

Continental European Beef Breeds: Their Use and Impact on the United States Beef Industry

by

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Summary:

This thesis explores the United States beef production and a few of its facets, more specifically, how the Continental European beef breeds can impact quality for consumers and profitability of producers. Continental European beef breeds are versatile, hearty, and possess leaner meat than the popular British breeds. The findings in this project will challenge norms of the industry, which favor British breeds, but also confirm their validity if the norms are proven productive and efficient. This project is not meant to be of “anti-Angus” sentiment, but instead considers maximizing potential in beef producers’ use of hybrid vigor in a commercial beef production setting. The scope of this project, is to explore the most beneficial breed usage/combination(s) in production to provide maximum palatability for the consumer, while also maintaining and maximizing high profits for farmers and ranchers. The project explores previous research on the carcass quality and productivity of the European breeds such as Charolais, Limousin, and Simmental, as compared to Angus, an industry standard.

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Introduction:

According to the National Beef Tenderness Survey, the livestock and meat industries are challenged with constantly seeking ways to produce beef that results in maximum *palatability* for consumers while doing so at the *lowest cost* (Morgan et al., 1990). However, farmers and ranchers must raise beef at the lowest cost possible, while still maintaining superior quality, resulting in higher profits. What can satisfy both parties are efficiency in genetic selection and consistency of production. Beef is bought and sold on a per-pound basis, so it only makes sense to strategically incorporate the European beef breeds, which are known for their size and growth that translates directly to more pounds.

The United States consumes 25.7 billion pounds of beef per year, more beef than any other country in the world (Cook, 2017). It is vitally important that production practices be constantly refined and improved to meet the needs and tastes of the increasing global population. The U.S. produced 11.4 million pounds of beef in 2016 and ranks first in beef production, accounting for nearly twenty percent of the world's beef supply (Cook, 2017). It is also very important that the U.S. supplies a consistent, quality product, not only at home but also abroad in export and trade. Programs such as the National Beef Quality Audit (NBQA. *see glossary*) exist to serve the needs of producers and consumers as they work together to improve U.S. beef. The primary measure of beef quality according to consumers is tenderness (Crouse et al., 1989). Furthermore, Beef Quality Assurance (BQA. *see glossary*) defines quality beef as, "Quality beef [that] consistently satisfies customer expectations for eating and preparation

characteristics... Expectations may include tenderness, flavor, juiciness, color, leanness, packaging, ease of preparation, and price” (BQA, 2017). In the U.S., there are a few problems regarding consistency of beef quality. The most relevant issues identified in the latest National Beef Quality Audit are as follows: Eating satisfaction, weight and size of the animal along with its cuts, and lean/fat/bone ratio (NBQA, 2011). Most consistency problems can be attributed to inconsistencies in production and management practices at the beginning of production at the farm. Some factors influencing the most relevant beef quality issues are variability in management practices such as feeding, weaning/preconditioning, and breed usage.

Angus cattle, a popular British breed, have gained much popularity in the beef and meat industries. When some individuals eat at a restaurant, they may often notice the “Certified Angus Beef” logo on the menu. Certified Angus Beef (CAB. *see glossary*) was established in 1978 by a group of farmers in the American Angus Association who believed that they could produce a quality product and decided to push their product through extensive marketing strategies (CAB, 2017). The American Angus Association capitalized on their marketing strategy by simply being the first breed association to push their product that heavily. Not many people have heard of Certified Simmental Beef because there is no such thing. Although Angus is the best known among beef breeds regarding quality, it is not necessarily the best in all measures. *Figure 1: Certified Angus Beef Compared to Choice Beef*, shows data conducted by NBQA comparing CAB to regular choice graded beef, which could likely be an array of breed or

breed mixtures. The differences in the beef measures are slim. Some palatability measures in the study include juiciness, tenderness, and flavor intensity.

Tenderness is one of the more important traits according to consumers. Many studies show that consumers are willing to pay premium if guaranteed a tender product (National Beef Tenderness Survey, 2016). See *Figure 2*. The choice graded beef matched up almost exactly with the CAB graded meat, which suggests that CAB is just a marketing tool that the American Angus Association uses to promote their product over other breeds.

It is very important that the U.S. supplies a consistent, quality product, not only at home but abroad in export and trade. *Figure 3* shows some current beef census numbers: 31.2 million head of cattle, and 727,906 farms, which equals an average of 43 head per herd. There is a unique set of issues that come with having so many different producers; consistent quality is one of the most outstanding issues. Programs such as the National Beef Quality Audit exist to serve the needs of producers and consumers as they work together to improve U.S. beef. The primary measure of quality beef according to consumers is tenderness, which is one of the palatability measures recorded in the data of this project (Crouse et al., 1989). Later chapters and data will focus on some of the key palatability measures and show how the European breeds' carcasses grade when compared to Angus' carcass.

This project explores research associated with Continental European beef breeds and their contribution to beef quality as a means of bringing more consistency, satisfaction, and quality to U.S. beef production and consumption.

The Continental breeds can make a positive impact on the U.S beef market by way of their added size, weight, leanness, live weight, and frame (Taylor, 1984).

The United States commercial beef industry is mainly comprised of Angus and Hereford and other British breed crosses (Crouse et al., 1989). Perhaps by crossbreeding Angus and other British breeds with Continental beef breeds, farmers will produce a more desirable market calf, therefore increasing their profits but also providing a consistent, quality beef supply for consumers.

Capitalizing on the use of hybrid vigor in the commercial industry will help balance the meat market, bringing a lean balance to the often-fatty British breeds, and superior marbling to the often-leaner European breeds.

Chapter 1: History of the Beef Industry in the United States

History is a powerful tool and can show us data, trends in growth/improvements, and perhaps help us learn from mistakes and innovate from them. The beef cattle industry is no different; throughout America's relatively short history, cattle have been a major factor in our society and its development. The reach of the cattle industry goes from food to pharmaceuticals. Over time, the beef industry has evolved from producer-driven preference to consumer preference. It has become more efficient in production through genetic improvement, diversity, selection, and other improved practices.

The cattle industry saw an earlier start in North America compared to the establishment of the United States. During the 1500s, beef cattle were imported to California and Texas from Mexico, well before major U.S. colonial settlements (BeefCheckoff, 2017). In the later 1500s, the beef industry made its way to Florida and emerged significantly. It was not until the 1600s that beef cattle reached New England, and what is now New York, Pennsylvania, and other Northeastern states from Eastern Europe and England. From the 1600s, all the way to the 1800s, beef cattle were used in more ways than just beef; they were used for draft (pulling), milk production, and meat after their useful life had ended (BeefCheckoff, 2017). The cattle herds of a young United States were sparse until the mid to late 1800s because beef for consumers was considered a luxury good in economics, and before beef cattle became a commodity, they were a necessity (BeefCheckoff, 2017).

As the 20th century approached, cattle became more of a commodity, as the country had advanced technologically, with the invention of the tractor. The cattle business had taken off and was thriving in the late 1800s. The operations were mainly family entities and focused in the West. During this period of the industry, producers raised 4-5-year-old grass-fed steers and shipped them by live train (BeefCheckoff, 2017). Grasses and rangelands were the sole food source for early American herds, until later advancements in feed/grain production. It is safe to assume that the beef produced and consumed in the late 1800s and early 1900s, was a vastly different product than we have today. Prior to grain feeding to accelerate the growth and market readiness of the animal, one may assume the four years to raise a market animal were incredibly inefficient. It was not until 1914 that we started feeding and slaughtering cattle at a younger age due to a reduction in the number of cattle. Because the animals were being slaughtered at an earlier age, the meat was much higher quality, while being much more tender; the industry uses this practice today.

