Uses of Genomic Predictions in Commercial Beef Cattle Operations

A Senior Project

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ABSTRACT

This paper aimed to achieve two different objectives. The first objective of this study was to identify and explain the genetic gain achieved in commercial beef cattle operations with the use of genomic predictions versus the use of visual appraisal and EPDs. The second goal of this paper was to develop a method to easily explain genomic predictions and their practical applications on commercial beef operations to a lay audience, specifically to ranchers. In order to accomplish these objectives, I evaluated three of the most common selection methods used by producers today. These included visual appraisal, expected progeny differences (EPDs), and genomic enhanced predictions. I used actual data from two California ranches that have already begun using genomic predictions as part of their management programs. The ranches that I collected data from were San Benito Cattle Company, Hollister, CA and Flyin' M Cattle Co., Tracy, CA. This information illustrated that almost any progressive beef operation could incorporate genomics into its management system. To achieve my next objective, I again used examples from the ranches I received data from, as well as wrote my own information within the guide that aimed to answer questions that producers may have. Lastly, the second objective portion of this paper also served as an instructional tool for producers that focused on giving them guidance as to how they should go about administering, collecting, and applying the data that genomic predictions provide in a manner that was both practical and beneficial for their operations.

Keywords: Cattle, Genomics, Beef

INTRODUCTION

Today, more than ever, cattle producers are faced with daunting decisions. The choices that producers make each and every day have the potential to benefit or harm their livelihoods. One choice cattlemen make on a yearly basis is cattle selection. Every year, producers across the United States use some type of criteria to select cattle, whether they are evaluating breeding bulls, replacement heifers, or cows. For years, the basis of this selection involved simply visual appraisal of the cattle, as well as unadjusted data. Cattle that possessed physical traits that were deemed desirable, such as frame, size, body length, etc., were chosen to enter breeding programs, while cattle that did not possess the right combination of traits were sold into different markets. Later, the use of Expected Progeny Differences (EPDs), were developed in order to give producers a more reliable set of data to base their breeding decisions on. EPDs gave producers the ability to predict the performance of future offspring of a certain individual. EPDs have proven to be a very useful selection tool and are still used heavily today, however, thanks to scientific research cattlemen are now able to utilize technology that gives them selection capabilities that expected progeny differences never could. Known as genomics, scientists have discovered how to analyze the performance of an individual animal based upon its genetic makeup. Genomic predictions allow producers to make more informed decisions about the animals that they raise by identifying certain traits possessed by each individual animal. The focus of this work was to identify and explain the benefits that genomic predictions have within the commercial cattle industry and how producers can reap the benefits of using genomic predictions within their herds. Concurrently, this paper will serve as a guide for producers who have a desire to learn more about incorporation of genomic predictions within their operations.

I was interested in exploring and explaining the numerous benefits that genomics can provide to producers and how they differ from selection methods used in the past. In addition, I aim to show the practical applications of genomic predictions that are geared towards benefitting the commercial operation. The study will also depict examples of ranches that have already begun using genomic predictions and the outcomes of their trials in an attempt to show how easy genomics can be incorporated into a commercial beef operation.

This work is aimed to achieve two objectives. The first objective of this paper was to identify and explain the genetic gain achieved in commercial beef cattle operations with the use of genomic predictions versus the use of visual appraisal and EPDs. The main goal of this section of the paper was to showcase the benefits that genomic predictions can provide and the ways that this information can be applied to various operations. The second objective that this paper had was to develop a method to easily explain genomic predictions and their practical applications on commercial beef operations to a lay audience, specifically to ranchers.

The goal of this part of the study was to compile information that was easily understood and informative that could be given to producers and assist them in utilizing genomic predictions on their own ranches. To show the differences of keeping cattle due to their actual physical appearance and their true genetic merit, it was critical to look at the main "keep/cull" methods used by beef producers and assess the value of each. As previously stated, there were three common methods that producers have the ability to use in order to make their genetic selections: Visual Appraisal of the animal, Expected Progeny Difference (EPDs), and Genomic Predictions. Each one differs in the rate of genetic progress made.

For years, it has been argued that commercial cattle producers are reluctant to really try and understand all of the latest information that science and technology can provide. In fact, many commercial producers are just now learning how to read and analyze EPDs, while there are still many more that do not. Producers who do not utilize EPDs still rely on raw, unadjusted information, such as actual birth weight and weaning weight, or even visual appraisal to make their selection decisions. For example, when selecting replacement heifers from a calf crop, many commercial cow/calf producers from my ranching community take the top 50% or so of their heifer calves based on heifers that are heavier, have larger frames, appear to be more mature, and that are structurally sound. Many of the calves that do not fit in these parameters are sold as feeder or stocker heifers, instead of being kept as breeding replacements. These ranches typically run an average of 400 to 600 mother cows, depending on the year, and have an average calf crop of about 385 to 575 calves. This may sound simple, but it is a technique that many ranchers are accustomed to and is effective. Although this method will include some of the genetically superior calves in the herd, it is impossible to determine all of the calves with the best genetics that should be kept as replacements due to numerous variables. These variables can sometimes be uncontrollable, such as a calf that is culled because it was born later in the season or a calf that was kept due to its size as a result of being on better feed. To better understand this concept, an actual study should be done on a set of replacement females to determine the average amount of genetically superior females are culled from a herd based on visual appraisal, but this was unable to be completed for this paper due to time constraints.

The second method of identifying genetic merit is Expected Progeny Differences, more commonly known as "EPDs". EPDs were developed to provide cattle producers with an effective tool to evaluate prospective breeding stock (University of Florida, 2008).

The main goal with creating EPDs was to improve the accuracy and make predictions of the genetic potential of a single individual animal and its ability to transmit those traits to its offspring. In a very brief summary, the calculations used to generate EPDs are inserted into a computer and numerous equations and computations are carried out, resulting in one single value number for each statistical category. Most all of these mathematical sequences are carried out by breed associations, but each association follows criteria set forth by the National Cattle Evaluation (NCE) (Hansen, University of Florida, 2006). There are many factors that influence the creation of and accuracy of EPDS. These factors include the following:

- Performance records of the individual, its sire, dam, offspring, and its relatives

- Contemporary group adjustment for managerial and environmental factors

- Calculations incorporating genetic links between traits

- Adjustment for differences in relative merit for individuals of the same contemporary

