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The Agricultural Growth and Malting Production of Barley Grains in Northeast Tennessee and Southwest Virginia

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The Agricultural Growth and Malting Production of Barley Grains in Northeast Tennessee and Southwest Virginia

A thesis
presented to
the faculty of the Department of Business and Technology
East Tennessee State University
in partial fulfillment
of the requirements for the degree
Master of Science in Technology

by
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May 2016

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ABSTRACT

The Agricultural Growth and Malting Production of Barley Grains in Northeast Tennessee and Southwest Virginia

by

Mark Evans Patton

The purpose of this study is to explore the history and production processes of beer and examines the components that contribute to its brewing. The narrative will provide a timeline of the processes that are required to create the product of beer beginning with the agricultural products and following the brewing processes that result in beer as the finished product. I will also examine the business of agriculture and grain processing and will provide some historical perspectives of grain, beer, and malting. I will also consider whether the growing, processing, and malting of grains in the East Tennessee and Southwest Virginia Region is feasible as demonstrated through this research and reported findings.
ACKNOWLEDGEMENTS

I would like to thank everyone who helped me in the performance and execution of this Graduate Thesis Project which will complete my requirements for the Master of Science Degree in Technology. To the professors at ETSU who have guided me through the portal of knowledge – a hearty thank you is in order. To all brewers and farmers who agreed to be interviewed and graciously took the time out of their busy schedules to sit through my interrogations, “Thank you.” A special thanks goes out to my family who has endured my late nights, late wake-up calls, and general coffee-fueled grumpiness throughout.
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CHAPTER 1

INTRODUCTION

Growing and malting barley grains are processes that have been popular for millennia and will continue to thrive as long as beer remains a legal and socially accepted beverage. The rise of the micro-brewing industry, especially within the last 10 years, has provided many alternatives for the beer enthusiast in style, flavor, and alcohol content of beers. The homebrewer has benefited from changes over several years because of laws that permit brewing in the home. An investigation will be conducted the feasibility of growing, processing, and malting barley grains within the Northeast Tennessee and Southwest Virginia region. The researcher will present the reader with history, business, and agricultural information associated with this malted beverage.

Background of the Problem

In September 2014 the “Agriculture Business and Management Forum” was presented by the Small Business and Development Centers in Kingsport, Tennessee. Representatives from the banking, government, educational, and agricultural communities were present. Additionally, individuals from many walks of life including farmers, business owners, landowners, and entrepreneurs participated. This event provided a great deal of information about the business of agriculture and other businesses associated with agriculture. The researcher began to consider as a result of hearing a lecture at this conference that growing malting barley, the main ingredient in beer, and processing it locally could be an industry in the Northeast Tennessee and Southwest Virginia region.
To make inquiries, the researcher approached an individual who was from the State of Tennessee Department of Agriculture. This person’s lecture was “The Decline of Tobacco and Introduction of Soybean as a Staple Crop for Tennessee.” The researcher had a short interview period with him and asked, “Can barley be grown in this region? And if so, why was it not a consideration?” The lecturer replied, “It can indeed be grown, but there was not a demand for it.” As a follow-up question the researcher asked, “If there was a demand for it, could this be considered a staple crop?” The lecturer answered, “Absolutely, but it has to be worth it in dollars to the farmer before the farmer will consider it.”

It was this conversation that solidified the idea for the investigation of growing and malting beer grains in the East Tennessee and Southwest Virginia region. The micro-brewing industry is rapidly growing, not only across the nation, but in this region as well (Avento, 2014). A Google search for breweries in the region revealed 41 breweries and brew pubs along the I-81 corridor between Radford, Virginia, and Knoxville, Tennessee.

**Statement of the Problem**

The micro brewing industry has grown significantly across the United States, Canada, and Europe over the past several years. This growth has also been seen in the Northeast Tennessee and Southwest Virginia region. There is an ever-increasing demand for beer grains across the country that may reach the point of causing shortages of barley grain supplies in the future. There is also a grassroots movement to use and support local agriculture in local products. This region is rich in farmland and farming technology. To prepare for any future shortages of barley grain supplies and support local agriculture a local malt house could be developed to support local microbreweries with the processing and malting of locally grown barley.
Purpose of the Study

The goal of this study is to research the malted barley industry from three different viewpoints: agriculture, barley malting processing, and the micro-brewing industry. The data gathered will then be applied to the Northeast Tennessee and the Southwest Virginia region as to the potential of locally sourced malted barley production catering to the growing demand from regional micro-breweries. The study will include a review of the latest malting technology in line with today’s manufacturing best practices. The study will also focus on the business of farming and the malting industry.

Limitations and Assumptions

Due to time and resource limitations the researcher will attempt to reach as many regional beer-based businesses for personal interviews as possible; however, this would require traveling over several hundred square miles and some interviews will have to be conducted via electronic sources.
CHAPTER 2

LITERATURE REVIEW

The literature review will focus on four areas:

1. A historical review of cereal grains and beer making, both from a pre-history perspective to modern times.
2. Survey of the agricultural aspects of the modern grain industry.
3. Specific focus on malt production including the technology and the artisanship of the discipline.
4. Examine the business aspects of the grain and microbrew industries and the requirements for bringing the final product to market.

Historical Perspectives

Cereal Grains

To understand the history of beer one must first understand the origins of beer’s main ingredient which is barley. As barley is a cereal grain its history parallels other grains that have become domesticated.

From many points of view cereal grains have been considered the primary staple food of civilization. Wheat, barley, oats, and rye are all important as they grew wild in prehistoric times and were among the first grains domesticated. The rise, wealth, and power of early civilizations were dependent on the cultivation of these grains (Hornsey, 2003).

Pre-History. There are differences of opinion from scientists as to when and how prehistoric domestication of cereal grains began. As there was no significant recordkeeping during the early to middle stone age times (Paleolithic and Mesolithic periods), archeologists and
scientists rely on artifacts of these periods to understand what events led to the discovery of grains, their domestication, and how these staples affected early man.

During the Stone Age period the ice cap began receding, regions were warming, water levels began rising and humans – as hunter-gatherers – were using rudimentary stone and bone tools. How cereal grains came to be domesticated is not definitively known. The most popular narrative that seems to emerge is that Stone Age tribes were nomadic and moved around in small groups of 10 to 12 to hunt and gather wherever food sources were plentiful. When the local food sources ran out, the group would simply move again to another location. The length of stay in any area would be dependent on how plentiful local resources were. Meat was a primary food source, but wild fruits, nuts, and grains were seasonally collected for consumption (Mark, 2009).

As humans wandered in most regions of the globe, artifacts from archeological digs indicate that the Western Asia/Eastern Mediterranean regions were areas of great settlement due to the climate and plentiful surroundings. In these regions two wild grains grew in abundance—wild wheat (*Triticum araraticum*) and barley (*Hordeum spontaneum*) (Timemaps.com, 2015b). One particular area within this region called the “Fertile Crescent” or the “Cradle of Civilization” is known today as the Middle East. On a modern map it would border on Northeastern Egypt, Israel, Jordan, Syria, Lebanon, and Southern Iraq. James Henry Brested, an Egyptologist, first used the name “Fertile Crescent” in his 1916 book “Ancient Times: A History of the Early World” (Mark, 2009).

Because of the climate and surroundings the inhabitants of the Fertile Crescent first developed Neolithic era (third and last stage) Stone Age technology earlier than other nomadic peoples in other regions of the globe. The discoveries of villages, pottery, grinding stones,
polished stone tools, and weapons indicate the inhabitants of this area evolved from being hunter-gatherers to sedentary hunter-gatherers, and then to farmer-hunters (Bar-Yosef, 1998).

**Agriculture.** There is not a general consensus as to when mankind moved from being hunter-gatherer to farmer. This is a mystery that has been well debated and scrutinized over many years. Robert Braidwood of the University of Chicago states there is a link between the domestication of barley grain and the change from nomad to settler. His work in the 1950s established a link between agricultural and archeological studies and put the beginnings of farming between 12,000 and 8,000 BCE (Hornsey, 2003).

**Sumerian Culture.** Nomadic tribes settled on a southeastern part of the Fertile Crescent in an area between the Tigris and Euphrates Rivers known today as southern Iraq. This land had wild animals, edible vegetation, rich soil, and abundant water. The Sumerians are believed to be the first civilization that lasted over 3000 years – between 5000 and 1750 BCE (Mark, 2011c).

As the nomadic tribes began to settle in this area and harvest the abundant natural resources they learned to use the land by cultivation. The Sumerians had the first identifiable society based upon agriculture. It took two thousand years but by 3000 BC the region was prosperous and teeming with activity (Ives, 2011). By this time there were several cities and villages with the main city of Ur having a population of over 40,000 people and thousands of hectares (100 acres) of land used for farming (Mark, 2009).

Many types of cereals and vegetables were grown and wheat and barley were harvested twice a year. The success of these people was measured over hundreds of years with many new advancements in farming and social technology helping them advance their culture. These accomplishments include agriculture, the wheel, irrigation, dividing time into minutes and
seconds, writing, law, government, and the development of trade and trade routes (History-world.org, 2015).

**Babylonian Culture.** By the time Babylonians came to power as a city and regional power most of Mesopotamia (Greek for land between two rivers) had been settled along the Tigris and Euphrates rivers. Although there were many cities and peoples, the agricultural way of life was the staple of this country and region. Many customs, religious beliefs, laws, and manners were adapted as the norm from their predecessors, the Sumerians. The trade lines the Sumerians had established centuries earlier were still in effect with grains being the chief commodity traded (Mark, 2011a).

During this time grains were used for barter, paying taxes, payment for work and as currency. The grains that were primarily grown and used for these endeavors were barley and wheat with the former being most prominent. As agriculture was one of the main activities of Babylon farming technology increased, canals were built for irrigation, domesticated animals such as oxen were used, and farming implements were invented to make the work easier.

Later, in Babylon most of the land was owned either by the temples, the King, or wealthy nobles. The tenant farmer concept was developed as did laws that governed rent and payment for such activates. At the end of the growing season all entities shared in the harvest; the Temples received a portion of the grain as a gift and the King received his portion as taxes which was put into the cities’ royal granaries. The landowner’s rent was paid with grains and what remained went to the tenant farmer (History-world.org, 2004).

Babylonian civilization was at its height in this region from 2000 BCE to around 538 BCE when they were conquered by the Persians. However this change did not affect agriculture
or trade as they continued to serve and enrich the new regimes. It should be noted that great advancements in writing, law, trades, science, and mathematics were conceived by this society and can largely be attributed to the country’s successful economy and wealth of which agricultural successes were significant (Mark, 2011a).

**Egyptian Culture.** Another country that came into power around the same time was Egypt (a country that borders on the northwestern side of the Fertile Crescent). Egyptians settled along the Nile River which was heavily used for agriculture and trade in a culture similar to that in Mesopotamia along the Tigris and Euphrates rivers (Mark, 2009).

Egypt, a treasure trove of art, architecture, agriculture, mathematics, science, and trade, was a powerful empire and a political force in the ancient world. As with the Mesopotamians, Egypt’s history dates back several thousand years to prehistoric times. From 5000 to 3100 BCE Egypt slowly evolved from hunter-gatherer to agricultural (History.com, 2008).

The country was unified along the Nile River in 3100 BCE by King Menes. The first capitol of ancient Egypt was built at the site of the Nile River delta in the city of Memphis. As with other ancient civilizations the economy and strength of the country was driven by its agricultural prowess. Farming was a principal occupation and wheat and barley the main crops produced. The yearly farming cycle included flooding, draining, plowing, sowing, harvesting, threshing, and storing of grain. Later levees, canals, and dams were built to control the water from the Nile. In addition laws were enacted to define the responsibilities of tasks within this cycle (History.com, 2008).

In the height of Egypt government officials surveyed each peasant’s land to estimate the amount of yield to be harvested and levy taxes to be paid at harvest. The annual Egyptian yield
was estimated between 1.5 and 2.5 million tons of grain during the new Kingdom era (18th dynasty, 1567-1085 B.C.) with the largest harvest occurring every 3rd year (History.com, 2008).

**European Culture.** The continent of Europe also developed from a hunter-gatherer society, but its Neolithic (prehistoric) culture (after 7000 B.C.) lagged behind that of its eastern neighbor in the Fertile Crescent (region of modern Middle East). In addition, because Europe had a larger land mass and different climatic regions the continent developed at different rates. Many factors played into this late development from hunter-gatherer to farmer: colder temperatures, soils thick with the roots of wild grasses, shorter growing seasons, lack of communication between isolated nomadic groups, lack of technology in nomadic groups, and late development of agricultural skills (Timemaps.com, 2015b).

Slowly Europeans become more sedentary and eventually turned to farming as a mainstay for food due to gradual developments in farming technologies and interactions with more advanced cultures from the southeast. By 6500 BCE, agriculture began to spread from the east to cultures along the Mediterranean coastal areas and to the west and north to the Balkan regions. Grains had to be adapted to the different climates; this process took hundreds of years. Agriculture spread to warmer regions of the Mediterranean faster than the colder central and northern regions of Europe, but progress continued in both regions with a mix of fishing and farming in the south and hunting, gathering, and farming in the north (Timemaps.com, 2015a).

By 5500 to 5000 BCE agriculture-based cultures inhabited Western Europe along the southern Atlantic coast into what are now the British Isles. The northern Atlantic coastal areas saw a mix of fishing, gathering, and agriculture. The societies of the Atlantic regions eventually
turned eastwardly toward central Europe and at some point met with central European cultures (Timemaps.com, 2015a).

Agriculture took hold by 4500 to 2500 BCE and permanent settlements started to appear and develop into larger villages and hamlets. The use of the plow, polished stone and bone tools, and non-ferrous objects began to appear. Permanent storehouses for grain began to appear as well along with different cultures and dialects of Indo-European languages (Timemaps.com, 2015).

**American Culture.** Barley is not indigenous to the Americas and first arrived with European settlers in the 1600s. A desire for beer products compelled the first settlers in New England to begin growing barley, although poorly, around the year 1602. Large-scale production did not occur until settlers moved westward into what is now New York state and began growing a Scottish 6-row species. New York remained the prominent growing area in the 1700 and 1800s (Schwarz, Horsley, & Scott, 2011).

