Information management in cow-calf operations: data priorities, recording, and sharing

by

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Abstract

Animal information management presents a major challenge in the beef cattle industry. How data is gathered, recorded, utilized, and shared are constrained by time, cost, and technology. Effective information collection and administration provides a valuable tool for producers to facilitate efficient cattle management. The transfer of detailed production and health information from cow-calf to downstream producers enables tailoring production decisions, reducing redundant animal health interventions, and facilitating cattle and beef marketing. Additionally, sufficient information flow within the beef supply chain is necessary for the provision of beef production information desired by consumers.

The purpose of this project is to design and develop a mobile electronic animal information record-keeping and sharing tool, known as the "CalfDex," for cow-calf producers to support improved management practices and streamline data sharing to downstream customers. The functionality and interface of the CalfDex is being designed based on input collected from cow-calf producers through surveys constructed to identify and prioritize information they would want to record with the tool along with their willingness to share specific information with cattle buyers. Additionally, surveys were conducted with feedlot managers to identify information they want to receive from cattle suppliers that could be efficiently collected and transferred with use of the CalfDex along with their willingness to share selected data with cow-calf producers.

Highlighting the potential benefit of a program like the CalfDex, survey results suggest there is a lack of uniformity in the way beef cattle records are kept as well as a lack of data sharing between supply chain participants. The surveys conducted also built an understanding of the prioritized information needs of cow-calf producers and value associated with specific information shared to downstream producers. This insight was considered in designing the structure of the CalfDex to streamline functionality and ensure the program met producer needs. Currently, the

CalfDex is in the final stages of the development period. Once development has been completed, beta testing trials will be conducted to evaluate the effectiveness of the program to manage animal information and facilitate information sharing in the beef cattle supply chain.

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Chapter 1 - Introduction

1.1 Background

The beef cattle industry faces exposure to several external and internal challenges, and many of these issues are easily observed and widely recognized by producers in the industry. Price uncertainty, consumer behavior, emerging government policies, and animal health issues are a few major concerns faced by producers in the beef cattle sector. A less apparent challenge is the growing need for effective management of animal information across the supply chain. This includes how data for individual animals is gathered and recorded, shared among supply chain participants, and utilized by producers across production sectors. Individual animal information is a valuable resource for producers to improve operational management, and advancing information management is essential to the development of the beef cattle industry.

The beef cattle sector, relative to other livestock industries, has not kept pace with advancements in individual animal record-keeping (Salin, 2000). This sluggish advancement likely results from time, cost, and technology constraints. General farm record-keeping requires time, and gathering comprehensive information for each animal in a producer's herd is especially time consuming using conventional record-keeping methods. There is an opportunity cost associated with the amount of time that must be spent managing detailed information. Additionally, one-time costs of implementing an electronic record-keeping system to facilitate data organization ranges from around $150 up to $600 (Doye et al., 2017). While several programs exist to facilitate increased efficiency in cattle information management, adoption is relatively low with only around 20% of U.S. cow-calf producers utilizing computerized record-keeping on their farm in 2012 (Pruitt et al., 2012). Though effective data recording is possible without the use of

electronic record-keeping systems, this low adoption rate indicates a lack of widespread motivation to improve information management in the beef cattle industry.

The need to improve animal information management in the beef cow-calf industry is clearly visible with the relatively low adoption rate of electronic animal information management tools by U.S. cow-calf producers. This suggests that the industry lacks an accessible and easy to use tool enabling producers to capture basic animal information on the farm and share it with downstream producers. Unlike many of the current electronic cattle recordkeeping program options, a tool designed around managing essential animal information in a low cost and simple manner is more likely to achieve adoption and provide the benefit of electronic animal data management and information sharing capabilities. Though focusing on simplicity and streamlined functionality results in less comprehensive capabilities, it provides a more attractive option to producers utilizing relatively rudimentary forms of information management and those who are unwilling to invest time and capital into more comprehensive programs.

1.2 Objectives

The first objective of this study is to identify, categorize, and rank animal information needs of cow-calf and cattle feedlot producers gathered through surveys distributed to both types of producers across the Midwestern United States. This information was gathered to be considered in the development of a mobile animal information management program, known as "CalfDex." The second objective is to develop, test, and analyze the functionality of the program along with benefits provided to cow-calf and downstream producers using the tool.

1.3 Organization

CalfDex is an electronic animal data record-keeping and sharing tool designed to promote a greater level of animal data recorded at the cow-calf level, simplify the sharing of information to

downstream customers, and promote data transparency downstream to consumers and upstream to producers. The tool was designed as a smartphone application to be utilized by cow-calf producers and allow them to enter data such as calving, health, and weaning information for their calves quickly and easily in the field. The data is gathered on the local database of the user's device and can then be uploaded to a cloud database where the current and historic data is stored for each producer. Additionally, the program includes a function that allows cow-calf producers to generate a report of essential animal information to be shared with downstream producers when calves are sold which includes data necessary to allow improved procurement and management practices once cattle are received. By providing producers with a simple way to both record and share animal data, CalfDex aims to promote improved herd management, cattle marketing, and information transparency throughout the beef cattle supply chain.

The success of CalfDex depends heavily on two factors: the usability and functionality of the program. The usability addresses the time constraint of gathering and recording animal information on the farm. Throughout the designing phase of CalfDex, emphasis was placed on simplifying data recording to encourage cow-calf producer to utilize the functions of the program. The functionality of the program relates to how capabilities of CalfDex align with producer needs. Surveys were conducted with cow-calf and feedlot producers to assess the importance of various animal information categories to both record at the cow-calf level and share with downstream producers. Understanding the importance of animal data through various production stages provided a foundation on which to structure an effective information management tool and promote adoption.

Chapter 2 - Literature Review

2.1 Animal Information Benefits

Numerous benefits arise from the presence of detailed individual animal data throughout the beef cattle supply chain. For cow-calf producers, improved information management provides insight into both present and past herd performance, enabling producers to efficiently track herd performance over time. Additionally, effective information collection and administration provides cow-calf producers with improved tools to facilitate effective herd management due to the ability to formulate decisions based on compiled data. Because individual animal information is necessary in the process of effective calf management, CalfDex was designed to include functionality to assign data to each animal in the herd.

Although information management begins at the cow-calf production level, benefits of individual animal data follow cattle throughout the supply chain. For cattle feeders, information on feeder cattle age, weaning status, vaccination history, medical history, and nutritional history of animals is of great benefit. Such information provides indicators of how the animals will perform regarding average daily gains, carcass qualities, and disease resistance in the feedlot (Busby et al., 2004, and Faber et al., 1999). Because these points of information are of such importance to cattle feeders, it is important that they are gathered and recorded at the cow-calf level. CalfDex's focus on information is rooted in the realization of this importance, as this information can be shared directly with feeders from cow-calf producers. However, it is also necessary for this information to be shared with intermediate producers such as backgrounders or stockers so they are able to share the data with feeders.

2.2 The Importance of Animal Information Sharing

The willingness of producers to share animal data is key to disseminating the benefit of individual animal data downstream and upstream across the beef cattle supply chain. Data sharing throughout the entire beef cattle supply chain facilitates product traceability which promotes production efficiency, improved profitability, and increased competitiveness for the beef industry (Peel et al., 2011). The beneficial effects of data sharing are realized by all sectors of the beef cattle industry. However, benefits accrued by producers at different production stages are not identical. To promote openly sharing animal data along the beef cattle supply chain, is it important that producers of each stage of production understand potential benefits they could reap from engaging in a relationship of openly sharing animal information with other supply chain participants.

The transfer of detailed production and health information from cow-calf to downstream producers enables tailoring of downstream production decisions. Downstream data sharing promotes the reduction of redundant animal health interventions as producers often revaccinate purchased cattle without detailed vaccination history (Athanasios et al., 2006). Additionally, downstream information sharing facilitates cattle and beef marketing as producers are not able to capture the full value of their animals if certain information, such as preconditioning protocols followed, is not received by buyers (Bulut et al., 2006). Upstream data sharing also provides benefit to producers by allowing them to adapt more quickly to changes in the market by receiving feedback on their production practices (Peel et al., 2011). This includes animal performance data shared from feedlot producers to cow-calf producers regarding their animals' carcass quality information, average daily gain, and disease resistance while at the feedlot.

2.3 Data Transparency in the Beef Cattle Industry

Information transparency is a growing value-added opportunity and, in some cases, a requirement in the beef industry. Internationally, systems to improve bovine traceability are increasing in popularity. In the United States, farm to consumer traceability is voluntary, but demand for it is increasing (Schroeder et al., 2012). A substantial portion of this demand stems from increased consumer preference for greater amounts of detailed food information shared from the farm level. The desire for this information is shown in the willingness of consumers to pay a premium for beef with traceability, transparency, and assurance characteristics (Dickinson, 2002). To follow changing consumer preference trends in beef traceability and transparency requires an improvement in information management in the United States beef cattle sector. By increasing the amount of information available for each animal, producers are better able to provide consumers with the product qualities they desire.

Consumer demand for individual animal traceability is growing; however, focus in this area is also a growing focus for stakeholders in the beef cattle industry. These stakeholders include the United States Department of Agriculture, The National Cattleman's Beef Association, and states that produce and export a large amount of beef (Shear, 2020). The developing focus on individual animal traceability can be heavily attributed to international outbreaks of Bovine Spongiform Encephalopathy (BSE) and Foot & Mouth Disease. (Shear, et al., 2019) In the United States, most red meat produced can be traced back to the processor. However, often meat is not able to be traced through the entire production system back to the farm of origin (Bailey and Hayes, 2002).

Traceability along the supply chain from retail product to its origins requires a sufficient system of records along with certifications (Bailey and Hayes, 2002). The functionality of CalfDex

provides a user-friendly method for obtaining this system of records; therefore, promoting individual animal traceability. In the United States, there is an ongoing effort to implement a national animal identification system known as CattleTrace. This program was launched in 2018 in the state of Kansas and, as of January 2020, began an initiative to expand to a national scale (Shear, 2020). CalfDex, or a similar program, could be utilized to function in coordination with CattleTrace. As the CattleTrace program is utilizing UHF RFID tags in the collection and assignment of animal information, CalfDex would likely also require the implementation of RFID technology (Shear, et al., 2019).

2.4 CalfDex Competition and Role in the Industry

In the U.S., numerous recordkeeping program options exist for cow-calf producers. This includes handwritten options such as the National Cattleman's Association's Redbook, general use spreadsheet software, and dedicated animal management software (Lalman et al., 2017). The development of, and increased accessibility to, personal computers and the internet has promoted the introduction of several recordkeeping programs designed for cow-calf producers. Most of these programs allow producers to input cow, calf, sire, and herd information (Lalman et al., 2017). Additionally, several of the more comprehensive programs allow producers to incorporate financial recordkeeping alongside animal records.

Many of the most prevalent electronic cattle recordkeeping programs in the market today share common functions. Programs such as CattleMax, Cow Sense, CattlePro, and Ranch Manager all allow users to input detailed information for cows, bulls, and calves (Lalman et al., 2017). This includes a more expansive range of information types than are included in CalfDex such as purchasing costs, physical attributes, and detailed pedigree information. The focus of CalfDex is to provide a streamlined and intuitive tool for cow-calf producers to gather and record data for

their calf crops with a focus on capturing information important to both the producer and downstream consumer. Therefore, the expansive data capturing capabilities for every animal in the herd of the programs mentioned, and those like them, are not available with CalfDex. However, Ward et al. (2008) found that Oklahoma producers individually identify 21% of calves verses only 8% of cows in their production records suggesting that producers find more value in individual animal recordkeeping for calves than breeding stock.