As mentioned previously, technological advancements would drastically change the beef industry, as many industries were changed in the 20th century. G.F Swift invented the refrigerated rail car, therefore enabling larger shipments of beef across the country (BeefCheckoff, 2017). Chicago and Kansas City were the epicenter of all beef produced for consumption. The meat packers and processors were also located at the railyards, while major distributors were in Philadelphia, New York City, and Boston (BeefCheckoff, 2017). Feed yards would not see a widespread start until the late 1850s. These feed yards were

built near or onsite at cotton mills, where the byproducts were being used for feeding the animals. Feed yards would later become the primary source of beef for consumers and remain as such today.

In 1906, Upton Sinclair wrote *The Jungle*, which brought to light the horrible conditions of the Packingtown neighborhood of Chicago, Illinois. Packingtown is a self-explanatory name; it is where the meat packing industry was located. Sinclair describes Packingtown as a ruthless, disgusting, unsafe and unforgiving place in his famous book. The timing of Sinclair's book would be instrumental to the advancement and improvement of the beef industry moving forward. One could say that Sinclair was the first true whistle-blower in an industry that would forever be closely regulated and watched from that time on. Even today, over 100 years after Sinclair wrote *The Jungle*, food sourcing, safety, and security are all major topics in the food industry. The simple reasoning for this is food will always be a necessity for society, so it is always going to be a relevant topic. It is believed that the 1950s is when beef began to take off as a consumer choice, due to the invention and creating of "fast food." The mid-20th century, and forward, marks a transition in the beef industry for consumers and producers alike; the industry became consumer focused and no longer based on the producer.

An interest in quality was born in the beginning of the 1900s and has grown since then, due to beef becoming a luxury good because of America's economic and sociological advancement. Farmers have had to adjust to the preferences of the consumers; it is one of the biggest influencers on the prices of

beef, which directly influences farmers' income and livelihood. The farmers' methods of breed selection, feed, and general environment all directly influence the outcome of our beef supply in the United States, as well as the rest that we export. There is a total of 93.5 million head of cattle in the United States, and 727,906 different farmers who raise that beef (BeefUSA, 2017). The numbers break down to an average herd size of 43 head of cattle per farm in the U.S. Subsequently, this essentially means that there is beef being sourced from 727,906 different styles of production, breed selection, and environments.

Chapter 2: Background and Overview of the European Breeds

The continental European beef breeds are commonly referred to as the larger, or exotic breeds; the breed group is made up of the following: Blonde d'Aquitaine, Charolais, Chianina, Gelbvieh, Limousin, Maine Anjou, Normande, Piedmontese, Pinzgauer, Romagnola, Saler, Simmental, and Tarentaise (Thomas, 2009). In the United States, the most common of these breeds are Charolais, Limousin, and Simmental. These breeds have been fully integrated into U.S beef production, especially the commercial segment of production. Noted generally for their large frames, lean meat, and saleable product yield, the continental European breeds are utilized significantly in crossbreeding systems for beef production. Charolais, Limousin, and Simmental have all made a huge impact on the beef industry, and have made significant strides in quality since their arrival, much later than the British breeds of cattle (Angus, Hereford and Shorthorn). Since these breeds are somewhat newer in comparison to others, they still have untapped potential, especially in crossbreeding systems. Multiple studies show that the use of a European x British breed cross will result in a superior offspring due to the phenomenon of hybrid vigor, especially in terminal crossbreeding systems with the sole purpose of meat/pound production. As for the three most common European breeds, Charolais, Limousin, and Simmental have all influenced the breeding industry significantly. Composite breeds between European breeds and British breeds exist because of hybrid vigor (offspring will out produce its two [full-blood] parents) (Thomas, 2009). This in turn means that using only one breed in a commercial production setting is wasted

potential and nonsensical. However, if an individual wants to sell seedstock/full blood animals, he or she would be required to only raise that one breed. When two different breeds are crossbred there is greater response to heterosis (i.e. Angus x Simmental), than if two parents of the same breed were mated.

The European breeds are naturally a very hardy breed group due to their time being developed in their original lands (Taylor, 1984). The European breeds faced extreme temperatures and climates centuries ago and were able to sustain and thrive in the mountainous regions of France, Italy, and Germany. That same hardiness characteristic has been passed to the existing cattle today, and it stands as one of their greatest qualities among many. In today's market, Charolais and Simmental are often crossed with Hereford and Angus, and Limousin are crossed with Angus almost exclusively, creating the LimFlex composite breed. Today, many composite breeds exist through the crossbreeding of different breed groups. Like LimFlex, SimAngus is a composite breed created by crossing Simmental and Angus. SimAngus is its own breed but falls under the American Simmental Association and their breed Expected Progeny Difference (EPD [see *glossary*]) guidelines. Typically and historically, producers will experience higher birth weights (bw) with the European breeds that translate directly to higher weaning weights (ww) and final weights (Greiner, 2009). In *Table 1, Sire Breed Group Averages for Birth, Weaning and Feedlot Performance Traits*, researchers measured the differences in birthweights, weaning weights, average daily gain (ADG), and final weights of Angus-Hereford cross calves compared to Charolais, Limousin, and Simmental calves. Through

the study, researchers determined that the Angus x Hereford cross calves were out produced by the European calves in all categories. In this study, the European breeds were born heavier, weaned heavier, and had a higher daily gain (ADG) than the British cross calves. Even considering hybrid vigor between the Angus x Hereford cross calves, they were still significantly lighter than the European calves at weaning and final weight. The average difference in final weight between the European group and the British group was 81 pounds in this particular study. As stated earlier in the paper, F1 (see *glossary*) Angus x Hereford crosses, bred to a terminal European sire would produce the most desirable commercial market animal (Wheeler, 1996). A desirable market animal is defined by the Beef2Live website as: 1,220 pound live-weight, 62% dressing percentage, and choice quality grade, and on *Picture 2* (Boggs, 1993).

The commercial beef industry is based on pounds. The market price for feeder cattle as of March 18, 2018, is 139.98 per hundred-weight, almost \$1.40 per pound. Since the beef industry is based on pounds, it only makes sense to maximize hybrid vigor in using crossbreeding systems between different breeds to add more pounds. The European breeds were originally brought to the U.S. to add frame, growth and size to the much smaller framed British breed cattle. Table 2, *Dressing, fat, bone/other, and muscle percentage comparisons between Angus and Charolais, Limousin, and Simmental* showed the European breeds possessing more muscle, less fat and higher dressing percentages than Angus. The data shows that the European breeds are well suited for the commercial

beef industry and its producers because of their efficiency turning pounds into retail product.