- Adjustments for change in genetic trend within a population

It is very important to note that all EPDs reported are based on a certain population. What this means is that EPDs that are created for Angus cattle are computed from data collected only from within the Angus breed. Also, EPDs will vary year to year, based upon breed averages for a certain breed within a certain year. Naturally as genetics progress, the breed average progresses, theoretically making younger cattle genetically superior than their predecessors. This occurrence is known as genetic trend, which shows the change in different traits of a breed over the years. **Figure 1** shows a graphical example of genetic trend and how it has affected weaning and yearling weights of American cattle breeds. The meaning of the graph is to signify how selection of superior animals over time has significantly impacted the development higher merit animals within breeds.
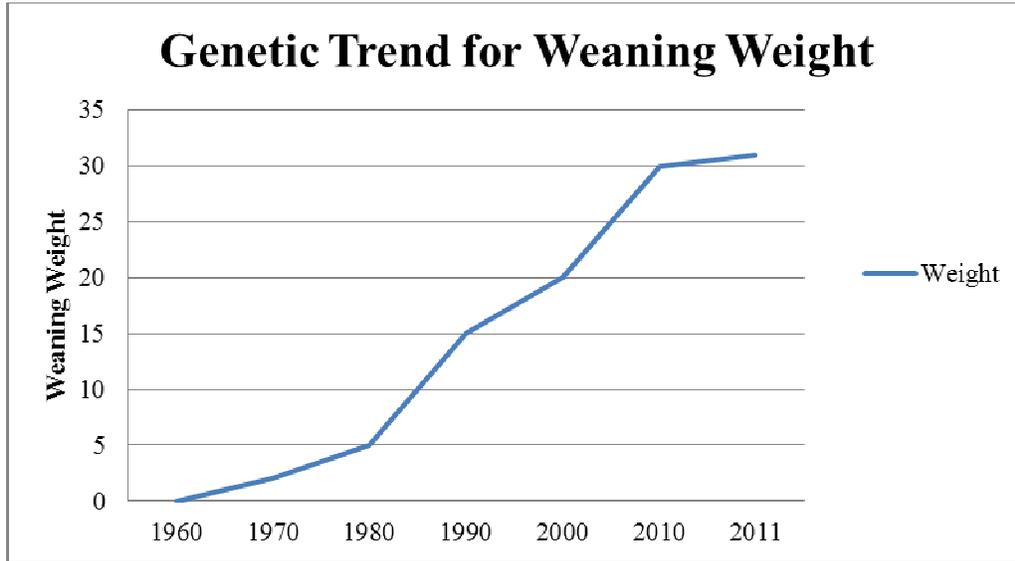
Figure 1: Genetic trend for weaning and yearling weights of all American beef breeds.

Each breed has their own set of averages that cannot be compared to other breeds unless an across breed adjustment factor is used. The most important and useful part of the EPD is the accuracy. Accuracy is a measure of reliability of the EPD. It is expressed between 0 and 1.0, with 0 showing no accuracy and 1.0 being perfect knowledge of the true genetic merit of the individual. Accuracies that are closer to 1.0 give a more reliable estimate of an animal's true genetic value for that particular trait. Without any accuracy, an EPD is just a raw average of the sire's and dam's EPDs. Accuracies play a crucial role in the genetic prediction because they indicate the amount of risk a producer will take when using a particular animal in a breeding program. Accuracy is a reflection of the number and distribution of progeny per sire along with how much pedigree information is available (University of Florida, 2008). More importantly, accuracy gives producers an indication as to how reliable or unreliable the EPD information on an individual animal actually is.

Figure 2 and Figure 3 give an example of comparative accuracy between a highly accurate individual and one of very low accuracy. EPDs are much more helpful than visual appraisal in management and selection because they provide a set of parameters for producers to select an individual animal and allow the producer to incorporate both phenotype and genetic merit into his or her decisions.

Production

CED ACC	BW Acc	WW Acc	YW Acc	RADG Acc	YH Acc	SC Acc	Doc Acc
+12 .95	+1.0 .98	+70 .97	+123 .96	+.07 .77	+.5 .97	+.13 .97	+6 .97

Figure 2: A partial EPD for **SS Objective T510 0T26, ABS Global, DeForest, WI**.

Production

CED ACC	BW ACC	WW ACC	YW ACC	RADG ACC	YH ACC	SC ACC	DOC ACC
+7 .05	+1.9 .05	+47 .05	+89 .05	+.14 .05	+.5 .05	+.05 .05	+10 .05

Figure 3: A partial EPD for **FMCC New Day 102, Flyin' M Cattle Co., Tracy, CA**.

Based upon numerous studies by institutions such as the University of Florida, EPDs do provide a benefit to the producers who use them. Researchers have found that using cattle with higher EPD accuracy and percentiles do transmit those traits to their progeny. **Table 1** demonstrates the terminology and categories used in a typical beef EPD. With that being said, EPDs also have their limitations. Inaccurate reporting can lead to falsified EPDs. Since much of the EPD profile is based upon the submission of actual weights from producers, there is a chance that incorrect data can be reported. Data can also be skewed due to the environment that the submission sample was raised in.

For example, if a sire has offspring in a herd that is raised in dry, desert type conditions, the weights of those calves may be lighter compared to calves that ran on irrigated pasture and weaned off heavier than their desert counterparts, varying the data of the sire. Lastly, EPDs are only associated with animals registered in their respective breed associations. With this being said, a commercial producer only has access to EPDs mostly if and when he is dealing with registered bulls. The commercial cowherd has no calculated information to base managerial decisions off of, so when it comes time to make choices, like keeping replacements, the producer is limited and visual appraisal is usually what he resorts to.

The final method of cattle selection is more valuable and slightly more accurate than EPDs. Through the use of genomic predictions, cattlemen can now evaluate their cattle on the genetic level, instead of simply making decisions based on their phenotype. Genomics is defined as the sequencing of genetic material within bovine DNA and using that information to understand the expression of each gene, how they work with one another, their location on the chromosome, and how they are controlled. The way that genomic predictions work is by breaking down DNA into gene segments, which are coded A, C, T, and G, and examining the differences within the gene sequence. Identifying the differences in the alleles of each gene is known as genetic variation and has a direct correlation to phenotypic expression because it is the basis for genetic differences between individuals of a given population. In plainer terms, breaking down the gene sequences within a certain breed allows for the discovery of differences in genetic traits that may not be present in every animal within the population, such as the tenderness gene, Calpain 3.

This variance in the DNA sequence in known as a single nucleotide polymorphism (SNP) and occurs when there is a difference within the genome of a single individual in comparison to others of the same population. Changing the gene sequence and frequency within the genetic makeup of an animal is what leads to different genetic traits possessed by an individual. Through the utilization of genomic predictions, producers are able to discover animals that have these certain identifiable traits and capitalize on their profitability. Gathering this information makes genomic predictions much more reliable than EPDs because genomic predictions incorporate genotypic, phenotypic and pedigree data (if animal is registered) in order to assess the genetic value of the animal, whereas past evaluative tools relied only on predictions and phenotypic data. Genomic predictions of today expand farther beyond the selection tools of the past and give producers the ability to trace the inheritance of individual genes of animals by identifying genetic markers within the genome, which are associated with certain attributes of the animal, such as coat color or weight gain.

Table 1: List of terminology for a typical Angus EPD, American Angus Assoc.

Production

CED	**Calving Ease Direct**. Predicts the calving ease of a sire when he is mated to heifers. Higher value EPD should indicate fewer unassisted births in first calf heifers.
BW	**Birth Weight.** Birth weight of a sire's offspring when compared to breed average. Expressed in pounds.
WW	**Weaning Weight**. Predictor of a sire's ability to transmit growth at weaning to offspring. Expressed in pounds.
YW	**Yearling Weight.** Weight of a sire's offspring at 365 days. Expressed in pounds.
RADG	**Residual Average Daily Gain.** Expressed in pounds, predicts a sire's genetic ability for post-weaning gain in his progeny, compared to progeny of other sires.
YH	**Yearling Height.** Only for Angus cattle, predicts the difference in yearling hip height.
SC	**Scrotal Circumference.** Reported in centimeters, it predicts early maturation of offspring of a sire.
DOC	**Docility.** Expresses a difference in yearling cattle temperament. Higher value is more desirable.