In the 1800s, as European settlers moved west, barley production increased in states such as Wisconsin, Iowa, and Ohio. In the 20th and 21st centuries, barley production became centralized in western and mid-western states (Schwarz, Horsley, & Scott, 2011).

Spanish monks brought many types of seeds, including barley, from Spain to California on the American west coast in 1769 (Fastcards.califa.org, 2016). California remained a major grower of barley into the 1970s (Schwarz, Horsley, & Scott, 2011).

**Modern Grain Industry**

Today, cereal grains are grown in many regions of the world, and wheat, barley, oats, rye, and corn are grown in great quantities; these grains are still, for the most part, the staple foods of
the world. Barley, the main focus of this report and ranking 4th in world grain production, is currently grown for three main purposes: livestock feed, beer production, and some human food consumption (Garvin, Raman, & Smith, 2003).

Most barley is grown in 17 countries with the highest production being in the European Union. The worldwide annual production yields about 141.19 million metric tons as of 2015 estimates (Globalbarleyproduction.com, 2015). There are many varieties and classifications of barley that have been adapted for their use and the climate in which they are grown.

**Origins of Beer**

Throughout world history alcoholic beverages have been produced from the ingredients that were indigenous to the local environment. A number of archeologists suggest the first fermented beverages were simply accidents of nature, but these happy accidents were later refined through trial and error over time. Beer is the most popular alcoholic beverage in the modern world with over 144 billion litters made per year. It is a massive worldwide industry and comes in many varieties (History.com, 2013). This section will explore the origins of beer from prehistoric to modern times.

**Prehistoric.** The production of beer is contemporary to wheat and barley domestication. There are different theories as to how and when beer was first produced as the events were prehistoric. Early humans were nomadic hunters and gatherers and harvests were based upon location and season. Nuts, berries, fruit, and wild grasses (such as barley and wheat) would have been gathered and consumed (Timemaps.com, 2015b).

The first fermented grain beverage was most likely made in the following manner:

1. A grain, possibly wheat or barley, was gathered in a vessel.
(2) The vessel, for whatever reason was abandoned.

(3) The grain became wet during a rain storm but then dried allowing the grains to sprout (malt).

(4) Another rain storm occurred filling the vessel with water. Wild yeast from the air collected in the vessel and the contents began to ferment.

(5) The vessel was found, by the same or another nomad, and the contents were consumed.

(6) There was an intoxicating effect that was strange and, in moderation, enjoyable.

(7) The beverage was reproduced, most likely through much experimentation.

(Ives, 2011)

This may be speculation, but probably plausible considering the conditions of the time. Another theory that parallels the above narrative could be that naturally fermented fruit-based beverages were enjoyed so much that there was a thirst for more raw materials to make new beverages (Cohen, 2012).

Early beer was not the malted beverage enjoyed today; however, it would have contained three of the main ingredients that are present in contemporary beers: water, barley (wheat), and alcohol. Regardless of the timeframe for beer creation and its adoption into the human diet it was appreciated and humans sought to replicate the beverage.

As civilizations evolved in the Fertile Crescent ancient Sumerians, Babylonians, and Egyptians, who were all producers of barley, consumed beer in some form as a part of their daily lives (Mark, 2011b). The alcohol content was low in this early beer and the drink itself was a
sweet, nutritious beverage that was much safer to drink than the water (Andrew, 2014). Archeologist Patrick McGovern has shown through chemical analysis of ancient jar residue the presence of dried beer stone, a substance that remains after the brewing process (Tucker, 2011). Evidence shows Sumerians, who drank beer through straws in order to avoid the bitter grains, sang a song called “Hymn to Ninkasi,” which was an “ode to the Goddess of Beer” (Andrew, 2014). The Babylonians developed many kinds of beer and commercialized it to a great extent. Production increased for trade and laws were enacted governing tavern owners (Mark, 2011b).

The masters of brewing were the Egyptians; evidence shows that every Egyptian man, woman, and child consumed beer. From the nobility to the common worker, each was allotted a daily portion which was a major source of nutrition (Ives, 2011). Each worker on the pyramids was allotted a daily ration of four to five litters of beer as payment and refreshment. The Egyptian scribes invented specific hieroglyphics for beer. A town on the northeast bank of the Nile called Pelazeam was dedicated to the production of beer and had over 50 to 60 varieties of beer that shipped in trade. A wealthy Egyptian may have been buried with a supply of beer and/or inscribed recipes with a mini brewery for use in the afterlife (Cambou, 2015).

The Romans and Greeks favored wine over beer as asserted by the Greek writer Xenophon in his book Anabasis written in the 4th or 5th century BCE. However, after the Romans conquered areas beyond Rome, beer continued to be brewed on the fringes of their empire. This is evidenced by beer containers circa 800 BCE found in a tomb in northern Bavaria (Mark, 2011b).
**Middle Eastern Beer Production.** Barley was the staple crop of the land inhabited by the early Christians and beer was consumed by almost everyone. References can be found in the King James Bible, which mentions barley and strong drink (Homan, 2002).

Although the Romans did not favor beer, in the Middle-East and other areas on the fringes of the Roman Empire fermented grain drinks (but not necessarily from barley in northern Europe) were brewed and consumed in great quantities. In time, however, legionnaires stationed in Central Europe developed a taste for beer as it was the local drink. The soldiers became so accustomed to it they started brewing their own beer and called it “cerevisiae” from, “Cere” the goddess of agriculture and “Vis” meaning strength (germanbeerinstitute.com, 2006).

At the height of the Roman Empire, circa 200 A.D., its territory spanned the Mediterranean Sea across North Africa to the Atlantic, the Middle East, and westerly across Southern Europe to Britain. By 500 A.D. Rome had lost most of its grip across Europe and the land was divided up into smaller kingdoms (Abels, 2015). During this turbulent time most of Europe was experiencing great change. Communication and trade routes were diminished, and many cities and villages, once used by merchants bringing foreign goods, were now isolated. The art of beer making was reduced to household production and methods passed down within kinships (Raley, 1998).

**Central Europe.** From 500 to 1000 A.D. Europe came under feudal rule as administered by the new conquering kings. Under the kings, dukes were granted land and their underlings, called serfs, would supply labor for farming, tending animals, supplying soldiers, and producing beer. During this time laws started to appear that outlined the right to make beer and the taxes
that would be collected on the goods produced from the serfs as tributes to the Dukes and Kings (germanbeerinstitute.com, 2006).

In 784 when Charlemagne, or King Charles of the Franks, came to power he divided his empire into large estates with each having a church and an established brewery. As a consummate beer drinker and brewer himself (Salem, 1878), Charlemagne wrote a set of ordinances that established standards for the personal cleanliness of brew masters and mandated strict record-keeping of the quantities and types of beers produced. As Charlemagne made his rounds of the kingdom he visited an estate where he would personally witness the brewing of the beer by the estate’s brew master. Before adding hops became common practice, the beer was spiced mostly by “wild Herbs” called Gruit that grew on royal lands. Essentially, even though everyone had the right to brew beer only the royal brew masters had access to the spices that made it taste good (germanbeerinstitute.com, 2006).

Eventually the making of quality beer in mass quantities fell to the Monastic breweries of the period which were granted brewing rights by the monarchies. Across Europe over 600 brewing monasteries were established to serve travelers and for the welfare of the community (Hieronymus, 2005). As water was not safe to drink, beer was the best alternative and was used to barter for commodities, pay taxes, and for tithing to the church. The Monks were scholars and improved upon the quality of beer because they kept strict records and learned over time the best techniques for brewing. During this period of experimentation they added hops to the brewing process. Hops added a bitterness to the beer which balanced the sweetness and, as discovered later, acted as a preservative which extended the beer’s shelf life. The addition of hops was
revolutionary as it meant the beer could be stored for longer periods and be transported farther distances (Cambou, 2015).

As time progressed the monasteries found themselves very successful in the beer, inn, and hospitality realms. Their beer was so popular they started selling it commercially. At the same time the Catholic Church was becoming more powerful and animosity was growing between the clergy and the monarchs who fell under the Church’s jurisdiction. In 1084 this changed when King Henry the IV of Germany as Holy Roman Emperor unseated the Pope. After these events the church lost some power and most monasteries lost the privilege to brew beer (germanbeerinstitute.com, 2006).

During the 1100s the beer trade turned into a civil business enterprise primarily run by wealthy noblemen of the local aristocracies. The quality of the beer was not reliable for the next 300 years as knowledge and skill were lost during the transfer of brewing responsibility from scholarly monks to craftsmen. As craftsmen increasingly used inferior ingredients to turn a profit, over time beer lost its popularity in central Europe. In an effort to turn the beer trade around and bring back profits local governments intervened and started regulating the trade. The year 1466 saw the introduction of the German purity laws, “Reinheitsgebot,” which were established in the town of Munich. These regulations stated “only barley, hops, and water may be used to make the brew” (germanbeerinstitute.com, 2006).

Britain. The Romans first invaded southern Britain during the 1st Century BCE and established a presence in the middle of the 1st Century AD. Their control reached from southern Britain north to what is now Scotland. As per the Roman Empire’s usual operating procedure they began to urbanize the population by building roads, towns, bridges and walls. When they
first arrived, however, they found that the inhabitants of this land already had a strong drink made of fermented grain. What they did not know and what modern archeology has shown us is the Celtic peoples had landed in Britain nearly four or five centuries before the Romans did (Hornsey, 2003).

When the Celts came to Britain from mainland Europe they probably brought with them the technology of brewing and the raw materials for brewing. Modern archeologists speculate that barley, millet, and wheat had been domesticated and some knowledge of brewing had already been introduced by earlier settlers to the British Isles (Hornsey, 2003).

While Britain was in Roman control for almost 400 years the Romans had little influence over the land now known as Scotland and Ireland. Roman records from 301 AD indicate that British beer was a commodity and appeared on a price listing from the Roman Emperor Diocletian with a price set at 4 denarii. It is difficult to make an exchange rate from denarii to today’s dollars but to provide a better comparison a Roman soldier at that time earned about 150 denarii a month (Dalka, 2002). As the Roman Empire was in its final decline, Romans were no longer building towns by the 4th Century, and many Roman towns were falling apart. Urban folk began moving to country villas and beer production followed into these rural areas. In the year 410 AD Rome abandoned Britain and left the defense and administration to the “Romano-British” culture (Hornsey, 2003).

Briton was self-governed for a few years but was infiltrated by invading Germanic tribes that came from mainland Europe. These Germanic peoples consisted of the Saxons, Angles, Jutes, and some Franks who were also beer makers and drinkers. It took about 100 years but by 600 A.D. the Anglo-Saxon forces demolished most of Romano-British culture. Under Anglo-
Saxon rule many of the areas that had been controlled by the Romans broke off into several kingdoms with some areas still controlled by Romano-Celtic culture. Anglo-Saxon Briton would produce three types of alcoholic beverages: mead, beer, and 11 types of ales (Calladine, 2012).

William of Normandy became the king of England after defeating King Harold II at the Battle of Hastings in 1066. King William, who believed in self-sufficient communities, re-established the monastery as the center of the community as they were throughout continental Europe. Thus, beer making moved from being primarily a home and family operation, to large quantity industrial operations under the control of monks. William was also concerned with the quality of beer and ale. He appointed “Ale-Conners” to sample beers throughout the kingdom and levy fines on those responsible for beer of poor quality (Hornsey, 2003).

By the 13th century commercial beer and ale making was overtaken by bread bakers who were protected by laws such as the “Assiza Panis et Cervicie” (the standard, or Assize of Bread and Ale which regulated prices) (Hornsey, 2003). Beer making again was done within individual homes which continued into the 14th century. So much beer was being made in homes during this period Hornsey (2003) indicates that “75% of all households brewed and sold ale out of the home, while 29% brewed so much they were regarded as commercial.”

By the 15th century beer and ale were again being produced commercially. Beer guilds had been established a few centuries before and were well entrenched within the trade. Governmental regulation was also well established but seemed to change according to the whim of whomever was in power. For example, Henry the VIII outlawed hops for beer and ale in 1530. However, beer and ale were now well established within Britain and the art continues there to this day.
The Modern Beer Industry

In 2014 the worldwide production of beer was 1.96 billion hectoliters (Statista.com, 2016b) or roughly 51.8 billion gallons of beer. Beer has had its historical highs and lows and according to Ives in the 2011 documentary “How Beer Saved the World,” it is the number one consumed beverage on the planet.

The United States’ production of beer at 5.9 billion gallons in 2014 is second only to Europe which is the number one producer at 10.5 billion gallons (Statista.com, 2016b). The most successful beer makers in the U.S. were Eberhard Anheuser, Adolphus Busch, Frederick Pabst, Joseph Schlitz, and Frederick Miller, all of whom built empires on beer to quench the thirst of a growing nation. Today, these producers’ brands are still in existence and some have merged to form worldwide conglomerates (History.com, 2008).

The top beer producers in the world today are Anheuser-Busch Inbev, SABMiller, Heineken, Carlsberg, and Asahi Group Holdings. Other than the growing micro-brewing industry the companies mentioned are the owners and controllers of most of the beer production and distribution in the world. To put this into better perspective a breakdown of the top two companies is provided below.

Anheuser-Busch Inbev

As this company’s name implies, Eberhard Anheuser and Adolphus Busch formed a partnership and combined their strengths and talents to form Anheuser-Busch (AB) in 1879. The St. Louis based company flourished and created the renowned “Budweiser,” an American lager beer known around the world. They also used innovations such as pasteurization and refrigeration to keep their product fresh for the customer (Anheuser-busch.com, 2016).
Offering several products, the company would eventually become the top U.S. producer of beer. Although publically traded, the management of the company was kept within the Anheuser-Busch family (Anheuser-busch.com, 2016). In 2008 the company was purchased by European rival Inbev from Belgium; Inbev controls the brands of Stella Artois, Bass, Brahma, and Michelob. The company is now the top producer and distributor of beer in the world with yearly sales of $36 Billion U.S. dollars (Merced, 2008).

