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Analysis of feeding behavior of group housed growing–finishing pigs

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ABSTRACT

Feeding behavior and time spent eating contains valuable information that can be used for managing livestock, identifying sick animals, and determining genetic differences within a herd. Individual animal feeding behavior, in a commercial-sized pen, was recorded using radio-frequency identification (RFID) technology and a series of multiplexers. Data were collected on 960 pigs (mixed barrows, 406 and gilts, 600) over 4 grow-out periods. The animals entered the facility at 24.6 ± 5.4 kg (mean ± standard deviation) at approximately 65 days of age and exited the facility at 101.4 ± 13.8 kg (between 116 and 133 days later). Time spent at the feeder was analyzed for the effects of days on feed, sex, weight gain, and health effects. The amount of time spent at the feeder averaged 68.8 min day^{-1} pig^{-1} over the grow-out period, and increased from the day the pigs enter the facility (24.0 ± 1.6 min day^{-1} pig^{-1}; mean ± standard error) until plateauing at approximately 40 days later (76.7 ± 2.4 min day^{-1} pig^{-1}; age ~ 105 days). After the plateau, barrows spent 13.6 more minutes per day at the feeder than gilts. Pigs classified as 'high gaining' (79.2 ± 5.1 min day^{-1} pig^{-1}) spent more time at the feeder than pigs classified as either 'normal' (72.6 ± 2.6 min day^{-1} pig^{-1}) or 'low gaining' (67.6 ± 5.3 min day^{-1} pig^{-1}). This initial manuscript demonstrates the potential of utilizing feeding behavior or time spent eating as a method of managing animals.

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1. Introduction

Feeding behavior contains important information that can enable producers to better manage livestock; similarly researchers can benefit by better understanding factors that influence feed intake. Feeding behavior in livestock species has been reported in many different studies (Bach et al., 2004; Bigelow and Houpt, 1988; Chapinal et al., 2007; Morgan et al., 2000; Nienaber et al., 1990, 1991). Each study includes various parameters of feeding behavior parameters that have included feed intake, meal (bout) length, meal (bout) interval, number of meals (bout) per day, total time spent eating, and rate of eating.

Systems are currently available to measure feed intake in association with feeding behavior for cattle (Basarab et al., 2003; Chapinal et al., 2007; Kelly et al., 2010), swine (Andree and Huegle, 2001; Chapinal et al., 2008; Hyun and Ellis, 2002; Nienaber et al., 1991), small livestock (Basarab et al., 2003; Gipson et al., 2006, 2007; Goetsch et al., 2010), and poultry (Puma et al., 2001). While some of these systems provide the user with feed intake data in addition to feeding behavior, they require feeders to be accessed by a single animal at a time and due to the cost only a limited number of feeding stations are placed in a pen. While, feed intake is a very important parameter in some studies (i.e. genetic evaluation, nutrition studies), it may not be necessary for others. Limited access to the feeder can alter the animal's behavior and maybe be representative commercial sized pens. In addition, to not altering feeding behavior, a system to monitor only feeding behavior has less equipment and no moving parts, therefore is less costly and easier to maintain. Therefore, systems that allow recording of feeding behavior (without feed intake) may be more applicable to production animal facilities. The parameters that could be measured in such a system would include meal (bout) length, meal (bout) interval, number of meals (bout) per day, and total time spent eating. Feed intake (kg/day) and rate of eating (g/min) are two parameters that could not be monitored in such a system.

Systems that record feeding behavior could provide a useful tool in managing production animals. Research has indicated that feed intake and feeding behavior changes can occur with relation to thermal conditions (Nienaber and Hahn, 2000), diet (Adijaoude et al., 2000; Fuller et al., 1995), social interactions (Goetsch et al., 2010), dominance ranking (Chapinal et al., 2008; Soltysiak and Ogalski, 2010; Val-Laillet et al., 2008; Walker et al., 2008), number of animals in a pen (Korthals, 2000), and health status (Griffin, 2001). Some research has worked to develop analysis methods for the process the feeding behavior data (Gates and Xin, 2008). However, most of these data were collected from small groups or individually housed animals. There is a need to investigate the dynamics of

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feeding behavior in livestock species within a commercial setting. With the continued improvement in instrumentation and better understanding of animals' responses, systems could possible be developed to electronically monitor animals ensure proper care of animals for improved well-being, for profitability of operations, and to ensure the correct use of antibiotics in our meat animals.

Objectives of this research were to describe the development of a system to record feeding behavior, then use the system to collect data to (1) determine how time spent eating varies with pig age, (2) quantify differences in time spent eating between barrows and gilts, (3) determine the impact of weight gain on time spent eating, and (4) evaluate the impact of health on time spent eating. The results of this data analysis will help assess the potential of utilizing feeding behavior to manage animals in a commercial setting.