The European breeds have historically been a means to increased quality and profitability and should be continually implemented in today's market as well. Throughout the European breeds' history in the U.S., they have been critical to the success of the beef industry in the U.S. and have positively influenced the growth and the overall state of the beef industry because of their added frame and yield. Table 3, *Breed type differences for measures of size and growth*, and Table 4, *Crossbreed differences for measures of size and growth and carcass traits*, showed researchers data regarding the relationship of European breeds and crossbreeds birthweight and weaning weights compared to Angus and angus cross birth and wean weights. Tables 3 and 4 show the possible benefits of implementing hybrid vigor through crossbreeding systems. In Table 3, the Charolais x Angus calves outgained the pure Angus calves by nearly one hundred pounds, but the birth weight was twenty-five pounds more. Additionally, when observing carcass quality data on Table 4, Angus cross calves earned a 10.6 quality grade, while the next best was Simmental crosses at 9.6. It is well documented that Angus cattle tend to have higher quality grades, but European breeds yield significantly more meat, possess leaner carcasses, and significantly higher dressing percentages (Long, 1980). Perhaps crossing the two groups would enable more quantity and quality simultaneously.

Chapter 3: Charolais Overview

Charolais is one of the oldest breeds of French cattle, documented as early as 878 A.D (AICA, 2017). They are naturally horned, but through breeding up and genetic selection, they have become mostly polled (no horns). Charolais are stout, sound, structured white cattle known for their size, cutability and red meat yield. Mature bulls weigh around 2100 pounds and females 1400 pounds (AICA, 2017). *Picture 3, Charolais bull*, shows a current Charolais sire as an example of the breed. The bull in the picture is near-perfect phenotypically with strong pasterns, deep ribs, and a thick, strong, level topline. He displays not only what is desired in Charolais, but all cattle.

Soon after World War 1, a Mexican-French industrialist named Jean Pugibet brought some of the white cattle to his ranch in Mexico (AICA, 2017). He had seen the Charolais during the War and was impressed by their appearance and productivity. It was not until 1934 that the Charolais breed came to the United States from Mexico. From that beginning, the breed grew rapidly and have sustained that same growth. Wherever they were shown, the big white cattle commanded attention. Livestock producers across the country were searching for animals who would improve their profits, so naturally, cattlemen admired the Charolais for their muscling, structure and size. Farmers and ranchers were also very impressed with the calves they produced. An ever-expanding demand for purebred Charolais seedstock kept an active market for both bulls and females and have continued today.

Charolais add more pounds while possessing a light-colored hide, keeping them cool and active in warmer climates therefore making them a great choice for commercial cattlemen. Charolais are naturally hardy due to their origins in the French mountains where they adapted to the harshness of the climate (AICA, 2017). They are efficient grazers, often out in the hot sun eating while some of the darker colored animals stay in the shade to deter heat stress. “More pounds, more profit” is the motto of the American International Charolais Association. “Charolais’ greatest strength is red meat yield and cutability” (AICA, 2017). “The ability that the breed has to produce calves that grow well and have a high propensity for muscling, produces meat that we can utilize,” according to Dr. Gretchen Mafi, professor of meat science and Boulware Endowed Chair of Animal Science for Oklahoma State University. “One advantage Charolais has over other breeds is that farmers can continue to select for improved quality while taking advantage of increased muscle and yield, which are very valuable to our industry,” she continued. (AICA, 2017).

Today, Charolais cattle are a favorite among American cattlemen and the beef industry. Charolais can survive and thrive in any part of the world, due to their hardiness and adaptability (AICA, 2017). A black hided Charolais calf (Charolais x Angus) is one of the most favorable market calves that a farmer can produce. This is because Angus possesses great marbling, and black hide, while the Charolais is responsible for the white coat, added weight and saleable product (AICA, 2017). With Charolais, farmers never have to worry about climate conditions, and can count on larger, heavier calves who will increase profits.

Chapter 4: Limousin Overview

The history of Limousin cattle is rumored to be as old as the European continent itself. Cattle drawings found in caves were estimated to be around 20,000 years old in Montignac, France (OSU, 1997). These cattle drawings have a strikingly familiar resemblance to today's existing Limousin breed. The Limousin originated in the regions of Marche and Limousin, located in south central France (OSU, 1997). Because of the harsh climate and poor soil quality, growing field crops was very difficult; therefore, an emphasis was placed on animal agriculture. Throughout their history, Limousin cattle became a breed of unusual sturdiness, health and adaptability. This lack of natural resources in their homeland also enabled the region's isolated farmers to develop the breed with little outside genetic interference (OSU, 1997). Limousin were well known for their beef qualities and their meat early in their history and have continued to steadily improve. They were referred to as the "butcher's animal" in France, mainly due to their high red meat yield and size, like many other European breeds (OSU, 1997).

The large framed and heavily muscled breed is originally golden-red, with a lighter color under the stomach, inside the thighs and around the eyes and muzzle. Refer to *Picture 4, Limousin Bull*, for a visual of the physically imposing Limousin. Seen in the picture, Limousin are heavily muscled, with large rumps and long bodies. More recently, like many other breeds, Limousin has had to adapt to the market preference of black colored hide. Limousin with black genetics can vary in color from light brown progressing through different ages to

a deep black at a fully mature age. Mature bulls weigh around 2000 pounds, while mature Limousin females average 1,300 pounds (OSU, 1997).

Limousin are known for their muscularity, feed efficiency and carcass quality. In history, they were often called the carcass breed as their carcasses have excellent conformation making them well suited to the market that demands a high-quality lean beef product. Limousin guarantee first-rate productivity at a low cost. Bulls are extremely fertile, and their good conformation and lighter frame ensures ease of calving (OSU, 1997). Females demonstrate high fertility, a good milking ability, high conception rates and ease of calving.

As the Limousin breed developed in France, cattlemen in North America were looking to Europe to improve their native beef cattle here in the United States. With the importation and growth of many breeds, cattlemen were open to new additions to their herds. The first Limousin imported to Canada was “Prince Pompadour.” (OSU, 1997). After his arrival, Prince Pompadour was brought to the United States to be part of Limousin exhibitions at various cattle shows and did much to draw attention to the breed. After the importation of Prince Pompadour to Canada, a group of five Limousin bulls followed in 1969 (OSU, 1997).

The first Limousin bulls were not imported permanently into the United States until the fall of 1971. The first Limousin imported into the U.S., Kansas Colonel, was born and raised in Canada. Bob Haag of Topeka, Kansas, imported him for a group of Kansas Limousin breeders. As these cattle were arriving in North America, cattlemen interested in the breed realized the need for an

organization to promote and develop the breed in the United States and Canada.

In the spring of 1968 at the Albany Hotel in Denver, fifteen cattlemen formed the North American Limousin Foundation (NALF) (NALF, 2017).

Chapter 5: Simmental Overview

“The American Simmental is genetically engineered toward efficient, economical production of tender, lean, palatable beef -- the product in demand by consumers today,” says the American Simmental Association (ASA, 2017). The Simmental breed is among the oldest and most widely distributed of all breeds of cattle in the world (ASA, 2017). There is evidence of large, productive red and white cattle being found in property records of Western Switzerland, where the breed was originated. *Picture 5, Simmental Bull*, shows a large red and white Simmental bull. Like Limousin, the Simmental breed has had to adapt to the favored black hide genetics due to the rapid growth, popularity and influence of the Angus breed. See *Picture 6, Angus Bull*, to compare the rest of the European breeds to the Angus bull.

The original red and white Simmental were highly sought because of their rapid growth development, outstanding production of dairy products, and their use as draft animals (ASA, 2017). Simmental are known for their gentle disposition, impressive stature and their excellent dairy qualities that have seeped into their more recent role as a beef breed. As other more prominent dairy breeds like Friesian Holstein and Jersey cattle became more popular for large scale dairy production, Simmental became a beef breed.