Inbev also has a long history of beer making. Inbev was the product of a merger that occurred in 2004 between two very large beer makers: Interbrew Stella Artois’ a Belgium Company and AmBev of Brazil. Interbrew S.A. has roots back to 1366 and AmBev is a conglomerate of consolidated South American breweries SAB. (Merced, 2008).

Anheuser-Busch was absorbed by Inbev in 2008 for $52 billion U.S. dollars but kept the Anheuser-Busch name as part of the deal. ABInBev is now the largest beer producer in the world and produces the flagship beers, Budweiser, Corona, Stella Artois’, Beck’s, Michelob, Modelo, and a number of popular South American, European, and Asian brand beers (Ab-inbev.com, 2016).

SABMiller

Miller Brewing was established by Frederick Miller in 1855; by 1888 the company had grown from a 25 employee/300 barrel a year factory to an 80,000 barrel a year/9,500 employee brewery. Like Anheuser-Bush (AB) the majority share of the company remained in the hands of its founder’s family until 1969 when it was sold to Phillip-Morris. Under Phillip-Morris the company wanted to enlarge in order to be in direct competition with Anheuser-Bush. Miller expanded its production from7 million to 31 million barrels a year by 1978. By the early 1980s
Miller Brewing was in second place behind Anheuser-Bush. Competition was fierce during this time as was manifested in the “lite beer wars” as each introduced new products (Fundinguniverse.com, 1996).

In 2002 The Miller Brewing Company was purchased by South African Brewery (SAB), a large and diverse international company that was established in the 19th century. In 2008, SABMiller entered into a joint venture with Molson Coors Brewing Company who ranked 2nd and 3rd, but remained behind Anheuser-Bush (Martin, 2007). The conglomerate SABMiller produces over 200 brands of beer worldwide and includes well-known flagship brands of Miller, Coors, Hamm’s, Grolsch, Molson, and Fosters. Headquartered in London, England, SABMiller operates breweries and has offices on six continents.

What Makes Beer . . . . . . . . . Beer

The discussion of grain and beer origins have been observed, with some historical background, to show how all these factors came together to make the beverage known as beer. This section explores the process, ingredients, skill, knowledge, and chemistry of brewing beer and will examine the various elements of barley, wheat, water, yeast, hops, and adjuncts that go into producing this worldwide manmade phenomenon.

Ingredients

Barley. While the cereal grains of barley, wheat, oats, and rye have all been used in varying concentrations, depending on the region of the world, to make beer, barley is usually the grain of choice. Barley has been touted as the “perfect grain for making beer” says beer author Randy Mosher in a 2016 Craftbeertemple.com article. The reasons for this are biological combined with the characteristic levels of protein, enzyme, and starch content that give
contemporary beer its distinct flavor. In addition, for a grain to be used in beer it must be malted. Malting is a process that will be discussed in detail later but barley grain malts much better than other cereal grains. Lastly, the husk of the barley acts as a natural filter during the mashing process of brewing beer (Craftbeertemple.com, 2016).

**Wheat.** Wheat is also used in beer making although it is mostly preferred for the bread and pasta industries (Frane, 1996). Wheat comes in many different varieties; those used in beer making must also be malted to bring out the enzymes, proteins, and starches needed to produce the sugars and flavors in the beer wort. Wheat contains glutens and more proteins than barley and can make beer products hazy and translucent verses the clear appearance of barley based beers (Beeradvocat.com, 2016). The malting of wheat can be problematic due to the extended times to steep and germinate as wheat requires more moisture than barley and more time to germinate (Fleming, Johnson, & Miller, 1959). Popular in America, Germany, and Belgium, wheat can be used by itself in beers or as adjuncts in concert with barley (Frane, 1996).

**Water.** Through the ages specific beer types have gained their notoriety from the aroma, appearance, bitterness, taste, color, and smoothness and are usually identified from the area of the world from which they came. The character of these different types or brands of beer come from the formulation of the ingredients and the process or recipe used. But the main ingredient that is often overlooked and the one that gives these beers some of their regional characteristics is the water (Palmer & Kaminski, 2013).

The French word “Terroir,” quoted in a 2011 online article in Draft Magazine (Draftmag.com, 2011), is defined as “the earth considered from the point of view of agriculture.” It describes “le goût de terroir” as “the flavor or odor of certain locales that are given to its
products, particularly with wine” (as cited in Grand Dictionnaire universel du XIXe siècle, Pierre Larousse’s 19th-century French dictionary). Taking this concept as being applied to wine it can also be applied to food and beer as they are agricultural products. This also takes into consideration the environmental conditions (soil, water, and air) of the area from which items are produced and which will affect the flavor of the product (Draftmag.com, 2011).

Water has remained the only ingredient in beer that has always remained “local” to where the beer is made. If the brewer wants to apply the concept of “Terroir” into their brew to give it truly a local flavor then the water would be changed very little from its natural source (Palmer & Kaminski, 2013).

Before modern times the water source that was closest to a brewery, whether hard or soft depending on the mineral content, is what was used for the brewing process. Today, unless the brewery has a dedicated source from a well, spring, or stream, brewing in general comes from a municipal water source. Although water may be clean and safe to drink, as in potable municipal water, this does not mean it is suitable for brewing. Safe drinking water may contain chemicals, such as chlorine, that may alter the taste of the beer (Palmer & Kaminski, 2013).

In modern times water from any source can be modified through chemistry, to suit whatever beer style that is desired. Not only can contaminates be removed, mineral content can be added or deleted as needed and the pH value can be changed to suit the style of beer being made (Palmer & Kaminski, 2013).

As brewers formulate new beer recipes or refine old ones, water chemistry should be considered as should any other ingredient within the mixture. Mash pH is important: darker beers require more alkalinity and lighter beers less alkalinity because of the acid levels in the dry
ingredients. Ultimately, consumers’ palates decide whether the brewer’s attempts have been successful or not (Palmer & Kaminski, 2013).

**Yeast.** Without yeast, beer as we know it would not exist; it is necessary for the fermentation process to occur. Yeast converts about 48% of the wort into ethanol, about 46% into carbon dioxide, and the remainder into new yeast. This is called the cold side of the beer making process as the wort must be cooled before adding the yeast. This is the most vulnerable time in the process because of the possibility of introducing bacteria into the cooled wort. With proper technique and sanitation practices the brewer can introduce the yeast to a rich environment suitable to metabolize the sugars. During the fermentation process the yeast will produce hundreds of other compounds that enhance the aroma, texture, and flavors of the beer (White & Zainasheff, 2010).

During ancient times beer was simply left in an open vessel to collect natural yeast in the air for fermentation. The peoples of these ancient days assumed fermentation was a magical process that happened to the mixture of malted grain and water (Kiefer, 2001). Early beer makers learned that the substance left in the bottom of the vat after fermentation (the yeast) could be added to the next vat that was ready for fermentation. This process was faster than relying on natural yeast from the air and accelerated the fermentation process. The technique known as “re-pitching” is still used in modern times. Maintaining strains of yeast became part of brewing techniques as the brewers knew the different yeast were part of the characteristics of beer styles (White & Zainasheff, 2010).

In the 17th century when the microscopic world became known through the invention of the microscope scientists of the time started to compile data that would eventually become the
science of microbiology (Kiefer, 2001). During the 19th century some scientists thought that yeast was a single-celled organism and was responsible for fermentation. However the greater scientific community thought fermentation was a spontaneous chemical reaction and this was long held as the official theory. This theory was eventually dispelled by Louis Pasteur who proved that the metabolism of yeast was responsible for fermentation (White & Zainasheff, 2010).

The word of Pasteur’s research soon spread and Pasteur toured many breweries across Europe to analyze their yeast. Chemists became some of the highest paid workers at the breweries when it was discovered that by controlling the consistency of the yeast a higher quality of beer could be produced (White & Zainasheff, 2010).

In many ways modern beer is more science than craft. Most large breweries have dedicated laboratories with highly trained chemists who not only test all ingredients for various attributes but develop and maintain the strains of yeast specifically used for a brand of beer. Modern yeasts are developed, grown, and isolated for specific styles or brands of beer. These yeast strains are pure and free of bacteria which can cause off tastes in the beer and give it a shorter shelf life (White & Zainasheff, 2010).

**Hops.** It is unclear as to when hops were first used as an ingredient in beer. There is evidence that it became very popular during the 9th century as farming records, beer recipes, and other writings reflect. Believed to grow wild in France and central Europe and hops became popular as it spread throughout Europe and England (Hornsey, 2003).

Many different types of plant fauna and fruits were used to spice beer over the ages. Hops became popular because they were easy to grow, easy to harvest, were flavorful, had distinct
aroma, and proved to be a good preservative. The monks of a Benedictine order in Bavaria are credited with first cultivating hops as an ingredient for beer around 859 AD. Today hops are grown in the United States and throughout the world (Hornsey, 2003).

*Hamulus lupulus L.* is the botanical name for hops and is popular in today’s Indian Pale ale style of beers. There are male and female varieties of hop plants but the brewer is only concerned with the female plant and the aromatic cones it produces. The male plant flowers and is only used in breeding (Jason, 1996).

Hops come in many different varieties but take on different characteristics depending on where they are grown and the climate and soil conditions. The different flavors, aromas and bitterness contained in hops come from three chemicals consisting of essential oils, hard resins, and soft resins. The flavors in the hop come from the 250 essential oils and the bitterness comes from the soft resins broken down into alpha and beta acids. The hard resins are part of the hop but have no part in the taste of beer (Jason, 1996).

**Adjuncts.** As the name implies an adjunct is a supplement added to the main part of something. In modern brewing adjuncts are popular with the microbrew industry and can be any ingredient that adds something to the quality (taste, color, or body) of the beer (Jason, 1996).

Adjuncts are not new; they originated in the Middle Ages and were called Gruits. The definition of a Gruit is, “The combination of vegetable matter used as an additive in brewing” (Hornsey, 2003). In those days ingredients were hard to acquire and people brewed with whatever was indigenous and non-poisonous to their region. Even big brewers and monasteries brewed Gruit but acquired the best ingredients of laurel leaves, rosemary, heather, sweet gale, and hops (Hornsey, 2003).
Hops was originally considered a Gruit because it was just another indigenous plant that grew wild. During the 14th century hops became so popular for their aroma, taste, and preservative value that the beers made and spiced with other ingredients slowly disappeared (Hornsey, 2003). Large modern breweries use grain adjuncts of corn and rice to lower the protein, raise the conversion enzymes, or to add a different taste and character to the beer.

The Processing of Raw Materials

Malting. The art of malting parallels the art of brewing beer. Both subjects have become a merger of scientific knowledge and artistic knowhow in modern times. Brewing quality beer starts with a quality grain that has been grown and harvested with great care. After the harvest this high quality grain is then cleaned, sorted, and processed (malted) under closely controlled conditions to deliver the highest quality malt for brewing beer (Mallett, 2014).

U.S. Malting Industry. In 2014 it is estimated that 22 million metric tons of malt were produced worldwide (First Key, 2014). In 2012 craft brewers accounted for 18% of U.S. malted barley demand at 405,000 tons with 61,000 tons being specialty malts (Montana Department of Commerce, 2014). The overall malt produced in the U.S., calculated from the largest malt producers, is 1.52 million tons (First Key, 2014).

Barley production has been in decline for many years but is on the rise again due to the demand for locally sourced products, malt export demands (Bond, Capehart, Allen, & Kim, 2015), and the craft beer industry (Heisel, 2014).

Barley Quality. All barley can be malted, but not all barley is good for malting. The characteristics of a good malting barley are as follows:
• Must be carefully harvested as too many broken or skinned kernels are not good for germination.

• Pre-malting storage of the grain should be well ventilated with the moisture content kept below 13 percent.

• The plumpness of a kernel is a factor as plump kernels process with lower levels of husk and contain higher amounts of starch.

• Must germinate rapidly and uniformly.

• Must have good levels of enzymes.

• Must have protein levels of 12 percent or less. (American Malting Barley Association, 2016)

**Malting Basics.** The basic process of malting barley:

• Wet the grains and keep them moist for germination.

• Let them sprout.

• Dry them and remove the rootlets.

This process is deceptively simple and manageable in small quantities. This becomes quite technical when the volumes of grain being processed are in thousands of metric tons (Mallett, 2014).

**Malting Technology**

**Renaissance Technology.** English author William Harrison’s 1577 account on England of that time included a description of malting technique (Mallett, 2014).

The best barley, which is steeped in a cistern, in greater or less quantity, by the space of three days and three nights, until it be thoroughly soaked. This being
done, the water is drained from it little and little, till it be quite gone. Afterward they take it out, and, laying it upon the clean floor on a round heap, it resteth so until it be ready to shoot at the root end, which maltsters all combing. When it beginneth therefore to shoot in this manner, they say it is come, and then forthwith they spread is abroad, first thick, and afterwards thinner and thinner upon the said floor (as it combeth), and there it lieth. (Harrison, 1577)

The technique just described is still used in varying forms today. It is labor intensive, processed in large quantities, raked and shoveled by hand for drying (Mallett, 2014).

**D’Heureuse Air Treatment.** In 1875 Rudolph D’Heureuse applied for a U.S. Patent (U.S.P. #179,700) for an invention that used free circulation of moistened air for barley germination. The moistened air was kept at a temperature between 60 and 70 degrees Fahrenheit and considered a suitable temperature for germination (Mallett, 2014).

**Galland-Henning Pneumatic Malting Drums.** Nicholas Galland had a patented air circulation system but took malting a step further by incorporating a circulation system into spinning metal drum. The barley was placed in the drum and slowly turned while moist air was pumped in resulting in a more uniformed malt. The first drums went to Germany and some to Milwaukee, Wisconsin. Julius Henning a German inventor later contributed to the design. In 1887 Robert Nunnemacher bought the American rights for the design from Galland and Henning and started the Galland-Henning Pneumatic Malting Drum Manufacturing Company in Milwaukee. The company eventually manufactured brewing industry machinery to those who would become giants in the industry today including Blatz, Schlitz, Anheuser-Busch, Miller, and
Pabst. The company is still in business today under the name of Galland Henning Nopak, Inc. (Nopak.com, 2016).