Maternal

CEM	**Calving Ease Maternal**. The difference in unassisted births of a sire's female offspring as first calf heifers.
Milk	Reported in pounds, predicts the average weight of a sire's daughter's calves at 205 days old. Milk is highly variable due to environmental conditions and nutrition of the herd.
$EN	**Cow Energy Value**. Only for Angus cattle and expressed in dollars, predicts the money saved per cow per year based on cow energy requirements. A higher dollar value is more favorable.

Carcass

CW	**Carcass Weight**. Expressed in pounds, it is the adjusted weight of a sire's offspring's hanging carcass.
Marb	**Marbling**. Adjusted marbling score at 365 days of age. Scored based upon USDA marbling degrees.
REA	**Rib Eye Area.** The estimated adjusted 365 day rib eye area measured between the 12th and 13th rib of the animal, using an ultrasound machine. Estimate of the percent of muscling in the actual live animal.
FT	**Fat Thickness.** Back fat thickness measured over the 12th and 13th rib. Used to calculate yield grade and total body fat of the animal.

Values

$W	**Weaned Calf Value**. Expressed in dollars, it estimates the value of a sire's weaned calves and their performance.
$F	**Feed Lot Value**. Expressed in dollars, this is a comparison of a sire's offspring versus calves of other sires in post weaning merit.
$G	**Grid Value**. Expressed in dollars, it is a comparison of the value of a sire's calves sold on a grid system, versus calves of other sires.
$B	**Beef Value**. Expressed in dollars, it measures the difference of a sire's calves for performance and carcass value compared to offspring of other sires.

MATERIALS and METHODS

Genetic Progress Made Through the Use of Genomics

In order to accomplish the first objective, I examined the benefits of genomic predictions and ways that they can be applied to a commercial beef operation. I first explained all three selection methods commonly used by producers, which are visual appraisal, expected progeny differences (EPDs), as well as genomic predictions. I studied the ways that genomic predictions differ from other selection methods. In doing so, I was able to showcase the value that genomic predictions have within the commercial cattle industry and how they can become an integral selection tool that can be used in almost any commercial cattle operation. In addition, I also evaluated many of the benefits that genomic predictions can give to producers that other selection methods simply cannot provide.

Lastly, I was able to show why genomic predictions are not only useful to a commercial producer, but how they are actually affordable and profitable when used for the correct applications. To do this, I have incorporated data from ranches that have already begun using genomic predictions on their cattle. As previously mentioned, the ranch data used in this study was provided by San Benito Cattle Company of Hollister, CA and by Flyin' M Cattle Co. of Tracy, CA. San Benito Cattle Co. is a commercial cow/calf and stocker operation composed of approximately 4,000 mother cows and a varying number of stocker calves, depending on the year. The ranch runs their cattle in the steep foothills slightly southwest of the San Luis Reservoir. The climate consists of cold winters, along with hot, dry summers. The ranch focuses on raising cattle with high carcass merit; therefore, San Benito Cattle Company chooses to use bulls that will pass this on to their offspring.

As a result, mostly Angus and Charolais bulls are used and many of the females on the ranch are Char/Angus based, due to the rotational breeding plan that is in place. The other data source, Flyin' M Cattle Co., is a seed stock and commercial cattle operation based out of Tracy, CA, though the cattle are raised in the eastern foothills outside of Clements and Ione, CA. Similar to San Benito Cattle Company, the cowherd resides on native pastures year round, but winters are wet and cold, while summer is hot and dry.   The ranch consists of a purebred Angus cowherd, as well as commercial cattle that are mostly Angus based. The main goal for the ranch is to produce functional females that can survive in range conditions, as well as improve the genetic merit of their cowherd in order to increase marketability of their Angus bulls. Both ranches have found ways to incorporate genomic predictions into their selection criteria and their data was used to exemplify just a few of the applications that genomic predictions can be used for and how real ranches are currently using information provided by genomic predictions to assist them in making management and marketing decisions.

Developing a Method to Explain Genomic Applications to a Commercial Producer

The second part of this project was to develop a method that explains to a commercial producer how genomic predictions work and how they can be applied. This portion of the work reviewed some of the information from the main body of the paper, specifically what a genomic prediction is and why they are beneficial. As stated above, I have incorporated actual data from ranches that have already turned to genomic data to take their operations to new levels.

From here, I explained the practical uses for genomic evaluations within the commercial industry, as well as some other ways that genomic predictions can be useful to the commercial producer.

Lastly, I gave a small tutorial on how easy it is to collect and obtain genetic data on animals. My hope for this section of the paper was to give producers some idea as to how easy it is to integrate genomics into an operation and how they can be a very useful management tool when applied in the correct way.

RESULTS AND DISCUSSION

With the amount of practical and profitable information that genomic predictions can provide to producers, their use in commercial cattle operations needs to be seriously considered. Utilizing genomic technology gives cattlemen a wealth of new information, unparalleled insights about the cattle they raise and assists them in management decisions that will lead to increased profitability. Up until now, there has not been a practical method of evaluating cattle on the genetic level. Now that highly accurate, large, high density panels (50,000 markers) are available at a reasonable cost, cattlemen can incorporate what they see on the outside (phenotype) with the true genetic makeup of the animals they are selecting. What sets genomic predictions apart from all other selection methods is their ability to identify animals that carry certain desirable traits that cannot be or are difficult to measure using EPDs. For example, reproductive and feed efficiency traits would be impossible to determine by simply looking at an individual or a set of EPDs. The information needed to collect this sort of data would be expensive, as well as time consuming, as it would take multiple years to compile this data. With genomic predictions, the results can be found in less than three weeks. Using DNA information allows producers to discover data such as this and incorporate it into their decision making. Another aspect of genomic predictions that makes them so valuable is their ability to identify young animals at an early age that possess high genetic merit. Again, this decreases the amount of time that data needs to be collected on a certain individual, as well as providing the producer with rapid feedback to let him or her know if an animal should be considered valuable or not within their respective herds. **Figure 4** is an example of a scorecard from a tested individual and gives an example of traits that are measured within a DNA test.

DNA testing can be used in a variety of different applications and can provide valuable predictions for the producers that decide to utilize the information. Rather than explaining every aspect of the genomic profile and the countless ways they can be used, I believe that it is best to learn from producers who are already using genomic predictions successfully within each of their own respective programs. Each of these examples is adopted from real ranches that have experienced real results from using genomic predictions.

Igenity DNA Profile Scores

IG384 Results Recvd Date: 08/17/2011

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
6	6	5	6	9	6	6	6	5	5	1	5	3	7	6	

CW	Marb	RE	FAT	Tend		Color	BVD
7	5	7	6	5			

Figure 4: Igenity DNA scorecard for **FMCC Concrete 007, Flyin' M Cattle Co., Tracy, CA.**

San Benito Cattle Company, a 4,000 head cow/calf and stocker operation located in Hollister, California, has found many uses for genomic profiles within their business. The ranch began using the Igenity profile as a way to identify parentage of their calves back to their sires. Doing this allowed them to distinguish those calves that were higher performing than their contemporaries and linked this performance to their sires. This in turn, gave them the ability to determine which bulls in their battery were superior and produced better progeny, as well as which bulls were underperforming. This also gave the ranch the ability to distinguish lineage that would be profitable to continue using on the ranch in future bull buying decisions. By identifying the superior sires within their lineup, San Benito Cattle Company collected and used these bulls more heavily within their breeding program, in an attempt to produce a more uniform, higher performing calf crop.