The Simmental breed was officially brought to the U.S. in the late 1960's and the American Simmental Association was formed in October of 1968 (ASA, 2017). Simmental spread to Britain, Ireland and Norway in 1970 and to Sweden and other Northern European countries shortly thereafter (ASA, 2017).

Simmental are second in total number of cattle in the world, second only to Brahman which are worshipped in some cultures/religions (ASA, 2017).

European countries have specialized in the development of strains and traits of the Simmental. A great deal of pride is associated with the product that has been developed by each country, and, in some cases, by specific herd books within countries (ASA, 2017). Only in America has there been an opportunity for an expansive breed blending effect to take place. The results have been greater performance and productivity because only the best cattle coming from the various countries are utilized in the composition of the American Simmental. The resulting product can express the superior traits from all European strains, providing for even greater flexibility and opportunities for innovation.

The ASA was the first breed association to publish a sire summary; many breed associations followed. The American Simmental meets today's demand for a beef animal that can thrive under a variety of conditions (ASA, 2017).

Simmental have bred-in ability to adapt to hot and cold temperatures, to dry or humid climates, to range conditions or confinement-rearing making them an attractive commercial animal. Cattlemen may use Simmental to increase weaning weight, milking ability, and docility (ASA, 2017). Milking ability traces back to their roots as a dairy animal. Simmentals ability to milk well has proven to be a great maternal trait but also has proven profitable in their role as a commercial beef animal. The more nutrition and milk a calf receives from the dam, the less feed the farmer needs to supplement to get the calf ready to market (ASA, 2017).

Simmental have long been a relevant breed in America, and they continue to grow in popularity. ASA has set high standards for Simmental and innovated in many areas including carcass quality, beginning cow recognition programs, and composite breed creation. ASA created Simbrah, a Simmental x Brahman composite breed that is insect resistant and heat tolerant (ASA, 2017). Additionally, the association has developed the previously mentioned SimAngus composite breed to get in on the excitement that is, Angus. No other breed association has been as active in innovation and research in the last 5 years as (ASA, 2017). The Simmental should continue to grow in popularity and contribute greatly to the commercial beef industry due to their many great qualities.

Chapter 6: State of the Beef Industry in the U.S

Constant herd expansion and the steady increase in supply has resulted in the state of the industry being in a place of growth and optimism as of 2017 (BeefUSA, 2017). The steady growth of the industry indicates a few things, the first of which being that more beef is being consumed not only domestically, but worldwide. Therefore, our exportation of beef is set to reach new highs in the coming years. China, for the first time in 14 years, has opened beef importation from the U.S; with over 1.3 billion people, this was a huge positive move for U.S beef farmers as well as the whole U.S economy (BeefUSA, 2017). The beef industry is estimated to be worth over 68 billion dollars in 2018 (BeefUSA, 2017). With China having more than four times the U.S population, demand is set to take off in the coming years. As a result, with such high demand, and perhaps a lower supply due to the volume of demand, the price of beef could skyrocket. Currently, the U.S imports about 2.3 billion pounds of beef per year from New Zealand, Canada, and Australia, all of which is mainly lean grinding meat for fast food hamburgers (BeefCheckoff, 2017). Similarly, the U.S. imports the same amount that it exports, at 2.3 billion pounds, which makes the U.S. the largest importer of beef in world. The main difference in the import and export of U.S. beef trade is that the U.S. typically imported lower grade beef for fast food, but exports primal cuts (BeefCheckoff, 2017). Japan has been the main U.S beef importer in the world at 258,653 metric tons (BeefCheckoff, 2017). Refer to *Figure 4* for more beef industry statistics and metrics, which include U.S. individual state data, demographic data, and production numbers.

The Fresh Meat Market Basket Analysis states that grocery carts that contain beef produce 44% more sales than carts that contain chicken because beef typically costs more. However, when beef is in the shopping cart, one can expect that the customer will buy marinades, seasonings, mushrooms, other produce, and seafood. In economic terms, beef fluctuates from a normal good to a luxury good, depending on the state of a country's economic environment at any given time; this makes beef production, consumption, and forecasting very difficult (BeefUSA, 2017). When the economy does well, people tend to buy more beef because they can afford it; accordingly, when the economy is down, there will usually be a noticeable dip in beef consumption (NBQA, 2011).

Chapter 7: Improving Upon Quality

The Tennessee Beef Alliance (TBA [see *glossary*]) exists to do much of what this project is about, which is to improve quality and consistency of beef production while producing higher profits for the farmers. TBA is a group of cattle producers who all use standardized methods of production (feeding, vaccinations, and weaning) resulting in a consistent product at market, which proves to bring higher premium than typical market animals. For instance, if the current market price for feeder cattle is \$1.40 per pound in an area, one may expect a TBA calf to bring 5-10 cents more per pound than a standard market calf. Cattle buyers are willing to pay premium price for preconditioned calves because it reduces risk/chance of those cattle dying or having diseases and it promotes uniformity. TBA functions under the guidance of Tennessee Livestock Producers (TLP [see *glossary*]).

The primary reason marketing groups like TBA exist is because 91% of beef producing operations in the U.S are family-owned or individually-operated (BeefUSA, 2017). This means, unlike the dairy industry where the industry is dominated by large farms or companies, the beef industry relies on small producers for most of its supply, shown in *Figure 3*. When there are so many different producers, that puts many variables into play. Quality and consistency can tend to vary due to variance in environment, genetics, and phenotype. Groups like TBA are trying to push the concept of grouping smaller herds to make large truckloads of standardized cattle who have all been raised under the same requirements and guidelines. This is just one of many ways that the

consistency and quality of beef can be vastly improved, while increasing farmer's and ranchers' profits. Marketing alliances such as TBA have put in place production requirements to ensure that their beef supply is a sound, quality product. Unlike the standard sale barn, TBA can ensure and verify that their cattle have undergone protocol to guarantee a certain level of consistency (McKay, 2018). Perhaps there should be a stronger presence of marketing alliances and standardized production requirements in the beef industry. The production requirements and standards of the Tennessee Beef Alliance can be seen in a document shown in *Picture 1*.

As our society becomes more health conscious, it may be to the industry's advantage to use the leaner European breeds more often. In a study observing the carcass traits of various breeds under the same constant variables, it was determined by researchers that the production of a cross between Hereford and Angus, bred to a Piedmontese (a rare European breed noted for their lean and tender carcass) produced the most tender and most lean cut of beef in this particular study (Wheeler, 1996). The national beef tenderness study states that consumers agree that they would pay more money to ensure that they are receiving a tender product (National Beef Tenderness Survey, 2016). This should be great news to producers, and they should be looking to improve tenderness in their products, as it has constantly been proven to be one of the biggest economic influencers in beef consumption. Refer to *Figure 2, Importance of Tenderness* for more information regarding the relevance of tenderness in the beef industry.

One may compare the chicken industry to the beef industry, which for the most part is a vertically integrated industry; large corporations such as Tyson Foods and Perdue Farms serve as a good example in this scenario. Whereas beef is being sourced from many different producers, under many different circumstances, the whole U.S chicken supply is coming from a handful of companies, (not farmer/producers) who own their own feed mills, properties, and staff their own nutritionists. The poultry production companies source their chicken from two main poultry genetics companies, Aviagen and Cobb-Vantress. The comparison between beef and poultry shows that the poultry industry does not struggle with consistency issues as much as the beef industry, because everything the industry does is standard across the board. While there are so many beef producers doing so many different practices, there will almost always be a chance of inconsistency in quality, and the production of the meat. Beef can be compared to chicken, but only so much. Some people like the idea of sourcing their beef from their local farmers, rather than buying it from large retailers, who have quality standards. Some consumers value having the local option available, which is great for farmers because when they sell direct market, they can greatly improve their profits. However, there is much more chance of food safety concerns, quality issues, and inconsistency when you purchase your beef from an individual, rather than a retailer. Regardless, there is much to consider moving forward in the beef industry given that the dairy and poultry industries are mostly corporate dominated industries, and beef is raised by 727,906 different farmers, quite the opposite.