**Compartment based Malting.** In 1877 Jules Saladin applied for a U.S. Patent (U.S.P # 192292 A) for his invention of an apparatus that is described as a large steel rectangle box that contains 55 to 60 inches of wetted barley and is aerated by stirring the slurry with large helical mechanical screws. At the same time cool humid air is pumped through the mixture. This came to be known as the Saladin Boxes and the technology is still in use today (Mallett, 2014).

**Towering Malting Systems.** This system is a vertical tower and has different levels with chambers for steeping, germinating, and kilning the barley with a final discharge of processed malt in the bottom chamber. The tower uses gravity for grain movement to the next level. This type of system was developed in the 1960s and is still in use (Mallett, 2014).

**Pre-Malting Treatments**

There are a number of pre-malting treatments and inspections that must be accomplished prior to being sent to the malting facility (Mallett, 2014).

1. The grain must be inspected and tested to ensure it is the right quality for malting. This includes testing for protein, starch, and enzyme levels.

2. The grain must be thoroughly inspected for disease including insect damage, head blight that produces *deoxynivalenol* (DON) a mycotoxin, and *fusarium graminearum*, a fungus.

3. The grain must be inspected for damage to include broken kernels, insect damage, and pre-harvest sprout damage.
4. The grain must be sorted or graded so that the kernels are healthy, plump and uniform.

5. The grain must be cleaned of field debris, rocks, trash, weeds, stems etc. (Mallett, 2014)

![Malting Process Diagram]

Figure 1. The Malting Process

**Malt Attributes**

While developing good malts in the past, maltsters and brewers alike relied on good understanding, experience, and sensory perception in testing the raw materials used in the brewing process. This included the look, smell, taste, color, and texture of the malted barley. Today there are a number of scientific tests performed before the malt arrives at the brewery. Along with the malt a certificate of analysis (COA) is included in the order (Mallett, 2014).
The purpose of the COA and the many attributes listed on it are twofold: (1) to make predictions of how it will perform during the brewing process, and (2) serve as a record for malt house production analysis. The following are attributes listed on a COA:

**Protein Modification.** Includes the pH values (level of modification and estimation of wort pH), soluble protein ratios (level of malt modification), and a measure of the amino acids (healthy yeast growth and fermentation) (Mallett, 2014).

**Carbohydrate Enzymes.** Test for diastatic power and alpha amylase. This translates to the efficiency of the malt to convert its starches into sugar during the mashing process (Mallett, 2014).

**Carbohydrate Extract.** This is a quality test for the content of water, protein, soluble carbohydrates, and insoluble substances. The flavor and alcohol content in beer is a function of the extract or soluble carbohydrates (Mallett, 2014).

**Carbohydrate Modification.** Describes the breakdown of the carbohydrate including the fine/course difference (measures extract yields during fine and course grinding), friability (brittleness), viscosity, and beta gluten level (gums) (Mallett, 2014).

**Other measurements.** There is an assortment of other measurements that include: acrospires length, flavor, color, disease, molds, carcinogens, broken kernels, and bushel weight (Mallett, 2014).

**Storing Malt**

Malt, as does other agricultural products, has a shelf life; however, through best practices packaged malted barley can be stored and protected for up to 24 months. It is suggested that malt be used within six months of manufacture for full flavor effects (Brewingwithbriess.com, 2016).
Threats to the malted grains include: moisture, insects, and pests. The equipment used to store the malt, either at the malt house or the brewery, should be kept in clean and good working condition. Periodic inspection and maintenance is paramount both for the grain and the equipment. Moisture is the worst enemy, especially in regions with high humidity. Moisture can spoil and damage the malt so any indication of it should be handled as soon as possible (Mallett, 2014).

**Types of Malt**

Types of malt used in a beer recipe or formula are dependent on the desired type of beer, color, and finished flavors sought. The lighter colored barleys are generally used as base malts and have low protein and high enzymatic characteristics. Base malts are usually the majority of the malt used in a recipe. The darker kilned or roasted barleys go through a number of different treatments for color and flavor characteristics. They have little to no enzymatic value and are used in the beer primarily for flavor and color characteristics. The following breakdown is provided:

*Base Malts.* Have enough enzymes for self-conversion. Generally used as the base malts for all types of beer. These include Pale, Pilsner, Pale Ale, Munich, and Vienna malts.

*Caramel Malts.* Un-kilned malt that is drum roasted straight from the germinator. These include Crystal, Dextrin, and Hybrid malts.

*Roasted Malts.* Base malts that are roasted for flavor and color but have no enzymatic value. These include Biscuit, Amber, Brown, Chocolate, and Black malts.
Special Process Malts. These are not typical malts. Beers made with these types of ingredients will probably only be found in brewpubs or specialty beer stores. These include Acidulated, Peaty, and Smoked malt (Mallett, 2014).

Grain Milling

An important aspect of quality brewing which is often overlooked by less experienced brewers is the quality of the grist used in the mash tun. Grist is crushed malt that has gone through a set of grinding rollers in a mill. Mills are mechanically technical and come in many sizes and compositions depending on the brewer’s needs and what kind of capital is available (Mallett, 2014).

The factors to consider when selecting the milling equipment is the size of the brewery, the yields of extract desired, type of brewing equipment, type of brewing process used, dust management, cost in time, and quality of the malt used. These are many factors to consider but an experienced brewer will know the capabilities of the brewery and adjust accordingly (Mallett, 2014).

A home brewer may have a simple hand cranked two roller mill which can process a grain bill for a five gallon batch of beer within 30 minutes. The rollers of this mill will have some adjustment to grind the malt finer or coarser. As a home brewer uses the malt husk as a filtering element to drain off the wort a coarse grind is desired. The tradeoff between a course and fine grind is the lower amount of endosperm exposed to the mashing process results in less extract from the malt (Mallett, 2014).

This same example can be applied to the larger beer manufacturers and microbrewers. The equipment and the process will determine the tradeoffs:
- The finer more consistent grind equals more extract per pound of malt, saving cost in material.
- The larger capacity of the mill equals saving cost in labor and time.
- The finer the grind equals the greater possibility of gumming up the process depending on the type of equipment used. (Mallett, 2014)

There are three types of milling processes to consider: dry milling, wet milling, and steep conditioning wet milling. Each has its own set of advantages and disadvantages depending on the characteristics of the brewery. If a large brewery has a several thousand pound grain bill per batch of beer even a small percentage in material savings will pay for a quality mill (Mallett, 2014).

**Hops Processing**

Hops may be used dry or wet depending on the brewing recipe. The use of wet hopped beers has been popular in recent years, but the brewery must be relatively close to where the hops are grown. Hops have a short shelf life and can spoil within hours of the harvest; therefore, expedient handling and processing is in order. The main characteristics in the hop that must be preserved are the acids and essential oils used for bittering and aromatic flavoring (Fisher & Fisher, 1998).

**Local Processing.** Once the hops are harvested they must be shielded from sun and artificial light. The drying process should commence as soon as possible. Low yields can be dried in paper bags or placed on a screen in an area that is dry, warm, and dark. The use of an oast is more practical for larger yields. An oast enables larger amounts of hops to be stacked in
units with air circulated throughout. Packaging and freezing should be done immediately after the hops have been dried. Once frozen the hops will stay fresh for up to one year. Hops that are dried and intended for use within a few days may be refrigerated (Fisher & Fisher, 1998).

**Commercial Processing.** On a commercial scale, hops processing essentially uses the same handling principles previously discussed with the difference being the amount of material processed and the facilities used (Azeus, 2016). The main processes involved are:

1. **Testing for chemical qualities after harvest.** This is usually done with an on-site laboratory. It is essential information for the brewer’s knowledge when formulating a recipe.

2. **Drying of the ingredients.** This is essential for preserving acid and essential oil properties. The strengths of these properties decrease the longer it takes to process. An eight to ten percent moisture level is desired and accomplished in large quantities of hops using similar techniques already described. After the drying process the hops must be cooled.

3. **Crushing.** A high speed hammer mill is used in the crushing process reducing the hops to a pre-determined size of particle.

4. **Pelletizing.** After they are crushed and reduced the hops are forced through a die and cut into predetermined links. Care must be taken not to overheat the material in this process as heat can degrade the chemical properties of the hops.

5. **Packaging.** After being pelletized and cooled the material is ready for packaging. The main concern in packaging is oxidation of the hop material over time. A system of packaging should be selected that eliminates light and air from the product. After packaging the product should be frozen and kept frozen for shipping (Azeus, 2016).
The Agricultural Side of Beer

Barley Industry

Barley is a minor player in overall grain production worldwide and seems to take a back seat to the more important world food crops of corn, wheat, and rice. Barley is extremely resilient and can grow and thrive in harsh environments. It is grown all over the globe, from tropical to frozen regions (Crop Trust, 2016).

This section is an exploration in the current barley industry. Barley and barley malt are both worldwide traded commodities. It is a cash crop to farmers, the malting industry, and the food/ beverage industry and contributes greatly to the economy of the states in which it is grown (Montana Department of Commerce, 2014).

World Industry. A USDA report for market year 2015/2016 indicates worldwide production of barley was 141 million metric tons (USDA, 2016b). The leading uses for barley in order of importance is: animal feed (high protein type), malted beverage (low protein and high enzymatic value), seed, and food (Crop Trust, 2016). A 2013 estimate ranks barley 4th in worldwide grain production and sits at 144 metric tons as compared to corn at 1,018 metric tons (Statista.com, 2016a).

The top producers of barley in the world are Russia, Australia, Canada, France, and Germany, and the top importers are Japan, China, Saudi Arabia, Belgium, and the Netherlands. As of February 2016 total barley in world trade amounted to 26.3 million metric tons. The top consumers of barley are the European Union, Russia, Saudi Arabia, and Canada. Developing nations with harsh climates account for 18% of barley production and 25% of land used for
barley production (Crop Trust, 2016). The total world land mass used in the production of barley is 49 million hectares and equates to 121 million acres (USDA, 2016d).

**U.S. Industry.** The United States ranks 11th in world barley production at 4.62 million metric tons, using 3.11 million acres of land according to a 2016 report (USDA, 2016e). Barley is grown throughout the United States for the same uses previously mentioned: animal feed (52%) and beer (40%) with the other 8% as food products and seed (Limagrain Cereal Seeds, 2010).

In the 2015/2016 market year U.S. barley imports were 391,900 tons and exports of 261,267 tons. The price for barley was between $5.30 and $5.70 per bushel, and averages to a $1.7 billion industry for that year. Malting barley is predominantly grown in the northern plains of the United States, contributing to jobs and the economy in that region. In 2015 the U.S. exported 149,000 tons of malt and imported 16,000 metric tons.

Table 1 illustrates the barley industry of the U.S. as compared to the world and other select countries.

Table 1

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<tr>
<th>World Barley Comparison by Select Country</th>
<th>Production Tons</th>
<th>Imports Tons</th>
<th>Exports Tons</th>
<th>Food, Seed, Industrial Tons</th>
<th>Feed Tons</th>
<th>Farm Price = Dollars/Bushel</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>146.16M</td>
<td>26.3M</td>
<td>26.3M</td>
<td>42.28M</td>
<td>97.21M</td>
<td>N/A</td>
</tr>
<tr>
<td>U.S.</td>
<td>4.62M</td>
<td>391,900</td>
<td>261,267</td>
<td>3.33M</td>
<td>1.08M</td>
<td>$5.30-$5.70</td>
</tr>
<tr>
<td>EU</td>
<td>61M</td>
<td>0.3M</td>
<td>8.6M</td>
<td>15.6M</td>
<td>37.5M</td>
<td>N/A</td>
</tr>
<tr>
<td>Canada</td>
<td>8.2M</td>
<td>0.1M</td>
<td>1.4M</td>
<td>1.2M</td>
<td>5.4M</td>
<td>N/A</td>
</tr>
<tr>
<td>Austral.</td>
<td>8.7M</td>
<td>0.0</td>
<td>6.0M</td>
<td>1.3M</td>
<td>1.3M</td>
<td>N/A</td>
</tr>
<tr>
<td>Russia</td>
<td>17.1M</td>
<td>0.1</td>
<td>3.7M</td>
<td>4.8M</td>
<td>9.1M</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Source Data: USDA Market Years 2015/2016
Overall agriculture activities contributed 17.3M jobs, 14.7 million jobs to associated industries, and a total share of 4.8 percent of the GDP during 2014 in the U.S. (USDA, 2016a).

**Figure 2. Employment in Agriculture and Related Industries, 2014**

**Figure 3. Value Added to GDP by Agriculture and Related Industries, 2007-2014**

**NE Tennessee and SW Virginia.** Researching the USDA web sites for information on barley in Tennessee and Virginia has yielded an illustration of the area of interest (Appendix A) and information of estimated crops grown in that area on Table 2. Additional information has been captured through various news articles, studies, and conversations with those within the agricultural industry. During the last year the researcher has attended two area agricultural events and talked with several farmers and officials in the region.

As a composite of the researcher’s various conversations there was a consensus that it was a good idea to grow malting barley in the region as most farmers already grew barley as an animal feed. It was further indicated that the problem with growing feed barley in this area was
the climate and amount of moisture through rain and humidity. Heavy moisture can be a problem causing mold and disease which can be devastating to barley crops (Personal communication, 2015 & 2016).