Not only does the ranch use genomic profiles to find the standouts in its bull battery, but it also uses DNA markers as a way to select and breed cattle that will produce acceptable yields on the rail. San Benito Cattle Company has made it a goal to market feeder cattle that will grade choice or better on the USDA quality grading scale, as well as maintain an acceptable yield grade. In order to accomplish this, the ranch uses genomic and EPD information together to determine bulls that will transmit superior carcass traits to their offspring. Doing this allows the ranch to choose which bulls need to be mated to certain groups of cows in order to produce highly marketable calves. Doing so has paid dividends for the ranch. Calves offered from San Benito Cattle Company have had very good demand because buyers are aware of the extreme amount of selection pressure the ranch puts on all of their cattle. Buyers are able to purchase these calves with confidence because they know that the San Benito Cattle Company calves have more reliable data than almost all of their competitors.

Genomic predictions in the commercial cowherd are not limited to simply linking sire to offspring through distinguishing parentage. They can also aid in making decisions when selecting replacements. Flyin' M Cattle Co. of Tracy, CA, now uses genomic predictions to do just that. When it comes time to selecting replacements, Flyin' M Cattle Co. collects blood on their potential replacement candidates and uses an Igenity profile to determine which heifers should stay in the breeding herd. In the three years since they began testing, Flyin' M Cattle Co. has been able to identify genetically superior females that would have otherwise been sold as feeder heifers or as commercial bred cows. They have found that doing this increases the values of their females for future generations. In April of 2011, the ranch decided to test a small sample of potential cow prospects.

These females derived from the ranch's purebred Angus herd and had EPDs that ranked many of the cattle as simply average in respect to breed averages of the American Angus Association at that time. The cows had just had their first calf in the fall prior to the test, so it was decided that if the cows had a test that proved them genetically inferior, their calves would be weaned and the cows would be sold as young bred cows. The cattle were blood tested and the samples were turned into the Angus Association so that they could be evaluated using the Igenity profile. The results of the test were very positive. Flyin' M Cattle Co discovered that the cattle, who had only average EPDs prior, increased in value thanks to the test. In fact, the cows' increased in accuracy of their traits (up to .38% in some production traits), and received data that was unable to be measured (Residual Average Daily Gain, Docility). The test also provided information that increased the genetic value of all of the cows. Cattle that were simply average prior to the test in regards to their EPDs, now were ranking within the top percentile of certain traits. The profile was also able to provide solid carcass data for these females, which was previously very inaccurate (.05%) or not even collected. The Igenity panel revealed that the cattle Flyin' M Cattle Co regarded only as potential cow prospects all had solid carcass traits, increasing their value to the breeding herd. Now, looking at carcass traits alone, Flyin' M Cattle Co. has found that their females who had genomic information for carcass data are passing on these traits to their offspring at a higher rate than females who had been randomly selected as replacement based on phenotype alone. As a result, this increased the carcass characteristics of progeny that were later tested and kept for replacements or marketed as breeding bulls. Even more ironic is the fact that some of the females in this tested group were going to be sold at auction as commercial bred cows.

Given the prices of cattle at that time, these cows would have sold for approximately $70 per hundredweight, but using the Igenity profile, the cattle were retained and are now worth over $2,000 per head as breeding cows, thanks to their genomic enhanced value. **Figure 5** shows a display of the Igenity panel scores from some of these actual cows and the increases in their EPDs, as well as percentile rankings for certain traits within the breed. Not only have they been able to identify their genetically superior animals, but they also use the genomic profiles as a measuring tool to gauge the genetic progress they are making in their breeding program. The Igenity panel allows them to easily look at individual traits where their animals excel, as well as traits where there needs to be improvement through better mating. Using the genomic predictions as a sort of progress report, Flyin' M Cattle Co. is able to make better mating selections that will solidify the genetic shortcomings within their own herd and helps them to make choices that will help them achieve their herd objectives. These are just two examples of producers who have found the benefit of genomic predictions and the value that they can add. Producers can utilize genomic predictions at any stage of production.
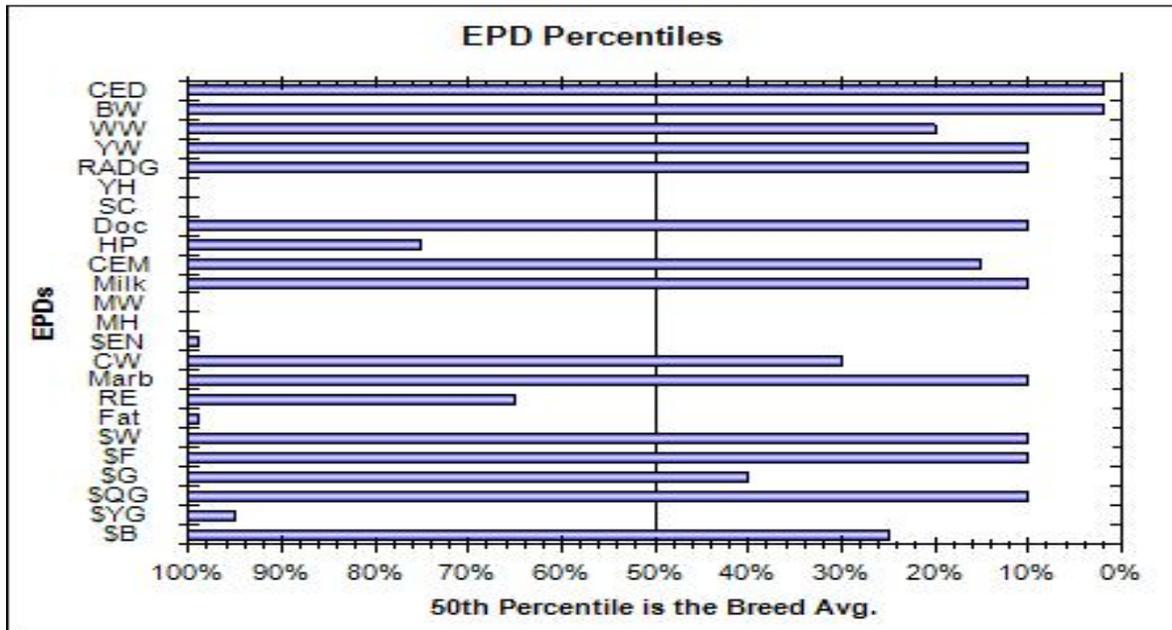
Igenity DNA Profile Scores

IG384 Results Recvd Date: 04/26/2011 File: 434783 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
7	2	4	7	8	3	4	4	6	7	5	7	5	4	4	

CW	Marb	RE	FAT	Tend		Color	BVD
7	6	5	7	5			

Ear Tag 8805

Igenity DNA Profile Scores

IG384 Results Recvd Date: 04/26/2011 File: 434783 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
6	4	5	6	8	3	3	6	7	6	7	7	5	5	5	

