Geography of Apple Orchards in Wisconsin: Examining the Core of Cultivation

Kody Bankston

Morgan Jarocki

Adrienne Miller

ABSTRACT

This study looks at the locations of orchards in Wisconsin and examines the reasons behind the initial choice for those locations as well as recent changes in popular locations and orchard methods. The most significant reasons appear to be family history with a parcel of land, the microclimate of the land, and constructed geographical features. New trends in orchard location choice is mainly the emergence of many small orchards (under 10 acres) near large direct to market regions (cities).

INTRODUCTION

Although most people do not recognize apples as a staple product in Wisconsin, apples are a large part of the fall traditions for many people. Various reasons account for the clusters of apple orchards in the state. Yet, orchards exist outside of these regions. This study hopes to identify the reasons behind the locations of orchards in Wisconsin as well as some of the changes in location experienced over time. Some of the reasons for locations that are scientific such as soil type, topography, and climate. Other reasons are based on constructed geography like ethnic history, market locations, or authority promotions. A balance of these factors will play into the location chosen for any orchard. To uncover the motives current orchardists had for choosing their locations we have used survey and interview question, along with other publicly available ancillary data.

LITERATURE REVIEW

General Background

Terminology

To simplify understanding of the topics discussed, the following are a handful of common terms within the apple industry. **Cultivar** is the accepted term for the individual variety of apples. **Grafting** is the art of connecting two pieces of living tissue together so that they unite and grow as one (Jackson 2003, 126). **Keeping quality** is a phrase that refers to the ability of a cultivar to retain both its firmness and flavor within storage. **Precociousness** is a rating for apple trees of cultivars and their production at a young age; the more precocious a tree, the younger the age it can produce the fruit (Roper

2002, 4). In tree physiology, the **rootstock** makes up the "bottom" root system and structural base while the **scion** is the "top" part which consists of a fruiting cultivar (Jackson 2003, 126).

Cultivars

There are 7 major cultivar families, from which nearly all popular modern cultivars stem from. These patriarch cultivars are the "Delicious", "Golden Delicious", "Fuji", "Granny Smith", "Jonagold", "Gala", and "Idared" families. Unlike most other fruits, the apple is marketed by individual cultivars. Each cultivar has a unique balance of flavor (sweetness, tartness, etc.), texture (or crispness), color, and flesh amount (size). These details are often the qualities most espoused by society and their plentiful combinations allow for individual cultivars to become distinguished from others by the consumers (Jackson 14). Those growing apples must take into consideration qualities of each cultivar that are less aesthetic; growing range of cultivars, maturation date (which plays a role in storage capabilities), or a result of modern breeding which is mainly about disease resistance. Limits tied to these considerations in cultivars are what prevent a handful of popular cultivars from being a viable crop in even the southernmost orchards of Wisconsin. (Roper 2002, 1-4). There are also instances of government encouragement to growing specific- or breeding new- cultivars that pander to particular customer market desires while also fitting into requirements created by the farmer's environment (LeHeron & Roche 1996, 424).

Farming Practices and Limitations

Basic Knowledge

Growing Apples In Wisconsin, a work from the UW Extension, provides helpful information specifically to beginning growers in Wisconsin. Roper, Mahr, and McManus draw on extensive first-hand knowledge to write on everything from site selection to pest management and disease control. Because the work is centered on Wisconsin it goes into detail on certain problems that Wisconsin growers are more likely to have such as a cold climate and apple scab (Roper, Mahr, and McManus 2000). Unfortunately, there is no other perspective on the topics and some growing models and methods are not discussed. Incomplete information is given in such an authoritative manner, especially to people with little experience of their own, it can be taken as the only word and followed without question which could have effects on the new orchards the authors are not intending. In this work, soil management, for example, is glazed over. Topics that are briefly covered, but sound complete may not be researched further by a novice farmer.

Grafting

As grafting is a crucial component of commercial orchards, there exists a large body of work on the topic. Gordon notes that standard rootstocks typically can withstand a root zone temperature as low as 14°F. While dwarfed rootstocks are injured at a root zone temperature of about 18-22°F (Gordon, 27). Selecting the appropriate rootstock depends on a variety of characteristics including control of scion growth and productivity, adaptations to soils and climate (e.g. low temperature resistance), disease and insect resistance and anchorage (Barritt 1992, 132-133). Barritt's chapter on apple rootstocks from *Intensive Orchard Management* provides the characteristics of rootstocks in general as well as the strengths and weaknesses of specific kinds of rootstocks.

