The Use of Genetics to Improve Dairy Cattle Welfare

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Abstract

For many years selective breeding has been used to improve production in our livestock animals. Recently with the public becoming more concerned with the welfare of our livestock animals ways in which we can improve animal welfare has been a growing topic. For animals to have good welfare, it follows that they need to be in good health. This study looked at the way to improve welfare in dairy cows by selecting for disease resistance. We conducted an extensive literature review, along with surveying producers and producer groups. From our survey and literature review we determined which diseases are a concern in terms of welfare in the dairy industry, and which dairy cattle diseases have a genetic resistance component. After talking to producers they mentioned that lameness, caused by a bacterial infection called digital dermatitis, is a substantial welfare concern. In addition to digital dermatitis, literature searches and surveys of producer groups indicated that mastitis was also a major concern in dairy cattle welfare. Mastitis was found to have a genetic component, while digital dermatitis research regarding any heritability is still ongoing. Heritability refers to the ability for a parent to pass a genetic trait such as disease resistance onto their offspring. The other diseases that have a genetic component are metritis, ketosis, and Johne’s. To convey this information our group assembled an array of deliverables, including webpages on Livestock Gentec’s website, a consumer article, a producer article and an academic article. We also presented a PowerPoint presentation at the Livestock Care Conference, along with a poster and a short paper. Our recommendation for improving the number of healthy dairy cow daughters is careful recording of maternal breeding and sire health.

Key Words
Genetics, Dairy Cows, Welfare, Disease, Mastitis, Lameness, Digital Dermatitis, Ketosis, Johne’s, Metritis.

Introduction

Animal welfare is growing topic of concern to the public. Many individuals believe that animals are sentient and experience pain and emotion like humans and are concerning themselves with the welfare of the livestock from which their food is coming from (Stafford 2015). Animal welfare can be best and most universally assessed by the five freedoms which include “Freedom from pain, injury and disease” (McCausland 2014). The European Food Safety Authority (EFSA) has created a procedure to assess dairy cattle welfare using guidelines and a scoring system. The assessment covers seven major areas: food and water, housing and equipment, management, milking and mastitis, locomotor disorders, disease control and genetic and breeding (EFSA 2012). Studies have also shown that consumers are more willing to pay for products that are associated with a higher level of livestock welfare (Nocella et al. 2009). Dairy cattle have become a sector of concern as mastitis, lameness, ketosis and metritis occur in the population (Cole et. al 2013). Mastitis is the inflammation of the mammary gland and may be caused by bacteria among other issues such as physical or chemical injury. Mastitis does not only affect the welfare of the animal but also has many economic effects on the industry.
ranging from increased veterinary costs to lost milk production to culling of animals (Thompson-Crispi et al. 2014). Lameness refers to reduced locomotion and can be the result of a variety of factors. Lameness can be assessed using visual cues such as posture and gait. Lameness has a variety of implications on the industry such as culling, reduced calving and treatments which can result in lost milk (Kougioumtzis et al. 2014). Ketosis is a metabolic disorder that is associated with early lactation and the high energy demand for modern milk production. Preclinical ketosis can be readily treated if detected but subclinical ketosis is a disease of great concern to the industry as it causes decreased milk production, which is linked to other aspects of animal welfare and can cause displaced abomasum, lameness, and metritis. Detection is costly as it requires a blood or milk test for ketone bodies such as BHBA, acetone, and acetoacetate (Ehret et. al 2015). Metritis refers to uterine disease; antibiotic treatment is necessary for the disease in many cases as it a severe illness and can be fatal. Reproductive efficiency is an aspect of the industry and therefore this disease has an economic impact as well as being painful for the cow (Giuliodori et al. 2013). Genetic heritability has proven to be mechanism for improving other traits in dairy cattle such as milk production. Heritability is the percentage of observed differences for a trait (i.e., observable traits or “phenotypes”) between individuals in a population attributable to genetics, and more simplistically refers to the ability of a parent to pass a genetic trait onto their offspring.

Materials and Methods

The research employed both primary and secondary methods in collecting the data required for the study. The primary methods used in collecting the data were interviews and questionnaires. The group settled on these two primary methods since they save time in survey administration and also offer close contact with the respondents to get the actual facts first-hand. The respondents used in the research were producers, an industry person and producer groups. Additionally, the group also used secondary sources (academic articles) from the University of Alberta library. The secondary sources provided additional information on diseases, economics and impact of genetic in dairy cows. We used the secondary sources to get precise and appropriate guidelines/description on how to conduct the survey step by step.