Most of the comprehensive cattle record-keeping programs output data into reports. It is common for these programs to allow the user to define what information is to be included in a report. As such, producers using these programs could compile reports similar to those generated by CalfDex to be utilized for informed decision making and sharing information downstream (Lalman et al., 2017). Since the programs mentioned allow a more detailed level of data recording and a similar capability of report generating to CalfDex, some producers who are utilizing these types of programs in their operation may not find value in CalfDex. However, CalfDex is not designed to directly compete with comprehensive whole-herd and financial production record keeping systems. Additionally, though it is a possibility for future versions of the program, CalfDex does not support integration with EID ear tags, so producers utilizing EID ear tags in their operation might opt for a program that is able to take advantage of this tool.

CalfDex could prove to be a simple complement or alternative to more complex recordkeeping systems. There are multiple scenarios where CalfDex could serve as a complementary program to preexisting information management practices. Many cow-calf recordkeeping programs do not give producers the capability of recording animal data on a mobile device in the absence of cellular signal that can then be uploaded to an online databank. In this case, producers who utilize these programs might find value in the accessibility of the data

recording function of CalfDex. However, the producer would have to enter data twice as CalfDex is not currently integrated with other record-keeping programs. With the cloud data storage capabilities of CalfDex, it is possible that this integration could be developed in the future.

Where CalfDex is best positioned in its current state is as a simplified alternative to complex cow-calf recordkeeping programs and possibly a complement to simple recordkeeping methods. Though the program does not capture the level of individual animal and herd data that the programs discussed earlier do, it offers producers an easy-to-use option to capture critical information and share it with buyers. CalfDex is designed to be an attractive option to all cow-calf producers, but especially those who currently use handwritten, spreadsheet, or other simple forms of recordkeeping. Implementation of CalfDex could include replacing handwritten records with the program to improve the efficiency of utilizing animal records, using the program alongside handwritten or electronic records to facilitate improved data recording capabilities and downstream information sharing, or implementing the program alongside a financial record keeping program to better gauge operational efficiency and success. Though it could be implemented in a seedstock operation, the program is likely better suited for use with commercial cow-calf herds due to the lack of expansive pedigree data captured by the program.

It is intuitive to assume that cow-calf producers using detailed recordkeeping programs have a higher willingness to devote time and money to detailed individual animal recordkeeping. However, some producers may not share this willingness or are simply reluctant to devote time to learning and implementing a complex electronic recordkeeping system. Pruitt et al. (2012) support this claim as they found in a national survey of U.S. beef cow-calf producers that around 46% of respondents keep individual records but only approximately 20% utilize computer records. For the producers who understand the value of individual animal data, have access to a mobile device, but

are unwilling to invest time and money into a complex electronic data management program, CalfDex could be a viable option. The program is designed with simplicity as one of the main priorities with the goal that it would be an attractive option to producers using handwritten or simple electronic methods of recordkeeping. Though CalfDex does not provide producers with the same capabilities as some more expensive recordkeeping programs, it provides an easily learned and operated option to transition operations into more sophisticated information management practices. However, even producers who have implemented a more complex recordkeeping system could find use in the program's offline field entry capabilities if their program lacks this function.

2.5 Barriers to Technology Adoption

As with any form of newly introduced technology, electronic recordkeeping programs face obstacles to producer adoption. Yapa and Mayfield (1978, p.146) claim adoption of new forms of technology requires at least four conditions to be satisfied. These four conditions are "(1) the availability of sufficient information; (2) the existence of a favorable attitude towards the innovation; (3) the possession of the economic means to acquire the innovation; and (4) the physical availability of the innovation." Gillespie et al. (2007, p.90) added three additional conditions that must be met alongside those presented by Yapa and Mayfield. Those are "a positive impact of the technology on the producer's net return, the willingness of the producer to alter management practices to adopt the technology, and the applicability of the technology to the producer's operation."

Regarding individual animal record keeping, there are several factors that specifically relate to adoption rates. In their study of U.S. cow-calf producer adoption of technology, management and production practices, Pruitt et al. (2012) found that the level of vertical integration, size of the operation, and demographics of the producer were all key factors in

explaining adoption rates. Additionally, these factors influenced adoption of computer and internet use by U.S. cow-calf producers. To ensure the success of CalfDex, the factors affecting information management technology adoption were taken into consideration. The focus of this project is examining the impact of the developed tool to producers rather than achieving high adoption rates. However, factors affecting adoption rates also likely reflect producer satisfaction.

Chapter 3 - Methods.

3.1 Cow-Calf Survey Design

The design of CalfDex interface and functionality is based directly on the inputs of cow-calf producers. To gain an understanding of producer needs, a survey was designed and conducted. Participants were selected based on recommendations from state cattle associations and livestock organizations as those who have demonstrated interest in participating and potentially beta-testing CalfDex. Emphasis was placed on choosing producers in and near the Midwest region of the United States (Kansas, Missouri, and Arkansas). Though this limited region introduces a potential selection bias, this is the region in which the CalfDex will first be introduced and tested. If the program expands usership outside of this region, additional producer input and feedback would be required to ensure the program meets the needs of producers in targeted regions.

Emphasis was placed on choosing operations with breeding herds of at least 100 cows for the cow-calf producer survey. This was assumed to be the typical production scale to gain substantial benefit from the use of the program, and the information sharing aspect of the CalfDex will likely be most effective for larger operations who are capable of selling large lots of calves. It is likely that the sample, being comprised of primarily larger operations, is biased toward large operations that are more likely to be progressive in their information management practices. However, there were commonalities discovered in the survey results of participants who reported breeding herd sizes less than 100 cows.

The survey was conducted with both commercial and seedstock operations, as needs for the program differ for each production type. In total, 25 surveys were gathered from cow-calf producers. Seven surveys were conducted through phone interviews, and 18 were gathered using an online survey created using Qualtrics survey software (Qualtrics, Provo, UT). A copy of the

Table 3.1. Information types included in the data recording questions of the cow-calf survey

Cow-Calf Producer Survey Information Recording Questions	
Question Category	Information Type
Information to record within the CalfDex	● Age of Dam
	● Birth Date & Weight
	● Calf Sex
	● Calving Complications
	● Calving Weather
	● Cow & Calf ID
	● Illnesses & Treatments Given
	● Implant Status & Type
	● Location/Pasture
	● Vaccines Given & Date Administered
	● Weaning Date & Weight

survey tool can be found in Appendix A. The online surveys captured the same information as the

phone interviews but also allowed respondents to answer some questions in an

open response format rather than selecting from categories as had been done with the phone

interviews. The proposition to conduct the producer surveys was submitted to review by The

Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas

State University and was found to be exempt from further review. A copy of the exemption letter

can be found in Appendix A.

The cow-calf producer survey consisted of 19 questions capturing data on general producer

information, their operation, and what program capabilities would benefit them. General operation

information captured data including producer age, breeding-herd size, record-keeping systems

used, and type of electronics they carry. The survey presented a list of animal information options

and asked producers to indicate whether they would want the ability to record the data in the

Table 3.2. Information types included in data sharing questions of the cow-calf survey

Cow-Calf Producer Survey Information Sharing Questions	
Question Category	Information Type
Information to share to downstream producers	● Birth Date & Weight
	● Calving Complications
	● Calving Weather
	● Illnesses & Treatments Given
	● Vaccines Given & Date Administered
	● Weaning Date and Weight
Information to receive from downstream producers	● Average Daily Gain (ADG)
	● Days on Feed
	● Death Dates and Rates
	● Finished Weight
	● Illnesses & Treatments Given
	● Vaccinations Given
	● Weather Information

program. Respondents were also asked to assign a priority rating for each attribute to provide insight on what types of information were most important to include in the data recording functionality of CalfDex. These animal information types can be found in Table 3.1.

The next section of the survey presented producers with questions regarding their current level of information sharing with cattle buyers. Additionally, they were asked what data they would be willing to send to buyers, specifically feedyards, and what data they would want to receive from downstream producers to assess animal performance beyond the cow-calf operation. These animal information types can be found in Table 3.2. In the last section of the cow-calf survey, producers were asked if they had any additional comments or ideas for the design of the program. This supplemental information was used in the developmental phase of the CalfDex to

ensure the program aligned with the needs of producers to maximize effectiveness and promote adoption.

3.2 Feedlot Producer Survey Design

To ensure that the information sharing aspect of CalfDex provided benefit for downstream beef cattle producers, a survey was designed to gain an understanding of information feedlot managers would want and how the information shared through CalfDex would be utilized. The survey was distributed to a small group of Kansas feedlots. This geographical location was chosen to improve consistency in responses and due to the majority of the beta testing participants being located in Kansas. Additionally, emphasis was placed on choosing feedlot operations with a one-time capacity of at least 10,000 cattle targeting commercial operations as opposed to farmer-feeders. Four surveys were completed through phone and in-person interviews, and three were completed via an online survey using Qualtrics survey software (Qualtrics, Provo, UT). A copy of the survey tool can be found Appendix A. As with the cow-calf producer surveys, the feedlot producer surveys were found to be exempt from further Institutional Review Board review as stated in the exemption letter found in Appendix A.

The feedlot survey consisted of 15 questions. The first set of questions captured basic operational information such as capacities and cattle procurement sources. Additionally, feedlot producers were questioned on current practices for receiving animal data and if they believe current methods are sufficient. The survey also questioned managers on whether they maintain contact with, and provide information to, producers from whom they source cattle. The focus of the feedlot survey was to assess information feedlot producers want to receive on incoming cattle, how they would utilize this information, and what animal performance data they would be willing and able to share with cow-calf producers. Understanding these three factors is key to streamlining the

Table 3.3. Information types included in the data receiving questions of the feedlot survey

Feedlot Survey Information Receiving Questions	
Question Category	Information Type
Individual animal information	● Birth Date & Weight
	● Calf ID
	● Calf Sex
	● Castration Date & Method
	● Dam ID & Age
	● Illnesses/Treatments
	● Sire ID & Genetic Information
Whole-load animal information	● Breed Information (e.g., beef/dairy, polled, color)
	● Co-mingled Load or One Seller
	● Dewormer Type & Date Given
	● Diet History
	● Farm Weight (pre-shipping)
	● Frame Size & Muscling
	● Implant Type & Date Administered
	● Origin of Calves
	● Transportation Time & Distance
	● Type (e.g., preconditioned, bawling calf)
	● Vaccines Given & Date Administered
	● Weaning Date & Weight

information sharing functionality of CalfDex to improve the potential benefit gained by both cow-calf and downstream producers.