To complete a grafting union, a callus must form between the scion and rootstock. Calluses will generally develop between 0-40°C but growth rates will increase with temperature in the range of 5-32°C (Jackson 2003, 135). Anything above 32°C will usually result in injury and anything above 40°C will cause death of tissues in just a few days (Jackson 2003, 135). Jackson's chapter on grafting and Barritt's chapter on rootstocks really complement each other well in terms of our research goal. With these two sources, we can see the whole picture on one of the oldest and most important processes in commercial apple orchards.

Climate

The commonly held belief is that Wisconsin's climate isn't accommodating for the needs of orchardists and other fruit farmers. *Growing Fruit in the Upper Midwest* provides the account of a pioneer Wisconsin orchardist who successfully started an orchard with hundreds of trees but after just three years only two of the trees remained (Gordon 1991, 23). In addition to the historical information, Gordon (1991) also provides traits of different rootstocks useful in Wisconsin (pg. 29-30), the harvest times of different cultivars (pg. 33) and the general characteristics of these cultivars as well (pg. 37-46). The only disadvantage of this book is that it's over 20 years old and thus some of the data may be outdated so we must be careful what we source.

The article "The Lake and the Fruit" notes the environmental challenges imposed on Wisconsin orchardists (Bogue 1985, 494). Historically, orchardists in Door County struggle to grow apples due to shallow and sandy soil (Bogue 1985, 500). However, Door County's close proximity to Lake Michigan mediated temperatures in the local microclimate (Bogue 1985, 497). It's also worth mentioning that the temperature around Lake Michigan's

eastern shore is mediated to an even greater extent which benefits orchards in Michigan even more so (Bogue 1985, 497). Michigan orchards are actually the main focus of this article, which is its main drawback, but it still provides plenty of vital historical information on Wisconsin orchards, especially in Door County.

Soil and Weed Management

Soil management is particularly important in young orchards, even more so if the trees are dwarfed or if the soil is poor initially (Lipecki and Berbeć 1997, 180). The article by Lipecki and Berbeć explores the potential costs and benefits of various soil management practices in orchards. Herbicides are by far the cheapest and easiest methods of weed management (Lipecki and Berbeć 1997, 173) but growing awareness of herbicides' environmental damage, as well as their potential to cause soil erosion in orchards on slopes through decreased vegetation cover (Lipecki and Berbeć 1997, 173), have caused many orchardists to rethink their practices. In older orchards, introduction of a permanent sod is recommended to maintain good soil conditions (Lipecki and Berbeć 1997, 180). However, introducing sod in a young orchard could cause problems of competition between the grass and the trees (Lipecki and Berbeć 1997,180). This article provides some great insight on the practices within apple orchards as well as the implications of said practices. The authors provide raw data in tables and charts while still interpreting the results for those that may not be able to understand their significance.

Gordon also provides some guidelines on the right soil for an orchard. Fortunately, apples will grow on most mild (a pH of 6.0-6.5 is best), reasonably fertile soil but they cannot survive if the soil becomes waterlogged for extended periods of time (Gordon 1991, 51).

Pest management and disease

Known pest threats

Common insect pests in Wisconsin include the codling moth, plum curculio, and apple maggot (Roper 2002, 1). Birds also will eat the crop at varying stages from flower bud to fruit, as well as damage the trees in attempts to obtain the sap (Mols & Visser 2002, 891). Virus-induced compatibility can cause grafts to snap at the union or even threaten the health of the tree. Tomato ringspot is one such virus which is transmitted by a soil-borne nematode (Jackson 2003, 133). Collar rot and fire blight can pose serious problems for rootstocks and often results in tree death after infection. Choosing a rootstock with a genetic resistance to these diseases is the most effective method of prevention but fungicide application in the soil adjacent to the tree has also shown to prevent collar rot. (Barritt 1992, 136-137)

Management techniques

Pest management is an issue that almost entirely is left up to the local farmer except for what the government dictates can or cannot be used as a pesticide or fungicide. (LeHeron & Roche 1996, 424). However, there are some organizations that have taken up the role of working with farmers not only to meet governmental policies, but to surpass them. For example, Wisconsin's Eco-Apple project was taken up by Wisconsin Apple Growers Association (WAGA), the UW Extension, and the University of Wisconsin-Madison Center for Integrated Agricultural Systems to create local grower networks and individualized integrated pest management (IPM) coaching (Hirsch and Miller 2008, 40A-41A). Within this project the growers were given some new technologies and procedures to handle pests with less pesticide use. No information is given on the actual results of the program. The Wisconsin state conservationist recognized the program and moved it to the

responsibility of the local working group rather than the state level (Hirsch and Miller 2008, 42A). This, along with other Farm Bill changes on the state level have changed the way the program will be administered in the future (Hirsch and Miller 2008, 42A). Fortunately, the project did reach at least thirteen growers in Wisconsin and may have had a greater impact on lessening the future use of pesticides in apple orchards.