Table 2

TN Agricultural Products in Acres

<table>
<thead>
<tr>
<th>Crop Value</th>
<th>Category</th>
<th>Pixel Count</th>
<th>Acreage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corn</td>
<td>644565</td>
<td>143347.8</td>
</tr>
<tr>
<td>5</td>
<td>Soybeans</td>
<td>680597</td>
<td>151361.1</td>
</tr>
<tr>
<td>11</td>
<td>Tobacco</td>
<td>16835</td>
<td>3744</td>
</tr>
<tr>
<td>12</td>
<td>Sweet Corn</td>
<td>5602</td>
<td>1245.9</td>
</tr>
<tr>
<td>21</td>
<td>Barley</td>
<td>2405</td>
<td>534.9</td>
</tr>
<tr>
<td>24</td>
<td>Winter Wheat</td>
<td>15582</td>
<td>3465.4</td>
</tr>
<tr>
<td>27</td>
<td>Rye</td>
<td>5124</td>
<td>1139.6</td>
</tr>
<tr>
<td>28</td>
<td>Oats</td>
<td>1458</td>
<td>324.3</td>
</tr>
<tr>
<td>29</td>
<td>Millet</td>
<td>221</td>
<td>49.1</td>
</tr>
<tr>
<td>39</td>
<td>Buckwheat</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>236</td>
<td>Dbl Crop WinWht/Sorghum</td>
<td>310</td>
<td>68.9</td>
</tr>
<tr>
<td>237</td>
<td>Dbl Crop Barley/Corn</td>
<td>9701</td>
<td>2157.5</td>
</tr>
<tr>
<td>254</td>
<td>Dbl Crop Barley/Soybeans</td>
<td>15625</td>
<td>3474.9</td>
</tr>
</tbody>
</table>

Source Data: USDA https://nassgeodata.gmu.edu/CropScape/
In 2008 the University of Tennessee, Institute of Agriculture conducted a study in collaboration with Anheuser-In-Bev to grow three 6-row varieties of barley. The varieties of Thoroughbred, Price, and Eve were developed at Virginia Tech. The seed was planted in six different areas of Tennessee. The Knoxville area plot was not included due to a hail storm that destroyed the plot. The experiment of the five remaining plots turned out well with very good yields and showed promise for this winter crop in Tennessee (Allen, Johnson, Williams, & Main, 2008; UT AgResearch, 2008).

On the Virginia side farmers are being very proactive in the pursuit of malting barley. In a 2015 Americanfarm.com article Virginia farmers, maltsters, and brewers are coming together in a collaboration to grow and source local grains (Clougherty, 2015). The state of Virginia, as with many states across the nation, has a growing micro-brewing industry and the need for quality raw materials is in demand. Currently malting barley is somewhat of a niche market with only 500 acres being grown state wide, but the “Barley to Beer” movement is pushing forward. Growing malting barley can be risky due to fungus and disease, but research continues to improve the varieties for adaptation to the regional climate. In the meantime the state still has a very large feed industry and grows about 33,000 acres of feed barley (Clougherty, 2015).

**Tobacco to Grains**

In 2004 the U.S. Government de-regulated the tobacco industry. Before this time tobacco farmers who were granted the rights to grow tobacco received a subsidy from the U.S. Government in the form of artificially elevated prices for their crop. This kept smaller farms in business and the tobacco industry on the world map as foreign tobacco markets were becoming increasingly competitive (Bomey, 2015).
As part of the deregulation deal and to ease the loss of revenue for the farmer a 10-year program, the Tobacco Transition Payment Program (TTPP) was established to be financed by tobacco manufactures. This would enable farmers to stay in business and transition to another cash crop or revamp their tobacco business model to stay in business without the government subsidy (Bomey, 2015).

By 2005 and subsequent years afterwards many smaller farms stopped growing tobacco altogether. A lot of them sold their tobacco growing rights to investors and some farmers who decided to stay in the tobacco trade bought up smaller farms in order to grow more tobacco. In 2014 the TTPP payments ended and the farmers who are left are strictly on their own and in full time competition with foreign markets (Bomey, 2015).

Some farmers have diversified into soybean, wheat, corn, and malting barley as cash crops. One farmer in North Carolina is growing a newer strain of wheat along with tobacco. The tobacco must be rotated to different fields every year and the wheat makes an excellent cover crop where the tobacco previously was grown but the wheat is also a cash crop for harvest. The wheat was being used exclusively for the baking industry but with the growing demand from the micro-brewing industry some is now being sold to a local malt house (Goalen, 2015).

Some farmers in Tennessee and Virginia are experimenting with growing newer strains of malting barley that have had promising results in this region. Barley is an excellent cover crop whether grown for animal feed or for human consumption. It also makes an excellent winter crop for harvest just before summer crops are sown or can be grown in the summer (Stanley & Stanley, 2004).
Statement of the Research Question

With the growing demand of malted barley across the U.S. due to the beer brewing industry, does this region have enough demand from the local microbrewers to warrant growing, processing, and malting its own barley?
CHAPTER 3
RESEARCH METHODOLOGY

Research Design

The research model for this thesis is descriptive in nature and uses both qualitative and quantitative analysis. The main purpose of the survey and interview questions was to establish the demand for barley malt in the Northeast Tennessee and Southwest Virginia region. Determining the demand for barley malt was very important to this study as without the demand, the need for locally malted barley would be a moot point. Additional survey and interview questions were asked to establish grain and micro-brewing industry trends in the area as related to available supplies, distributors, origins, and types of grains preferred as well as business models, quality factors, industry barriers, and niche ingredients. As an add-on research project for the agricultural side of this thesis the researcher planted, grew, and harvested a four foot by four foot patch of barley to make first hand observations of barley growth in the Tennessee climate.

Research Model

The research was conducted through personal interviews on specific subjects and also through a data gathering device. Trends and data analysis will be noted and cataloged with the use of Excel spreadsheets.

Survey Population

The survey population was obtained from breweries and brewer supply shops in Northeast Tennessee, Southwest Virginia, and Western North Carolina. In essence, the area of
interest was a 100-mile radius with the city of Johnson City, Tennessee, as the center point. Some breweries selected were just outside of the area indicated. The total count of breweries and brewer supply shops in the area indicated is 50 and the researcher was able to make contact and sample 22 of these. The ideal sampling would have been a total of 33 for a 90% confidence rate with a 5% margin of error; however, this was not possible given the timeframe and reluctance of the survey population to be interviewed. The total number of 22 sample subjects works out to a 14% margin of error.

**Sources of Data**

The primary source of data collected was the survey results. A secondary source included the personal interviews with each surveyed subject asked to respond to interview questions and follow-up discussions. Additional data were collected through observations of the barley crop grown and harvested by the researcher.

**Data Gathering Device**

A ten-question survey was used as a data collection device and all interviews were recorded and annotated and the recording was subsequently erased. The survey was not anonymous during collection and consisted of “Yes” or “No” questions, a business location demographic question, ingredient/product quantity questions, and general industry questions for descriptive analysis. There was space allocated on three questions for additional responses and all participants were asked to include any additional responses they had. After the research participants completed the surveys and interviews were conducted, the data findings were compiled without company names (anonymously), and findings were transferred to an excel...
spreadsheet for analysis. All additional responses and answers to follow-up questions were analyzed for patterns and trends.

**Distribution Method**

During the data collection process, a period of about three weeks, the researcher contacted every brewery and brewer supply shop found within the 100-mile area of interest. The researcher visited those that responded to phone calls and emails. During these on-site visits subjects completed surveys and electronically recorded interviews were conducted. The researcher was also given a tour of every facility visited.

**Treatment of Data and Procedures**

Research participants were asked to answer the survey as completely as possible and were told the interview would be electronically recorded (with participant permission) and the information (both survey and annotated interviews) would be entered into a spreadsheet without source identification. This was done for two reasons: (1) to protect the respondents’ privacy and (2) as a preventative measure so the researcher could not form any biases or opinions about any participant. After all data was gathered the quantitative and qualitative findings were compiled into excel spreadsheets for pattern and trend analysis.
CHAPTER 4

RESULTS

The research question presented at the end of Chapter 2 was supported by the subject responses indicated in the surveys and interview responses. For each survey and interview question the researcher provided a brief explanation of the question’s background so that the reader could better understand the researcher’s focus and scope. The researcher applied quantitative and qualitative calculations where applicable. If a qualitative analysis were done on a particular question, results would indicate whether or not any pattern or trend should be noted during the analysis and will be further reviewed in Chapter 5. Copies of the survey and interview data composite are included in Appendix C and E.

Survey Questions

There were a total of 22 survey participants who answered 10 survey questions. These questions included:

- One company identification to be used in the event of follow-up questions prior to data analysis.
- One opinion.
- Two preference.
- Six industry demographic questions

For further breakdown within the survey there were two “Yes” or “No” questions, two quantity questions, and one range question. In addition to the yes/no and in/out/or both responses (total of 3 questions) survey subjects were asked to explain their answers and were afforded
space to do so. Any question that was not answered by the survey participant was indicated with the total number of participants that answered the question.

**Question 1.** This question asked for the company’s name and was designed for initial identification of the company in the event the researcher had follow-up questions before the information was anonymously annotated into a spreadsheet for analysis.

**Question 2.** This requested company location demographic. The study indicated a 100-mile area of interest with Johnson City as the center point. The researcher wanted to provide geographical locations within the area of interest as descriptive detail.

**Question 3.** This question is a professional demographic question and was designed to measure the subject’s average time in the Micro-Brewing industry either as a professional brewer or an associate in the industry. The researcher determined that this could be a good descriptor as to experience within the profession and may be relative in the overall analysis. The findings indicate that of the 19 subjects that answered this question five of those surveyed (25%) had been in the business 10 years or more; the remaining 15 subjects (75%) averaged 3.39 years as professionals in the industry.

**Question 4.** This question was formulated as a preferential/opinion question to learn what varieties of barley are preferred by brewers in the region to be used as a base malt for their beer product. The base malt is the majority of malt used for the grain quantity of a recipe. This is a broad question as there are many base malts on the market. The answers to this question ranged from 2 Row, 6 Row, Grain Companies named, and specific barley names; the results are tabulated in Appendix C. Determined through conversations with the subjects and for the sake of
this study most brewers use 2-row pale barley as a base malt and some use 6-row or both as their base malt. The 2-row and 6-row come in many different varieties.

**Question 5.** This question was designed as a company demographic question designed to identify the main distributors of grains to this region. This is important to know as it gives an idea of the logistics for distribution to the area. After close scrutiny of the grain vendors listed, it was apparent that they could be divided into business sub-categories of Brewery Distributors, Home Brewery Store Distributors, and Maltster Distributors. Most of the Micro-Breweries use Brewers Supply Group (BSG) for their barley needs. BSG and Handcraft are owned by the Rahr Corporation and also are the United States distributor of Weyermann malt from Bamberg Germany. One point to keep in mind is that the brewery distributors stock the malt from large industrial malting companies. If a brewery uses high volumes of malt it can buy directly from the large industrial malting company. The researcher again used Johnson City as the center point in formulating the distances from the various companies. The results are annotated in Table 3 with the distributors, distances, locations, and number of times listed included.

Table 3

*Grain Supplier Use and Distance Chart*

<table>
<thead>
<tr>
<th>Distributors</th>
<th># Times listed</th>
<th>Miles away from Johnson City</th>
<th>Distributor Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brewery Distributors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brewer Supply Group (BSG)</td>
<td>9</td>
<td>266</td>
<td>Atlanta, GA</td>
</tr>
<tr>
<td>Country Malt</td>
<td>5</td>
<td>75</td>
<td>Fletcher, NC</td>
</tr>
<tr>
<td><strong>Home Brew Store Dist.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brewcraft USA</td>
<td>2</td>
<td>0</td>
<td>Local</td>
</tr>
<tr>
<td>Handcraft (BSG)</td>
<td>1</td>
<td>0</td>
<td>Local</td>
</tr>
<tr>
<td>L.D. Carlson</td>
<td>2</td>
<td>14</td>
<td>Hampton TN</td>
</tr>
<tr>
<td><strong>Maltsters and Distributors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Briess Malt Co.</td>
<td>4</td>
<td>805</td>
<td>Chilton, WI</td>
</tr>
<tr>
<td>Rahr Corp. (Owns BSG)</td>
<td>1</td>
<td>1,070</td>
<td>Shakopee, MN</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---</td>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>Weyermann (Dist. By BSG)</td>
<td>1</td>
<td>1,070</td>
<td>Shakopee, MN</td>
</tr>
<tr>
<td>Cargill</td>
<td>1</td>
<td>786</td>
<td>Sheboygan, WI</td>
</tr>
</tbody>
</table>

**Question 6.** This is a “Yes” or “No” question with space provided for additional explanation. The question was designed to solicit opinion and attitudes on buying malted barley that was locally grown and malted in the region. The results indicated 19 “Yes,” 1 “No”, and 2 “Maybe.” The most common explanations indicated supporting local, cost, quality, and availability.

**Question 7.** This question was designed to quantify the amount of beer brewed by the survey subjects on a monthly basis. This nominally correlates with the amount of barley used and also gives greater definition of the micro-brewing industry in this area. The results indicate that on a monthly basis the quantity of beer brewed is 170,506 gallons with an annual total of 2,046,072 gallons. The amount of beer brewed by home brewers was estimated by the amount of malted barley purchased from Home Brew Supply Stores.

**Question 8.** This question was designed to quantify the amount of malted barley used by the survey subjects on a monthly basis. The question also applies to the Home Brew Supply Stores regarding the amount they have sold to home brewers on a monthly basis. Together they form a composite of the nominal amount of malted barley being used in this area. The results indicate that on a monthly basis the quantity of malted barley used is 303,470 pounds with 3,641,640 pounds annually. The amounts of barley used by home brewers were derived from the amount of barley sold by Home Brew Supply Stores.

**Question 9.** This question is an industry demographic question to indicate how many of the breweries surveyed distributed inside the region, outside of the region, or both inside and
outside the region with added space provided for explanation. The definition of distribution inside the region could be to a brewpub, across county lines, or elsewhere in the region. The definition of outside the region would be outside the area of interest or a 100 mile radius around Johnson City, TN. The Home Brew Supply Stores was not included in this question. The researcher asked this question for general information as a descriptor of the brewing business. The results indicate that 11 distribute inside the region and 7 distribute both inside and outside the region.

**Question 10.** This is a “Yes” or “No” question with space provided for additional explanation. The question was designed to learn whether the survey subjects had an interest in using organically grown and non-GMO barley as an ingredient as opposed to GMO commercial barley. The researcher thought this was significant as not only a generalized ingredient type descriptor but also as a descriptor in the realm of niche ingredients. The results indicate, 19 “Yes” and 3 “No” with explanation answers indicating: already use, as natural as possible, want it, not concerned, no interest.

**Interview Questions**

There were a total of 20 interview participants that answered 10 interview questions which resulted in a total of 12.4 hours of interview time. Overall, the interview questions included five “Yes” or “No” questions and five descriptor questions all designed to give understanding and insight into the micro-brewing industry. A total of four interview questions either directly or indirectly overlap four of the survey questions and will be observed during the background description of the questions to which this applies.
The interview questions were analyzed qualitatively with the results arranged in quantified answered categories of first, second, and third most answered results to the questions. Note that some results indicate the phrase “or a facsimile of,” indicating several answers of similarity. A narrative of overall findings to each question is included and also noted comments of interest the researcher thought had informational value and would add to the subject discussion.