To understand the importance of animal information received by feedlot producers on purchased cattle, the survey presented the information types shown in Table 3.3 and asked respondents to indicate whether they would want to receive each piece of information and to provide an importance rating for each. The types of information presented were separated into two classifications, individual animal and whole load, to provide clarity on how each would be received

Table 3.4. Information types included in the data sharing questions of the feedlot survey

Feedlot Survey Information Sharing Questions	
Question Category	Information Type
Information to share upstream to cow-calf producers	● Average Daily Gain (ADG)
	● Cost of Gain (COG)
	● Dead/Down in the Truck
	● Death Rate and Dates
	● Feed Conversion
	● Finished Weight
	● Illnesses & Treatments Given
	● Vaccinations Given
	● Quality and Yield Grade
	● Other Carcass Data

by the feedlot. Individual animal information includes data that would be assigned uniquely to each animal received. Whole load information includes data associated with every animal in the group. The insight gained from this portion of the feedlot survey would be compared alongside data the cow-calf producers are willing to share. This comparison was used to identify data desired by downstream producers that cow-calf producers are willing to share. Lastly, the feedlot survey presented the information types presented in Table 3.4 and asked feedlot producers if they would be willing to share each with cow-calf producers. Although these results would not directly affect the development decisions of CalfDex, they provided insight on the possible benefits of two-way information sharing that a program like CalfDex could promote.

Chapter 4 - Survey Results

4.1 Cow-Calf Producer Survey Results

The cow-calf producer survey captured basic producer and operation information. Questions regarding producer and farm demographics gave insight into the respondents and their operation that were taken into consideration when examining results. Respondent producer ages ranged from 28 to 74 years with a mean of 52. The breeding herd sizes of the operations owned by those surveyed ranged widely with the smallest being 21 cows, the largest being 550 cows, and a mean size of 185 cows. The majority of participants operated commercial cow-calf operations. Of the 25 total respondents, 64% indicated that their herds are commercial, while the other 36% indicated that they ran seedstock operations. This is important because, as mentioned earlier, it is likely that CalfDex would fit best in a commercial operation due to the inability of producers to record detailed calf pedigree information.

When asked about their current production record-keeping method, approximately half of respondents indicated they utilize electronic devices for recording operational data with other producers reporting some form of pen and paper record-keeping method. The broad range of record-keeping methods reported indicates a lack of uniformity in how information management in the cow-calf sector is approached. Only 26% of the producers indicated they had ever implemented a program dedicated to cattle production record-keeping excluding general use programs such as spreadsheet software. These producers were asked a follow up question regarding what they would change to improve the system they had used. There was consensus in the responses with multiple producers indicating that they would benefit from improved remote access capabilities, the ability to create multiple users, and an intuitive interface.

As CalfDex is designed to function in a mobile platform, producers were asked if they and their employees carry electronics while they are working. Nearly all (92%) producers indicated that they and their employees carry electronics supporting the notion that a mobile-based platform would be a viable format for CalfDex to be utilized for most cow-calf operations. To determine what mobile software platform to develop CalfDex in, producers were asked if they and their employees carry Apple devices, Android devices, or a mix of both. A third of the respondents indicated that there is a mix of Apple and Android devices used in their operations, so it was determined that CalfDex would need to be compatible with both device platforms to maximize accessibility to producers.

Results to survey questions regarding information cow-calf producers want the ability to record and priority ratings of each are shown in Figures 4.1 and 4.2, respectively. The insight obtained through this set of questions ensured that CalfDex allowed producers to record highest priority information. As observed in Figure 4.1, the majority of respondents indicated they want to record all information types presented in Table 3.1. However, some animal information appears to be essential to the cow-calf producers surveyed. Notably, producers showed the most interest in recording data related to basic cow-calf herd management. All respondents indicated they want the ability to record cow and calf identification, calf sex, and calf birth date. Additionally, nearly all (96%) respondents indicated they want to record weaning date. Another area of major interest is medical information with vaccination type, vaccination date, and illness/treatment data receiving a strong majority of responses indicating producers want to record them (87%, 83%, and 78% respectively).

Figure 4.2 shows the mean priority rating given to each type of information by producers on a scale of 1 to 3 with 1 being the highest priority. These questions were presented in an

Figure 4.1. Cow-calf producer information recording preference question results
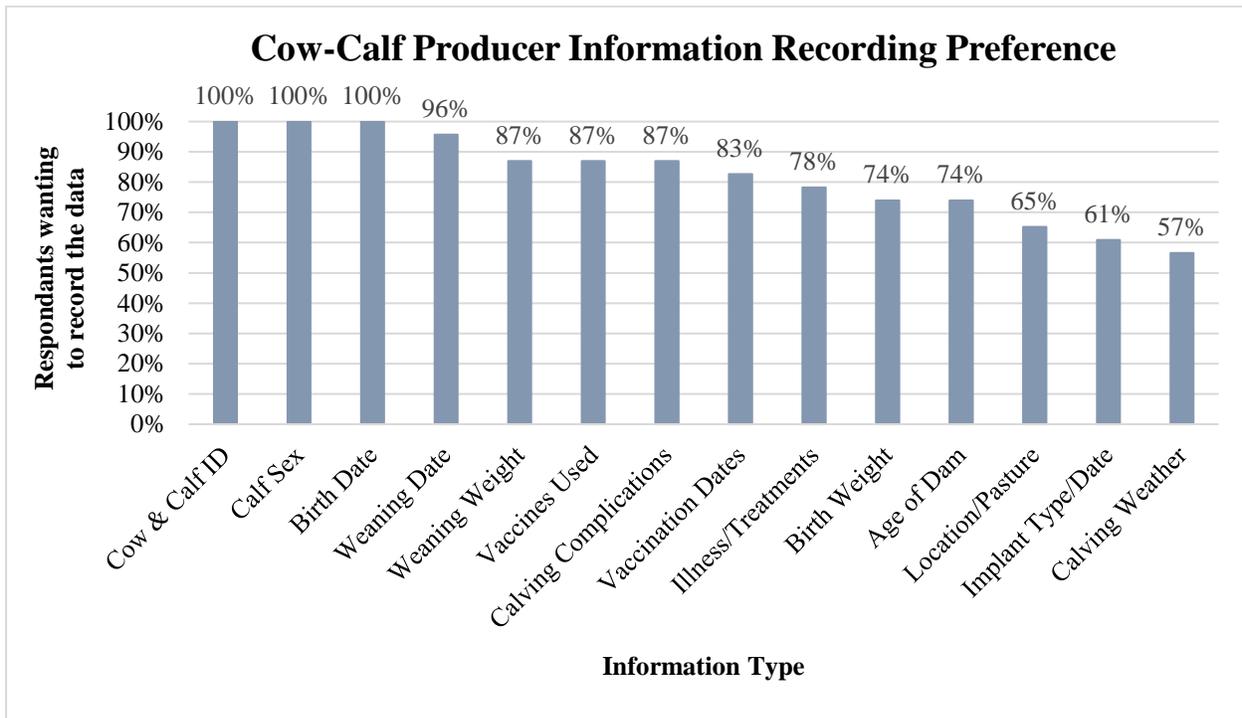
unconstrained three-point Likert scale. The results closely follow the order of the results in Figure

4.1 with the most desired data receiving the highest priority ratings; however, the orderings do not

exactly align. For instance, illness and treatment information was only desired by 78% of

respondents making it the ninth most desired data out of the 14 given. However, with a mean

importance rating of 1.35, illness and treatment information recorded the fourth highest priority

ranking of the data given. Additionally, though a substantial number of producers indicated that

they would want the ability to record vaccination information (87% for vaccinations used and 83%

for vaccination dates), data regarding the type of vaccination given along with the date

administered received relatively low mean importance ratings of 1.74 and 1.68, respectively.

The findings of data cow-calf producers want the ability to record and their priority

rankings for each suggest basic calf identification and information and health data are the two most

valuable groups of information to cow-calf producers. General calf management information,

including calf identification, sex, birth date, and weaning data, have the greatest importance to

Figure 4.2. Cow-calf producer information priority rating question results

Cow-Calf Producer Information Priority Ratings

Cow & Calf ID — 1.15
Calf Sex — 1.15
Birth Date — 1.2
Illness/Treatments — 1.35
Weaning Date — 1.42
Location/Pasture — 1.5
Weaning Weight — 1.5
Calving Complications — 1.61
Birth Weight — 1.63
Vaccination Dates — 1.68
Vaccines Used — 1.74
Implant/Type — 1.93
Age of Dam — 2.07
Calving Weather — 2.5

X-axis: **Mean Importance Rating (1=high, 3=low)** (0, 0.5, 1, 1.5, 2, 2.5, 3)
Y-axis: **Information Type**

producers. Health information was the second most valuable type of data and includes data such as illnesses, treatments given, and vaccination details. Additionally, when compared to the information type recording preference results shown in Figure 4.1, the importance rating results confirm that calving weather, dam age, and implant information are low priority information types to the producers surveyed.

To evaluate if the results of the priority rating questions were statistically different for each type of data, chi-squared tests were completed for each possible pair of data types. These results indicate if the distributions of producers assigning a high (1), medium (2), or low (3) importance ratings to each pair differ at a statistically significant level. Due to not all survey participants assigning an importance rating to each type of data presented, the distribution was converted to a ratio giving the percentage of producers that assigned each rating level to the data types. Table 4.1

Table 4.1. Priority rating question chi square test results

Data Type	Age of Dam	Birth Date	Birth Weight	Calf Sex	Calving Comp.	Calving Weath.	Cow & Calf ID	Illnesses /Treat.	Implant/ Type	Location /Pasture	Vac. Dates	Vac. Used	Weaning Date	Weaning Wt.
Age of Dam	1.00											Reject Ho at α=.05		
Birth Date	3.9E-12	1.00										Fail to reject Ho		
Birth Weight	7.1E-03	3.4E-05	1.00											
Calf Sex	1.6E-14	4.0E-01	4.1E-07	1.00										
Calving Comp.	2.0E-04	6.5E-07	6.3E-02	2.1E-09	1.00									
Calving Weather	1.9E-05	6.3E-22	1.1E-11	1.5E-23	1.1E-15	1.00								
Cow & Calf ID	8.1E-14	5.0E-02	1.1E-06	6.3E-03	2.1E-07	7.8E-25	1.00							
Illnesses/Treat.	1.8E-10	2.1E-05	2.3E-05	1.4E-07	1.4E-03	2.3E-23	1.1E-03	1.00						
Implant/Type	5.9E-03	1.3E-14	2.0E-04	1.2E-17	6.5E-03	1.9E-11	2.4E-15	7.4E-09	1.00					
Location/Pasture	3.6E-06	3.4E-05	2.3E-02	1.7E-07	4.8E-01	3.5E-18	2.5E-05	2.3E-02	1.0E-04	1.00				
Vac. Dates	6.4E-08	3.5E-12	3.4E-06	3.3E-15	1.9E-02	3.4E-20	2.1E-11	1.0E-04	3.3E-03	7.7E-03	1.00			
Vac. Used	1.4E-08	2.7E-14	1.7E-07	1.9E-17	2.7E-03	1.3E-20	1.9E-13	5.5E-06	3.2E-03	6.4E-04	7.5E-01	1.00		
Weaning Date	1.9E-07	6.1E-04	8.9E-03	4.9E-06	1.1E-01	1.3E-19	7.4E-04	7.6E-02	1.9E-06	6.5E-01	8.0E-04	4.0E-05	1.00	
Weaning Weight	5.1E-05	6.4E-04	2.8E-01	6.6E-06	2.4E-01	7.8E-16	8.0E-05	2.6E-03	3.2E-05	3.6E-01	9.2E-05	4.2E-06	2.8E-01	1.00

shows the p-values derived from the chi-squared value obtained from each pair-wise comparison of alternative data types. These results show that, of the 91 data type pairs, 81 were statistically significant at a 95% level of confidence indicating that the distributions of answers are different for these information types. As could be expected, the pairs of data types that do not have statistically different distributions of answers have similar mean importance ratings as presented in Figure 4.1.