The National Beef Quality Audit (NBQA) of 2011 states that carcass inconsistency is one of the most difficult barriers to overcome in the industry. 2011 NBQA data shows that 16% of the U.S beef production was considered inferior. USDA Yield grades (see *glossary*) 1 and 2 are the most desirable grades, with 3 being average, 4 poor, and 5 least desirable. Table 5, *Angus, Charolais, Limousin, and Simmental compared at same intramuscular fat content* shows researchers data proving the European breeds excel in areas that would help increase the overall satisfaction of consumers. The measures include flavor, juiciness, and preference, all of which, European breeds outperformed Angus, but not tenderness (judged by a sensory panel). Table 6, *USDA Quality Grade and Yield Grade (USDA Quality Grade %)*, researchers data shows much of U.S. beef production being yield grade 2, which is sufficient, but the combined totals of select and utility beef made up **38%** of U.S. beef production. The researcher's data proves that there is still much more to be done regarding the consistency of quality beef production in the U.S. The continental European breeds may be able to bring balance to the industry if strategically incorporated at a higher rate on the farm.

Chapter 8: Carcass Quality Data

There is will always be a need for consistency in food supply, otherwise the industry can become untrustworthy, causing farmers to lose profits and consumers to lose satisfaction. When consumers purchase steak, they expect a consistently tender product according the State of the Beef Industry report of 2017. Seventy-eight percent of consumers report that they were satisfied with the quality of the beef that they purchased in 2017. One may say that seventy-eight percent is high, but there still is, and will always be a need for constant improvement as variables are always fluctuating, such as market and weather conditions. If that 78% was a test grade, it would be an average score, at best. Balancing quantity and quality will always be a relevant issue in beef production and will always need to be improved upon. If production were to be solely Angus driven, the beef supply would be smaller in size, highly marbled, but sometimes be excessively fat. If production were to be solely European breed driven, one would see that the beef supply would be larger, slightly less marbled, but also very lean, which may not be a terrible consideration due to the health consciousness push in the U.S. currently. Refer to Table 7, *Marbling scores, retail product, and cutability comparisons (Longissimus)*, and Table 8, *Sire breed group averages for carcass traits* for further insight to the comparisons of the carcass qualities of the selected breeds. In the study, the data shows a mean difference of 80 in the marbling scores between European breeds and Angus; the Angus scored 564, whereas the European average was only 484 (scale 400-600). Angus is superior in marbling, but also note the other categories in the

tables such as retail product and cutability. In retail product (amount of saleable product), the European breeds outperformed the British breed by an average of 24 pounds per animal, which is quite the difference. In economic terms, this is a significant advantage for the European breeds because as mentioned earlier, beef is sold on a per-pound basis. Lastly, the cutability of the of the European breeds in this study was 51.4%, and the Angus was 49.6%. This means that the European breeds have more lean meat, more specifically 51% of its carcasses cut out lean meat, whereas Angus carcasses cut out 49%.

Conclusions

This project highlighted the uses and impact that three continental European breeds have on U.S. beef from a production and consumption standpoint. The data by researchers spanning roughly 30 years shows how great the European breeds are in certain areas, but also how well Angus performs in areas like marbling and quality score. The European breeds perform well in the areas of retail product, weaning weight, cutability, and leanness. While both British breeds and European breeds have great qualities, it is best not to pick one or the other in a commercial production setting. Instead, it is better to incorporate both groups to maximize hybrid vigor, therefore increasing poundage, and to balance carcass quality as well. Lastly, the standardization of management practices would greatly increase quality of beef supply in the U.S. All of this with the goal “...[t]o produce beef that results in maximum *palatability* for consumers, but doing so, at the *lowest cost* for farmers, resulting in higher *profits*” (Morgan et al., 1990).

Further Research Possibilities:

If this project were to continue, there could be many additions or even subtractions depending on where the author would want it to go, as it is a broad topic. More specifically, chapters could cover: 1) feed conversion efficiency differences among breeds, 2) sensory evaluations, 3) cost to gain ratio differences among breeds, and 4) expand breed list to Gelbvieh and Salers breeds. These would all be great topics to cover if this project were to continue. Additionally, obtaining access to a Warner-Bratzler Shear Force test (WBSF [see *glossary*]) would prove useful in this project in determining tenderness values of selected breeds' cuts of beef. WBSF is a device with a blade that measures the force required to cut through meat. WBSF would get a more accurate tenderness measure on a cut of beef. Economically, much could be done by researching the cost of raising European and British breeds the most efficient ways possible. Factors such as hardiness, average daily gain, disease susceptibility, and nutrition requirements are all relevant to farmers' profit margins. Lastly, this project could expand to studying individual cuts of beef from these breeds in order to weed out irrelevant data pertaining to unpopular cuts. Ribeye, New York Strip, Filet Mignon, and Sirloin could all be measured from these different breeds, and even some cross breeds to see the possible quality differences between them.

References:

- Albertí, P., B. Panea, C. Sañudo, J. Olleta, G. Ripoll, P. Ertbjerg, M. Christensen, S. Gigli, S. Failla, S. Concetti, J. Hocquette, R. Jailler, S. Rudel, G. Renand, G. Nute, R. Richardson, and J. Williams. 2008. Live weight, body size and carcass characteristics of young bulls of fifteen European breeds. *Livestock Science* 114:19–30
- BEA. 2017. Gross-domestic-product-(GDP)-by-industry. https://www.bea.gov/industry/gdpbyind_data.htm
- BeefCheckoff. 2017. A guide for professionals. Beef Retail. Available from: <http://beefretail.org/CMDocs/BeefRetail2/FinalBeefCheckoffCourses/Beef%20U%20Industry%20History%20Final.pdf>
- Boggs, D. Characteristics of an ideal market steer.1993. Beef2Live. Available from: <https://beef2live.com/main.aspx>
- Breeds of Livestock, Limousin Cattle (OSU). 1997. *Animal Science*. Available from: <http://www.ansi.okstate.edu/breeds/cattle/limousin/>
- BQA. 2017. What is "quality" beef? Beef Quality Assurance. Available from: <http://www.bqa.org/about/what-is-quality-beef>
- Chambaz, A., M. Scheeder, M. Kreuzer, and P.-A. Dufey. 2003. Meat quality of Angus, Simmental, Charolais and Limousin steers compared at the same intramuscular fat content. *Meat Science* 63:491–500.
- Cook, R. 2017. World beef exports: ranking of countries. <http://beef2live.com/story-world-beef-exports-ranking-countries-0-106903>
- Crouse, J.D., Cundiff, L.V., Koch, R.M., Koochmaraie, & Seideman, S.C. 1989. Comparisons of bos indicus and bos taurus inheritance for carcass beef characteristics and meat palatability. *Journal of Animal Science*. 67:2661-2668. doi:10.2527/jas1989.67102661x

Ensminger, M. E. 1987. Beef cattle science (6th ed.). Danville, IL: Interstate Printers & Publishers, Inc.