Finding alternatives that are safer, and ultimately cheaper, is a desire for agricultural workers. In the case of the apple, there have been attempts to use nesting bird populations to control insect pest populations. In a controlled experiment, it was found that caterpillars damage apple crops through almost the entire stage of apple growth, from bloom onward. If any birds were to be used as a pest control, the birds must either have a preference for caterpillars even at the insects' younger stages, or have multiple species of birds to control varying stages (Mols & Visser 2002, 896-9). This study was conducted in the Netherlands, however, and did not say whether or not their avian of choice lives globally, or if the species is more localized.

Effects

Despite hopes for new methods in pest control, traces of past pest management strategies are still being felt, even in places that are no longer orchards. In Wisconsin, along with a handful of other states, the extent of urban sprawl eventually grew to a point where orchards once on city fringes were removed for urban development. Yet the soils of these new subdivisions are heavily laced with arsenic due to the abundant use of lead arsenate (LA). LA became the pesticide of choice for apple orchards in the early 20th century thanks to the chemical's ability to control the codling moth, since then its use has dropped precipitously due to its toxicity(Hood 2006, A472). The results felt from LA

should not be limited to that chemical alone. Orchardists have to find a balance between social responsibility and having a consistently high crop yield.

People and Orchards

Owners and workers

In *Wisconsin German Land and Life* there are a few resources that give some historical data to our view of orchard owners and workers. In the chapter "A Geographical Perspective on Nineteenth Century German Immigration to Wisconsin", Bawden details the main locations German immigrants settled in Wisconsin before the Nineteenth century. Germans mainly settled in a crescent-shaped region from north-central Wisconsin to the southeast quarter of the state (Bawden 2006, 82-82). Bawden repeats the usual reason for so much German settlement in Wisconsin and in this area particularly: it looks like Germany's Middle Rhine (Bawden 2006, 89). This information coupled with some details about fruit growing in that region of Germany also found in the book would suggest that apple growing in this area would consist of women growing fruits in the garden for household consumption (Ortlepp 2006 30, 46). It will be interesting to see through further research if this is true or if the orcharding model held by German-American families in that region today was created by an influence other than family immigration history.

An example of changing orchard models is the case of 20th century Door County. By 1918, labor needs in Door County could no longer be met by women and children (who until then made up most the work force) so workers were often brought in from organizations like the YMCA and Boy Scouts of America (Bogue 1985, 511). One orchard even hired workers off of the Oneida Reservation west of Green Bay (Bogue 1985, 511).

Late in the 20th century, orchard owners began to rely more heavily on Mexican and Mexican-American workers as well as mechanical picking devices (Bogue 1985, 511).

Apple Culture

Apple culture in this case is the intangible meaning apples have to different people in different times and places. A description of this type of meaning can be found in *Research Methods of Geography* in the chapter on "Analyzing Meaning" (Gomez and Jones 2010, 392). "Meaning" they say, "can invoke a more complex emotive sense of engaging with objects" and "is not something that we are simply exposed to when we engage with these objects, but is something that is *made* through this very process of engagement" (Gomez and Jones 2010, 393). Apples offer multiple dimensions of meaning because they are created by orchardists and interacted with daily by consumers and, even more so, become a part of us by consumption. Therefore, apple culture is entrenched in meaning that comes from producers, but especially from consumers.

No one expresses the meaning of apples better than Barry Gray did in 1871 in *Harper's Bazaar*. Gray refers to apples as the "royal fruit" and makes claims that the apple may be the "most ancient of fruits" (Gray 1871, 1). Gray sites Greek and Roman mythological stories, the Garden of Eden, and many folk traditions all with deep connections to apples. He quotes poetry resounding with apple praise and centered on orchards and their beauty and bountiful gifts. Gray is a true apple connoisseur who brings up the amazingly complex notion of the metaphysical apple to life in very few words. We call this apple culture and it has many faces and has shown many changes over time.

The many shifts in apple cultivars and growing regions could be considered lightheartedly as "just the way it goes", but it is rare to have such a dramatic event in the

business of food go by without commentary. After all, the food we buy, cook, and eat becomes a part of us physically, emotionally, and culturally. One of the most drastic cases that shows this deep relationship people have with food is discussed in "Cooking in Memory's Kitchen: Re-Presenting Recipes, Remembering the Holocaust". This chapter is a response to the publishing of a translated cookbook of recipes a woman collected while imprisoned during the Holocaust. Not only have the recipes been translated from German to English, but one recipe has been rewritten using modern ingredients. Drew's initial reaction is very tentative, but once she realized that there were accompanying nutritional facts she was furious because of the bitter irony of including nutritional facts for a recipe saved by a woman who starved to death(Drews 2008, 71). The chapter includes details about the study of cookbooks and recipes as an academic pursuit. It seems that the weight held in a recipe or an ingredient is a combination of historical or cultural reference, past personal experiences, the process of acquisition, and the way the recipe or ingredient is presented.

