FITBITS FOR CATTLE: BIOMETRIC TRACKING DEVICES FOR LIVESTOCK MANAGEMENT

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ABSTRACT

This paper explores multiple published articles that report on the development and benefits of utilizing biometric tracking technologies to manage livestock and farm production. The articles vary in their purpose for implementation of biometric tracking technology as well as the different devices available or being developed for farmers to use. Osman Husain (Husain, 2016) takes an in depth look at how 'Fitbits for cows' can aid in increased milk production in Asia. Nate Beck (Beck, 2016) looks into how the Fitbit-like device for cows was developed in Wisconsin in order to improve record keeping in the dairy business. Other articles look into the development or modification of biometric tracking devices to benefit beef cattle production as well as sheep health. This paper examines research along with the author's background in Agricultural business and animal science to further understand the process of developing such technology as well as the benefits for utilizing biometric tracking technology.

WHO CARES HOW MANY STEPS A COW TAKES?

There is an ever growing need for increased food and fiber production within our economy. The United States alone has a population of 321.42 million (World Bank, 2015) individuals who depend on agriculture for their food, fiber, fuel, medicine, and many other products utilized daily. Added to this equation is the fact that the amount of land suitable for agriculture is diminishing, forcing today's farmers to develop ways to grow more food with fewer resources. Any technological development that would improve agricultural efficiencies provides benefits to both the farmer and the consumer by allowing for the farmer to produce higher yields at a lower cost and in turn passing these unit savings on to the consumer.

One way agriculturalists have sought to increase efficiencies is by improvements in livestock management practices. By developing more efficient management practices both the animals and the farmers are benefitted through providing a healthier environment for the livestock and more efficient yields for the farmer. As we explore some of the developments in biometric tracking devices and software in agriculture, you will find that the animals' health and well-being are the key focus.

Individuals such as David Cook, a co-owner of BoviSync, developed software that organizes and analyzes the health of a herd of cows (Beck, 2016). The basic idea behind the software Mr. Cook developed is to improve production while lowering overall costs through better record keeping and earlier response times to treatment of sick or injured animals. Without trying to reinvent the wheel, the software currently being developed is essentially a modified Fitbit, only with more features. The products are designed to easily be incorporated into the farmer's existing operation while working with other common devices such as the smartphone to manage the data received from that animal. This can help with cost efficiencies as well as aid in marketability. With some minor modifications, this type of technology could possibly be utilized across the agriculture industry.

WHAT TYPE OF DEVICES ARE CURRENTLY AVAILABLE AND HOW ARE THEY BEING USED?

While there are multiple types of hardware and software for biometric analysis purposes currently being utilized and tested in Agriculture, this paper will review a few of the key varieties currently in use or in the development stages. Although not all of the tracking devices that we will review are specifically created for the relay of biometric information, they all provide certain aspects of information tracking that has the opportunity to be incorporated into livestock management and improved record keeping.

Radio Frequency Identification (RFID)

The Michigan State University Extension department has done a considerable amount of research into the Radio Frequency Identification (RFID) system. Dan Grooms (Grooms, 2007) states that RFID describes a system that wirelessly transmits the identity of an object, in the form of a unique sequence of numbers or letters, using radio waves. The RFID is designed as part of an ear tag system to identify cattle both visually as well as through radio waves received by the transceiver. The article goes on to state that there are many types of RFID tag systems, however, the more passive, low frequency RFID systems were first used in USDA approved ear tags.

There are four basic components of an RFID system. First is the transponder, which is usually comprised of a microchip embedded into an encapsulating ear tag. The chip utilizes a metal coil antenna to send the identification information to the transceiver. This is a wand-like reader that works as both a radio transmitter and an antenna. The transceiver communicates the collected identification information to the data accumulator. This is the device where the information collected and received by the transceiver is stored. The idea is to utilize technology that is readily available to farmers today, such as a computer, smartphone, tablet or personal digital assistant (PDA). The last piece to the puzzle is access to the processing software that transforms the data into useful information. Without the processing software, the data collected is unorganized and inefficient.

As a general rule, the RFID system was designed more specifically for animal identification purposes. A more sophisticated approach to branding, ear tags or ear notching, the RFID aids in mitigating theft and lost livestock. It also provides a more sophisticated means of tracking that animal through sale barns or feed yards and into the initial stages of slaughter. Kansas State University animal scientist, Dale Blasi comments that RFID makes sense as a practical means of

animal identification, considering the National Animal Identification System's goal of being able to trace an infected animal's path throughout the country within 48 hours (Berg, 2006)

The only drawback for the RFID system is that it does not currently allow for real-time data to be viewed without the animal passing by the transceiver. The implementation of live data feeds would increase response times for lost or stolen cattle as well as infected cattle traveling through the country. As we will later see, there are additional technological developments that allow for live viewing of such information.