**Question 1.** This is an opinion question designed to query the survey subject’s personal observations of the changes to the micro-brewing industry within the Northeast Tennessee (TN), Southwest Virginia (VA), and Western North Carolina (NC) region. The researcher determined that this would provide information and insight into the trends of the micro-brewing industry in the selected region with respect to when it began and how far it has progressed.

**Narrative.** The most prevalent answer from the interview participants was that there had been growth in the micro-brewing industry. The conversations ranged from the micro-brewing boom currently underway in the United States to the number of micro-breweries opening in this region. Five years ago there were only four micro-breweries in the Tri-cities and Abingdon areas. Currently the number is up to eight with an additional two possibly opening soon. Other conversations included topics of high gravity beers, state laws for the beverage industry in general, and the education of the government and public sectors about the micro-brewing movement. The tabulated results are as follows:

1. Growth of the micro brewing industry in this area or a facsimile of same.
2. Comments about high gravity beers.
3. Comments about state laws.
Comments of interest: Public education about microbreweries.

**Question 2.** This is a two-part question. The first is a “Yes” or “No” question to determine if the survey subject thought the area was becoming saturated with micro-brewers. The second was an “Or” question to determine if the subject thought there was still room (capacity) for more competition (in the micro-brewery industry) in the area. This is an opinion question that attempts to provide insight from those in the industry on their thoughts about saturation of micro-breweries in the area and how this is perceived from the competition point of view. In addition, this is an overlap question from survey question nine.

**Narrative.** Overall, 17 of the 20 respondents who were interviewed indicated they do not think the area is saturated and there is plenty of room to grow. The two respondents who thought the area was over-saturated indicated this was because there are too many breweries for the number of micro-brew clientele and for those fighting for shelf space and taps at bars/restaurants. In addition at least six of the brewers thought the area would eventually become saturated whereas some of the brewers thought the area could never be saturated, using Asheville, North Carolina, as an example. The tabulated results are as follows:

#1: Plenty of room to grow or a facsimile of.

#2: The more breweries the better or a facsimile of.

#3: At least two brewers thought the market was saturated or in some way saturated and six others thought saturation was inevitable in time.

Comments of Interest:

- Micro-brewers are not in competition against each other or facsimile.
• If there are several of such as this in one area within walking distance it attracts people because they like to try out many different places.

**Question 3.** This question asked if the barriers to entrants into the micro-brewing business were getting too challenging for newcomers to break into the business. The researcher explained to the respondents that a barrier could be anything that would make entering the business difficult (i.e., regulations, cost of equipment, experience).

**Narrative.** There was a variety of opinions to this question with 15 of 20 respondents indicating that the barriers are rising with respect to Federal, State, and Local regulations, cost of equipment, and the cost of real-estate. However, seven of the respondents indicated the barriers were lower in general or lower in some particular aspect with the ease in obtaining licenses and the procurement of materials and equipment. Some of the respondents thought the bar was rising because of the new entrants and competition in the area, thus raising the quality factor and the satisfaction of educated palates. Lastly, micro-breweries are becoming very popular and piquing the interest of investors. Those that have the available capital to start a brewery are doing so for the investment value and not the craft. The tabulated results are as follows:

#1: Mostly comments about government entities making things harder; however, some indicated governmental regulation was getting easier.

#2: Comments indicating that barriers are not that high.

#3: Split on tabulation of cost of equipment and cost of real-estate.

**Comments of interest:**

• With more breweries comes more competition so everyone is striving for a better product every day.
• Customers arrive with more discerning taste and more difficult to please.
• Finding the start-up capital.
• There are local challenges with saturation, and tap real-estate. If we’re distributing ourselves you have the challenge of working with the distributors.

**Question 4.** This is a technology question that inquires about the equipment in the respondents’ breweries. This question was formulated to see what kind of equipment is being used in this region in comparison to what the researcher has observed at the larger production breweries other parts of the country.

**Narrative.** Essentially the smaller the brewery the more manual labor is necessary. Most of the respondents indicate having no robotics or computer controlled equipment. There are, however, several statements indicating energy efficiency in equipment performance, recycling of materials, and green footprints. Three of the respondents indicate using computer systems in their process. The first indicates using a computer system that monitors supply, materials, and product logistics as well as management processes. The second indicated that he wrote a computer program to monitor and control temperature on a mistune and the third respondent worked in a Home Brew Supply Store and indicated that he sold a heat solenoid that was operated by a computer. The tabulated results are as follows:

1: We do it by hand or some facsimile.
2: Comments on existing equipment, equipment upgrades, and efficiency.
3: Comments on a green environmental footprint.
Comments of interest: Only three brewers indicated using any type of computer control.

**Question 5.** This considered the question, “What does it take these days to stay ahead of the competition?” This line of questioning is directed toward the micro-brewing industry and what differentiates one brewer from the next. Examples included serve food, type of food, type of cliental, target by demographics, and use niche ingredients.

**Narrative.** The most prevalent answer regarding staying ahead of the competition concerned the quality of the beer. The general feeling is also that, not only does one have to make a high quality beer, but a variety as well while using niche ingredients. Most of the micro-breweries did not serve food but food was available via restaurants within walking distance or themed food trucks offering different cuisines each day of the week. In addition, some of the breweries have become music venues with live entertainment, karaoke, or both. Some of the respondents indicated it was very important to be part of the surrounding community and give back to the community when possible. The tabulated results are as follows:

1. Comments about better beer, more variety of beer, niche beer.
2. Food either produced and served in the establishment or provided by food trucks or nearby restaurants.
3. Some kind of music venue.

Comments of interest:

- Remain local and be a member of the community. It’s not just about making beer and throwing it out there; it is giving the consumer a reason to identify with you.
• One of the challenges we face is brand proliferation.

• A good logo is good and must be eye catching with a catchy name.

• Good location to survive.

• Staying ahead of trends, reading all the latest literature.

• Location, Location, . . .

• Culture is another big thing . . . we cornered the market on that I believe – you know by starting a co-op and bringing in the community and getting them involved.

• Process improvement is one of the most important things to move a business ahead.

• Educate the population.

• Research and Development is the way to stay current.

• People are more educated about beer.

• Location. A lot of money to start-up.

• Just listening to the customers.

**Question 6.** This is a follow-up query to Question 5 and seeks to understand the business model the company follows regarding operations, customer base, product, and marketing.

*Narrative.* Again, the most prevalent answer was to make high quality beer which seems to be of utmost concern for craft brewers. Three basic business models surfaced from the survey.

The first model is that of a basic brew-pub where the beer is brewed, served, and consumed on premises. In some establishments the reviewer visited, beer purchases may be served in a personalized container. To this model food may be added via food trucks or co-
located with a nearby restaurant. Entertainment may also be added with music venues in or
nearby the establishment. This model generally has the brewing capacity of three barrels or less.

The second model is that of the basic brew-pub but with the added capacity of 3 to 10
barrels or more and the ability to package the product for distribution in cans, bottles, or kegs.

The third model is a brewery and restaurant combination. This may vary from basic in-
house simple foods to fine dining. This model may also package and distribute based on their
business model and brewing capacity.

In all three models the issue of producing high quality beer falls under the jurisdiction of
state and local laws. This is a factor in the business model as some locations tend to have more
stringent regulations on this point and may not be in the best interests of the company financially
to meet the requirements of the regulations. The tabulated results are as follows:

#1: Comments about the quality of beer made.

#2: Comments about packaging, marketing, and taps.

#3: Comments about food.

Comments of interest:

- Our goal is to control some of the other breweries in our region – to
  become a regional hub.

- Make it, get the product out there, and sell it.

- Making things in our community better as much as we possibly can . . .
  and allowing the community to help us grow.

- Specialized beef and beer.
**Question 7.** This question is designed to explore the supply chain logistics of raw materials used by the various companies interviewed. As grain is a traded commodity the question also explores the seasonal cost. This is an overlap question from survey question five.

**Narrative.** The highest number of comments to this question indicates that of the raw materials that are used for making beer, hops are the hardest to get. The larger volume breweries tend to negotiate contracts for the specific hops they want at least a year in advance. This is because, unlike barley, there is no real substitute for hops due to the uniqueness of each hop variety.

Concerning the availability of malted barley, not a single respondent indicated they had a problem getting whatever variety they wanted. Some brewers preferred barley that was available exclusively from Europe or a particular supplier. Table 1, under the survey section of this thesis, illustrates the suppliers used by the respondents. The only seasonal price fluctuations noted were those for hops. The tabulated results are as follows:

1. Hops can be a problem to get, or facsimile of.
2. No problems getting ingredients.
3. Answers indicating ingredients are contracted out.

Comments of interest: Demand for hops are going up and the price is going up as well.

**Question 8.** This question explores the respondents’ interest in buying locally grown and processed ingredients. The question considers the condition of price and quality sameness with materials the respondents already purchase. This is an overlap question from survey question six.
Narrative. The leading comment for this question is: absolutely, we support local. However, some respondents expressed concerns regarding the quality and price of the materials. It was noted that there is already a malting facility in Asheville, North Carolina, called River Bend Malting that has been in business for several years. One of the respondents indicated they already buy from this company. Some of the respondents indicated that River Bend was too expensive, they could not provide the volume needed, and the quality was not consistent.

Some respondents also noted that there are several hops farmers in the local area but the same concerns prevailed as to the quantities, price, and quality of the material. One respondent remarked that this region was not good for growing certain hops due to the soil and weather conditions.

Some of the respondents thought making a beer with local ingredients was a great marketing platform. The thought is that people are loyal to their hometown or area and will buy the product simply because it is local. The tabulated results are as follows:

#1: Yes, absolutely or a facsimile.
#2: Like local, support local or a facsimile.
#3: Use local hops.

Comments of interest:

- When you buy local, that quantifies into fresher. Everybody wins when you go local.
- People will buy local beer just because it’s local.
- I tend to go with cheaper grains because it comes down to good technique.
- Anytime we can find local ingredients to use we will.
**Question 9.** As malted barley, hops, yeast, and water have come to be known as the main ingredients of beer many micro-brewers use various other ingredients to spic the beer they make. This question was designed to explore the niche ingredient factor of the industry and to see what niche ingredients are being used to differentiate the product.

**Narrative.** All respondents indicated they use niche ingredients in some of the various recipes they use. The type of materials ranged from natural fauna from the Appalachian Mountains, fruits, vegetables, flavorings, coffee, and chocolate. The most unusual ingredient mentioned was smoked crickets. One respondent said that one of the great things about craft brewing is the experimentation and to be creative with it. (As a note: to be called a beer some part of the product must be made with malt or an authorized substitute for malt must be used in the beverage according to CFR Title 27, Part 25.) Any ingredient used in the beverage must be approved with a Certificate of Label Approval (COLA) from the Alcohol and Tobacco Tax and Trade Bureau (TTB). The tabulated results are as follows:

- **#1:** Yes, we already do, or a facsimile of.
- **#2:** Experiment, creative.
- **#3:** Must get approval of ingredients if you change your recipe.

Comments of interest:

- Anything you put on your plate you can put into beer.
- Anything you can think of that is edible has been used in beer.
- People make a cool beer and people like it.
- Chuck it in if it works.
**Question 10.** This is an opinion question exploring the respondent’s interest in the use of Organic and Non-Genetically Modified Organisms (GMO) ingredients. Specifically the question asked two things: Would it be a factor in the micro-brewing industry? And what impact, if any, would beer made with this type of ingredient have on the industry? This is an overlap question from survey question 10.

**Narrative.** Most of the respondents thought it was a good idea and had heard of other breweries using this type of material, but the caveat was a cost concern and that the cost would be reflected in the beer price. Others thought it was a marketing ploy and in the end the taste of the beer (either made with non-GMO ingredients or not) and satisfaction of the customer would be the determinate. The general consensus was that most customers would not care about this type of ingredient unless it greatly enhanced the taste quality.

- #1: Costs or a facsimile.
- #2: Organic and non-GMO good or facsimile of.
- #3: A marketing ploy or a facsimile.

**Comments of interest:**

- The economics of beer gets lost in the craft . . . craft gets over-romanticized.
- It might be a tie breaker for some people but in the end it will be the taste of the beer.
- Genetics and the genetics research are not only going to influence the beer industry, but are also going to save mankind.
• Just because they can make more money they slap and organic label on something.

• Briess malts are all non-GMO.

• It would be extremely difficult to have that organic malt for the volume (being produced).

• You’re going to have to follow the demand of the consumer so I don’t think it’s gonna have that much of an impact.

• It does not affect the beer at all.

• Most hops are really organic, without the certification.

• It would seem that the supply side is reacting to this because people are reading labels.

• Fresh and local is the big push that we have seen.
CHAPTER 5
DISCUSSION

Agriculture

If grains and grain processing had never been discovered the fermented cocktail of ingredients we know as beer might never have existed. It took thousands of years, but as technology progressed in farming and processing, so too did the quality of beer. This evolution has continued into the 21st century.

Farming technology, teamed with plant science, continues to expand the numbers of species of grains that will grow and thrive in harsh climates where ordinarily they would have been difficult to grow. This is true in East Tennessee and Southwest Virginia as new species of barley have been trialed in the last 10 years with promising results.

As farming is a business, yield and quality must command more revenue from the harvest and not exceed the costs of growing the crops. New types of seeds and plants are developed to withstand the humidity and rainfall in this area thus increasing the chances for successful crops. If the malting barley crop turns out well (i.e., of sufficient quality for brewing beer) it will capture a good return. If the crop does not result in the desired quality it can still be sold as animal feed but at a much reduced price. Grown malting barley is somewhat of a gamble causing a number of farmers to turn to other cash crops. Farmers in the Midwest where the grain business is lucrative have to be contracted prior to the growing season to entice them to grow malting barley. Still, a few problems do exist.

