high L= marked low
1	982000001140270	2	575.000000	597.000000	11/3/2007 02:30 PM	N
1	982000001134209	1	630.000000	630.000000	11/3/2007 02:17 PM	N
1	982000001000097	1	564.000000	564.000000	11/3/2007 02:19 PM	N
1	982000001161976	1	621.000000	621.000000	11/3/2007 02:24 PM	N
1	982000001125900	1	608.000000	608.000000	11/3/2007 02:31 PM	N
1	982000001084029	1	601.000000	601.000000	11/3/2007 02:33 PM	N
1	982000001122429	1	648.000000	648.000000	11/3/2007 02:44 PM	N
1	982000001004775	1	683.000000	683.000000	11/3/2007 02:54 PM	N