The closing section of the cow-calf survey was included to provide insight utilized in developing the information sharing functions of CalfDex. This insight is crucial to maximizing the effectiveness of CalfDex as a complete information management tool. To gain an understanding of their current information sharing practices, producers were asked if they retain contact with, and receive data from, downstream producers who purchase their cattle. Only 42% of respondents indicated they retain contact with buyers after their cattle are sold, and 33% responded they receive animal data from buyers that allow them to evaluate cattle performance. These results highlight the lack of consistency in openly sharing animal information across the beef cattle supply chain.

Figure 4.3. Cow-calf producer information sharing willingness question results
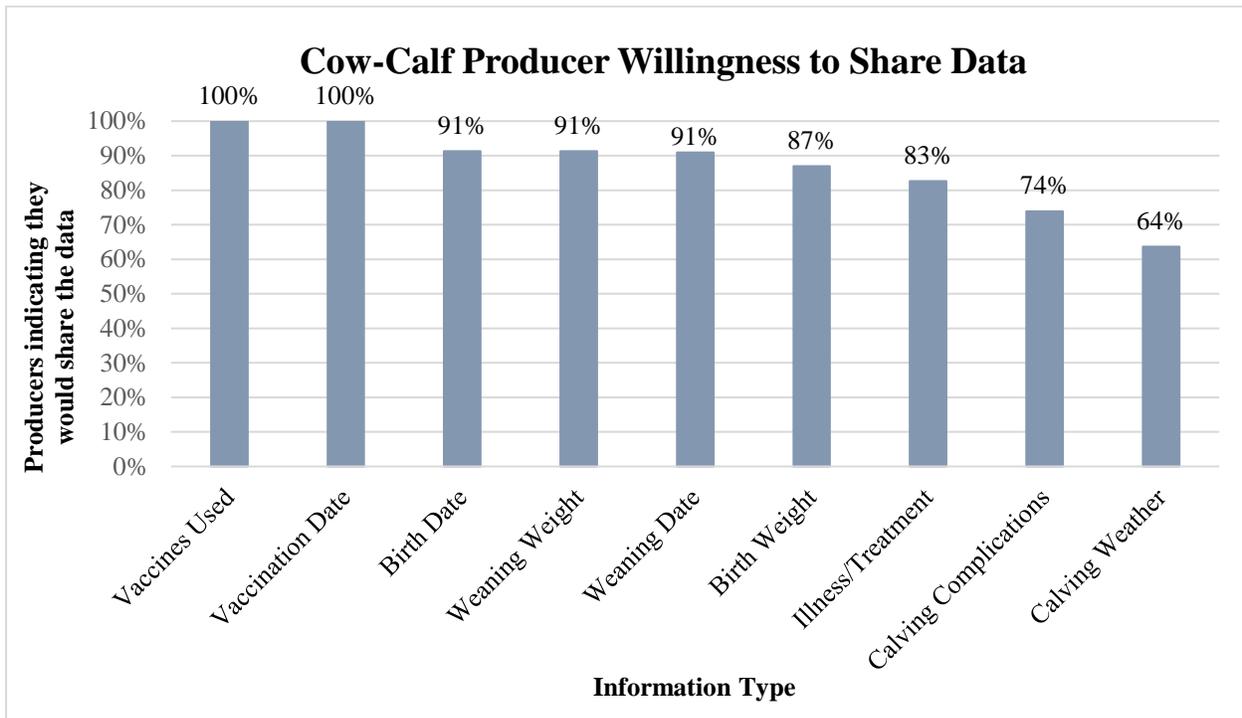
The information sharing section of the survey also assessed information cow-calf producers are willing to share with buyers and information they want to receive from downstream producers. Figure 4.3 shows the results of cow-calf producer willingness to share the information types presented in Table 3.2. Results reveal the majority of respondents are willing to share all types of data presented. Notably, all producers indicated that they would be willing to share both vaccines used and vaccination dates. This is particularly significant given the common issue of cattle being needlessly revaccinated due to the absence of vaccination records. Though these results were obtained from a small sample, it does raise the question of whether this issue stems from cow-calf producer unwillingness to share vaccination data or downstream producer unwillingness to utilize vaccination records to tailor management decisions for each lot acquired.

The results presented in Figure 4.3 suggest cow-calf producers are generally comfortable with distributing animal data to downstream producers. However, being comprised of only 25 responses, this sample would have to be expanded to make this claim with confidence. Also, the

Figure 4.4. Cow-calf producer information receiving preference question results
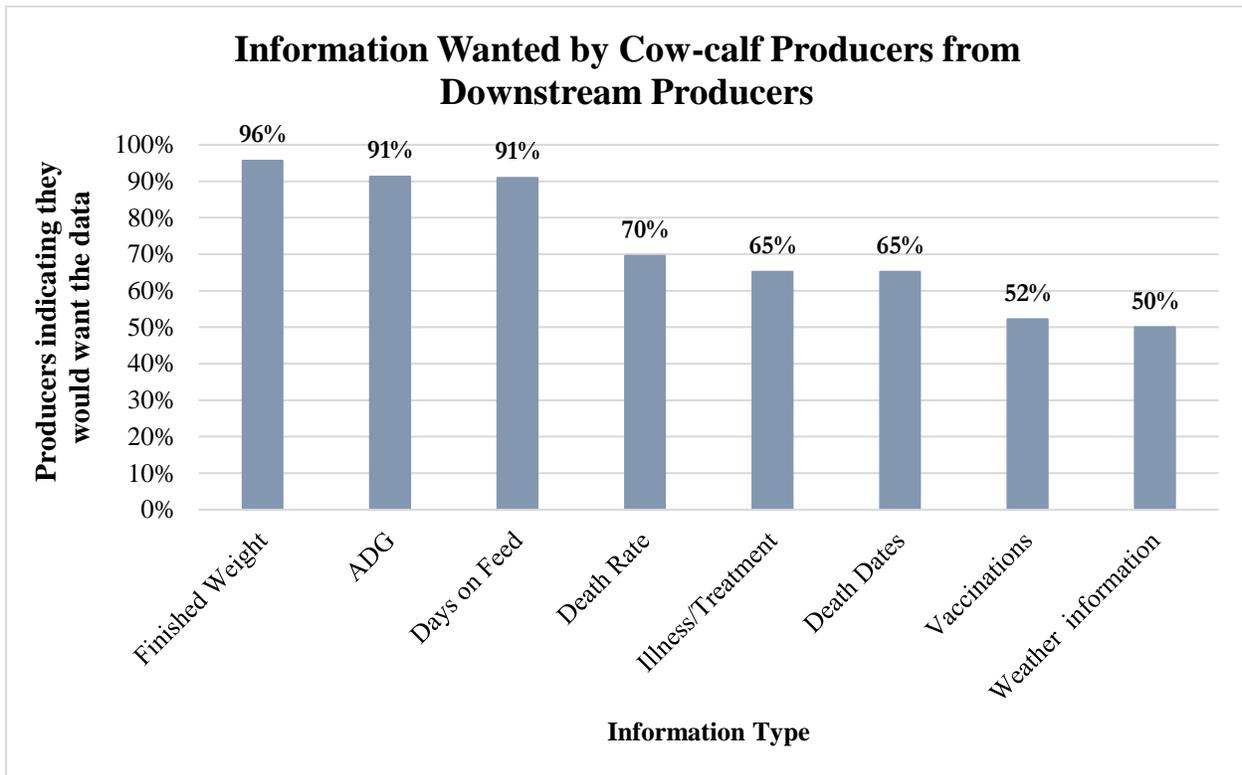
amount of information cow-calf producers are willing to share likely relies on the amount of information downstream buyers are willing to share back and the relationship between the two parties. Relative to the other types of information presented in Figure 4.3, significantly fewer producers indicated they would be willing to share calving complications and calving weather to downstream producers (74% and 64% respectively). Conversation with cow-calf producers regarding these pieces of information suggested this result stemmed from the producers not believing this data would be valuable to buyers, as it would not affect animal performance in downstream production settings.

Figure 4.4. shows results from questions regarding information cow-calf producers want to receive from downstream producers. The types of information desired by the highest number of producers were finished weight, average daily gain, and days on feed wanted by 96%, 91%, and 91% of producers, respectively. These results show that information indicative of animal

performance is of the highest importance to cow-calf producers to receive from downstream producers. Specifically, these particular types of information relate to the animals' weight gaining ability. In contrast, other types of information presented in Figure 4.4 are more likely to be affected by outside factors. Illnesses, treatments, vaccinations, and death information of cattle, especially cattle in the feedlot, can all be affected by other cattle, weather, or management practices that do not directly indicate the performance capacity of an individual animal or group of animals. These results suggest data most desired by cow-calf producers can be linked to traits affected by genetics that could be altered or management practices that could be modified to improve downstream animal performance. However, all information types were desired by at least half of the producers surveyed, and all but weather information were wanted by the majority.

4.2 Feedlot Producer Survey Results

As with the cow-calf producer survey, basic operation information was gathered for the feedlot producer survey. The one-time capacities of the feedlot operations included in the survey varied greatly in size with the smallest being 8,000 head, the largest being 355,000 head, and the mean one-time capacity of around 91,000. One-time capacity numbers were asked due to the recognition that feedlot size likely affected responses to survey questions presented due to differences in management styles. Respondents were asked to indicate what percentage of cattle they receive from various sources. The mean percentages for each source were: 23% from auction markets, 21% retained ownership or custom fed, 21% from private sales, 5% from online auctions, and 30% from other sources. The cattle source data was important to obtain as information transparency typically varies for each source. For example, a feedlot that sources a majority of cattle from online auctions will likely receive more animal information than an operation that sources most cattle from sale barn auctions.

Regarding current information receiving practices, only 29% of feedlot managers surveyed reported using electronic methods to receive animal data. From further conversation, many respondents indicated that the method varies by customer and that multiple methods are used in the typical operation. These various methods include phone calls, fax, and others. Nearly three-fourths (71%) of respondents indicated their information receiving methods were sufficient. However, many participants noted that they sometimes had difficulties receiving sufficient cattle health data. When questioned about current information sharing practices, 71% of respondents indicated they maintain contact with and provide animal information to customers. This question was asked specifically for cattle not fed as retained ownership or custom fed cattle. This was clarified because feedlot managers will typically remain in contact and share detailed animal information for cattle in these programs.

The main portion of the feedlot producer survey asked respondents to indicate what data they want to receive on incoming cattle and indicate the importance rating of each. These questions presented both the individual animal and whole load information introduced in Table 3.3. The survey presented each type of information and allowed participants to select from the three following choices: "no, I would not want this information," "yes, I would want this information, but it would not change how I process/manage cattle," and "yes, I would want this information, and it would change how I process/manage cattle." The results from this section are compiled in Figure 4.5 for individual animal information and Figure 4.6 for whole load information.