2. Materials and methods

2.1. Equipment

A system to monitor feeding behavior in group-housed swine was developed and installed at the USMARC. The system utilizes radio-frequency identification (RFID) system and was designed around a commercial reader (Texas Instruments, Series 2000 High Performance Remote Antenna-Reader Frequency Module [RA-RFM][RI-RFM-008B-00]). This reader was designed to read low frequency half duplex electronic identification tags (EID) that were affixed to the animal. The radio-frequency signal was distributed to a series of antennas using a multiplexer (MPX) designed and constructed by the authors. Multiplexers were used for two different applications in the system: first to distribute the signal to various pens, and second to distribute the signal to various antennas within a single pen. The same multiplexer design was used in both applications.

Multiplexers were designed to function as multiple (eight switch locations) switches connecting the signal from the RA-RFM to the correct antenna. Fig. 1 shows a block diagram of a MPX; an input to the MPX can be directed to any of eight outputs with double pole switching. Multiplexer switching was controlled by a four-wire system: three control lines and a ground. The MPX control signal originated with the Series 2000 Control Module where control lines were latched under control of TFX-11 micro-controllers, Onset Computer Corp., 536 MacArthur Blvd., Pocasset, MA 02559, via RS232 communication. Multiplexer control switching was designed as a current loop, with a 0 or 4 milliamp signal representing 0 and 1 respectively. Current loop control was chosen for noise immunity over long wire runs. The control currents were used to drive LEDs in optical isolators, making the MPXs electrically isolated and immune to potential ground loops. Optical isolator boards were designed to couple the control lines that originated at the Series 2000 Control Board to the MPXs. The TFX-11 micro-controller sent a serial command to the Series 2000 Control Board, which latched the correct binary code for the correct feeder and the correct antenna within the feeder. Binary coded optically isolated lines distributed the signal to the MPXs, which latched the correct relays providing a pathway to and from the RA-RFM.

2.2. Software

The software was designed in two separate components. The first component was intended to function on the main computer and was designed for timing, data management, and display. The second component was intended to function on a micro-controller and was designed to control the sequence of the antennas and to capture one cycle of data. This approach was used for ease of expansion; multiple micro-controllers can be added to the system for larger installations.

The operational software for the PC host computer was written using HT Basic (HT Basic for Windows, Ver. 9.5. TransEra Corp., 375 East 800 South, Orem, UT 84097). The host system determined the timing of each scan (a sequence of powering each antenna and recording the EID number if present). This timing can be changed and was determined by the speed of the host computer; for this application a 20-s time base was used. After the host computer initiated the scan, it was available to summarize the number of hits

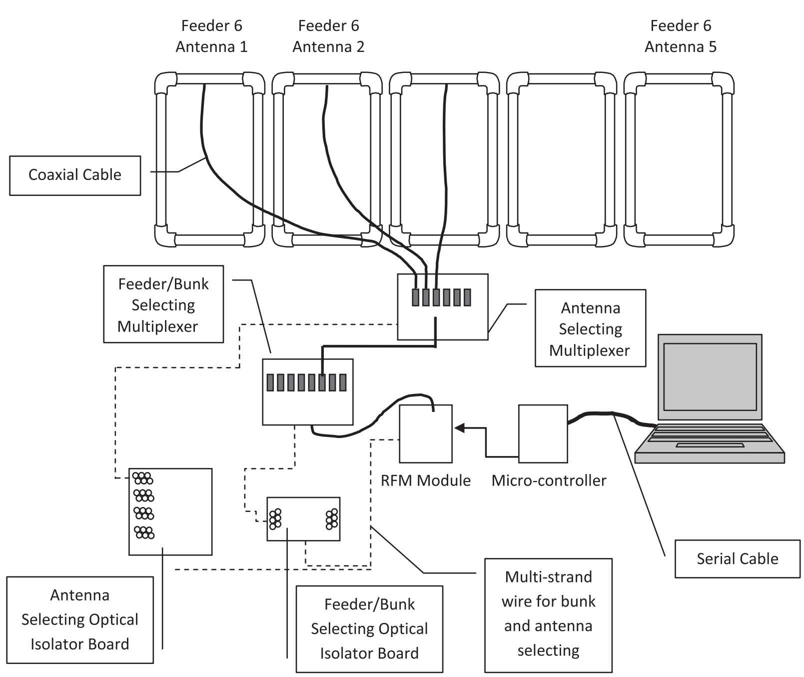

Fig. 1. Schematic of the feeding behavior monitoring system including all components needed to collect feeding behavior data from one pen of animals. Additional eight multiplexer boards can be added to this system for expansion up to 64 antennas. Expansion beyond 64 antennas requires an additional micro-controller, RFM module, a feeder selecting optical isolator board, an antenna selecting optical isolator board, feeder selecting multiplexer and a set of antenna selecting multiplexer boards.