First, growing malting barley is unlike growing standard barley for animal feed. The seed is planted in the same manner but great care must be taken to control fungus and disease. This
requires more time in the field to perform visual checks and properly apply chemicals to control any outbreaks. This could result in additional costs for chemicals and labor and will affect the bottom line.

Second, the harvest of the barley must be meticulous in order to cause as little damage as possible to the grain. Too much damage in the form of broken or skinned kernels can greatly reduce the quality of the crop. If the damage is extensive maltsters and brewers will not accept it. Farmers in this region will have to be educated by the local farm bureaus and co-ops on the finer points of malting barley growing, harvesting, and handling techniques.

Third, if the region gets too much rain close to harvest time it may cause pre-harvest sprouts that can ruin a crop for malting purposes. This can be mitigated by the farmers keeping a close eye on the weather forecast and, if need be, harvesting early. Farmers and maltsters working with malting barley should work together and establish good lines of communication because neither will profit from the crop if it is of inferior quality fit only for sale as cattle feed.

The Processing of Malted Barley

Malting barley is as much a craft and a science as is brewing beer. The maltster needs to understand many things to produce a quality malt that is usable by brewers. To understand that quality is to understand the agricultural side (1) recognizing the attributes of quality malting barley, (2) understanding the changes that take place both physically and chemically during the processing stages that will make the barley be usable by brewers, and (3) protecting the malt until it gets to the brewer. The maltsters are the middle men, so to speak, as they are in contact with both farmer and brewer and should have a good relationship with both.
The Region

The Northeast Tennessee and Southwest Virginia region essentially has access to only two malt houses. One, in Nashville, TN, produces malted barley for distilled spirits. The other in Asheville, NC, has been producing locally grown grains including barley and rye since 2010. A malting house in Northeast Tennessee and Southwest Virginia makes sense on several levels. First, these are farming regions with the capability of producing good crops of malting barley providing proper measures and techniques are used. This idea was previously discussed but warrants mention in this section as malting is closely tied into farming. The farming technology infrastructure is in place and only lacks the economic drive and incentive to start producing malting barley. That incentive would be a local malting house ready to buy quality malting barley from the farmer.

Second, the demand is here. With the rise of numerous regional microbreweries a local demand for malting barley is a reality. Most of the breweries contacted are getting their raw materials (malt) from regional supply houses but the raw grain itself originates from the Northwest U.S., Canada, or Europe. This will be discussed in greater detail when covering data collection.

Third, it makes good economic sense. Local malting houses would promote a positive economic impact on the farmer, the brewer, distributors, local businesses, and employment in this region.

Finally, people like to take pride in their community and, as part of this sentiment, it is characteristic to support and buy locally produced goods for the following reasons:

1. Fresher, high quality.
2. Lower transportation cost.

3. Greener, more eco-friendly.

**Malting Industry Costs**

Some malt houses will choose to be traditional in their approach to malting processes by manually producing the barley, using centuries old processing such as hand raking and shoveling to move the product within the malt house. While this method is more traditional and craft oriented it also requires quite a bit of square footage and is extremely labor intensive. An alternative method is to use malting machinery designed to take the place of the human. While very productive and efficient the machines are costly commodities to purchase and maintain. High quality malting machines enable the operator to monitor the environmental conditions of heat, moisture, cooling, and time in the overall malting process closely. In addition the machine makes efficient use of water and electricity to produce a consistent product.

The tradeoff is that of the procurement cost. This type of machinery runs about $500,000; additionally the user also has to factor in cleaning, storing, and packaging equipment, not to mention the space needed for the operations.

Therefore, regardless of the method a maltster entrepreneur uses to enter in this industry, it will be costly and require investors to make it a reality. It is estimated the business will most likely require a number of staffers, collaborators, consultants, or contractors with diverse backgrounds in business, engineering, agriculture, technologies, and chemistry in order to consolidate all necessary participants to produce a quality product efficiently and economically.
Brewing Industry

During this project there have been several references to the craft brewing industry and how it is driving the demand for malted barley. The industry continues to grow and the United States now supports more than 4000 craft breweries.

Research Data

Within the regional target area of this study, a nominal 100 mile radius around Johnson City, TN, one finds 46 breweries and 6 home brew supply stores. This area looks westward to Knoxville, TN, northeastward to Radford, VA, and southeastward to Asheville, NC. There are indications of at least 10 brewery openings in the near future.

Of those contacted in the regional craft brewing industry 22 surveys were returned and 20 interviews conducted. The study also takes into account the potential effect of the home brewers who consume a sizable amount of the malted barley. Four of those interviewed and surveyed were owners of a Craft Brewing Supply Store. They were very knowledgeable of the local industry and the amount of malt sold and used by home brewers.

Survey Data Composite

The survey data from 22 respondents were collected prior to the interviews; the data were captured and reported in Chapter 4 and on Appendix B. The categories of questions were: 1 information, 1 opinion, 2 preferences, and 6 industry demographic. Each category will be discussed as a subtopic with the exception of the information question that does not factor into the analysis. Four of the survey questions are overlapped on the interview questions to provide further information on the topic.
**Industry Demographics.** Demographics are critical in describing the characteristics of a population. In this case the population are those in the micro-brewing industry within the Northeast Tennessee-Southwest Virginia region. The researcher considered this important to the data in order to better understand how this industry operates within this region. The survey questions involved were numbers 2, 3, 5, 7, 8, and 9 (See appendix B).

- Of 22 businesses surveyed 20 answered question 2 which asked where the company headquarters were located; 18 are headquartered within this region, with the other two owned by restaurant conglomerates.

- Of the survey respondents 19 answered question three which asks how long the person has been a microbrewer. The average length of time of experience was calculated in two groups: five of the brewers averaged about 10 years and the other 14 averaged about 3.39 years of experience. Many of these breweries just started within the last 5 years which coincides with the amounts of time individuals have been brewers (i.e., new brewery = new brewer). It may be evidence of new professionals in a niche market. Aside from this survey and through much conversation with professionals from this industry arose the topic that some universities are starting classes and programs in micro brewing that have connections to the brewing industry (i.e., South College, Knoxville, TN).

- Most of the Micro-Breweries use Brewers Supply Group (BSG) for their barley needs. BSG is owned by the Rahr Corporation of Minnesota and who are the United States’ distributor of Weyermann malt of Bamberg.
Germany. Transportation logistics are a ground-freight type operation with the closest BSG supply house distributer in Atlanta, GA, which is more than 266 miles from Johnson City. They are a Business to Business (B2B entity) and only sell directly to professional brewers or home brew supply stores.

- The estimated monthly quantity of beer brewed in this region is 170,500 gallons per month with a nominal annual basis of 2.05 million gallons. This quantity was reported by the 22 breweries and homebrew shops that were sampled and represents a large annual production volume within the region than can support a local source of ingredients.

- The estimated monthly quantity of malt used in this region is 303,500 pounds with an annual basis of 3.64 million pounds. Question eight was designed to show the demand for malted barley in this region. This is a significant amount for the region which should be of interest to potential investors. The regional amount, however, is not significant when compared to the U.S. production of 1.5 million tons of malt annually.

- Distribution of beer by breweries in this region was measured in three categories: within the region, outside the region, or both. The definition of distribution inside the region could be within a brewpub, county line, or the region. The definition of outside the region would be outside the area of interest or a 100-mile radius around Johnson City, TN. Of the 22 surveyed, 18 respondents answered the question with the total results...
indicating that 11 distribute within and 7 distribute both within and outside of the region.

Preference Answers. This section included questions about barley variety preferences by those in the brewing industry in this region. The researcher thought this was important to see if there was a trend in preferences for types of barley and if buying from a local source fell into this category. The survey questions on this subject were numbers 4 and 6.

- There are many different varieties of barley in the 2-row or 6-row species. The answers provided by the respondents regarding preferences for any one of these were inconclusive. There was an array of answers given that identified company names or specific types. According to research, micro-breweries tend to use the 2-row species largely because it yields greater extract per pound of malt and larger breweries have a tendency to use the 6-row.

- There is interest to buy and source locally grown barley by this region’s breweries and home brew supply stores. Most want to support local industry and be a part of their community. The main concerns were cost and quality of the malt. If these two factors cannot equal the malt they buy now, they would not be interested.

Opinion Answer. The opinion was about organic and non-GMO grains being available for use in the region and whether or not brewers would be interested in using them. Most indicated they would be interested with remarks indicating that it would be more natural and healthy; however, some indicated they were not interested or not concerned. This was also asked on the interview questions and to be followed up in the next section.
Interview Data Composite

The interview data regarding the thoughts of these professionals on specific topics was captured and collated in Chapter 4. The topics included observations and insights regarding the industry, preferences for ingredients in brewing, niche or specialty ingredients, and logistics of materials.

Industry. The majority of those in the industry thought there was elevated growth in the micro-brewing industry within the United States and in this region and that there is the potential for growth in this region. As business people they know this region may become saturated eventually but did not feel they were in competition with others in the region. They explained that most are friends and colleagues who helping each other. Overall, they felt the one most important aspect of the industry is to produce high quality beer that is made with the freshest ingredients they can find and sold at an affordable price.

They try to cater to their customers by providing food and entertainment. They did not view this as a competitive measure but just as adding attraction to the mix. Only three of the interviewees served food directly from their establishment; the remainder did so via gourmet food trucks or was co-located by a restaurant. Most of the entertainment was in the form of live bands, open mic night, karaoke, or juke box music.

Most respondents thought industry barriers were rising with respect to federal, state, and local regulations, the cost of equipment, and the cost of real-estate. However, about half thought that the barriers were rising due to new entrants into the industry who produce high quality beers, meaning competitors will have to improve their product’s quality.
There are three models that became apparent during this study: the Brew Pub Restaurant, the Brew Pub Distributer, and the Brew Pub. All make their beer in-house but not all distribute. The data showed that if the brew pub distributed, they had a brewing capacity of 3 to 10 barrels. If they did distribute, whether self-distributing or selling to a distributor, it seemed to them a constant competition exists for store shelf space and tap handles at bars. Some respondents said the only way to grow a business in this industry is to make the product visible and gain market recognition. Others had no desire to distribute whatsoever and were content with the business and sales they had.

*Ingredients.* Most of the respondents indicated they did not care what the origins of the ingredients were (U.S., Canada, or Europe) as long as the ingredients were of adequate quality to produce their product. Others were very specific and indicated they only buy from Europe or a specific producer of malt. Most respondents indicated they would source locally for their materials if the quality and price ranges were similar.

Most respondents said they buy locally for certain niche ingredients such as pumpkins for Fall brews or other herbs that are indigenous to the region. These are normally for limited and special brews and are usually not for their everyday beers. There are ingredients that are not necessarily from the region that are used on an everyday basis with brewers; examples include chocolate, fruit, or coffee. Respondents indicated that anything edible could be used in a beer and that brewers like to experiment with these “off the wall or freaky ingredients” but also reported that the basis of the beer must be barley.
Most respondents thought using non-GMO products was a great idea but the cost would be prohibitive. In addition most did not think it would make a difference as the taste is the determinate factor and that there was not a demand for this type of beer.

On the logistics side, most respondents indicated that hops was the only ingredient they have a problem getting from time to time. No delays in malt shipments were reported. Hops are generally contracted out a year in advance. Malt of most varieties is not a problem and usually arrives within 36 hours of ordering.
CHAPTER 6

CONCLUSIONS

In order to give a broad view of the subjects without going too deeply into any one area this thesis has provided an overview of the covered topics. The goal was to investigate the economic demand-driven feasibility of locally sourced malted grains – primarily barley – for local brewers of beer.

Agriculture – Barley is already grown in this region and has been for a long time. Malting barley is also grown in this region and can become a cash crop for farmers, but will take an investment in time, education, and farming technology to make it work. In addition, it will take a paradigm shift in thinking as farmers are businessmen and are focused on the cash crops of corn and soybeans which currently yield higher prices on the market.

Malting business – The technologies in the methods (old and new), machinery, and knowledge base are readily available for those who venture into this business. It takes substantial capital from investors to get this sort of business started and coordination between local county governments, farmers’ co-ops, local brewers associations, and local breweries to establish a networked rapport to support an operation of this kind.

In addition, the malt house will need staffers and consultants that have a working knowledge of agriculture, machinery technology, grain malting (processing) technology, and storage technology. As producers are using an agricultural food product an understanding of federal, state, and local laws as well as awareness of regulations from agencies such as USDA, OSHA, and EPA is critical.
Brewers – the malt house must be able to produce a product that is acceptable by brewers of all levels (professional and home brewers). The demand is there for malted barley, but without acceptable pricing and quality levels of the chemical profile, consistency, and quantity the brewers may be reluctant to use this malt.

Based on the research and collected data the study showed the following:

- Strong evidence exists for growing and malting barley within the Northeast Tennessee and Southwest Virginia region. This demand will continue to grow as more microbreweries and home brewing supply stores open for business within the region.
- There is also evidence that malting barley can grow in this area if farmers use proper growing and harvesting techniques. This includes 2-row and 6-row varieties.
- The technology to malt barley with either traditional methods or modern machinery is readily available.
- The malting industry could be lucrative for business and technology within this region.
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APPENDICES

Appendix A
Area of Interest

Note: Image produced from USDA website. https://nassgeodata.gmu.edu/CropScape/
Appendix B
Micro brewing Industry Survey

My name is Mark Patton. I am a graduate student at East Tennessee State University. I am conducting this survey to gather data in regards to my graduate thesis on the micro-brew beer industry in the Northeast Tennessee and the Southwestern Virginia Region. Please answer all questions to the best of your knowledge. All information obtained through this survey will be kept in strict confidence and will only be used for the purpose of this thesis. Your support is greatly appreciated! THANK YOU!