Story Meat

In some countries, consumers can walk into the grocery store, use their smartphone to scan a barcode on a packaged meat product and then view information about where and how that animal was raised and even background information or image of the farmer who raised it. The idea behind this source-verified meat is to keep consumers informed and connected to the end product of farming. Although this identification process does not necessarily keep up with that animal's health, it is a way to utilize good record keeping practices using technology readily available to farmers today. This concept could easily be an important step toward the end goal of integrating biometric and identification tracking into a single technology.

Active Tags

The Cattle Traq division of the American Biomedical Group in Oklahoma City, Oklahoma, modified a technology application that was already being used by the military to develop the Cattle Traq tracking system. "The technology was developed to track military shipping containers inside the hold of a U.S. Navy Ship[1]" says Jim Burgess, Cattle Traq President. Antennas and high frequency ear tags or bolus tags are used to track and transmit information about the animal's location and vital signs (Berg, 2006).

While the ear tags are currently developed more for location analysis, the bolus tag has been modified with the purpose of reading and transmitting biometric information. A bolus is essentially a large pill-like object that is administered to cattle down the throat of the animal. The current device used by Cattle Traq weighs 4 to 6 ounces, this helps the device to settle in the rumen or stomach of the cow. Both the bolus and ear tag have specific identification methods that link them to that particular animal. These products were designed to work together to collect and transmit information about the animal's location, body temperature, pH or internal gas pressure, or other pertinent data. The purpose of tracking an animal's temperature, pH or gas pressure is to detect early signs of illness. Cattle hauled or handled extensively as well as those fed high caloric diets are more susceptible to bloating, stress or illness. Not only is checking cattle via foot or horseback multiple times each day a time consuming process, it may not be the most effective method, especially in comparison to hands free biometric analysis. The tags are designed to send an alarm to the farmer's computer or handheld device to notify them when an animal has shown abnormal vital signs or wanders outside the perimeter of the farm. This is accomplished using multiple antennas. This information can greatly help save time, money or energy in identifying a sick, lost or stolen animal. The convenience of the Cattle Traq system is evident in the idea that a farmer

[1] Berg, L. (2006).

can view all the pertinent information of each cow, whether it be their location, temperature, or stress level, from the comfort of their home or vehicle. Rather than having to go out searching for the lost animal, the farmer can use the tracking information sent to his or her phone from the Cattle Traq ear tag and go straight to where that animal is located.

The limitation with the Cattle Traq device is the necessary adaptation for the product to be effective on non-ruminant livestock. The bolus tag works well because it is located inside the cow's rumen. In order for this technology to be as effective on simple stomached livestock such as horses or swine, modifications would need to be made to develop a harmless way for the farmer to house the tag on or inside the animal. This would take additional testing because of the differences in physiology that might inhibit accurate test results.

Ever Hear of QuickBooks for Cattle?

David Cook, a co-owner of BoviSync, developed software that organizes and analyzes the health of a herd of cows. Dairy owners can use the software to learn why milk production has dipped, how illnesses have spread through their herd and other reasons (Beck, 2016). The technology utilizes similar devices related to the bolus tag marketed by Cattle Traq that relays each cow's vital signs to the BoviSync system on the farmer's computer, smartphone or tablet. The software then breaks down that information and organizes it into spreadsheets and tables. The system also keeps track of information such as breeding and calving dates, dates for artificial insemination of open cows, veterinarian visits and diagnosis, average gestation cycle, calf genders and milk yields. While this software was originally developed for the dairy industry in Wisconsin, with minor adjustments it could be a very beneficial tool in the management of beef, sheep, swine and even equine operations. The BoviSync system is designed for improved farm reports. It is a unique and well organized program with many areas of opportunity to record data from daily operations. It could be modified slightly to improve record keeping with livestock on any type of farm.

Accelerometers for Beef

While knowing how much cud a cow chews per day or how many steps it takes does not sound extremely beneficial, an active cow is a happy cow. In Dr. Karin Orsel's study according to (Owens, 2015), accelerometers were attached to the identification ear tags in a group of cattle in order to collect information about how much energy was expended by moving around, resting, eating and chewing their cud. The study was designed with the intentions of testing and adapting the accelerometer technology to beef cattle operations. Similar technology is currently implemented through collars on dairy farms. However, the physiological makeup of beef cattle, with higher muscle mass in the neck and body, limit the effectiveness of the collars as compared to that of the lighter muscled dairy breeds. The plan was to identify correlations between changes in activity, especially mastication, and illness such as a respiratory disease. Overall the study with ear tags on beef cattle had mixed results. The ear tags could identify when a cow was eating feed within 95 percent accuracy; however, it was only 49 percent accurate on discerning cud chewing in the animal (Owens, 2015).

Retinal Vascular Pattern (RVP)

Wes Ishmael (Ishmael, 2006) reviewed different types of biometric identifiers, lending his focus on digital imaging of the animal's retinal vascular pattern. According to his interview with Bruce Golden, CEO of Optibrand, a forerunner in digital imaging of an animal's Retinal Vascular Pattern (RVP), RVP is foolproof.