Results for the individual animal information question show that the feedlot managers surveyed overwhelmingly desire a medical history of each animal with all responding that they would want illness and treatments data and that it would alter how they manage cattle. This finding is significant considering that many of the feedlot producers that were surveyed expressed

Figure 4.5. Feedlot producer individual animal information preference question results

Individual Animal Information Wanted by Feedlot Producers
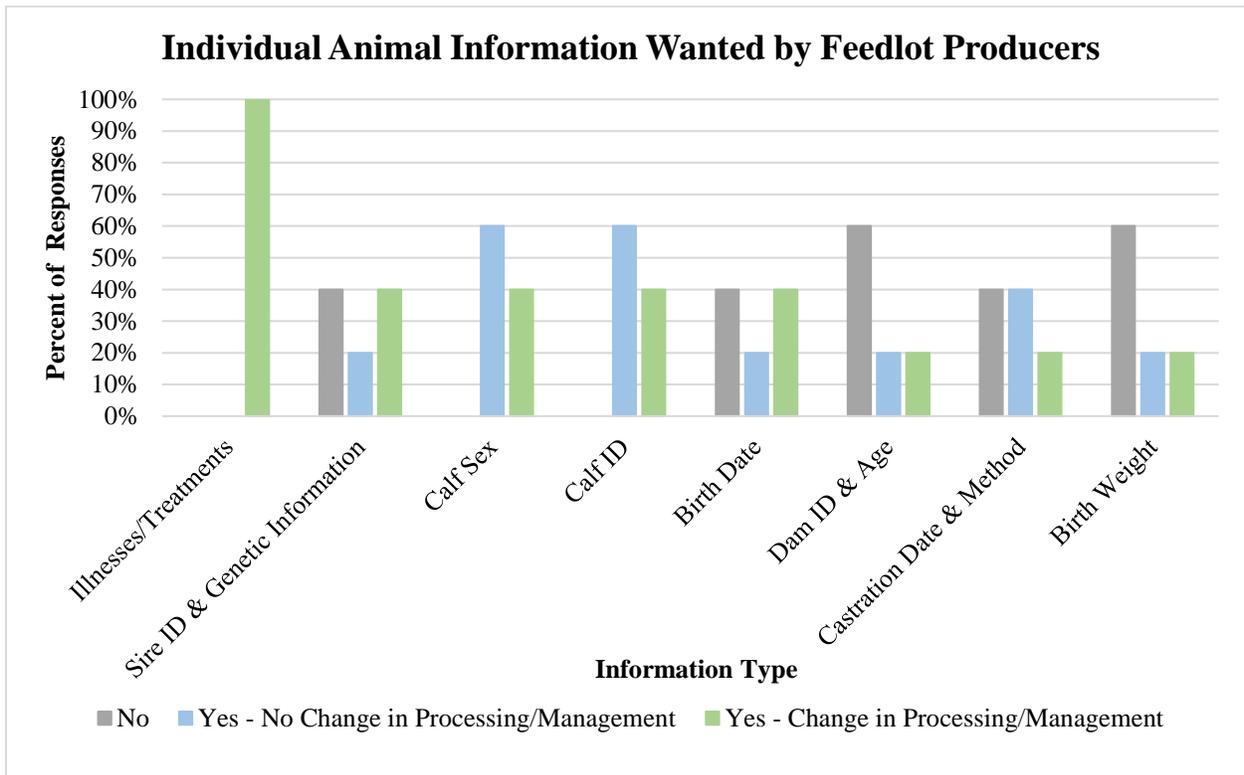
Figure 4.6. Feedlot producer whole load information preference question results

Whole Load Information Wanted by Feedlot Producers
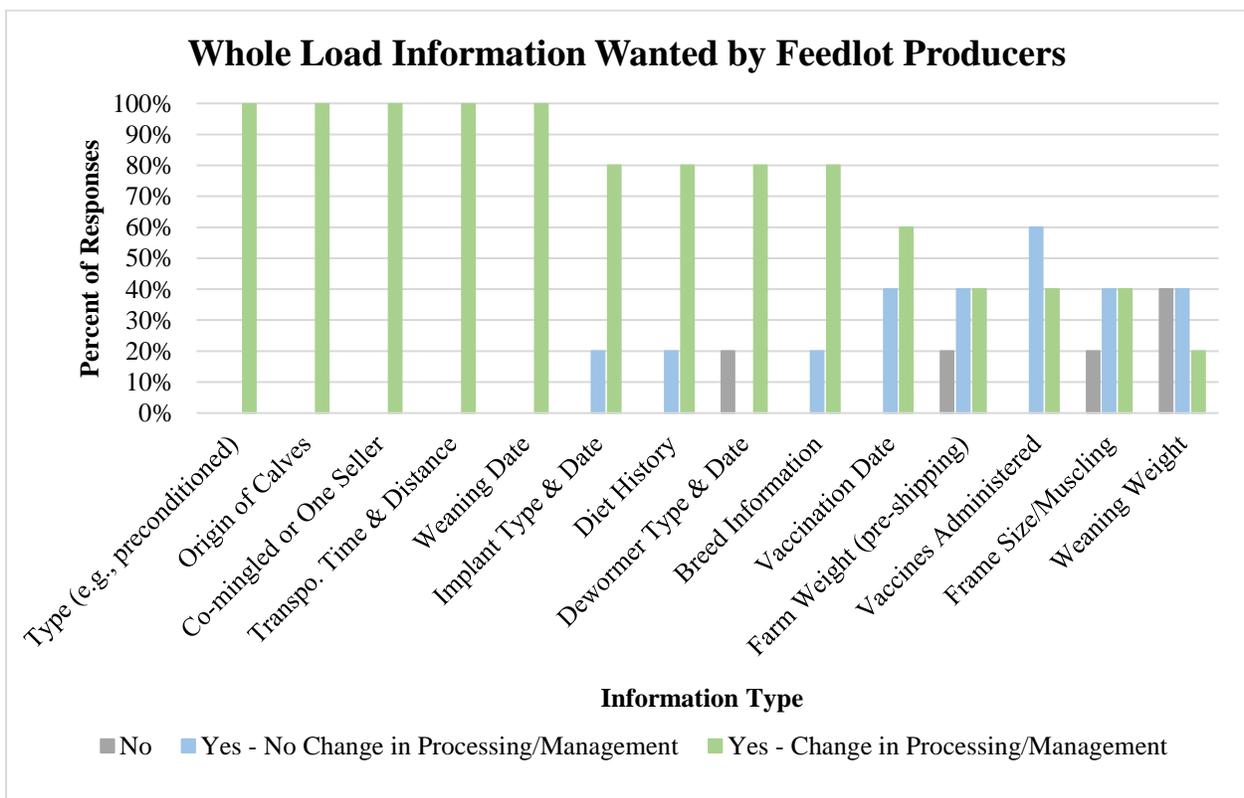
difficulties obtaining the medical histories of calves in some circumstances. Calf sex and identification information were wanted by all respondents, but the majority (60%) indicated that they would not impact management. Dam identification and age along with calf birth weight were the only two types of data that the majority (60%) of respondents did not desire. Further conversations with feedlot producers revealed these results stem from the fact that many did not believe that this information would affect calf performance while at the feedyard.

Results for the whole load information, as with the individual animal results, show that some information types were essential for the feedlot managers surveyed. In fact, all whole load information types were wanted by a majority of respondents. Type, origin of calves, indication of a co-mingled load, transportation details, and weaning date were wanted by all respondents, and all indicated that these information types would affect management and procurement practices. Implant type and date, diet history, dewormer type and date, and breed information all received a strong majority (80%) of these responses indicating they would impact animal management decisions. Vaccination types and dates given were both wanted by all respondents, but only the date of vaccinations received a majority (60%) of responses indicating that it would alter management practices. Although 60% of respondents indicated they want weaning weight data, it was the least desired information of those presented.

For each information item presented, participants were also asked to provide an importance rating. The rating was on a scale of 1 to 10 with 1 being no importance and 10 being high importance, and the questions were presented in an unconstrained ten-point Likert scale. Figure 4.7 presents results for the individual animal information and Figure 4.8 presents results for load information. The individual animal information ratings resulted in similarly ordered results to those in Figure 4.5. Data types with relatively high mean importance ratings (over five) were

Figure 4.7. Feedlot producer individual animal information importance question results
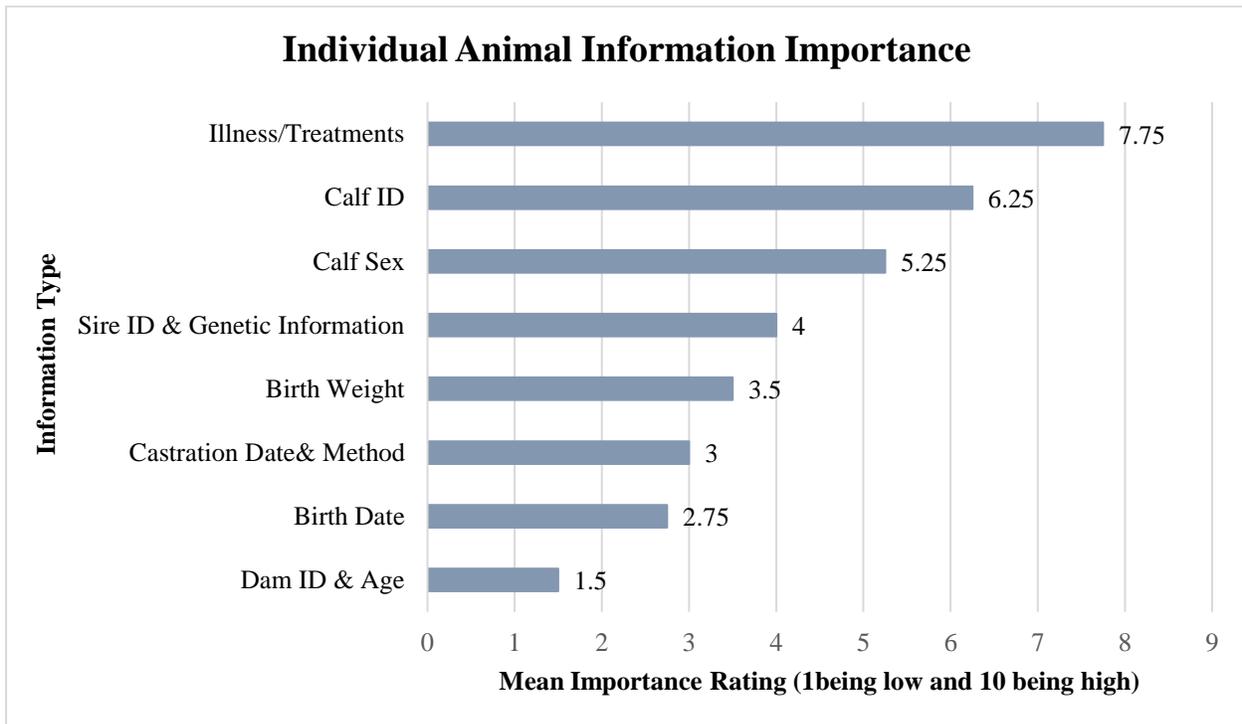
illnesses and treatments with a mean rating of 7.5, calf identification with a mean rating of 6.3, and calf sex with a mean rating of 5.3. These types of information were also the only wanted by all individuals surveyed. The high importance of illness and treatment data along with all producers indicating that it would alter cattle processing and management highlights the value of medical history details to downstream producers. The cause of the lower ranked information types' rating was because many feedlot managers did not believe that this data had significant implication for how cattle would perform or be managed at the feedyard.

