Precision cattle management tools

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Introduction

When one thinks of precision agriculture, it is likely that thoughts quickly go toward row crop farming. Crop farmers have adapted technology very quickly and now the signs of precision farming are almost ubiquitous when one travels in any rural area. These technologies have allowed row crop farmers to optimize yields by more precisely applying seeding rates, chemicals, fertilizers, etc. based on various factors within and across fields. With the unpredictability in weather, prices, and margins, precision agriculture has quickly progressed from a luxury to almost a requirement for farming.
In the Upper Midwest farmer-feeder enterprise many of these same row crop farmers that have quickly incorporated precision agriculture are slowly beginning to apply precision agriculture practices to their cattle enterprise. It is clear that the cattle industry lags well behind the crop industry in terms of technology. It does appear that this is changing, and the appetite for precision cattle management is increasing.

The drivers for precision cattle management are many:

1. Labor and labor costs. Feedlot operators are motivated to incorporate tools that will allow for optimal management of cattle with fewer labor resources.
2. Optimizing cattle production. By managing cattle as individuals or small groups, producers can better design feeding, health, management, and marketing programs.
3. External forces. Whether it be packers, restaurants, grocers, or consumers there are many forces at play that shape the cattle industry. Different value-added programs and/or requirements from end-users may require or promote precision management approaches.

Some very basic and some highly sophisticated systems are now available, with many more in development, that will change the face of cattle management in the future. This review will make no attempt to exhaustively explore all current and emerging precision cattle management tools. The rapid pace of development makes this impossible. Instead, the goal of this review is to look at some key technologies that may be useful in precision cattle management in the near future.

Traditional Technologies

As the title implies, the focus of this paper will be on tools to improve precision management of cattle. However, it is important to revisit important technologies that are available for cattle production today. Though these technologies may not qualify as “precision” technologies, they are, nonetheless, critical technologies that, when used correctly, may be the difference between profit and loss in a cattle operation.

Maxwell et al. (2015) compared a natural feedlot system, with no use of growth-promoting implants, antibiotics, ionophores, or beta-agonists, with a conventional system using implants, antibiotics, and ionophores and a conventional system using all of those technologies plus a beta-agonist for the final 20 days-on-feed. In cattle that were on feed for 136 days, the conventional system without a beta-agonist increased average daily gain (ADG) 33%, feed efficiency (FE) 27%, final body weight (FBW) 10% (115

pounds/head), and hot carcass weight (HCW) 11% (84 pounds/carcass) compared with the natural feedlot system. When the beta-agonist was added to the conventional diet, the improvements were 38% for ADG, 33% for FE, 11% (132 pounds/head) for FBW, and 13% (101 pounds/carcass) for HCW compared with the natural feedlot system (Table 1).

Table 1. Effect of cattle feedlot production systems on growth performance and carcass characteristics. Adapted from Maxwell et al. (2015).

	Treatment[1]			
Item	Natural	Conventional	Conventional + Z	*P*-Value
Pens	8	8	8	
Total Head	112	112	112	
Days-on-Feed	136	136	136	
Initial Body Weight, lb	836	836	833	0.54
Final Body Weight, lb	1,191[a]	1,305[b]	1,323[b]	<0.01
Dry Matter Intake, lb/day	22.1	23.0	22.7	0.18
Average Daily Gain, lb	2.62[a]	3.48[b]	3.62[c]	<0.01
Feed Conversion[2]	8.33[a]	6.58[b]	6.25[c]	<0.01
Hot Carcass Weight, lb	767[a]	851[b]	869[c]	<0.01
Marbling Score[3]	471[a]	470[a]	432[b]	<0.01
USDA Yield Grade	3.04[a]	2.99[a]	2.65[b]	<0.01

[1]Natural: No antibiotics, ionophores, growth-promoting implants, or beta-agonists. Conventional: Utilized antibiotics (Tylan®, Elanco Animal Health), ionophores (Rumensin®, Elanco Animal Health), and growth-promoting implants (Revalor-XS®, Merck Animal Health) throughout the feeding period. Conventional + Z: Utilized all of Conventional treatment technologies throughout the feeding period plus a beta-agonist (Zilmax®, Merck Animal Health) for the final 20 days-on-feed.

[2]Transformed from feed efficiency.