Modern growth of orchards

Before the mid-20th century, orchards were commonly smaller, local operations geared towards providing for nearby cities and towns (Le Heron & Roche 1996, 418). This aspect of orchard geography still holds true within much of Wisconsin. However, there has been a shift in the focus upon specific cultivars. With the rise of refrigeration technology in the mid-20th century, the ability to grow produce on a large scale, store produce for longer times, and transport the produce further distances broadened the apple industry's perspective to a global view.

Individual regions may produce cultivars that grow best in their climates then ship these cultivars across the planet to a country whose cultural values stress particular traits. This is epitomized by Japan, who as a country prefer Fuji apples more than any other cultivar by a wide margin; yet much of the country's apple consumption are imports from New Zealand. However, commerce such as this has lead to heavier government influence. There are often top-down enforcements of crop standards that local farmers must meet to be able to ship their crop (LeHeron & Roche 1996, 423, 427-29). Even beyond the government influence is the winnowing of cultivar options grown en masse due to marketing by the apple industry and consumer demand for consistent standards and selections (Roper 2002, 1-4; LeHeron & Roche 1996, 420). While Wisconsin is not a global player, or even national player by any stretch of the imagination, these principles have influenced the apple market there as well. The Wisconsin Department of Agriculture conducted a study in the early years of the 1960's to determine how orchards across Wisconsin had changed by observing cultivar planted, tree numbers of these cultivars, and the tree age. What the survey found matches many of the same trends. Where apple trees had once been more numerous in the north and west portions of the state, the number of trees had become weighted more towards the urban centers of Madison and Milwaukee, as well as to the coastline of Lake Michigan. It was also possible to note the growth of cultivars such as the Cortland and the McIntosh (Sturges 1962, 19-20).

To our study of apple orchards this means that these aspects and more are contributing to the apple culture in Wisconsin. This is something we must be aware of while we ask our questions and especially when we attempt to create our hypothetical Wisconsin orchard.

Modern Trends

One of the most influential modern trends on the food industry is organic foods. In the study by Roussous and Gasparatos (2009), researchers compared apples from two orchards, one organic and one conventional. Besides the growing methods, all other factors (e.g. size, climate type, soil type, etc.) were kept the same between the two orchards (Roussous and Gasparatos 2009, 247-248). After harvest, the conventional apples yielded a mean fruit weight of 185 grams, 17 grams more than their organic counterparts (Roussous and Gasparatos 2009, 250). Conventional apples also had a mean fruit minimum width of about 49 millimeters which was 7 millimeters greater than the mean minimum width of the organic apples (Roussous and Gasparatos 2009, 250). In addition to greater weight and width, the conventional orchard also yielded almost twice as many apples as the organically managed orchard (Roussous and Gasparatos 2009, 247) However, we should be careful how we apply this data to our study because the apples in the Roussos and Gasparatos article grew under the Mediterranean climate of Greece whereas in Wisconsin the climate is much less hospitable. And while this article provides plenty of detailed information on the fruit itself, the authors have little to say about the orchards' effects on the surrounding environment.

One of the most influential trends on farms and orchards is farm-based recreation. The United States Department of Agriculture ran a study of Agrotourism in the United States with the goal of discovering whether or not there was potential for more farm-based recreational activity. The report provides a view of the types of farmers and places where farm recreation may have the greatest potential (Brown 2007, iii). Brown outlined the characteristics of the farmers and the farm locations as well as some aspects of

the farm-based recreation already present in the United States. Despite running statistical analysis on data that includes a relatively low percentage of American farmers, the information discovered which locations and farm characteristics are most conducive to creating a farm-based recreation model. Some discoveries pertinent to our study include that people in the Midwest make up about a quarter of the visitors to recreational farms and of the things visitors were most interested in, orchards rank second (Brown 2007, 8).

METHODS

Together, surveys, interviews, and ancillary data are collected and analyzed to give the best possible understanding of the landscape of Wisconsin apple orchards and the change in the landscape over time.

Surveys and Interview

Our survey is meant to explore a few of the factors we believe play a role in location choices. Questions ask for details about the orchard's acreage, length of existence, and location. Then we ask about the practices and processes used on the orchard such as cultivars grown, pest and disease management, pruning and training methods. Finally we ask about the orchardists' family heritage to see if initial settlement had any bearing on the orchard's location. See Appendix 2.1 for survey questions.

The interview is focused on getting a deeper history of the orchard going back to the original decision to create an orchard in that specific location. Family and immigration history tends to be a large aspect of location for orchards that have been established for a long period of time. We ask the orchardist how their orchard has developed over time and also ask how the orchardist has seen the landscape of orchards change in their lifetime.