Compared to the individual animal information types, load information types were shown to have greater importance. All whole load information types received a mean importance level of five or above compared to only three types of individual animal information. Results followed the order of those in Figure 4.6 with type, origin of calves, indication of co-mingled load, transportation time and distance receiving the highest mean importance ratings of 8.8, 9.0, 9.5, and

Figure 4.8. Feedlot producer whole load information importance question results

Whole Load Information Importance

Information Type	Mean ranking
Co-mingled Load or One Seller	9.5
Origin of Calves	9
Transportation Time & Distance	8.8
Type (e.g., preconditioned, bawling calf)	8.8
Implant Type & Date Administered	8.0
Weaning Date	7.8
Vaccination Date	7.7
Breed Information	7.5
Vaccines Administered	7.3
Farm Weight (pre-shipping)	7.3
Diet History	7.3
Dewormer Type & Date	7.0
Frame Size/Muscling	5.5
Weaning Weight	5.0

Mean ranking (1 being low and 10 being high)

8.8, respectively. The data that was most desired and received the highest importance ratings associates directly with calf procurement practices. For instance, understanding if cattle are traveling in a co-mingled load, how far they are traveling, and the medical history of each animal likely affects the procurement program calves undergo at feedlot arrival. Additionally, relatively high importance was given to data that could alter how cattle are managed once they are on feed such as diet history with a mean importance rating of 7.3, implant history with a mean importance rating of 8.0, and breed information with a mean importance rating of 7.5.

The concluding section of the feedlot survey captured feedlot producers' willingness to gather and share types of data presented in Table 3.2. Results of this section are shown in Figure

5.5. Results suggest that feedlot managers are generally open to sharing animal information to cow-calf producers. Notably, 83% of feedlot managers indicated willingness to share finished weight and average daily gains which were wanted by a large majority (96% and 91% respectively) of the cow-calf producers surveyed; however, further discussion revealed these results might not reflect the willingness for sharing information with all cow-calf producers. Multiple factors affect the amount and types of information shared by feedlot managers surveyed. This included the relationship with the producer, cattle being involved in a program such as grass fed or organic, and if the producer requested information on their animals. Due to these factors, it is difficult to accurately estimate willingness of feedlot producers to share each information type with the "typical" producer.

Chapter 5 - The CalfDex

5.1 Survey Implications

Identifying, categorizing, and ranking the results of both the cow-calf and feedlot producer surveys provided necessary insight to be considered in the development of CalfDex. Results from questions regarding data cow-calf producers want provided a basis on which to structure data recording functionality of the program. Survey results suggested cow-calf producers find general calf management information (calf identification, sex, birth date, and weaning data) and health information (illness, treatment, and vaccination data) most important of those given. Due to these results, it was concluded that these types of data were essential to include in the program. It is important to note, however, the categorization and ranking of information types in both surveys focused solely on preference and not the economic values of each information type. Therefore, rankings may not be based on economic value to the producers.

To ensure usability of CalfDex, unnecessary types of information were excluded to reduce clutter and increase simplicity. All information types presented in Table 1 except calving weather were included in the functionality of the program due to most cow-calf producers indicating they desired the ability to record each. Calving weather was excluded from the program due to only 57% of producers indicating interest in recording this information type receiving a relatively low priority rating in the surveys. Implant data was wanted by only 61% of producers and received a relatively low importance rating. Although these results are similar to those for calving weather, it was decided that this information type would be included due to the high importance to downstream producers revealed in feedlot survey results.

Feedlot producer survey results suggested information to be included in the functionality of CalfDex as explained previously would be sufficient to provide downstream consumers with

the most valuable data. With these types of information included in the program, downstream producers would be able to receive much of the data identified as important in the feedlot survey results. However, additional data entry will be required when selling cattle to provide downstream producers with all critical information types found in the survey results. While CalfDex will automatically provide much of the data feedlot producers value such as weaning dates, illnesses and treatments, and implant details, cow-calf producers will be required to enter data specific to each transaction. This includes additional information of high importance to downstream producers such as an indication of a co-mingled load, transportation time, and distance traveled from seller for each load sold.

5.2 App Development and Design

Following the completion of the cow-calf and feedlot producer surveys, an outline of CalfDex was drafted and presented to Stasyx, the software development group tasked with developing the program. Multiple in-person meetings were conducted with the developers working directly with the project. These meetings provided insight into the technical feasibilities and limitations of the program. This included how producers would record calf data, how data uploading processes would function, and how the program would handle multiple users inputting data for a single operation.

Through collaboration with the software development group, it was confirmed CalfDex would allow producers to input data in the absence of internet connection on their devices. However, this capability requires producers to take an additional step before leaving internet service areas to tend to cattle and input information if there are multiple users that have access to a particular operation's CalfDex account. The data entered in the program can only upload from the local cloud-based database when connected to the internet. With multiple users potentially

utilizing the program for a single herd, it would be possible that conflicting data could be inputted into the program if there were no extra steps taken. An example of this would be two individuals inputting data for a newborn calf and recording differing birth weights. When the two individuals rejoined an internet connection and attempted to upload the same data for the same calf, there would be a discrepancy in the information, and the program would not be able to discern which user's information was accurate.

Due to the possibility of conflicting data entry, the CalfDex will require users to "check out" a herd before leaving internet connection if multiple users are utilizing the program on a single operation. Checking out a herd disables the ability of other users to input information for that particular herd until the herd is "checked in" by the user that checked it out. This precautionary step ensures that no conflicting data is inputted by multiple devices. The CalfDex allows a single user to check out multiple herds at a time. Additionally, multiple users can check out herds as long as they are not the same herds. If the program is being utilized on an operation with only one user, it does not require herds to be checked out prior to leaving internet connection as there is no opportunity for conflicting data entry when only one device is being used.

Though the information sharing aspect of the CalfDex is a critical aspect of the final product, only the data recording functions of the program are operational at this time. Figure 5.1 provides a graphical representation of the current functionality of the CalfDex. The flowchart visualizes the numerous functional layers that make up the program. Additionally, it exhibits the path users take to input and view various types of data. For this portion of the app, emphasis was placed on building a simple but functional interface to ensure simplicity and functionality. Following this emphasis, five data recording tabs were added to the home screen that make up the main calf data entry functions.

Figure 5.1. CalfDex function mapping flowchart

List of animals in the herd

Individual animal page

ID, sex, birth date/wt., weaning date/wt.

Treatment, illness, and calving history

Individual herd page

Herds page

Calving tab (individ. animal)
- Dam ID
- ID, sex, birth wt.
- Complications, stillborn, or twin
- Vac., deworm, or implant

Process./vac. tab (all calves)
- Vac., deworm, or implant
- Castration performed
- Notes

Treatment tab (individ. animal)
- Pinkeye, pneumonia, scours, or other
- Vac., deworm, or implant
- Notes

Weaning tab (all calves)
- Vac., deworm, or implant
- Castration performed
- Weaning wt.
- Notes

Postweaning tab (selected animals)
- Retain to breed/ background, or sold

Add/remove animal

Add
- ID, sex, birth date/wt., weaning date/wt.

Remove
- Culled, dead, sold, or stillborn

Information capturing function

35

The first data recording tab is titled "Calving," and allows producers to add newly born calves to the herd. Screenshots of this tab in the CalfDex can be found in Appendix B, Figure B.2. When adding a new calf, producers first select the dam of the calf. The app then allows producers to input sex, identification number, and birth weight data. This page also includes a "yes/no" toggle for indication if there were complications while calving, if the calf was a twin, if the calf was castrated, or if the calf was stillborn.

The "Processing/Vaccination" tab allows producers to input data that applies to a group of calves when they are processed together. The first page presents a list of treatments such as vaccinations, implants, castration, etc. and allows producers to select what they will be administering to the calves at that time. The app then allows producers to input a description if desired. This could include medication brands, doses administered, or any other comments about the processing. Once the processing form is completed, the treatment data will automatically apply to the calves in the herd. This information, along with a date stamp, will then be available to view for each calf in the herd on their individual information pages. Screenshots of this tab in the CalfDex can be found in Appendix B, Figure B.3. The "Weaning" tab functions in the same manner as the "Processing/Vaccination tab but allows producers to record weaning weights for each calf gathered at the time cattle are processed for weaning. Screenshots of this tab in the CalfDex can be found in Appendix B, Figure B.4.

The "Treatment" tab allows a producer to input medical treatment data other than that administered to all calves when processed. This is to be used when treating an individual animal for some type of illness. Producers are first asked to select the type of illness the animal is being treated for. The options are scours, pneumonia, pinkeye, or other. Then, as with the "Weaning" and "Processing/vaccination" categories, the producer selects the treatment administered along

with an option to add a description of the medicine administered and/or procedure. Screenshots of this tab in the CalfDex can be found in Appendix B, Figure B.5.

The final tab, "Postweaning," allows producers to designate what they intend to do with the calves after they have been weaned. The app presents three categories to select from to designate the post-weaning status of the calves in the herd. The first designation is "sold" and removes the animal from the herd. Although the animal is not shown in the herd, all the data tied to that animal remains on the cloud database. The two other options allow producers to designate retained animals as retained for backgrounding and retained for breeding. Unlike the "sold" option, these animals remain in the herd. Screenshots of this tab in the CalfDex can be found in Appendix B, Figure B.6. Besides the "Postweaning" section, producers are able to remove calves, as well as cows and bulls, with the "remove" function. If a producer selects this option, they can select a removal reason from dead, sold, or stillborn. Like the "sold" option in the "Postweaning" page, the animals are no longer visible in the herd, but their data is preserved in the cloud database.

5.3 Data Sharing

Though the main focus of the CalfDex's information sharing function is direct sales between cow-calf producers and downstream producers, the program could also provide benefit for producers selling cattle in auction markets. Though the CalfDex could be utilized in any type of auction environment, it would be best suited for whole load sales which would exclude many auction sales as it is common for cattle from a single seller to be split into multiple lots. This would make it difficult for CalfDex users to share animal information as their cattle could be purchased by multiple buyers and they would be required to identify which animals were sold to which buyer. Additionally, since buyers are likely to comingle lots purchased from multiple sellers, it could be

difficult for them to utilize the information shared if it were not received for the other animals purchased.

With whole lot sales, information recorded in the CalfDex could be shared either at the time of the auction or after the sale takes place. Sharing the information at the time of sale would capture the greatest amount of benefit from the data. Data such as birth dates, vaccination details, and weaning dates increase the marketability of the calves promoting higher prices received for the animals. These higher prices would benefit both the producer and auction facilitator through commission earned on the sale. The CalfDex would likely prove most effective when selling cattle through an online auction. Online auctions regularly facilitate sales of unmixed cattle loads from a single source and are likely best suited for receiving and managing animal information electronically. Online auctioning is also more conducive to presenting animal information as lots are typically presented with some amount of information listed. However, it is also possible that large stockyards are able to make use of the data being shared.