[3]400=Small00, 500=Modest00

[abc]Superscripts indicate statistical difference ($P < 0.05$) within row.

Some simple economics based on September 2021 cattle market prices ($195/cwt carcass) indicates an extra 84 pounds of HCW to be worth $164/head. If one looks at it from a resource use perspective, the 27% improvement in FE indicates 1.75 fewer pounds of dry matter feed to produce one pound of live weight.

Traditional technologies available for cattle production extend well beyond cattle performance. Metaphylactic use of injectable antibiotics is often incorporated to reduce the risk of bovine respiratory disease (BRD) in the feedlot. Recognized as the #1 cause for morbidity and mortality in United States feedlots, BRD is estimated to cost the feedlot industry $6 billion annually (USDA, 2013). According to Abell et al. (2017), not administering metaphylactic antibiotics to high-risk incoming feedlot cattle increased mortality by 2.43x compared with the same class of cattle that received metaphylactic antibiotics. This basically supports the common rule-of-thumb in the feedlot industry that metaphylactic antibiotic treatment of incoming cattle will reduce morbidity and mortality by 50%. Using these figures

and current cattle, feed, and antibiotic prices, reducing morbidity from 50% to 25% and mortality from 6% to 3% results in an additional $30/head net return through the use of metaphylaxis. This figure only considers antibiotic costs and lost profit due to death loss and does not estimate added losses due to reduced performance in the higher morbidity and mortality group. Moreover, the use of metaphylaxis antibiotic treatment for incoming feedlot cattle is used less as a means to increase profitability and more as protection against major losses on high- or unknown-risk cattle (Dennis et al., 2018).

The point of this section reviewing traditional technologies is not to diminish the use of new technologies for precision cattle management. To the contrary, precision cattle management can be utilized to enhance the use of traditional technologies through targeted use in different classes and types of cattle. The use of metaphylactic antibiotics is a good illustration of this. Antibiotics are an expensive tool for feedlot operators and generally cost $3-4/cwt, or $15-20/head for a 500-lb animal. Traditional cattle management would apply metaphylactic antibiotics to all cattle in a high-risk group, even though many of them may not need it. By using precision cattle management, input costs can be reduced by targeting only the cattle that have a high risk of developing BRD while maintaining the overall morbidity and mortality of the group. To quote Dr. Robbi Pritchard, precision cattle management offers the opportunity to “use scalpels instead of axes” when feeding and managing cattle (Pritchard, 2015).

Current and Emerging Technologies

Before a feedlot operator can begin to effectively utilize precision cattle management, he or she needs to be able to simply manage and capture data. In the row crop enterprise, long before farmers using precision planting, fertilizing, etc. they at least could measure yield/acre. Although this seems like a basic necessity to measure performance baselines, identify areas for improvement, etc. there are still many feedlots that do not keep records accurate enough to adequately assess feedlot performance. Recent years have seen a major improvement in feed delivery and cattle tracking with the introduction of the Performance Beef cloud-based feed management software (Performance Livestock Analytics, part of Zoetis Animal Health). This system allows real-time monitoring of feed deliveries, delivery times and ration ingredient loading, estimate cattle performance, and utilize data to improve feedlot productivity among other features. This program has introduced many cattle feeders to the use of new, cloud-based technology for cattle management, and has been widely accepted among Upper Midwest farmer-feeders who previously did not utilize pen-level feeding and closeout information. Performance Beef has effectively set the baseline for new feedlot technologies: easy-to-use, easily adapts to a current feedlot system, provides real-time information, and provides tangible insights that can be used to improve feedlot operations.

Although the pace of discovery and development of precision cattle management technologies has increased rapidly, the practice is not necessarily new. One example of a technology that has been available for many years is the micro machine feed supplement management system. This system allows for “prescription” feed supplements for specific groups of cattle. Micro machines are particularly useful for larger feedlots with groups of cattle that may vary in size, sex, weight, marketing program, out date, etc. as they can utilize specialty additives such as beta-agonists for finishing cattle, direct-fed microbials or organic trace minerals for incoming cattle or sick pens, different ionophores (or no ionophore at all) for different groups of cattle, etc. For many years, however, micro machines were thought to be exclusive to larger, corporate feedlots and were thought to be too expensive and/or unnecessary for smaller farmer-feeder yards. Recent years, however, have seen the adaptation of micro machines in smaller feedlots.