CW	Marb	RE	FAT	Tend		Color	BVD
7	7	7	2	4			

Ear Tag 8126

IG384 Results Recvd Date: 04/26/2011 File: 434783 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
8	2	2	6	7	6	6	5	6	5	4	8	5	5	4	

CW	Marb	RE	FAT	Tend
7	6	5	5	4

Color	BVD

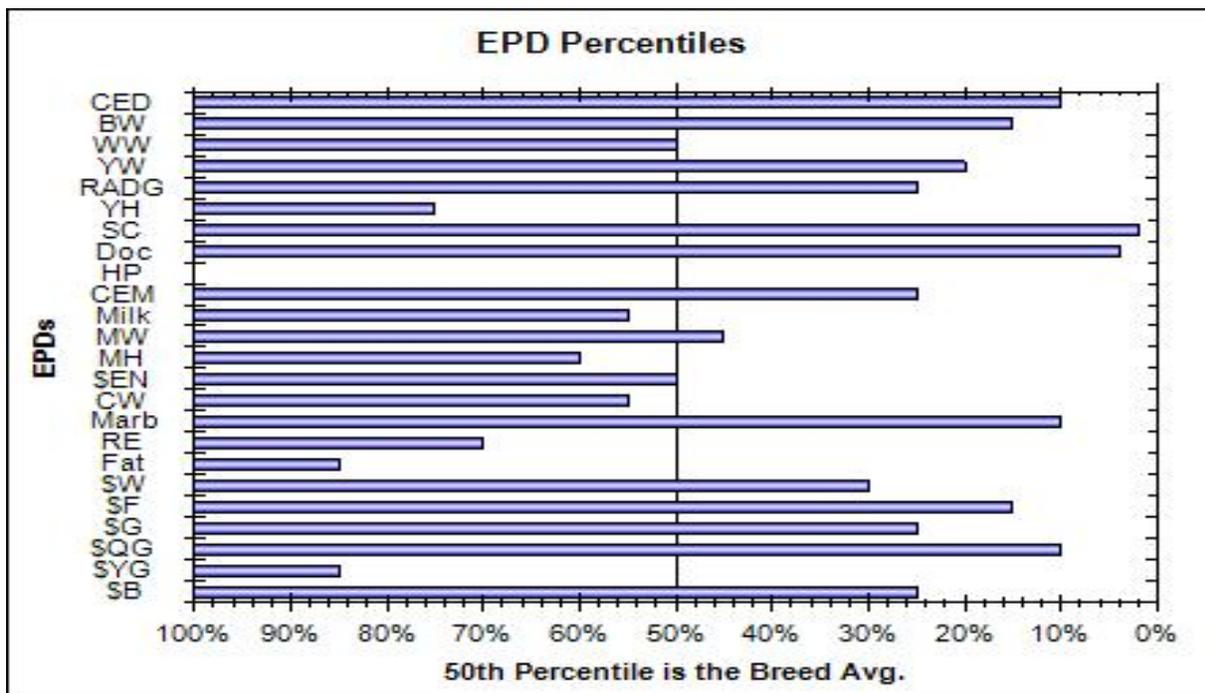**EPD Percentiles**

Ear Tag 8103

Igenity DNA Profile Scores

IG384 Results Recvd Date: 04/26/2011 File: 434783 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
7	4	3	5	7	5	6	6	4	6	3	7	3	5	6	

CW	Marb	RE	FAT	Tend
8	6	7	6	3

Color	BVD

Ear Tag 8803

IG384 Results Recvd Date: 04/26/2011 File: 434791 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
6	3	1	5	6	4	5	5	2	6	3	8	4	4	3	

CW	Marb	RE	FAT	Tend
7	6	5	6	5

Color	BVD

Ear Tag 8801

IG384 Results Recvd Date: 04/26/2011 File: 434791 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
4	6	8	7	9	3	5	7	5	4	1	5	3	7	5	

CW	Marb	RE	FAT	Tend
8	7	7	4	6

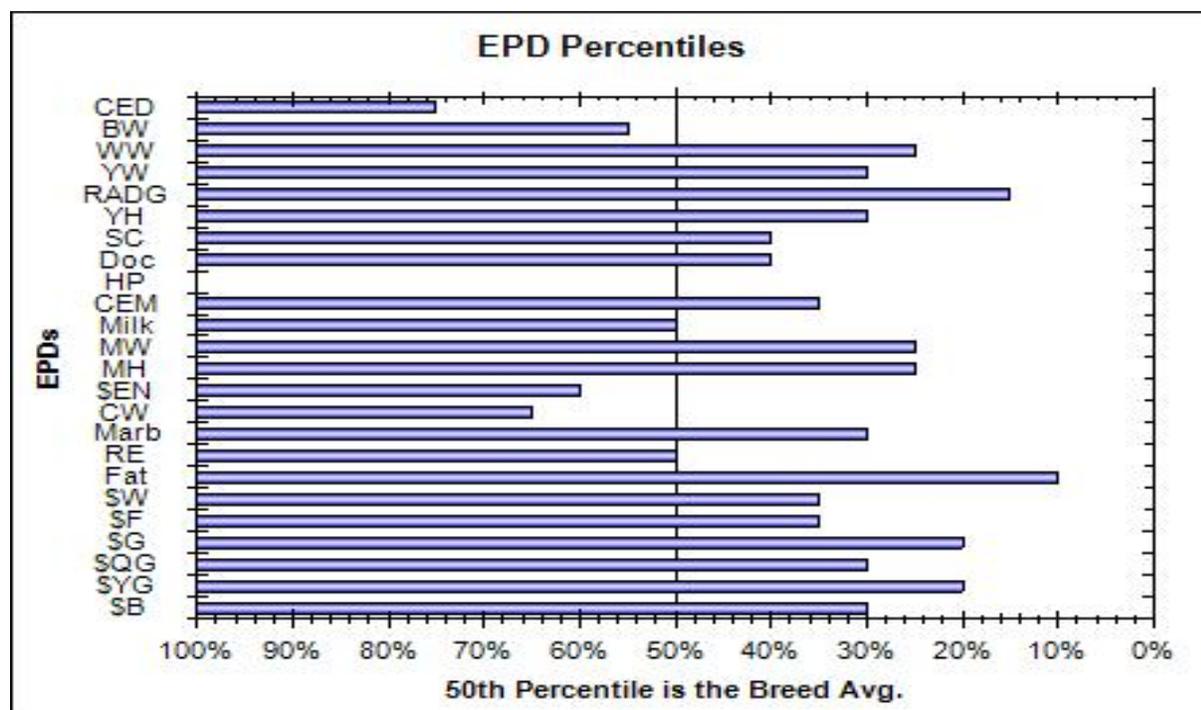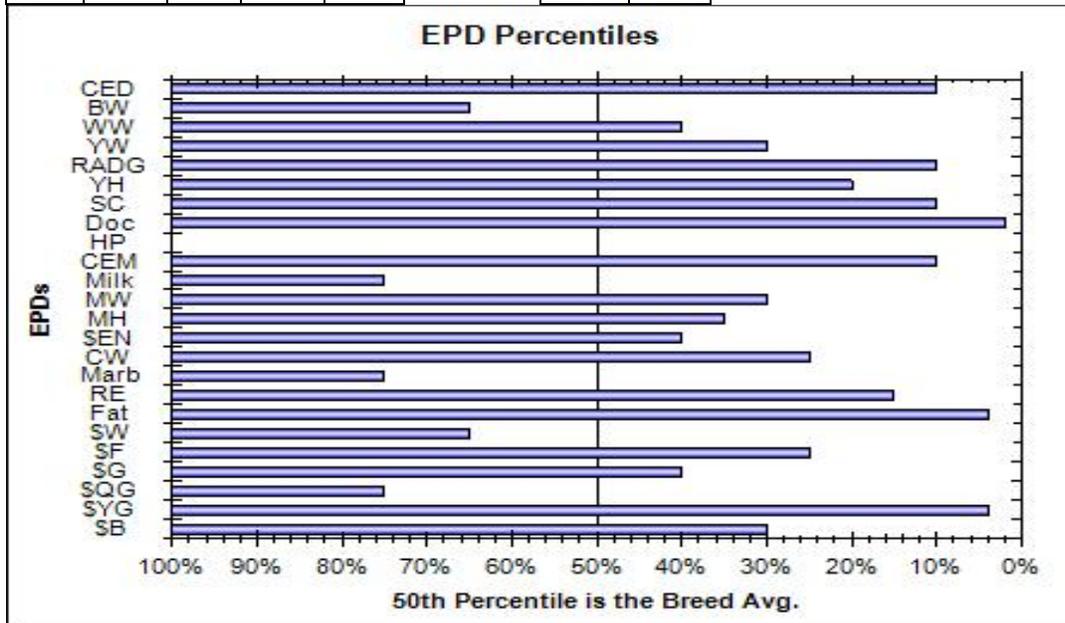| Color	BVD