1. What is the name of your Company (Optional)? ________________________________

2. Where is your Company located (Main Headquarters)? ______________________________

3. How long have your been a Micro-Brewer? ________________________________

4. What kind of barley do you prefer to use for your product? __________________

5. Where do you buy your Barley from? ________________________________

6. Would you buy your barley locally if the same quality and type were available? Yes or No
Please explain your answer:

7. What is the estimated quantity of beer, brewed on a monthly basis by your company? _______

8. How much barley do you use on a monthly basis? ________________________________

9. Does your product cater to the region in which you're located or outside your region? In/Out Both
Please explain your answer: ________________________________

10. If a non-GMO or non-chemically grown grain were available in the local region, would this be of interest to you? Yes or No
Please explain your answer: ________________________________
## Appendix C
### Survey Data Collation

<table>
<thead>
<tr>
<th>Brewery</th>
<th>How Long Brewing / Years</th>
<th>Base Barley most used</th>
<th>Main Distributor</th>
<th>Would buy locally</th>
<th>Beer Brewed / Monthly in U.S. gallon’s</th>
<th>Barley Used / Monthly in Pounds</th>
<th>Cater to region (In, Out, Both)</th>
<th>Non-GMO Interest w/concern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brewery 1</td>
<td>5</td>
<td>Rahr 2 Row</td>
<td>BSG</td>
<td>Yes - Support Local, cost, avail.</td>
<td>1,085</td>
<td>4000</td>
<td>In / Tap room</td>
<td>Yes - Cost</td>
</tr>
<tr>
<td>Brewery 2</td>
<td>2.5</td>
<td>2.6 Row</td>
<td>Multipule</td>
<td>Yes - Support Local</td>
<td>1000</td>
<td>1500</td>
<td>Both</td>
<td>Yes - Marketing</td>
</tr>
<tr>
<td>Brewery 3</td>
<td>5</td>
<td>2 Row</td>
<td>Country Malt</td>
<td>Yes - prefer local</td>
<td>155</td>
<td>350</td>
<td>In</td>
<td>Yes - No Change</td>
</tr>
<tr>
<td>Brewery 4</td>
<td>0.5</td>
<td>German Pilsner</td>
<td>BSG</td>
<td>Yes - NA</td>
<td>930</td>
<td>1900</td>
<td>In</td>
<td>Yes - Want it</td>
</tr>
<tr>
<td>Brewery 5</td>
<td>16</td>
<td>2 Row North American</td>
<td>BSG, Country Malt, Rahr</td>
<td>Maybe - Cost, avail., service</td>
<td>21700</td>
<td>42000</td>
<td>Both</td>
<td>No - No interest</td>
</tr>
<tr>
<td>Brewery 6</td>
<td>2</td>
<td>Euro Malt, Non-GMO, Organic</td>
<td>BSG</td>
<td>Yes - Already do</td>
<td>2200</td>
<td>6000</td>
<td>In / Tap room</td>
<td>Yes - Already Use</td>
</tr>
<tr>
<td>Brewery 7</td>
<td>1</td>
<td>2 Row</td>
<td>Country Malt</td>
<td>Yes - NA</td>
<td>1085</td>
<td>2000</td>
<td>In</td>
<td>Yes - Want it</td>
</tr>
<tr>
<td>Brewery 8</td>
<td>1.5</td>
<td>Bris</td>
<td>Briess</td>
<td>No / Price and quality</td>
<td>5000</td>
<td>10000</td>
<td>In</td>
<td>Yes - NA</td>
</tr>
<tr>
<td>Brewery 9</td>
<td>1.5</td>
<td>American English mix</td>
<td>Cargill</td>
<td>Yes / Local = Great</td>
<td>8800</td>
<td>15600</td>
<td>Both</td>
<td>Yes - NA</td>
</tr>
<tr>
<td>Brewery 10</td>
<td>5</td>
<td>English Pale</td>
<td>BSG, Cargill</td>
<td>Yes / Not grain growing region</td>
<td>4500</td>
<td>9000</td>
<td>In</td>
<td>Yes - Always better</td>
</tr>
<tr>
<td>Brewery 11</td>
<td>11</td>
<td>Non-GMO</td>
<td>Europe</td>
<td>Yes / NA</td>
<td>2600</td>
<td>5000</td>
<td>In</td>
<td>Yes - NA</td>
</tr>
<tr>
<td>Brewery 12</td>
<td>4</td>
<td>2 Row</td>
<td>BSG</td>
<td>Yes / NA</td>
<td>2000</td>
<td>4000</td>
<td>In</td>
<td>No - Not Concerned</td>
</tr>
<tr>
<td>Brewery 13</td>
<td>8</td>
<td>Pilsner 2 Row</td>
<td>Country Malt</td>
<td>Yes / Prefer Local</td>
<td>543</td>
<td>1000</td>
<td>In</td>
<td>Yes - I like organic</td>
</tr>
<tr>
<td>Brewery</td>
<td>#</td>
<td>2.3</td>
<td>Rahr, Weyerman</td>
<td>BSG</td>
<td>Yes / Support Local</td>
<td>2232</td>
<td>6000</td>
<td>Both</td>
</tr>
<tr>
<td>-----------</td>
<td>---</td>
<td>------</td>
<td>----------------</td>
<td>-----</td>
<td>---------------------</td>
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<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Brewery 14</td>
<td>2.3</td>
<td>Briess</td>
<td>BSG</td>
<td>Yes / Support Local</td>
<td>2232</td>
<td>6000</td>
<td>Both</td>
<td>No - to high of price</td>
</tr>
<tr>
<td>Brewery 15</td>
<td>13</td>
<td>Briess</td>
<td>Briess</td>
<td>Yes / cost, avail. A factor</td>
<td>2480</td>
<td>8000</td>
<td>Both</td>
<td>No - to high of price</td>
</tr>
<tr>
<td>Brewery 16</td>
<td>21</td>
<td>Briess, Weyermann</td>
<td>Yes / We support local</td>
<td>102300</td>
<td>163200</td>
<td>Both</td>
<td>Yes - Support Local</td>
<td></td>
</tr>
<tr>
<td>Brewery 17</td>
<td>0</td>
<td>Avanguard, Briess</td>
<td>L.D. Carlson Wholesale</td>
<td>Yes / NA</td>
<td>500</td>
<td>1000</td>
<td>NA</td>
<td>Yes - Price</td>
</tr>
<tr>
<td>Brewery 18</td>
<td>4</td>
<td>Chateau, Belgian, Pilsner</td>
<td>BSG, Brewcraft</td>
<td>Yes / Need this</td>
<td>150</td>
<td>300</td>
<td>NA</td>
<td>Yes - Always Preferred</td>
</tr>
<tr>
<td>Brewery 19</td>
<td>0</td>
<td>NA</td>
<td>BSG, Handcraft, Brewcraft</td>
<td>Maybe / price, quality, packaging</td>
<td>250</td>
<td>500</td>
<td>NA</td>
<td>Yes - Like Non-GMO</td>
</tr>
<tr>
<td>Brewery 20</td>
<td>10</td>
<td>Continental</td>
<td>L.D. Carlson Wholesale</td>
<td>Yes / Already carry Riverbend</td>
<td>2500</td>
<td>5000</td>
<td>NA</td>
<td>Yes - Support healthy practices</td>
</tr>
<tr>
<td>Brewery 21</td>
<td>9</td>
<td>Pale</td>
<td>Montana</td>
<td>Yes</td>
<td>8000</td>
<td>16000</td>
<td>Both</td>
<td>Yes - It is all we use</td>
</tr>
<tr>
<td>Brewery 22</td>
<td>8</td>
<td>Brewers Malt, 2-Row</td>
<td>Country Malt, Briess</td>
<td>Yes / Use as much as possible</td>
<td>496</td>
<td>1120</td>
<td>In</td>
<td>Yes - as natural as possible</td>
</tr>
<tr>
<td>Totals</td>
<td>5.9227</td>
<td>Blank</td>
<td>9 BSG, 5 CM, 4 Briess, 2 BC, 2 Cargill</td>
<td>18 Yes, 2 Maybe, 1 No</td>
<td>170,506</td>
<td>303,470</td>
<td>7 Both, 11 In</td>
<td>3 No, 19 Yes</td>
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</tbody>
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Appendix D
Interview Questions

1. In the time you have been in the Micro-Brewing industry what changes have you seen taken place within this region?

2. Do you feel the area is becoming saturated with micro-brewers? Or do you think there is plenty of room left for new competition?

3. Do you think the barriers are starting to get high for new entrants into the business?

4. Does your company use the latest in technology to produce your product? (i.e. energy efficient equipment, a better logistic chain for ingredients, robotics, computer control etc.)

5. What does it take these days to stay ahead of the competition? (i.e. Serve food, type of food, type of cliental, target by demographics, use niche ingredients, etc.)

6. What is your business model?

7. About your supply chain; Do you have a problem getting ingredients? Does the costs fluctuate with the season or grain market?

8. If the cost quality were similar would you buy local ingredients if they were available?

9. Have you thought about adding other ingredients to your beer that may be off the grid to traditional beer making? (i.e. Honey, Heather, Cactus, Fruit, Coffee, Millet, Tree Bark, Dandelion etc.)

10. Traditional ingredients of pilsner beer is water, barley, hops, and yeast. My findings so far indicate that most ingredients grown in the USA are of a GMO variety. Americans are becoming concerned about the possible health risk that GMO foods may have. In your opinion is this a factor in the micro-brewing business? And what impact if any, do you think a beer made with organic or non-GMO ingredients would make in the industry?
Appendix E
Interview Questions Data Collation

Question 1

#1: Growth of the micro brewing industry in this area or facsimile.

#2: Comments about high gravity beers.

#3: Comments about state laws.

Comments of interest: Public education about microbreweries.

Question 2

#1: Plenty of room to grow or a facsimile of.

#2: The more breweries the better or a facsimile of.

#3: At least two brewers thought the market was saturated or in some way saturated and six others thought saturation was inevitable in time.

Comments of Interest:

- Micro brewers are not in competition against each other or facsimile.
- If there is a lot of businesses like this in one place within walking distance it attracts people because they like to try out many places.

Question 3

#1: Mostly comments about government entities making things harder, however some indicated the gov. was getting easier.

#2: Comments indicating that barriers are not that high.
#3: Split on this, with cost of equipment and cost of real estate.

Comments of interest:

- With more breweries comes more competition, so everyone is raising everyone’s bar every day.
- with more discerning taste and more difficult to please
- finding the start-up capital
- There are local challenges with saturation, and tap real estate, and if we’re distributing ourselves you have the challenge of working with the distributors.

Question 4

#1: We do it by hand or some facsimile.

#2: Comments on equipment, equipment upgrades and efficiency.

#3: Comments on a green foot print with the environment.

Comments of interest: Only three brewers iterated any type of computer control.

Question 5

#1: Comments about better beer, more variety of beer, niche beer etc.

#2: Food either made and served in the establishment or provided by food trucks or very close-by restaurants.

#3: Some kind of music venue.
Comments of interest:

- Remain local, be a member of the community. It’s not just about making beer and throwing it out there, it’s given the consumer a reason to identify with you.
- One of the challenges we face is brand proliferation.
- A good logo is good and must be eye catching with a catchy name.
- Good location to survive.
- Staying ahead of trends, reading all the latest literature. Location, Location
- culture is another big thing we cornered the market on that I believe you know by starting a co-op and bringing in the community and getting them involved
- Process improvement is one of the most important things to move a business ahead.
- Educate the population.
- Research and Development is the way to stay current.
- People are more educated about beer.
- Location. A lot of money to start-up.
- Just listing to the customers.

Question 6

#1: Mostly comments about the quality of beer made.

#2: Comments about packaging, Marketing, taps etc.

#3: Comments about food.
Comments of interest:

- Our goal is to control some of the other breweries in our region, to become a regional hub.
- Make it, get the product out there and sell it.
- Making things in our community better as much as we possibly can and allowing the community to help us grow.
- Specialized beef and beer.

Question 7

#1: Hops can be a problem to get or facsimile.
#2: No problems getting ingredients.
#3: Answers indicating ingredients are contracted out.

Comments of interest: - Demand for hops are going up and the price is going up as well.

Question 8

#1: Yes, absolutely or a facsimile.
#2: Like local, support local or a facsimile of.
#3: Use local hops.

Comments of interest:

- When you buy local, that quantifies into fresher. Everybody wins when you go local.
- People will buy local beer just because it’s local.
- I tend to go with cheaper grains because it comes down to good technique.
• Anytime we can find a local ingredients to use we will.

Question 9

#1: Yes, we already do, or a facsimile of.

#2: Experiment, creative

Comments of interest:

• Anything you put on your plate you can put into beer.

• Anything you can think of that is edible has been used in beer.

• People make a cool beer and people like it.

• Chuck it in if it works. - We have an indigenous series of beers.

Question 10

#1: Costs or a facsimile.

#2: Organic and Non-GMO good or facsimile of.

#3: A marketing ploy or a facsimile.

Comments of interest:

• The economics of beer gets lost in the craft. Craft gets over-romanticized.

• It might be a tie breaker for some people but in the end it will be the taste of the beer.

• Genetics and the genetics research are not only going to influence the beer industry, but are also going to save mankind.

• Just because they can make more money they slap and organic label on something.
• Briess malts are all non-gmo.
• It would be extremely difficult to have that organic malt for the volume (being produced).
• You’re going to have to follow the demand of the consumer.
• So I don’t think it’s gonna have that much of an impact.
• It does not affect the beer at all.
• Most hops are really organic, without the certification.
• It would seem that the supply side is reacting to this, because people are reading labels.
• Fresh and local is the big push that we have seen.
VITA

MARK E. PATTON

Education

Public Schools, Gray Tennessee
Aviation Structures Mechanic Course, Department of the Navy
Non-Destructive Inspection Course, Department of the Navy
Senior Enlisted Advanced Leadership Course, U.S. Marine Corps
Certificate – Lean, Six Sigma, Theory of Constraints Green Belt, Department of the Navy
Undergraduate Minor Certificate – Aviation/Aerospace Safety, Embry-Riddle Aeronautical University
B.S. Professional Aeronautics with minor in Aviation Safety, Embry-Riddle Aeronautical University, GPA – 3.25/4.0
MBA Aviation, Embry-Riddle Aeronautical University, GPA – 3.81/4.0
M.S. Technology, East Tennessee State University, 2016 GPA - 3.92/4.0

Publications


Honors and Awards

Meritorious Service Medal
Navy and Marine Corps Commendation Medal
Navy and Marine Corps Achievement Medal
Good Conduct Medal x9
Presidential Service Badge
Meritorious Mast x4
Letter of Appreciation x4