The next step to move beyond these very useful technologies is to move from pen or group-based management to more prescriptive, individual-animal management. Although the current (and likely enduring) feedlot model is a pen-based model, precision cattle management can be utilized to manage individual cattle within a pen. Precision cattle management can also be used to identify similar cattle, group those cattle together in a pen or group of pens, and then apply prescriptive management to those pens or groups.

Sorting cattle into outcome groups has received considerable research attention, though the adaptation often depends on many external factors such as feed prices, carcass premiums/discounts, sorting

pens/facilities, etc. Sorting is utilized to decrease the standard deviation in FBW or HCW in finished cattle to optimize profitability and minimize discounts for overweight carcasses. Hilscher et al. (2015) compared groups of cattle that were unsorted with groups where the heaviest 20% of cattle were identified at feedlot arrival and marketed 14 days before non-sorted cattle with the remaining 80% of sorted cattle marketed seven days after non-sorted cattle. Through this simple sorting technique, based solely on initial body weight measured 154-157 days prior to harvest, HCW was increased six pounds and the standard deviation of hot carcass weight was numerically decreased 5 pounds. Using a more intensive sorting regimen where cattle were sorted 50 days prior to harvest into four groups based on body weight and marketed -14, 0, +7, and +28 days relative to the unsorted control resulted in further reductions in the standard deviation of HCW and reduced overweight carcasses (greater than 1,050 pounds) compared with the unsorted control.

Results from Hilscher et al. (2015) illustrate the value of sorting based simply on body weight. However, biometric measurements such as hip height and width may provide more accurate sorting criteria. The Cattle Classification Sorting System (CCSS), which was recently acquired by Elanco Animal Health, utilizes incoming cattle weight, hip height, and hip length to classify and sort cattle (Sperber et al., 2019).

A step further in cattle classification could be the use of cameras to classify cattle. Cameras that collect biometric measurements, such as CattleScanner (Cattler Corporation), could allow for in-pen identification of cattle weights and therefore eliminate the need to process cattle through chute for weight determination for sorting.

An additional feature to CattleScanner in-pen weight monitoring is the ability to utilize more accurate weight measures for growth model estimates. Current growth models utilize initial body weight and inputs such as weather, feed intake, and feed delivery to estimate ADG and current body weight. Variations in type of cattle, pen conditions, feedstuff nutrient measurements (or lack thereof), cattle management, etc. can make these ADG and body weight estimates very inaccurate.

For animal health, the Whisper-on-Arrival (WOA; Merck Animal Health) system is a chute-side technology utilized to predict the risk of BRD among cattle upon arrival to a feedlot, stocker, or backgrounder operation (Nickell et al., 2021). The WOA system provides a “treat” or “no-treat” recommendation for each individual animal based on heart and lung sound data. The goal of this tool is to identify and provide antibiotics to the cattle that truly are at risk of developing BRD while leaving those that are not at high risk untreated. Nickell et al. (2021) demonstrated that when WOA was utilized to identify cattle that needed antibiotics for BRD prevention compared with metaphylactic BRD administration, there were no differences in morbidity, mortality, or cattle performance outcomes. In this study WOA identified 70% of the cattle to be at high risk of developing BRD and therefore in need of antibiotic treatment. Therefore, even though 30% of the cattle were left without antibiotic treatment there were no differences in health or performance outcomes.

Other technologies such as ear tags to monitor cattle health and notify cattle producers of sickness (Quantified Ag, Merck Animal Health), automated bunk readers and feed trucks, real-time feed nutrient measurements, genomic testing to estimate cattle health and performance potential and many more are available and/or under development for use in feedlots. The dairy industry has made great strides in utilizing precision animal management technologies, particularly for reproduction and sickness identification. Many of these applications are being developed for the cattle feedlot industry as well.

In closing, every day it seems we are getting closer to the ultimate goal of an integrated system that will monitor cattle behavior, health, growth, and other parameters. This ideal system would allow a producer to identify individual cattle, place them in specified outcome groups, manage them appropriately based on genetics, marketing program, etc. and then continuously monitor health and progress toward a prescribed endpoint.

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