EPD Percentiles

Ear Tag 8501

Igenity DNA Profile Scores

IG384 Results Recvd Date: 04/26/2011 File: 434783 A-1183391 Flyin' M Cattle Co, Tracy CA

CED	BW	WW	ADG	YW	RFI	DMI	YH	SC	Doc	HP	CEM	Milk	MW	MH	Stay
7	5	4	6	7	4	7	7	5	5	5	8	5	6	5	

CW	Marb	RE	FAT	Tend		Color	BVD
7	4	8	2	4			

igenity.

Ear Tag 8101

Figure 5: Igenity Profile Scores from **Flyin' M Cattle Co., Tracy, CA.**

From conception to consumption, there is a place for genomic testing within American cattle operations. In fact, producers today cannot afford not to use genomic predictions within their herds because the benefits of the testing hugely outweigh the cost. For as little as $40, producers can determine which cattle can stay within a herd and which individuals need to be culled. An added $40 per head may seem like an unnecessary additional cost, but with the price of feed ($275+/ton) and fuel (approx. $4/gallon) it really is a minor cost in the grand scheme of things. In some cases, it may be even less than that. A study by UC Davis indicates that using DNA information does make economic sense for commercial producers.

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The study looked at using genomic information to make replacement heifer decisions and concluded that the breakeven cost to producers would be less than $5 per head, based on testing at least 20% of the potential replacement candidates (Van Eenennaam 2010). In addition, there can be extra incentives for producers who use genomic profiles as a selection and marketing tool for their cattle. For example, a cow/calf producer that has genomic information on his bulls, as well as his calves, can use the information provided to him from the genomic panel to increase marketability of his calves by enticing buyers and feeders to pay more for cattle that have reliable data to go along with them to the feed lot, as is the case for San Benito Cattle Company. Cattle that are sired by bulls with reliable carcass traits and have their own set of reliable data should bring premiums because they have the traits needed to perform in the feed yard. One example of this again refers to the study conducted by UC Davis. In an attempt to showcase the economic viability of genomic predictions in terms of sire selection, the study focused on a single ranch that marketed calves at 10 months of age and participated in a program that required certain carcass criteria for the calves at time of harvest. The ranch was awarded premiums for having calves that met or surpassed the carcass selection traits set forth by the program. The study also found as a result that the value of these calves over a period of time differed due to the superiority of the bulls used in the breeding program. The steer calves of this study averaged $721 per head, but the gross revenue generated from all of the male calves produced by each bull used in the study differed greatly. Gross returns ranged from $4,881 to $55,889 simply due to superiority of different sires identified within the bull battery. The most important lesson that can be gained from this portion of the study is that using genomic predictions to collect important data, i.e. identifying parentage, is that it can be cost effective and can pay huge dividends for producers who incorporate it into their operations.

CONCLUSION

Through the research conducted for this study, it can be concluded that genomic predictions do present a significant benefit to commercial cattle operations. They represent a new tool that can be incorporated with existing selection methods (visual appraisal, EPDs) in order to increase genetic merit. Genomic panels give producers so much useful information that it is hard not to justify their use. For the amount of information that the panel provides, the gain far exceeds the cost. For as little as $40 per head, producers can discover information that could never be measured until now. I do recognize that genomic predictions give more information than an ordinary rancher would need, but there are a few specific ways that genomics should be utilized on a commercial operation that would truly provide a high level of value. First and foremost, producers will benefit most from using genomics to identify parentage within their herd. Discovering high performing offspring and linking them to their sires can prove to be extremely monetarily beneficial. Second, genomic predictions need to be used to make replacement heifer decisions. This will ensure that only the best females are kept and that genetic progress within the breeding cow herd will continue to increase year after year. Lastly, for those producers who use Angus bulls in their breeding program, genomic panels specifically for Angus cattle need to be used to ensure that the proper mating is being made. Bulls pay for themselves by getting cows bred and through passing on their genetic traits to their offspring. Using a genomic panel allows producers to find out how reliable a bull's traits are, especially young bulls, and ensures that he will pass on desirable traits to each calf he sires. As previously mentioned, there is much more information that a genomic prediction can provide, however, these are the most practical applications on a commercial cowherd and will provide the largest amount of benefit for those producers who use them.

It is important to keep in mind though that DNA testing is not the total solution to improving genetic selection. Genomic predictions are simply another tool that producers have the ability to use. The best way to utilize the information provided from DNA testing is to use it in conjunction with other selection methods, where they can help increase the total information provided for a single individual. Combining the material offered by EPDs, visual appraisal, and genomic predictions is the best way for producers to make the best informed decisions about the cattle that they raise.

In addition to discovering the benefits that genomics can provide for producers, I was also able to identify some distinctions between the two genomic tests that I discussed in the paper that I felt were important to identify for producers. Throughout this work, I discussed genomic tests offered by both Pfizer and Igenity and some of the characteristics of each test.

I concluded that for the sake of using genomics within a commercial beef operation, Igenity was the more appropriate test for commercial producers. I came to this conclusion for a few different reasons. First and foremost was the difference in price of the two tests. Although the difference in price is minimal, if a producer was going to test a large quantity of animals, the price difference would be more significant. The basic profile for Igenity costs $38.00, not including the sample cards needed to conduct the test. With the cards, the basic test would cost about $40 total per test. Pfizer offers their HD 50K test to producers for $139.00 per animal, a difference of $101 from their competitor. The cost of this test does include parentage, where Igenity's does not. Instead, an additional $25 cost is applied to the base test if producers would like to identify parentage in their herds, making the test cost approximately $65.00 per animal. Still, Igenity is the most cost effective means for producers to DNA test their cattle.