A biometric identifier is essentially a feature specific to an individual that can be viewed or scanned for digital recognition. Humans use biometric identifiers every day through facial recognition and fingerprints. Nose prints, DNA and RVP are the most prominent and accurate forms of livestock identification. However, retinal vascular pattern identification is proven to be more efficient and accurate when compared to DNA, which is time consuming and costly, and nose prints which lack in consistency. The identification process is completed by taking a digital image of the retina, each animal has a unique pattern of blood vessels at the back of the eye. The sample is the permanent identification for that animal. Using the Optibrand system as an example, a digital image of an animal's RVP is recorded. This image is tied to a time and date stamp, as well as to GPS coordinates of where the image was recorded. Depending on the volume, it costs clients fifty to seventy-five cents per head for scanning and recording at Optibrand (Ishmael, 2006).

This specific and highly accurate approach to animal identification is being utilized by veterinarians, farmers and packers to ensure the identities of quarantined, rogue, or internationally shipped cattle. However, there are a few drawbacks to this technology in comparison to its counterparts, since RVP is currently limited to strictly identifying an individual animal. For example, utilizing DNA testing allows for extensive testing and research as well as tracking lineage for that animal. Furthermore, the technology does not provide a means of accumulating and analyzing health metrics on that specimen.

FUTURE DEVELOPMENT AND IMPLEMENTATION OF BIOMETRIC TECHNOLOGY

After reviewing several different types of biometric and identification tracking systems under development, you can see how agriculture is utilizing technology and working towards a more modern and efficient approach to management. There is an extreme amount of opportunity in biometric tracking devices improving agriculture both in the United States and internationally. At the right price, other countries could utilize such technology to improve yields and overall health, even marketing a safer product through value-added record keeping. Dairy farming is one of the biggest industries in Pakistan. However, Osman Husain's (Husain, 2016) review revealed their average daily yields of four to five liters per day paled in comparison to the average daily yields for North American based dairies of 32 liters per day. He attributes low yields to the primitive agriculture techniques still used in Asia.

Even though the biometric and identification tracking devices discussed are still within the research and development stages, there is an obvious benefit to the products overall goal. The key to developing and marketing these and similar types of technology to farmers is to keep in mind

how cost effective is your technology. Within that idea is the additional understanding that not all farms are the same. Dairy farmers in Minnesota and Wisconsin manage their operation on a much different scale and system than a beef cattleman in Texas. Most dairy operations are more automated today. Also, a feedlot manager has different needs for tracking certain biometrics like feed intake, average daily gain and illness as compared to heat cycles and milk production that a dairy producer focuses on.

The possibility for implementation into the pork, poultry, sheep and equine industries are tangible. For example, a similar biometric tracking device could be utilized in horse racing to monitor the animals respiratory and heart rate while training and even competing. Furthermore, equine have a more sensitive reproductive cycle that more accurate timing of estrus for breeding and gestation would be beneficial for horse breeders.

CONCLUSION

Consumers today are more aware of their health and diet than any other generation in history. There is an extreme interest in the food and fibers purchased along with knowing where those products come from and what it took to get them to the local grocery.

This added interest in where our food comes from as well as how it is grown has aided in the establishment of modern tracking and animal identification technologies such as the Country of Origin Labeling (COOL) law (United States Department of Agriculture, 2016). In the 2002 Farm Bill, retailers were required to provide country-of-origin labeling for fresh beef, pork, and lamb. Processed meats were originally exempt. Later in 2008, the requirements were expanded to include food items such as fruits, nuts and vegetables. While in 2015, Congress repealed the "COOL" law, there is a continued importance placed on knowing the origin or our food and fiber. This concept added to the fact that the world's population is quickly outgrowing its food source, makes for a very concerned farmer. How are farmers today supposed to grow more on less land than ever before? The key to increased production is designing more efficient methods of farming through innovative technology and management practices.

Over the last several decades, farmers have embraced technology to not only improve their livelihood but also increase production. From the tractor, to robotic milkers and computer controlled food bunkers, there is continuous room for improvement. While the development and implementation of biometric tracking devices in livestock is still in the research and development stages, there is an obvious benefit and place for it in the world of agriculture. Further testing and adaptation is necessary to not only provide a cost conscious product to farmers but also allow for more effective models developed for specific sectors of the agricultural industry. We see evidence for the necessity of different types of devices when comparing physiological differences between beef and dairy cattle and how this can impact the effectiveness of a product.

The opportunity for development in biometric identification technologies is readily available, with several venues already being explored. Provided the right funding and management were available to the information technology managers in agriculture, great progress as well as profits could be made both in the United States and on an international level as well. On that note, a chief marketing technologist for the United States Department of Agriculture could find a secure position with

multiple opportunities and prototypes to move forward with. Farming for food and fiber resources is likely always going to be a vital area for development and progression in order to feed and clothe the growing population.

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