Greiner, S. P. 2009. Beef Cattle Breeds and Biological Types. Virginia Cooperative Extension. Available from:
http://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/400/400-803/400-803_pdf.pdf

History. 2017. American International Charolais Association (AICA). Available from: <http://charolaisusa.com/members/history.html>

History of the Simmental Breed (ASA) . 2017. Simmental. Available from:
<http://simmental.org/site/index.php>

Limousin Today – Profit Tomorrow. 2017. North American Limousin Foundation. Available from: <http://nalf.org/>

Long, C. R. 1980. Crossbreeding for Beef Production: Experimental Results. Journal of Animal Science 51

Marshall, D. M. 1994. Breed differences and genetic parameters for body composition traits in beef cattle. Journal of Animal Science. 72:2745-2755. doi:10.2527/1994.72102745x

Morgan, J. B., J. W. Savell, D. S. Hale, R. K. Miller, D. B. Griffin, H. R. Cross, and S. D. Shackelford. 1991. National beef tenderness survey. Journal of Animal Science 69:3274–3287.

NBQA. 2011. Pillars of beef chain success: moving the industry forward. National Beef Quality Audit.

Our Story. 2018. Certified Angus Beef. Available from:
<https://www.certifiedangusbeef.com/brand/heritage.php>

Simmental. 2017. American Simmental Association. Available from:
<https://simmental.org/site/index.php/simmental>

State of the Beef Industry. 2017. <https://www.beefboard.org/>.

Continental European Beef Breeds: Their Use and Impact on the United States Beef Industry

Taylor, R. E. 1984. Beef production and the beef industry: A beef producer's perspective. Minneapolis, MN: Burgess Publishing Company

The Charolais Heritage....a Brief History. 2017. American International Charolais Association. Available from: <http://charolaisusa.com/index.html>

Thomas, H. S. 2009. Storey's guide to raising beef cattle. Storey, Pownal, VT.

Wheeler, T. L. 1996. Characterization of Biological Types of Cattle (Cycle IV) Carcass Traits and Longissimus Palatability. Journal of Animal Science.

Young, J., and J. McKay. 2018. Tennessee Beef Alliance Interview

Tables:

Table 1: *Sire Breed Group Averages for Birth, Weaning and Feedlot Performance Traits*

Breed(s)	Birth Wt. (lbs.)	200 Day Wean Wt.	ADG (lbs.)	Final Wt. (lbs.)
Hereford-Angus	75.2	432	2.51	1068
Charolais	86.5	480	2.89	1219
Limousin	80.6	443	2.49	1080
Simmental	84.9	458	2.73	1148

Source: Greiner, 2009

***ADG (Average Daily Gain)**

Table 2: *Dressing, fat, bone/other, and muscle percentage comparisons between Angus and Charolais, Limousin, and Simmental*

Breed(s)	Carcass weight (lb.)	Dressing %	Fat %	Bone and other %	Muscle %
Angus	740	56.2	21.7	16.9	61.4
Charolais	852.3	61	15.4	16.9	67.7
Limousin	793.6	63.7	13.2	15	71.9
Simmental	759.3	55.5	11.7	20.5	67.8

Source:

(Alberti et al., 2008)

Table 3: *Breed and crossbreed type differences for measures of size and growth*

Breed	Birth Weight (lbs.)	Weaning Weight (lbs.)
Angus	65.1	412
Charolais	87.6	539
Charolais x Hereford	80.75	548
Charolais x Angus	86	509

Source: (Long, 1980)

Table 4: *Crossbreed differences for measures of size and growth and carcass traits*

Breed	Birth Weight (lbs.)	Weaning Weight (lbs.)	Quality Grade	Dressing Percentage	Cutability Percentage
Angus cross	78	402	10.6	60.4	54.5
Charolais cross	85.1	434	8.9	63.6	71.2
Limousin cross	80.1	434	8.9	64.3	71.7
Simmental cross	83.7	450	9.6	62.8	70.2

Source: (Long, 1980)

Quality Grade: 9= select 10= low choice 11= high choice

Table 5: *Angus, Charolais, Limousin, and Simmental compared at same intramuscular fat content*

Breed	*Tenderness	*Flavor	*Juiciness	*Preference
Angus	4.8	4.45	3.62	4.61
Charolais	4.59	4.35	4.55	4.84
Limousin	4.77	4.43	4.68	4.95
Simmental	3.98	4.11	3.85	4.36

Source: (Chambaz et al., 2009)

**Sensory attributes were scored using the following scales for tenderness, flavor intensity, juiciness and preference: 1= very tough, slight, dry and much disliked; 8= very tender, strong, juicy and much liked.*

Table 6: *USDA Quality Grade and Yield Grade (USDA Quality Grade %)*

USDA Yield Grade	Prime	Choice	Select	Utility	Total
1	0	3.6	7.3	1.4	11.51%
2	0.4	22.8	15.3	2.4	37.11%
3	1.8	25.9	8	1.5	34.78%
4	0.5	6.3	1.4	0.4	10.90%
5	0.1	1.3	0.1	0.1	5.71%

Source: NBQA, 2011

Table 7: *Marbling scores, retail product, and cutability comparisons (Longissimus)*

Breed(s)	Marbling Score	Retail Product (lbs.)	Cutability
Angus	564	177	49.6%
Limousin	477	197	51.8%
Charolais	471	205	51.1%
Simmental	506	202	51.4%

Source: Marshall, 2014
**Marbling score: 400=select; 500=choice*

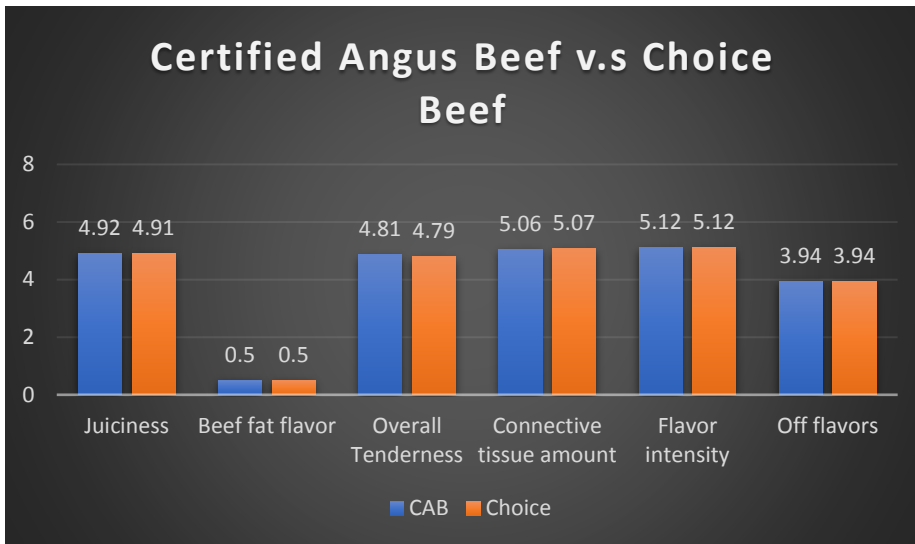
Table 8: *Sire Breed Group Averages for Carcass Traits*