Secondly, the Igenity panel offers a sufficient set of information that can actually be used practically by commercial producers. The Pfizer panel may be a more comprehensive test, but it provides more information than is really necessary for a producer operating on a commercial basis. In fact, I felt that the 50K test from Pfizer would be better used within a seed stock operation more so than it did for uses in commercial production. I concluded that Igenity provided just the right amount of information for commercial producers and was created with commercial cattlemen in mind, unlike the genomic test offered by Pfizer. Since the goal in beef cattle production is to ultimately produce a consumable end product, I concluded that Igenity's profile offers a test that puts an emphasis on traits that should be associated with commercial beef production; average daily gain, marbling, fat thickness, and yield grade just to name a few. For this reason, I felt that it was better suited to accommodate producers who are in the business of marketing cattle that will gain and grade while in the feed lot and on the rail. The HD 50K test seemed to put more focus on testing for growth traits, which I do feel is important, but did not offer as much comprehensive testing for carcass traits as the Igenity panel did. **Table 2** displays a comparison of the two DNA tests and the traits that each test evaluates. This being said, I also concluded that the results for the Igenity panel were much easier to read than results from a Pfizer genomic evaluation. Scoring each individual on a basis of one to ten was much easier to read than giving each animal a percentile ranking, as is done with results from Pfizer.

Table 2: **Various traits associated with each of the two DNA tests.**

Trait	Igenity Profile	Pfizer HD 50K For Angus
	Included in Test	Included in Test
Average Daily Gain	X	X
Net/Residual Feed Intake	X	X
Dry Matter Intake		X
Tenderness	X	X
Calving Ease (Direct)		X
Birth Weight		X
Weaning Weight		X
Yearling Weight	X	
Calving Ease (Maternal)	X	X
Milking Ability		X
Heifer Pregnancy	X	
Stayability	X	
Docility	X	
Yield Grade	X	
Carcass Weight	X	X
Back Fat Thickness	X	X
Ribeye Area	X	X
Marbling Score	X	X
Percent Choice	X	

The goal of the test is to be able to identify and apply the data provided through the test, but if the information is unable to be comprehended, it defeats the purpose. Igenity does a great job keeping the information relatively straightforward and because of that, I felt that it was better suited to fit the needs of any producer, whereas Pfizer's result system takes some research to learn how each individual animal scored. The scoring criteria and definitions for Pfizer's genomic prediction can be seen in **Table 3.**

The final reason that I felt the Igenity profile was the genomic test better suited for commercial producers was the fact that Merial and Igenity have been working with their genomic program for a longer duration of time than Pfizer has. Because of this, I felt that Igenity has a better understanding of what works and what does not work in regards to their testing.

Overall, I believed that both of these testing programs served their purpose very well, but it was clearly apparent that Igenity has developed a strategy that makes using the test very user friendly, but also quite practical for a broad spectrum of producers. Pfizer's DNA test seems to better suit itself for seed-stock producers, especially those who raise Angus cattle, where the HD 50K test for Angus can be applied. When used on this basis (for Angus cattle solely), Pfizer's DNA test is more than adequately comprehensive and provides key information that seed-stock producers need. This is not to say that this test cannot be used on commercial operations because it certainly can, but for the sake of this paper, I have found that this brand of genomic prediction is not suited to serve the commercial producer as well as Merial's Igenity Profile.

Table 3: Definitions of various traits within the HD 50K profile as defined by Pfizer Animal Genetics.

MVP	Unit	Description
Birth Weight (BW)	kg	An estimate of genetic difference between animals in their weight at birth. **Lower MVPs are desirable**.
Calving Ease Direct (CE)	*%*	Indicates the difference in genetic merit for the ability of an animal's calves to be born unassisted from two year old heifers. **Higher MVPs are desirable.**
Calving Ease Daughters (CEDtrs)	*%*	Indicates differences in genetic merit for the ability of an animal's daughters to calve unassisted at two years of age. **Higher MVPs are desirable**
Weaning Weight (WW)	kg	An estimate of genetic differences between animals in live weight at weaning, adjusted to 200 days of age, due to their genetics for growth. **Higher MVPs are desirable**
Milk (Milk)	kg	An estimate of an animal's maternal effect on the weaning weight of its calf adjusted to 200 days, due to genetics of the dam. **Higher MVPs are desirable**
Average Daily Gain (ADG)	kg/day	An estimate of an animal's breeding value for feedlot post-weaning gain per day, with higher values indicating growth genes from weaning to yearling. **Higher MVPs are desirable**
Carcass Weight (CW)	kg	Estimates genetic differences between animals in hot standard carcass weight, adjusted to 650 days of age. **Higher MVPs are desirable**
Rib Fat (Rib)	mm	Estimates the genetic differences between animals in fat depth at the 12/13th rib site, adjusted to a 300kg (660 pound) steer carcass end point. **Higher MVPs are desirable.**
Eye Muscle Area (EMA)	cm	Estimates genetic differences between animals in eye muscle area at the 12/13th rib site, adjusted to a 300 kg (660 pound) steer carcass. **Higher MVPs are desirable**
Marbling (Marb)	*%*	Estimates genetic differences between animals in marbling (% intramuscular fat) at the 12/13th rib site, adjusted to a 300 kg (660 pound) steer carcass. **Higher MVPs are desirable**
Tenderness (Tend)	kg SF	Indicates differences in genetic merit for meat tenderness based on the amount of shear force required to pull a blade through cooked steak sample. **Lower MVPs are desirable.**
Dry Matter Intake (DMI)	kg/day	Indicates genetic differences among animals kilograms of feed dry matter consumed per day in the feedlot on a finishing ration. Based on actual consumption of the animal. **Lower MVPs are desirable**
Net Feed Intake (NFI)	kg/day	Estimates genetic variation in dry matter consumed per day as compared to the animal's expected feed consumption based on its body weight and growth rate. Based on animal's actual efficiency in the utilization of feed consumed. **Lower MVPs are desirable.**

Works Cited

1. American Angus Association. 2011. Performance/ AHIR. EPD Definitions. Accessed Nov. 5, 2011. http://www.angus.org/Nce/Definitions.aspx

2. Hansen, G.R. and D.G. Riley. 2006. Expected Progeny Differences (EPDs) in Beef Cattle. University of Florida IFAS Extension. http://edis.ifas.ufl.edu/an164.>

3. "Igenity for Beef." *Igenity*. Merial Limited, 2009. Web. 28 Nov 2011. http://www.igenity.com/beef/profile/IgenityProfile.asp&xgt.

4. Northcutt, Sally L. 2011. Genomic Choices. American Angus Association. www.angus.org/AGI/GenomicChoice11102011.pdf

5. "Pfizer Animal Genetics." *Pfizer Animal Health*. Pfizer Inc., 2011. Web. 28 Nov 2011. <http://animalhealth.pfizer.com/sites/PahWeb/US/EN/Pages/Beef.asp&xgt.