5.4 Next Phases

Once CalfDex tool has completed the design and development stage, it will be implemented and evaluated through beta testing. The initial beta testing phase will assess only the information recording aspect of CalfDex. In this phase, the program will be shared with cow-calf producers of diverse sizes in the states of Kansas, Missouri, and Arkansas. The variation in operation size and location will allow observation of how the program fulfills the need of numerous production types. Participating producers will implement CalfDex into their operation to determine the effectiveness of the program for capturing and recording animal information in a convenient and easy-to-use manner. Additionally, producers will evaluate the effectiveness of CalfDex as a

calf herd management tool to improve operational effectiveness and efficiency using the recorded data.

In the final phase of beta testing, the information sharing capabilities will be designed and assessed based on producer feedback. Producers will trial the information sharing function of the program when selling calves to downstream consumers such as backgrounding operations or feedlots. The beta testing results will indicate the potential benefit for calf information recording and sharing programs such as CalfDex. This includes how cow-calf producers have potential to improve herd management and marketing, how downstream producers benefit from receiving detailed information on purchased cattle, and how the increased downstream flow of data promotes increased upstream data sharing across the beef cattle supply chain.

Chapter 6 - Conclusions

Information management in the U.S. beef cattle industry is an area of needed improvement. Survey results conducted with both cow-calf and cattle feedlot producers suggest data collection in the beef cattle industry lacks uniformity. Cow-calf producer surveys revealed many approaches to managing animal records with a broad spectrum of record-keeping systems reported ranging from pen and paper to online programs. Additionally, information sharing within the beef cattle supply chain lacks consistency with less than half of the cow-calf producers surveyed indicating they retain contact with buyers and only a third indicating they receive animal performance information from buyers. Interestingly, when asked if they remain in contact and share data with the individuals they purchase their cattle from, 71% of the feedlot producers surveyed indicated that they do both, differing significantly from the cow-calf survey results. A possible explanation for these seemingly conflicting results could be the cow-calf producers surveyed do not sell their calves directly to feedlots as this is the case for many cow-calf operations.

The lack of uniformity in the animal data recording process and consistency in the sharing of animal information found in the survey results illustrate the prevalence of poor information management in the beef cattle sector. These results also highlight the possible benefits provided by a simple and accessible information management facilitating tool such as CalfDex. Designed based on producer input gathered from the cow-calf and feedlot producer surveys, the functionality of the program was streamlined to maximize ease of use. This involved excluding information types that were found to be unimportant to both cow-calf and feedlot producers. However, survey results showed that calving weather was the only data category that was deemed unimportant by both parties.

The CalfDex has been designed to provide a simple solution to poor information management practices relating to the gathering and sharing of animal data. The program allows cow-calf producers to easily view and manage calf information wherever they are, regardless of internet connection. Preset functions for calving, processing, weaning, and treating calves ensure that producers are able to quickly gather important animal information. The ability to view information such as birth and weaning dates and weights along with treatment histories for each animal allows producers to evaluate the performance of the animals at both an individual animal and whole herd level.

Though the information sharing functionality has not yet been implemented in the CalfDex, it is arguably the most beneficial aspect of the program as it aims to promote information transparency across the beef cattle supply chain. The CalfDex will provide cow-calf producers with an uncomplicated way to share the information wanted by downstream producers with a dedicated function for generating a report for sold calves. Sharing animal information along the beef cattle supply chain benefits all participants. When sharing the data downstream, cattle buyers are better equipped to manage cattle efficiently. This includes eliminating unnecessary revaccinations, better understanding the recovery time needed from shipping stress, and identifying animals and lots as low or elevated risk of contracting illnesses. Increasing downstream data sharing is also likely to promote upstream data sharing data such as cost of gain, illnesses contracted, and carcass quality back to cow-calf producers. This information provides cow-calf producers with indicators on how to improve herd performance which better serves both them and their buyers.

Future beta testing trials are necessary to evaluate the success of the CalfDex as an animal information management tool. This includes the simplicity and functional interface of the CalfDex,

how it can be used to enhance cow-calf producer decision making to encourage adoption, and its efficiency in sharing information to downstream customers. These factors are crucial not only for adoption of the program but to ensure it succeeds in the goal of increasing the amount of animal information collected and shared in the beef cattle industry. Insight gained from survey results as well as future beta testing trials is valuable as technologies such as the CalfDex are developed to facilitate vertical supply chain information sharing.

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Appendix A - Producer Surveys

Cow-calf producer online survey instrument

Default Question Block

Please answer the following questions about your operation.

Producer age

[   ]

What is your breeding herd size?

Number of Cows   [   ]

What is your primary production type?

○ Seedstock
○ Commercial

What is your current record-keeping system?

○ Red Book
○ Phone app
○ Computer program
○ Other (please specify) [   ]

Have you ever used an app or electronic record-keeping system? If so, what app or program?

○ No
○ Yes (what app or program?) [   ]

What would you change to make the program or app you use/have used more user friendly?

[   ]

Do you (and/or your employees) carry electronics?

○ No
○ Yes

Do you and/or your emploees carry apple devices or other? (or a mix of both)

○ Apple
○ Other
○ Mix

Block 1

Please select whether or not you would like to be able to record each piece of information with the Calf-App. Then, indicate how would you prioritize that information on a scale of 1-3 (1=Very important, 2=Moderately important, 3=Not useful) For the information that you ranked as "Very important", how would you use it?

| | Would you want to record it? | | Priority | What are the uses of the information? |
	Yes	No	(1-3)	Uses
Cow & Calf ID	○	○	☐	☐
Age of Dam	○	○	☐	☐
Location/Pasture	○	○	☐	☐
Birth Weight	○	○	☐	☐
Birth Date	○	○	☐	☐
Calving Complications	○	○	☐	☐
Calving Weather (e.g. wet, snow, warm, cold)	○	○	☐	☐
Calf Sex	○	○	☐	☐
Vaccination Dates	○	○	☐	☐
Vaccines Used	○	○	☐	☐
Implant/Type	○	○	☐	☐
Illness/Treatments	○	○	☐	☐
Weaning Date	○	○	☐	☐
Weaning Weight	○	○	☐	☐

Are there any other pieces of information besides the ones above that you would want to record?

☐

Block 2

Do you maintain contact with the buyer of your cattle?

○ No
○ Yes

Do you receive information/data back from the buyer?

○ No
○ Yes

What information would you be willing to share with feed yards?

	I would be willing to share this	I would not be willing to share this
Birth Weight	○	○
Birth Date	○	○
Calving Complications	○	○
Calving Weather	○	○
Vaccines Used	○	○
Vaccination Date	○	○
Illness/Treatment	○	○
Weaning Weight	○	○
Weaning Date	○	○

Is there any additional information you would be willing to share with the feed yard?

[   ]

What information would you like to receive back from feed yards?

	I would want to receive this information	I would not want to receive this information
Death Rate	○	○
Death Dates	○	○
Weather (Compare death/heat relation)	○	○
Days on Feed	○	○
Finished Weight	○	○
ADG	○	○
Vaccinations	○	○
Illness/Treatment	○	○

Is there any additional information you would like to receive from the feed yard?

[   ]

Block 3

What is the number one thing you are looking for in a cow-calf record-keeping app?

[   ]

When the app becomes available, would you be willing to beta test it? If no, why not?

○ No (why not?) [   ]

○ Yes

Do you have any comments or other ideas about the Calf-App?

[   ]

Feedlot producer online survey instrument

Please answer the following questions about your feedlot.

What is your feedlot's capacity?

[   ]

Approximately what percentage of the animals in your feedlot are typically from each of the following sources? (should equal 100)

Retained Ownership/Custom Fed	0
Auction Market	0
Online Auction	0
Private Sale	0
Other (please specify) [ ]	0
Total	0

What is your current method for receiving information on incoming calves? (you can select more than one if you use multiple)

☐ Electronic
☐ Phone
☐ Paper
☐ Other (please specify) [   ]

Do you feel that your current method of receiving animal information is sufficient?

○ Yes
○ No

Related to the last question, why or why not?

[   ]

Do you maintain contact with producers you purchase cattle from? (not retained ownership)

○ Yes
○ No

Do you provide information/data back on cattle you purchase? (not retained ownership)

○ Yes (if so, what data) [_____]
○ No

What are the most important pieces of information on incoming calves that you are not consistently receiving?

[   ]

Data wanted

The following two questions involve individual animal information and whole load information. Individual animal information is tied specifically to each animal, and whole load information is tied to the entire truckload of animals.

For the following question involving individual animal information, please indicate whether or not you would want each piece of information on incoming calves and if it would impact how you process/manage the cattle. Then, give a value for each piece of information from 1 to 10 by level of importance (1=not very important, 10=extremely important).

	Would you want the information, and would it change how you process/manage incoming cattle?			Importance
	No, I would not want this information	Yes, I would want this information, but it would not change how I process/manage cattle	Yes, I would want this information, and it would change how I process/manage cattle	1-10
Calf ID	○	○	○	[ ]
Calf Sex	○	○	○	[ ]
Birth Date	○	○	○	[ ]
Birth Weight	○	○	○	[ ]
Dam ID & Age	○	○	○	[ ]
Sire ID & Genetic Information	○	○	○	[ ]
Illnesses/Treatments	○	○	○	[ ]
Castration Date & Method	○	○	○	[ ]

For the following question involving whole load information, please indicate whether or not you would want each piece of information on incoming calves and if it would impact how you process/manage the cattle. Then, give a value for each piece of information from 1 to 10 by level of importance (1=not very important, 10=extremely important).

	Would you want the information, and would it change how you process/manage incoming cattle?			Importance
	No, I would not want this information	Yes, I would want this information, but it would not change how I process/manage cattle	Yes, I would want this information, and it would change how I process/manage cattle	1-10
Implant Type & Date Administered	O	O	O	
Farm Weight (pre-shipping)	O	O	O	
Type (e.g., preconditioned, bawling calf)	O	O	O	
Diet History	O	O	O	
Origin of Calves	O	O	O	
Co-mingled Load or One Seller	O	O	O	
Transportation Time & Distance	O	O	O	
Vaccines Administered	O	O	O	
Vaccination Date	O	O	O	
Dewormer Type & Date	O	O	O	
Weaning Date	O	O	O	
Weaning Weight	O	O	O	
Breed Information (e.g., beef/dairy, polled, color)	O	O	O	
Frame Size/Muscling	O	O	O	

Are there any other pieces of information besides those listed that you would want?

You indicated that these pieces of information would impact how you process/manage incoming cattle:
${q://QID27%232/ChoiceGroup/SelectedChoicesForAnswer/3},
${q://QID28%232/ChoiceGroup/SelectedChoicesForAnswer/3}. Can you elaborate how?

Please indicate whether or not you would be willing to gather each piece of information and share it back to producers who you purchase cattle from. (not retained ownership)

	Yes, I would gather & share this	No, I would not gather & share this
Dead/Down in the Truck	O	O
Death Rate	O	O
Death Dates	O	O
Vaccinations Given	O	O
Illnesses/Treatments	O	O
Finished Weight	O	O
Average Daily Gain	O	O
Cost of Gain	O	O
Feed Conversion	O	O
Quality Grade	O	O
Yield Grade	O	O
Other Carcass Data	O	O

End Questions

What could I do in the future to improve this survey?

If you have any additional comments or concerns about the app, please enter them in the space provided below.

IRB exemption letter

KANSAS STATE UNIVERSITY | University Research
Compliance Office

TO: Ted Schroeder   Proposal Number: IRB-10782
        Agricultural Economics

FROM: Rick Scheidt, Chair
        Committee on Research Involving Human Subjects

DATE: 07/30/2021

RE: Proposal Entitled, "Calf App Research."