The group had contact with the producers and carried out interviews concerning the animal welfare, diseases and genetics programs using a number of questions (see Appendix A). For the start of the discussion, we asked producers and producer groups what their welfare concerns were. We then asked how these concerns were being dealt with and if genetic selection was being used. We asked the producers their opinion on selective genomics and the impact it has on the on the general production economics and welfare of the animals. This was meant to get the general views on using selective genomics as well as the benefits and the milestones it has achieved since its inception for use in animal welfare. During research and interviews we learned about a breeding program developed by the Canadian bovine genetics company, Semex, that uses a patented technology to select for animals with higher natural ability to combat infection and disease; these animals are

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1 Genomics is a discipline of science studying the genetic material that is contained in the DNA in order to determine the function and structure of genomes (the comprehensive set of DNA in a cell of an organism).
known as High Immune Responders (HIR) and the program developed is called Immunity + where HIR sires are used to breed healthy cattle. When speaking with an industry researcher we asked specific questions to touch on the goal of the Immunity + program, including the duration the program has been in place, the number of producers benefitting from the program, the enrollment rate since the start of the program, the benefits of sires and the expense of the program compared to other breeding program run by Semex. Moreover, the group had the chance of watching a video on Semex’s website about the impact of the program on the diseases such as mastitis and metritis. The group was interested in getting to know the success the program has achieved in improving the traits of the animal and future diseases the producers are planning to address through the program.

The group had the chance to talk to an industry person about the steps the industry has taken on using selective genomics and what the farmers should do to improve the welfare of the animals. After the discussion the industry contact provided us with a power point presentation, which had additional information apart from the questions we discussed during the interview.

The group also contacted producer groups to get their insight on animal welfare and impact of diseases on animal welfare. The questions aimed at finding out which disease has the biggest impact on their herds and the considerations (such as disease resistance) they take when deciding breeding strategies. Additionally, the group asked the producer groups about the current challenges, how the industry is addressing these problems and whether genetic selection is among the measures used to address these challenges. Moreover, the group asked the producer groups on the emerging tactics and trends for tackling problems with associated diseases.

**Results and Discussion**

From talking to producers and producer groups we found that many of them thought that management was the best way to improve the dairy cows’ welfare and reduce the amount of disease seen in the herd. We also found that producer’s biggest concern in improving the cows welfare was lameness caused by digital dermatitis. Literature indicated that mastitis was also a widespread concern in the industry and has both welfare and economic impacts. From these results we closely examined the possibility of reducing these problems using genetics.

After undergoing an extensive literature review we found that mastitis does have a genetic resistance component. The initial finding was that when observing the cows across lactations a positive genetic correlation can be seen; cows that contract mastitis in the first lactation often contracted mastitis in following lactations as well. From this information heritability can be inferred (Heringstad et al. 2005). Mastitis has a heritability coefficient of 0.07 showing that through selective breeding we can reduce the rate of mastitis (Koeck et al. 2012). This means that if sires are carefully selected for the resistance factor then fewer daughters would have issues with mastitis.

The other common concern that producers’ have regarding the welfare of their cows was lameness. For this study we will focus on lameness that is caused by a bacterial infection called digital dermatitis. This infection causes lesions on the heel of the foot, which may extend to between the claws of the foot and to the front of the foot.
This disease can be very detrimental to a herd as it is highly contagious. The bacterium that usually causes digital dermatitis is in the genus Treponema and the Spirochete family (Higginson et al. 2013). The infection usually causes mild to moderate lameness, and swelling usually does not occur unless a secondary infection is present (Higginson et al. 2013). An outbreak of digital dermatitis usually occurs in conditions with high humidity and poor hygiene, but can also be transferred when hoof trimmers are not sterilized between cows. To help decrease the spread of digital dermatitis hoof trimmers in Alberta have been keeping a record of cows found to have lesions. Best practices of hoof trimmers should include disinfection of tools after trimming any cows with lesions present. This program helps track the prevalence of digital dermatitis in Albertan Dairy. An effective treatment of digital dermatitis is a tetracycline hydrochloride paste applied to the infected area (Higginson et al. 2013). It has been found that the lesions can be painful during the healing and active stages so some type pain management may be necessary (Higginson et al. 2013). We were unable to find any information on the heritability for resistance to digital dermatitis alone but we were able to find the heritability coefficient for infectious lesions in dairy cattle which was found to be 0.092, which includes lesions caused by digital and interdigital dermatitis, foot rot, and heel erosion (Chapinal et al. 2013).