Breed(s)	Carcass Weight	Retail Product Yield (%)	*Marbling Score	USDA Choice (%)
Hereford-Angus	654	67.1	551	70.7
Charolais	747	70.2	523	59
Limousin	667	71.5	477	43.8
Simmental	695	70.1	510	63.4

Source: Greiner, 2009
***Marbling score: 400=select; 500=choice**

Figures:

Figure 1: *Certified Angus Beef Compared to Choice Beef*



(Source: NBQA, 2011)

Figure 2: *Importance of Tenderness*



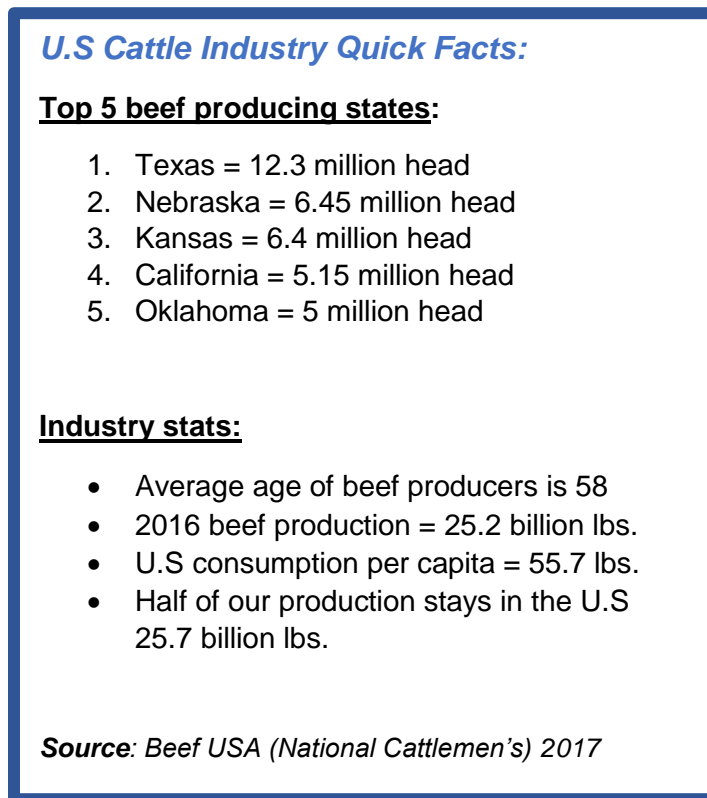
Source: (2015/2016 National Beef Tenderness Survey, 2016)

Figure 3: *Herd Sizes in The U.S.*




Source: (BeefUSA, 2017)

Figure 4: U.S. Cattle Industry Quick Facts




Pictures:

Picture 1: *Tennessee Beef Alliance Health Protocol*





2018 Tennessee Beef Alliance Health Protocol



Select one Brand, one Box, & an Approved De-wormer for a complete protocol

All HEIFERS are REQUIRED to have a shot of Lutalyse or Synchsure on second working!
(Consult your Veterinarian for this product)

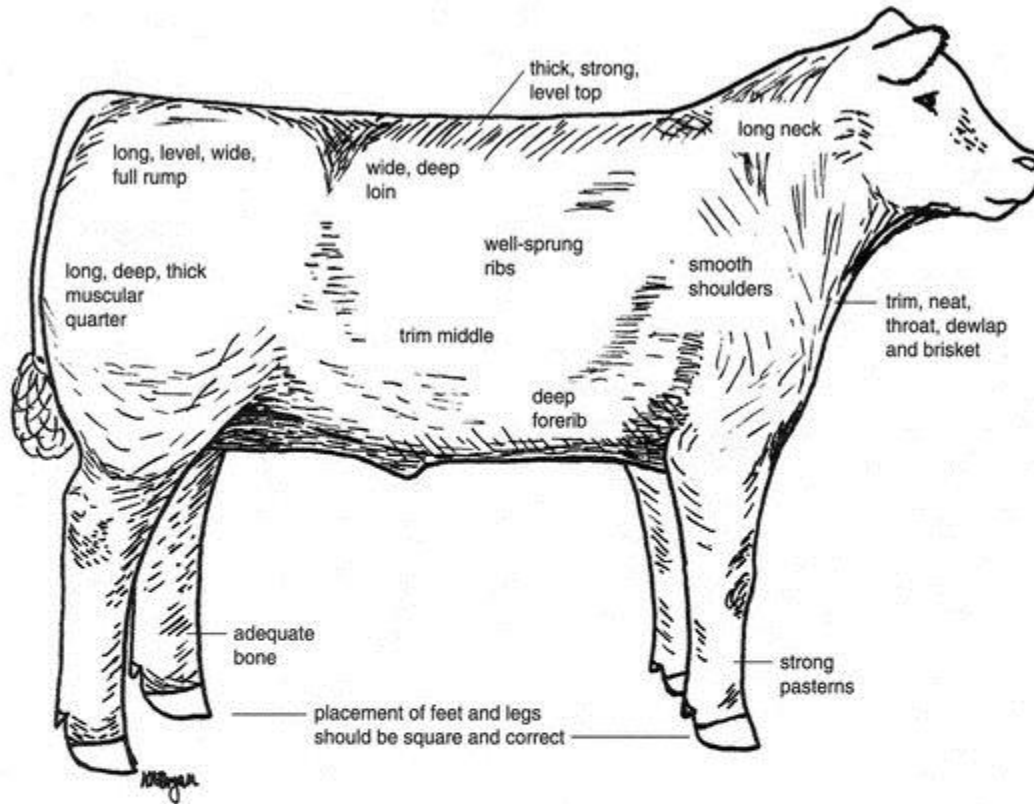
<div style="text-align: center; margin-bottom: 10px;">  </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Pre-Weaning:</p> <p>1st Working (2 weeks prior to weaning)</p> <ul style="list-style-type: none"> • TRIANGLE 5 • Presponse HM • Bar-Vac 7/Somnus <p><i>*Use Approved De-wormer*</i></p> <p>2nd Working (14-28 days later) (Following Weaning)</p> <ul style="list-style-type: none"> • EXPRESS 5 or Pyramid 5 • Bar-Vac 7/Somnus </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Post or at Weaning:</p> <p>1st Working</p> <ul style="list-style-type: none"> • EXPRESS 5 HS • Presponse HM <p><i>*Use Approved De-wormer*</i></p> <p>2nd Working (14-28 days later)</p> <ul style="list-style-type: none"> • Express 5 HS • Alpha-7 or Alpha-7/MB-1 </div> <div style="border: 1px solid black; padding: 5px;"> <p>Post or at Weaning:</p> <p>1st Working</p> <ul style="list-style-type: none"> • Pyramid 5 + Presponse SQ (Combo) • Bar-Vac 7/Somnus <p><i>*Use Approved De-wormer*</i></p> <p>2nd Working (14-28 days later)</p> <ul style="list-style-type: none"> • Pyramid 5 • Bar-Vac 7/Somnus </div>	<div style="text-align: center; margin-bottom: 10px;">  </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Pre-Weaning:</p> <p>1st Working (2 weeks prior to weaning)</p> <ul style="list-style-type: none"> • Cattlemaster GOLD FP 5 • Ultrabac 7 Somubac <p><i>*Use Approved De-wormer*</i></p> <p>2nd Working (14-28 days later) (Following Weaning)</p> <ul style="list-style-type: none"> • Bovi-Shield GOLD ONE SHOT (Combo) • Ultrabac 7 Somubac </div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> <p>Post or at Weaning:</p> <p>1st Working</p> <ul style="list-style-type: none"> • Bovi-Shield GOLD ONE SHOT (combo) • Ultrabac 7 Somubac <p><i>*Use Approved De-wormer*</i></p> <p>2nd Working (14-28 days later)</p> <ul style="list-style-type: none"> • Bovi-Shield GOLD 5 • Ultrabac 7 Somubac </div> <div style="border: 1px solid black; padding: 5px;"> <p>Post or at Weaning:</p> <p>1st Working:</p> <ul style="list-style-type: none"> • Inforce 3 • One Shot BVD • Ultrabac 7 Somubac <p><i>*Use Approved De-wormer*</i></p> <p>2nd Working (14-28 days later)</p> <ul style="list-style-type: none"> • Bovi-Shield GOLD 5 • Ultrabac 7 Somubac </div>
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Approved De-wormers Dectomax Injectable or Pour-on, Eprinex/Ivomec Inj. or Pour On/LongRange