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §104(d), category:Exempt Category 2 Subsection ii.**

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

Electronically signed by Rick Scheidt on 07/30/2021 5:43 PM ET

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Appendix B - The CalfDex

Figure B.1. **CalfDex home and individual herd pages**
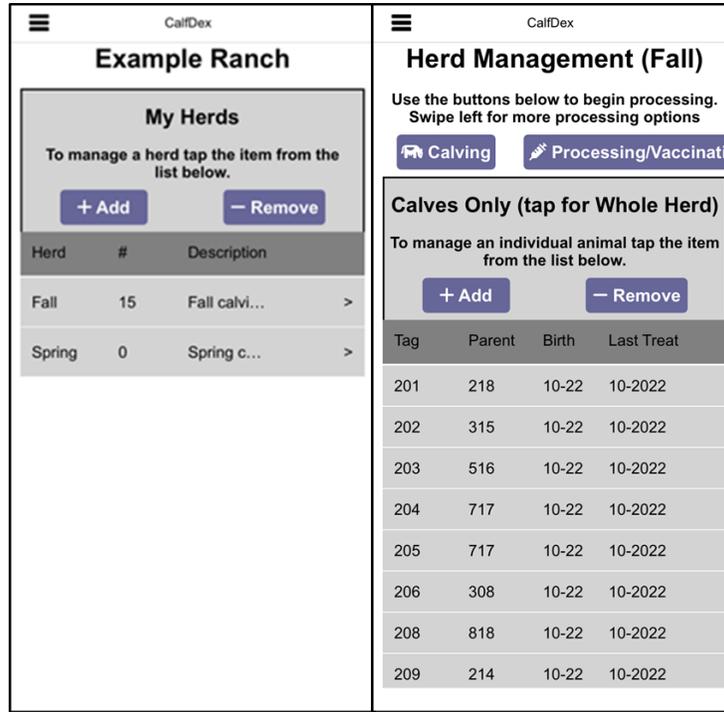
Figure B.2. **CalfDex calving tab screenshots**
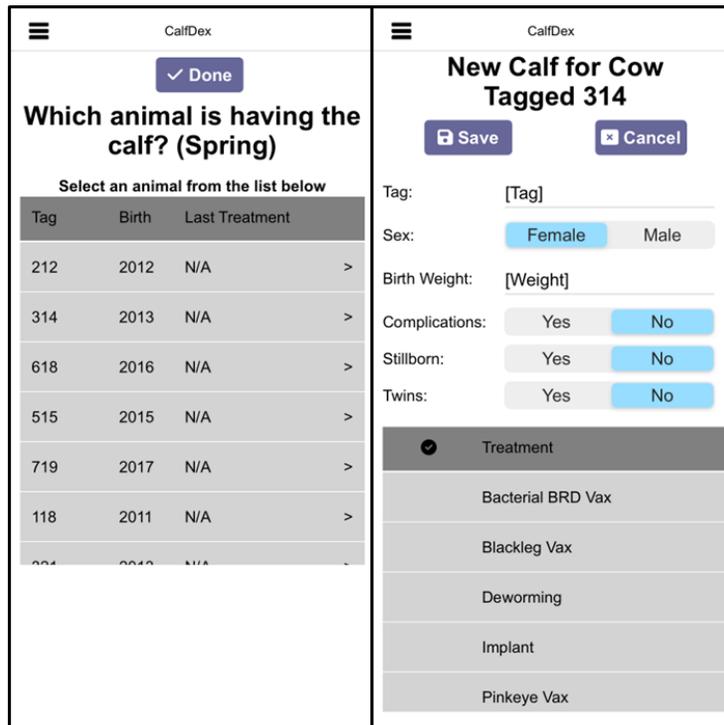
Figure B.3. CalfDex processing/vaccination tab screenshots
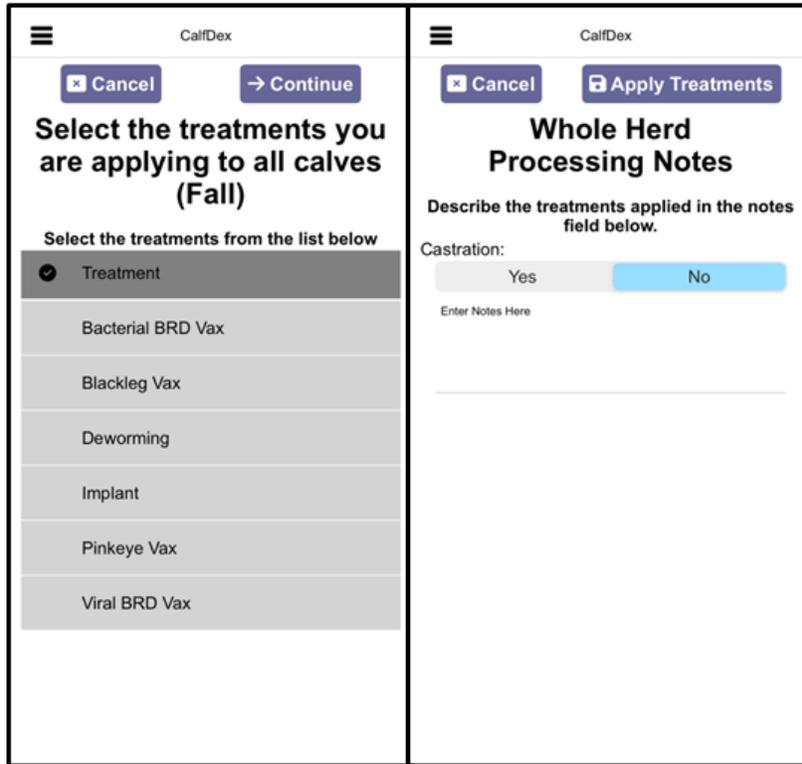
Figure B.4. CalfDex weaning tab screenshots
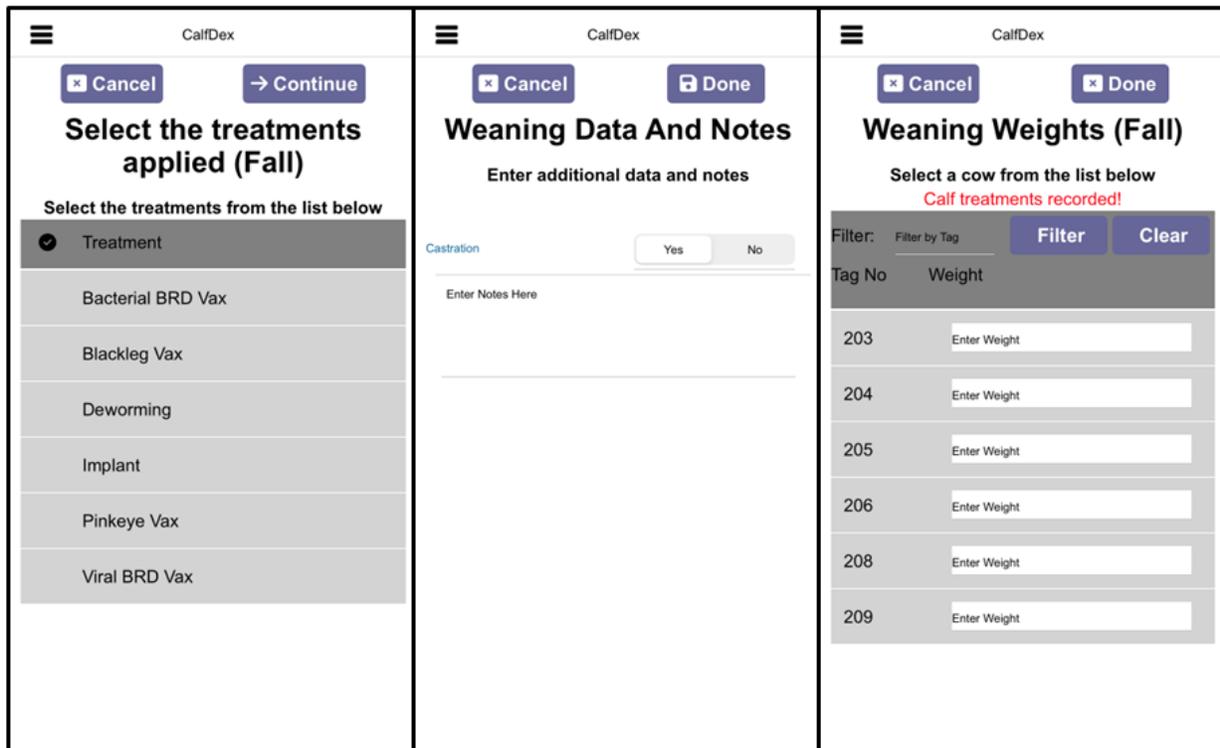
Figure B.5. CalfDex treatment tab screenshots
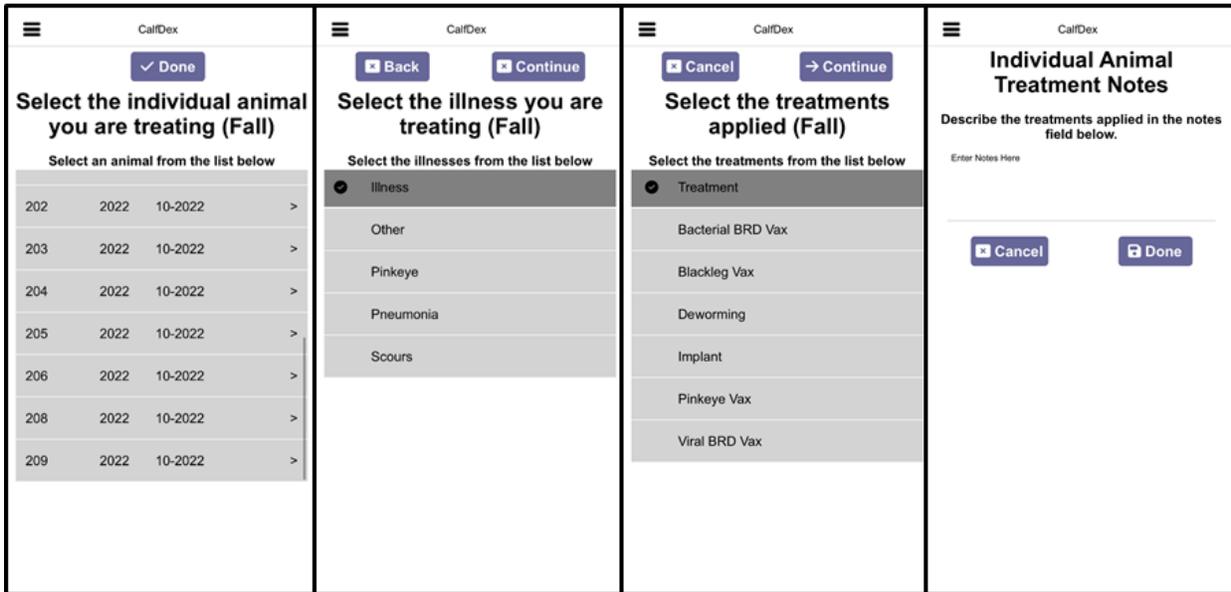
Figure B.6. CalfDex postweaning tab screenshots