Although this information is not standardized we do believe that personal perceptions are major contributions to the landscape. The interview with someone who we are calling one of the "authority figures" is useful to our argument about "authority promotion" of certain regions within Wisconsin. In this interview we focus on their position in the apple discourse and what they focus on telling people about choosing locations.

Soil Surveys

Through the use of soil surveys we will be able to determine the overall characteristics of the soil (e.g. drainage, fertility, etc.) underneath the orchards as well as the local topography (e.g. slopes). This information is available through the various county soil surveys of Wisconsin located in the map library. By using some of the methods laid out in the "Remote Sensing" chapter of *Research Methods in Geography*, we can create an "inventory" of the landscape or "an accounting of its land surface features" (Gomez and Jones 2010, 165). We will compare the hardcopy aerial photographs of the soil surveys with the digital images provided in the WAGA map in order to find the specific orchards that we want to sample. By analyzing counties with both high and low concentrations of apple orchards we hope to find a trend in terms of what soils characteristics orchard owners find desirable or undesirable.

Ancillary Data

Finally, we are using publically available ancillary data to help analyze the landscape of orchards in Wisconsin. This data includes the orchards' own websites where they often include a story about the history of the orchard and information about their growing methods. The Wisconsin Apple Growers Association (WAGA) website includes a database with the emails, addresses, and other information about the orchards in their association is

also very helpful to our research. We used that information to send our survey to those orchardists through email.

Data visualization and Spatial analysis

With the data gathered through the various methods stated above, the project will begin the approach of representing the information. As the research is geared towards locational data, mapping will be a common method of visualization. Through understanding cartography as a cognitive science, the purpose of the maps will balance between displaying attribute data of phenomena being mapped, and hopefully allow the map reader to draw new conclusions during the interaction with the map (Gomez and Jones 2010, 263-5). Specifically within the research, the maps will hopefully transmit greater trends concerning the "why" of orchard locations. One of the first approaches will be the creation of a map of orchard clusters to attempt to define popular growing regions. This cluster map will allow for guided observation on orchard location and reasons for variation of orchard locations across the state. Another approach will make use of a map representation style known as a temporal cartogram, which uses time as distance. We anticipate orchards geared towards tourism to put value in the perceived distance from "home" to the orchard, and hope to find proof of this using a map. Outside of mapping the data, non-spatial figures will be crucial to simplify data that is not easily translated onto maps. We will to utilize the information gathered from the survey and create a profile on orchard characteristics, such as cultivar popularity and soil types. These visualizations will only help strengthen the understanding of apple orchards across Wisconsin.

RESULTS

Survey

The survey questions sent out to Wisconsin orchards can be seen in Appendix 1. See Tables 1, 2, and 3 for the survey responses as well as the clusters each orchard falls into. Analysis of these results will be covered in the later discussion.

Interview Summation

An interview with Steve Louis, owner of Oakwood Fruit Farms, was conducted on November 10, 2012 at his orchard market location. Through the interview, we touched upon multiple topics ranging from personal orchard history to involvement of WAGA with orchards in Wisconsin.

Steve's great-grandfather immigrated to Wisconsin in the first decade of the 20th century, purchasing a small parcel of land where the orchard now sits. The family opened up an apple nursery on the land, mimicking what other farmers in the area had already chosen as a primary income resource. Within the next twenty years, a number of smaller, neighboring orchards became failed enterprises, so the Louis family began to purchase more and more land. Eventually this grew to a sizeable orchard area, specializing in both apples and grapes.

Family tradition dictated the use of intelligent farming practices that include consistent tree replanting (~5-10% annually) and crop evaluation. To prevent both soil exhaustion and the family business collapsing, the orchard expanded over time to other ventures such as growing corn on rotating fields and the raising of a cattle herd for the

farm. As a whole, the farm has prospered due to a mixture of the balancing of crop investment and landscape advantages. The surrounding region is covered with hills and ridges. This sharp change in elevation is a crucial element in apple farming, as the crop requires soil that is both well irrigated and well aerated. The inclines provide the added benefit of noticeable temperature differential between the tops of the hills and the valley floors below. In years such as 2012, this elevation difference was crucial to the difference in an orchard having a crop versus almost no crop for the year.

Steve Louis' current involvement as the head of WAGA comes from another family tradition of responsibility towards the community. As his father and grandfather had before him, participation in the greater orchardist community was a role required of those who are successful. WAGA itself is less of a promotional organization, but rather one of information provision. Members are required to pay annual fees based upon acreage of their orchards. WAGA will put on an annual conference where orchardists may come for seminars on farming and pruning techniques, business management, or information on scientific/technological discoveries made pertaining to apple farming. Along with this, WAGA makes an effort to keep members informed of changes in legislation that may affect the orchardists. As a whole, the organization is a non-profit that welcomes any willing to give input and feedback (as well as pay their dues).