Credits: Tennessee Livestock Producers (TLP)

http://www.tennesseelivestockproducers.com/pdf/2018_alliance_health_protocol.pdf

Picture 2: *A desirable market animal visual*



	NORMAL RANGE	AVERAGE	IDEAL
Live weight (lb.)	900 - 1,400	1,150.0	1,220.0
Dressing percentage	55 - 67	62.0	62.0
Fat thickness (in.)	.15 - 1.0	.50	.30
Ribeye area (sq. in.)	8 - 16	11.5	13.3
KPH fat percentage	1 - 6	3.5	2.0
Quality grade	Low Select - Avg. Prime	Low Choice	Avg. Choice

Adapted from *Live Animal Carcass Evaluation and Selection Manual*, 4th edition, 1993, Donald L. Boggs and Robert A. Merkel.

Source: (Boggs, 1993)

Picture 3: *Charolais Bull*



Credits: Select Sires

Picture 4: *Limousin Bull*



Credits: Select Sires

Picture 5: *Simmental Bull*



Credits: Select Sires

Picture 6: *Angus Bull*



Credits: Select Sires

Terms:

Beef Quality Assurance: (BQA) is a nationally recognized, state implemented program that provides information to U.S. beef producers and beef consumers of how efficient production can be paired with accepted science in order to raise cattle under optimum management and environmental conditions. BQA guidelines are designed to make certain all beef consumers are satisfied and can trust the beef industry (NBQA, 2011).

Carcass yield: The carcass weight as a percentage of the animals' weight on foot.

Certified Angus Beef: (CAB) a self-proclaimed quality and marketing label, recognizing exceptional Angus beef that is tasty, tender and juicy.

Crossbreeding: The mating of animals of different breeds

European Breeds: *(Thomas, 2009)*

- Blonde d'Aquitaine: originated from southwest France; large, white/tan coloring; noted for fast growth, carcass quality, and calving ease.
- Charolais: Large white cattle; originated from central France, and originally used for draft animals, and eventually beef. Became prominent in U.S. beef herds in the 1950's.

- Chianina: Italian; white; largest breed of cattle in the world; may reach 6ft. tall at the shoulders and weigh 4000 lbs.; introduced in the U.S in the 1970's.
- Gelbvieh: black, golden or red; fast growing; strong maternal traits; originated in Austria/west Germany, and like many other breeds were used for meat, milk, and draft.
- Limousin: black, dark red; well-muscled, and very lean; first imported to the U.S in 1969 from western France.
- Maine Anjou: red and white; hardiness and fast growth are their two main traits; originated from France.
- Normande: dual purpose; utilized in less wealthy economies; noted for fast growth and fertility; prominent in South America; originally brought to U.S soil by Vikings.
- Piedmontese: originally from Italy; noted for exceptional carcass quality and large yields; brought to the U.S in the 1980's.
- Pinzgauer: Austrian; known for their white stripe on the topline of the animal, mimicking a skunk tail.
- Romagnola: large white cattle with black tipped horns; Italian breed developed for draft purposes.
- Saler: black, dark red, burly, and long frame; used for hardiness and milking ability; originated from south central France.

- Simmental: black, yellow, red and white; noted for rapid growth and milk production; originally from Switzerland and imported to all 6 continents by 1971.
- Tarentaise: cherry red, with dark face and ears; dual purpose; compares to British breeds; originally from the French Alps, derived from brown swiss and brought to the U.S in 1972.

Expected progeny differences (EPDs): Source: (*Greiner, 2009*)

Provide estimates of the genetic value of an animal as a parent.

F1 crossbred animal: The first generation crossbred out of two parents of different breed. (i.e. full-blood Angus x full-blood Charolais = F1 calf)

Hybrid vigor (heterosis): biological phenomenon that causes crossbred animals to out produce the average of the two parent breeds

Intramuscular fat: (IMF) is fat that is inside the cut of meat; may be visible by white or yellowish lines throughout the meat; also considered **marbling**.

Marbling: specks or lines of intramuscular fat that is distributed in the muscles of an animal; usually graded/ judged between the 12th and 13th rib.

Palatability: acceptable to the palate; savory

Quality Grade(s): Quality grade is determined by factors that affect palatability of meat such as tenderness, juiciness, and flavor. These factors include carcass maturity, firmness, texture, and color of meat, and the distribution of marbling

within the meat. From highest to lowest, the grades are: *Prime, Choice, Select, Standard, Commercial and Utility* (NBQA, 2011).

Tennessee Beef Alliance (TBA): An alliance formed by the Tennessee Farm Bureau Federation to serve participating Tennessee Beef producers; the alliance groups cattle according to their grade to form truckloads to be bought at a premium. The cattle are all raised under the same protocol(s), therefore generating a consistent product across multiple producers, while also maximizing profits for those producers.

Terminal Breeding: crossbreeding with the intent to produce superior market animals (Typically a maternal dam crossed with a high growth/producing sire of another breed).

The National Beef Quality Audit: (NBQA) as part of BQA, is a comprehensive survey that evaluates beef industry efforts to improve beef quality.

Warner-Bratzler Shear Force: (WBSF) is a device with a blade that measures the force required to cut through meat.

Yield Grade(s): *Source: (Hale et. al, 2013)*

Yield Grade 1:

- The carcass is covered with a thin layer of external fat over the loin and rib; there are slight deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions. Usually, there is a very thin layer of fat over the outside of the round and over the chuck.

Yield Grade 2:

- The carcass is almost completely covered with external fat, but lean is very visible through the fat over the outside of the round, chuck, and neck. Usually, there is a slightly thin layer of fat over the inside round, loin, and rib, with a slightly thick layer of fat over the rump and sirloin.

Yield Grade 3:

- The carcass is usually completely covered with external fat; lean is plainly visible through the fat only on the lower part of the outside of the round and neck. Usually, there is a slightly thick layer of fat over the rump and sirloin. Also, there are usually slightly larger deposits of fat in the flank, cod or udder, kidney, pelvic and heart regions.

Yield Grade 4:

- The carcass is usually completely covered with external fat, except that muscle is visible in the shank, outside of the flank and plate regions. There is a moderately thick layer of external fat over the inside of the round, loin, and rib, along with a thick layer of fat over the rump and sirloin. There are usually large deposits of fat in the flank, cod or udder, and kidney, pelvic and heart fat (KPH).

Yield Grade 5:

- The carcass is covered with a thick layer of fat on all external surfaces; abnormally excessive fat.