6. Van Eenennaam, Alison. "Uses of DNA Information of Commercial Cattle Ranches." (2011): Dept. Animal Science, UC Davis 1-7. Print.

7. Van Eenennaam, A.L. 2010. Are DNA Tests for You? Beef Magazine. March 18-19, 23. http://beefmagazine.com/genetics/beef-dna-tests-20100301

8. Van Eenennaam, A.L., J.H. van der Werf, and M.E. Goddard. 2010. Value of DNA Information for Beef Bull Selection. 9th World Congress of Genetics Applied to Livestock Production, Leipzig, Germany. http://www.kongressband.de/wcgalp2010/assets/pdf/0094.pdf

9. Van Eenennaam, A.L., 2011. Combining EPD Info with DNA Test Results Improves Genetic Prediction Accuracy. Beef Magazine. February. 26, 28, 30. http://beefmagazine.com/genetics/improving-epd-dna-prediction-accuracy-0201/index.html.

10. Van Eenennam, A.L. Weaber, R.L., Drake. D.J., Penedo, M.C.T., Quaas, R.L. Garrick, D.J., Pollak, E.J. 2007. DNA-Based Paternity Analysis and Genetic Evaluation in a Large, Commercial Cattle Ranch Setting. Journal of Animal Science 85:3159-3169

11. VanRaden, P.M. and M.E. Tooker. 2007. Methods to explain genomic estimates of breeding value. J. Dairy Sci. 90(Suppl. 1):374(abstr. 413).

Appendix

A Producer's Guide for Using Genomic Predictions Successfully

Introduction

      This entire document has served as a means to explain what genomic predictions are and has given some references as to how they can be used on a commercial basis. What the paper did not cover is the steps needed in order to retrieve the data discussed in the sections prior. This small portion of the work will serve as a type of guide to assist producers in using genomic predictions and give some more insight as to how genomics can be applied.

Collecting Samples

      In order to utilize the data that a genomic prediction can provide, a sample from the desired animal(s) must be taken in order to DNA test. Collecting samples is quite easy and there are a couple different ways samples can be taken depending on which test is used.

      Igenity profiles and Pfizer DNA tests can both work with blood, hair, or tissue samples. With each method, it is important to document the correct identification number of each animal being tested.

      Hair Sample: Hair samples should be taken from the tail switch of the animal by means of pulling. The goal is to extract samples that have an intact follicle. It is important to note that hairs should not be cut. A viable sample would include 25 to 30 hairs with intact follicles for animals over 90 days old. Younger animals require a sample that includes 40 to 60 hair follicles. Hair samples are stored in a special hair sample card, which can be purchased. Samples are placed in the card root end first. Any excess hair that remains outside the card can be trimmed off.

      Tissue Sample: To collect tissue samples, cattle must be restrained in a squeeze chute. Tissue samples are taken from the ear, using a tag like tissue collector. Using an ear tagger, the tissue application collects a tissue sample in the female end of the collector. This small sample must be labeled and then can be mailed into the lab.

      Blood Samples: Blood samples are the last sampling method used by Igenity and Pfizer. To take a blood sample, blood cards must be obtained. These cards resemble match books and have a small round area in the center where the blood must be applied. Blood can easily be taken from behind the ear or from the tail head and dabbed onto this area on the card.

The card then easily folds up and allows for documentation of the animal on its outside. This is a great method of sampling because if done correctly, these samples remain viable for extended periods of time.

After any one of these sample collection methods are completed, the samples must then be mailed off to the lab. Addresses for each lab can be found on each company's respective website. Results of the tests should be returned in approximately 21 days or so, depending on how busy the lab is.

Determining Results

Igenity:

As stated previously, Igenity scores the cattle using a 1-10 system. What is important to understand is that although 10 is the highest score, it is not always the best score. Categories such as Birth Weight are areas where a lower number is better. However, in most categories, 10 is a desired score.

Pfizer:

Pfizer scores animals in terms of percentile rankings. For each trait, it is desirable to have an animal that ranks in the top 1%. What makes the test difficult to read is when animals rank outside the top 1%. When this occurs, it takes some time to learn about the where an animal is in terms of percentile ranking within its breed. The following table is provided by the American Angus Association and shows what a desirable score for each category within the two DNA tests would be.

Category	Igenity Favorable Score	Pfizer Favorable Percentile
Calving Ease Direct	10	1%
Calving Ease Maternal	10	1%
Birth Weight	1	1%
Weaning Weight	10	1%
Yearling Weight	10	1%
ADG Post-Weaning	10	1%
Milk	10	1%
Carcass Marbling	10	1%
Carcass Rib (Larger Desired)	10	1%
Carcass Fat (Leaner Desired)	1	1%
Carcass Weight (Heavier Desired)	10	1%
Dry Matter Intake	1	1%
RFI	1	1%
Tenderness (More Tender Desired)	10	1%
Docility	10	1%
Yearling Height	10	1%
Scrotal (Larger Desired)	10	1%
Mature Weight	10	1%
Mature Height	10	1%
Heifer Pregnancy	10	N/A

<u>Commercial Applications</u>

Both of these tests have many uses in all facets of beef production from producer to processor. Since this paper focused on using genomic predictions within the cow/calf sector of the business, applications discussed in this section will apply more to cow/calf producers. This work already talked about some of the uses that genomic predictions can provide, such as identifying parentage, but there are still more uses for these DNA test that are useful for cow/calf producers that until now could not be measured. On a broad spectrum, genomic predictions can give a rancher an overall genetic evaluation of his cattle. This can serve as a great tool to identify the strengths and weaknesses of cattle within a herd. Recognizing what traits need to be improved and which ones are satisfactory can shape breeding programs and allow producers to develop strategies that will assist them in improving the genetic merit of their herd. Another feature of genomic predictions that is very useful to a commercial operator is measuring heifer pregnancy rate. In the past, it would be impossible to determine what females were reproductively viable until they either had a calf, or until they were deemed non-breeders. The problem with this is that it takes a great deal of time, money, and feed to reach the point to determine if a heifer is very fertile or not. Using a genomic profile, producers can identify heifers that are more likely to be fertile and get bred, as well as those that have a very low likelihood of being viable breeders. Identifying and culling these individuals can result in savings for the producer. These are just a couple of practical uses that genomic predictions have for commercial producers. The list below lists more applications for genomic predictions that are useful for commercial ranches.

- ❖ Identifying animals with desirable residual feed intake
- ❖ Determining female stayability within a herd
- ❖ Determining docility of tested animals
- ❖ Evaluating carcass composition of bulls, cows, and calves
- ❖ Identifying superior breeding candidates
- ❖ Selecting superior bulls to use within breeding programs
- ❖ Testing for PI-BVD within herds
- ❖ Evaluating Carcass Composition of calves for retained ownership programs
- ❖ Identifying parentage (sire to calf)
- ❖ Selecting high quality replacement females
- ❖ Track and measure genetic performance of individuals or a herd

Through the use of genomic predictions, all of the following tasks can be accomplished. To summarize, genomic predictions can not only pinpoint good and bad individuals within a herd, but they can also help producers set and accomplish goals. By giving valuable insight, DNA testing allows producers to evaluate and make more informed decisions about the cattle that they raise and that is why they are very useful within the commercial sector of the beef cattle industry.