Over the years, Steve Louis has noticed a handful of small trends with apple orchards in Wisconsin. He can name off a handful of large, commercial apple orchards that have folded within the last 15 years, yet knows that not a single new orchard of that size or scale has opened to replace these closed orchards. On the other hand, he is seeing a growth

in smaller, personal orchards geared towards tourism or what he termed "club" varieties of cultivars. These orchards are generally a secondary source of income or a retirement hobby according to Steve. The owners usually are picking orchards based upon locations that look nice for a business (say a crossroads of highways between two mid-major cities). These orchards, however, are located in areas that are not always conducive to apple farming as a whole, and the crops are usually fraught with failures if the weather doesn't cooperate. This leads to a higher turnover rate of orchards and owners.

Finally, there is no accepted definition of what an apple orchard is. WAGA does not created one, and Steve ruefully admitted that it is a question that pops up quite consistently.

Soils Analysis

From the county soil surveys available in the map library, we found soil data on 19 different orchards across 10 counties. Of the 33 soil types we found in Wisconsin orchards, 17 of them are silt loam, six are sandy loam, eight are loam and two are loamy sands. See Figure 1 for a graphic representation of the percent distribution of soil types. All but two of the 17 silt loam soils are classified as at least moderately suitable for all crops commonly grown in their respective county. However, the soil surveys did not specify what crops fall under that category so we don't know at this time whether or not that includes apples. In fact, of all the soil surveys we sampled, only the Door County survey listed soils that were suitable specifically for orchard crops. Of the 17 silt loam soils, four are classified as either eroded or moderately eroded, one sandy loam and one loam soil were also classified as eroded as well. Soil surveys listed control of erosion as an important management practice

for many of these soils. Steve Louis, the owner of Oakwood Fruit Farm, and our literature (Lipecki and Berbeć 1997, 171) confirm sod as an effective means to prevent soil erosion.

Even within the same soil type, characteristics of the soil can change based on the slope. Thus far, the results of the Wisconsin soil surveys support the importance of topography that Steve Louis mentioned in our interview. Within the 33 different soil types, we found several additional subgroups stemming from variations in slope steepness. The local topography of these apple orchards typically consisted of soils with 2-6% slope or 3-8% slope. Only six of the nineteen orchards had a flat soil with a slope range as low as 0%. The steepest slope that we found from our samples had a range that went up to 45%. However, we only encountered this particular steep soil in one orchard.

Distribution of Cultivars

Through the data we collected from our survey, we isolated three cultivars that appeared more than any other: Honeycrisp, Cortland and McIntosh. Honeycrisp was the most popular, appearing on 14 of the orchards that responded to our survey. Cortland and McIntosh both appeared in 12 of the orchards from our survey. By contrast, Zestar was the next most popular cultivar appearing on seven orchards but most other cultivars could only be found in three or four orchards at most. Out of the orchard owners that responded to our survey, the number of cultivars that they listed ranged anywhere from 1 to 28 with a mean of 8 to 9 cultivars.

Of the cultivars identified by our survey respondents, we found that Duchess apples had the earliest harvest date range that started on August 5 (Roper 2002, 2-4). However, we only found Duchess apples on one of the orchards that responded to our survey.

Jonagold and Golden Delicious apples had the latest harvest date range that ended on October 25 (Roper 2002, 2-4). Also, a majority of the cultivars found in our survey results have a storage capacity from one to three months (including Cortland and McIntosh) and many can store for more than three months lasting well into the spring following the fall harvest (Roper 2002, 2-4).

Maps

A handful of maps were created to analyze the gathered data. The first map shown will be just a general reference map depicting the location of orchards across Wisconsin according to their membership in WAGA (Figure 2). For the cluster map, spatial analysis tools and a buffering zone around orchards were used to create loose clusters of orchards across Wisconsin. The map contains 8 distinct clusters ranging from the Door County, across the state's southern half, and up along the Mississippi River (Figure 3). Following that is a map depicting the age of orchards that responded to the survey sent out (Figure 4). Any trends that can be found for age and location will lead to further depth in understanding orchards. In hoping to view orchards locations from a cultural perspective, we created a map depicting apple festivals across the state (Figure 5). The temporal cartogram (Figure 6) covers the region surrounding Madison, WI (or cluster 5 in Figure 3). This map depicts the variation of orchards in driving time from the center of Madison and has labeled the orchards based on allowing visitors to pick their own apples or not.