From talking with producers we also found that they believed choosing High Immune Responder (HIR) sires is a cost effective way to improve the health of dairy cattle daughters. Animals with a higher immune response tend to be more able to combat any pathogen that they will be exposed to throughout their lifetime. For instance, mastitis is observed to occur less in cattle that have an enhanced immune system which can be identified using HIR technology (Thompson-Crispi et al. 2014). HIR technology tests the ability of an animal to mount an immune response against a pathogen and it is found that sires who respond better to the test produce daughters who have lower rates of many diseases as well as producing better colostrum (Thompson-Crispi et al. 2014). The inheritance rate of high immune responders appears to be significantly higher than that of any particular disease resistance on its own with an inheritance coefficient of 0.25-
meaning that sires that are classified as HIR have a 25-35% chance of passing this trait onto their offspring (Thompson-Crispi et al. 2014). Heritability of this trait is higher because high immune response is a more specific phenotype. As a result breeding for HIR in cows may be more rewarding than breeding for resistance to certain diseases which can be caused by a number of factors.

Figure 1


<table>
<thead>
<tr>
<th>Disease</th>
<th>Heritability</th>
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<tbody>
<tr>
<td>Mastitis</td>
<td>0.07</td>
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<tr>
<td>Digital Dermatitis</td>
<td>Under research - 0.09 for infectious lesions</td>
</tr>
<tr>
<td>Metritis</td>
<td>0.06</td>
</tr>
<tr>
<td>Ketosis</td>
<td>0.06</td>
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<tr>
<td>Johne’s</td>
<td>Under research</td>
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<tr>
<td>High Immune Response</td>
<td>0.25-0.35</td>
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High immune response also has an economic aspect as a high immune cow results in savings of $124/cow/year; and daughters of Immunity+ expected to have 4-8% reduced disease and $80 per daughter for profit (Semex 2012).

To get this information to as many different groups of people as possible we created an array of deliverables. Our main deliverable is a web-page that is part of the Gentec website. This website includes information on each disease we researched along with the heritability of these diseases. There is a short description of our project, along with short bios about each of us. There is a recommendations page where we discuss how this research could be used to help dairy cow welfare through the use of genetics to breed for disease resistance. There is also a media page where there are links to the rest of our deliverables (with some links being added as the project concludes). We will be presenting at the Livestock Care Conference (LCC), so our PowerPoint presentation that we give at the conference will be linked to the website. Along with the presentation we will also include our accompanying poster and paper, which includes a brief description of welfare and disease, along with the heritability of the various diseases.

We also made a series of articles which will be linked onto our main webpage. These articles were distributed by Livestock Gentec and were promoted via Twitter. In total we made three articles: a consumer view, producer view and academic view (to be distributed during at the end of April). The consumer view provided basic information about what consumers’ main concerns were about livestock welfare. We also provided information on how livestock welfare is typically evaluated, along with information about Alberta’s Animal Protection Act. In this article we provided a general description on how animal genetics can be used to decrease disease in livestock and therefore improve the animals’ welfare. The next article we made was our producer view. In this article we talked about the diseases that have been found to have a genetic component and how we can use selective breeding to help in reducing the prevalence of these diseases. We also discussed HIR, and how this may be a more cost effective way to have a healthier herd. Hoof health was also discussed in this article, and how research into the heritability of this is still ongoing. Our last article is the academic view (to be posted online in April 2015), in
this article we went into more detail on the heritability of these diseases, and where we could possibly conduct more research in the future.

Conclusions and Recommendations

In conclusion genetics does have a part to play in the welfare of a dairy herd in terms of disease resistance and susceptibility. Diseases such as mastitis, digital dermatitis, metritis, ketosis and Johne’s can have a significant impact on the industry in terms of economic loss and decreased welfare. A mechanism of improving herd resistance to these diseases would be to select only sires that show resistance or are classified as high immune responders. It would be in a producer’s best interest in terms of welfare and long term economics to keep careful breeding records and disease reports and take such information into consideration when selecting breeding stock. There are a number of existing programs in the industry that utilizes the knowledge of genomics to improve welfare such as Semex’s Immunity + but there is still ongoing research in the area.

References:


Appendix A – Survey Instrument

1. What are the biggest challenges you have in terms of welfare for your herd?
2. How do you address these welfare concerns now?
3. Which diseases have had the biggest impact on your herd? (if they go off on a tangent maybe pull conversation back to mastitis, ketosis, metritis, Johne's)
4. When making breeding decisions do you take disease resistance into consideration? If so how? If not would you consider this? If not why?