DISCUSSION

Common trends that we have seen running throughout the surveys, interview, and ancillary data fall under have been broken into three categories: Climate Considerations, Constructed Geographies, and Large vs. Small Orchards.

Climate Considerations

As mentioned, climate is taken into account more heavily by large orchard operations. Climate considerations include the climate of the state in total as well as the microclimate of the orchard itself which is determined by topography and soil types.

The first geographic trend we found relating to climate is an increasing number of orchards per county in the southern half of the state. For a visualization of this trend, see Figure 7. Soil surveys in Bayfield County (the northernmost county in Wisconsin) indicated that frost is a major determinant for the growing season of all crops in that county. Due to the importance of temperature and the difference that a few degrees can make, it makes sense to find more orchards in the southern half of the state where it will generally be warmer with a longer growing season.

From our survey of orchard owners, we also found some evidence to suggest that orchardists tend to select cultivars based on their capacity for storage. Several of the cultivars reported by orchard owners could last in storage for three months or more. However, when our survey respondents gave a reason behind their cultivar selections, it was usually due to high demand by consumers so we cannot say at this time how strongly storage capacity factors into an orchardists decision.

The results of the soil surveys suggest that local factors like drainage and topography play heavily into choosing the location of an apple orchard. However, about one-fifth of the sampled soils listed either flooding, wetness or ponding as a major

limitation which would form a unique challenge for orchard owners with land on those kinds of soils. Our results also show a trend in orchard locations on gentle hills, with a slope that generally falls between 2-8% slope. While we found a few orchards that had slopes as steep as 45%, these orchards represented a small minority.

A sloping orchard provides good drainage for not only water but also air. Just a few degrees could be the difference between a healthy tree and a total loss of growing apples. Near the end of this growing season, Louis's Oakwood Fruit Farm experienced a local microclimate eight degrees warmer than another nearby orchard. As a result, the loss of growing fruit at Oakwood was substantially lower than their neighbors because of Oakwood's location at the top of a valley. The bottom of the valley, where the neighboring orchard is located, instead acts as a cold sink which could cut the growing season much shorter than those at the top of the valley.

Orchards in the Dane County area (cluster 5) were generally described as "suitable for crops commonly grown in the county" but it did not list what crops this included. Given that Dane County holds more orchards than any other county in Wisconsin, we can assume that apples are a common crop. The soils here generally tend to fit the characteristics that we found desirable (e.g. good drainage, gentle slopes) with only a moderate hazard of erosion. The beneficial topography and proximity to Madison make Dane County a prime location for Wisconsin orchard owners.

The soil survey from Eau Claire county (an area in and around cluster 8), tells a different story from the Dane County soil survey. In the Eau Claire area, we found the steepest slopes out of all the sampled surveys. The hazard of erosion in this area ranges anywhere from slight to severe depending on the slope of the soil. Also, every soil in this

area that we sampled had low water availability. Due to the challenges imposed on orchard owners by these physical factors, we do not believe that cluster 8 formed as a result of the local microclimate but perhaps due to its proximity to relatively large cities like Eau Claire and Chippewa Falls.

The Door County soil survey (cluster 3) confirmed our findings from the literature that it is one of the better areas for apple orchards, at least, in terms of its physical traits. Slopes in cluster 3 never exceeded 6% and as a result the hazard of erosion is only slight to moderate. This is also the only area with a soil type specifically identified as suitable for orchard crops which partially explains why early orchard owners found this area appealing. Strangely, soil moisture can be a limiting factor due to either its susceptibility to droughts or, the opposite, flooding. The beneficial physical characteristics of cluster 3 cannot be ignored but its proximity to the Green Bay could factor into the accumulation of orchards in this area.

Constructed Geographies

Constructed geographies that orchardists take into consideration when selecting their orchard location include family history, market locations, and authority promotions. Family history with a parcel of land was commonly mentioned on orchards websites and in a few of the survey responses. Multi-generational operations are not uncommon to Wisconsin agriculture and apple orchards are congruent with that. Our original theory of ethnic background being a factor on location is inconclusive considering the small amount of data generated from our surveys about that (see Table 1). Market location is a large consideration for all orchards. Direct to market, the method in which the harvest goes from farmer to consumer with no middlemen, operations tend to choose locations closer to their

consumers while orchards whose apples are shipped to a grocery store tend to put less weight on the nearness of cities to market to. Authority promotions seem to be less of a factor for more recently acquired orchards, but the existence of Gays Mills orchards and those in Door County are evidence of the sway authorities like the Wisconsin Horticulture Society, the UW Extension, and even WAGA have on the location choice of orchards in Wisconsin.

Large vs. Small Orchards

The largest trend evident is the difference between large orchards and small orchards. Large orchards tend to have family history and the microclimate of their land as larger influences on their location than small orchards. Large orchards are generally located further from cities with large populations and have been established for a longer period of time. They usually produce only a few cultivars because that's "What the market demands" according to one survey respondent. Small orchards tend to be younger and located closer to direct market opportunities like large cities. They generally produce a varying array of cultivars. Orchardists of small orchards do not often have family connections to land, but have purchased land brand new to them. Because they want to be located close to their markets they do not take the microclimate of the land parcel as heavily into account when they consider their location.

Because of globalizing food economies, according to Steve Louis, large orchards have been shutting down while more and more smaller orchards have recently arisen. These small orchards either fail and close very quickly or last. Another large change in the orchard industry is the emergence of new methods of pest and disease management that

do not involve pesticides or herbicides. Smaller orchards are more likely to use these new methods and are much more likely to pursue Organic methods than large orchards.

CONCLUSION

Each orchard has its own reasons for its location. However, there exist overarching themes and trends in the founding and development of orchards. Through our research, two primary factors in determining orchard location are evident. All orchard clusters are found either in regions that are in close proximity to cities, or in an area of the state with "ideal" topography for the growth of apples. There are other factors that play into the character of orchards, such as the number of years in operation which we have found correlates with orchard size. Regardless, the most definitive of factors remain aspects of geography, both physical and culturally constructed.

FUTURE RESEARCH

Being given the unrealistic gift of unlimited time and funding to continue our research into Wisconsin's apple orchards, our approach would be to expand on what we currently have done. For starters, the number of interviews would increase to include multiple orchardists whose operations vary in size and commercial function. Having more time would also allow more survey responses to trickle in, as the sample seems a bit smaller than optimally hoped. We would also attempt to make connections within WAGA

and attend at least one of their annual conferences to understand the pressures of being an orchardist that originate off the orchard or from outside pressures.

The biggest benefit of having more time would be that our research could be conducted during the actual apple growing and harvest season, rather than beginning at the tail end of the harvest. This small change would allow for our group to view more stages of the apple growing process. We could then visit the orchards to have the orchardists explain the stages of growth, pest management processes, and other stages of production. Allowing the group to actually see and understand first-hand the world of being an apple orchardist.

Another benefit that more time and money would provide is generating better skills at geographic analysis. Our spatial analysis through GIS mapping, geospatial statistics, and other analyzing practices are still somewhat raw. Time and money could either buy the education to learn these skills, or hire someone who could assist in performing such analysis.

FIGURES

Figure 1.

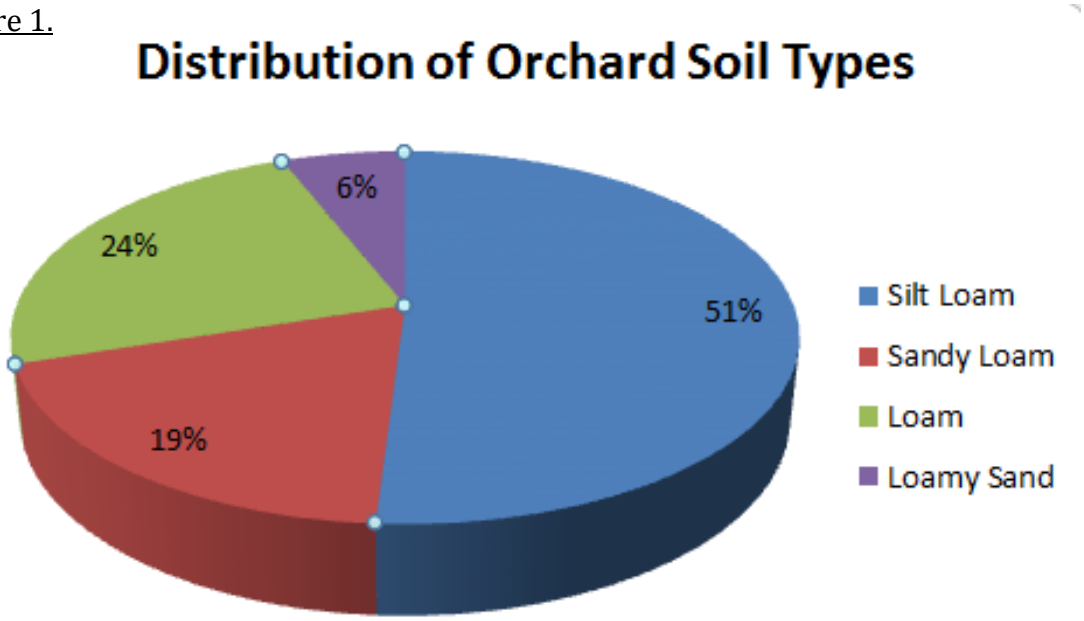


Figure 2.

Figure 3.

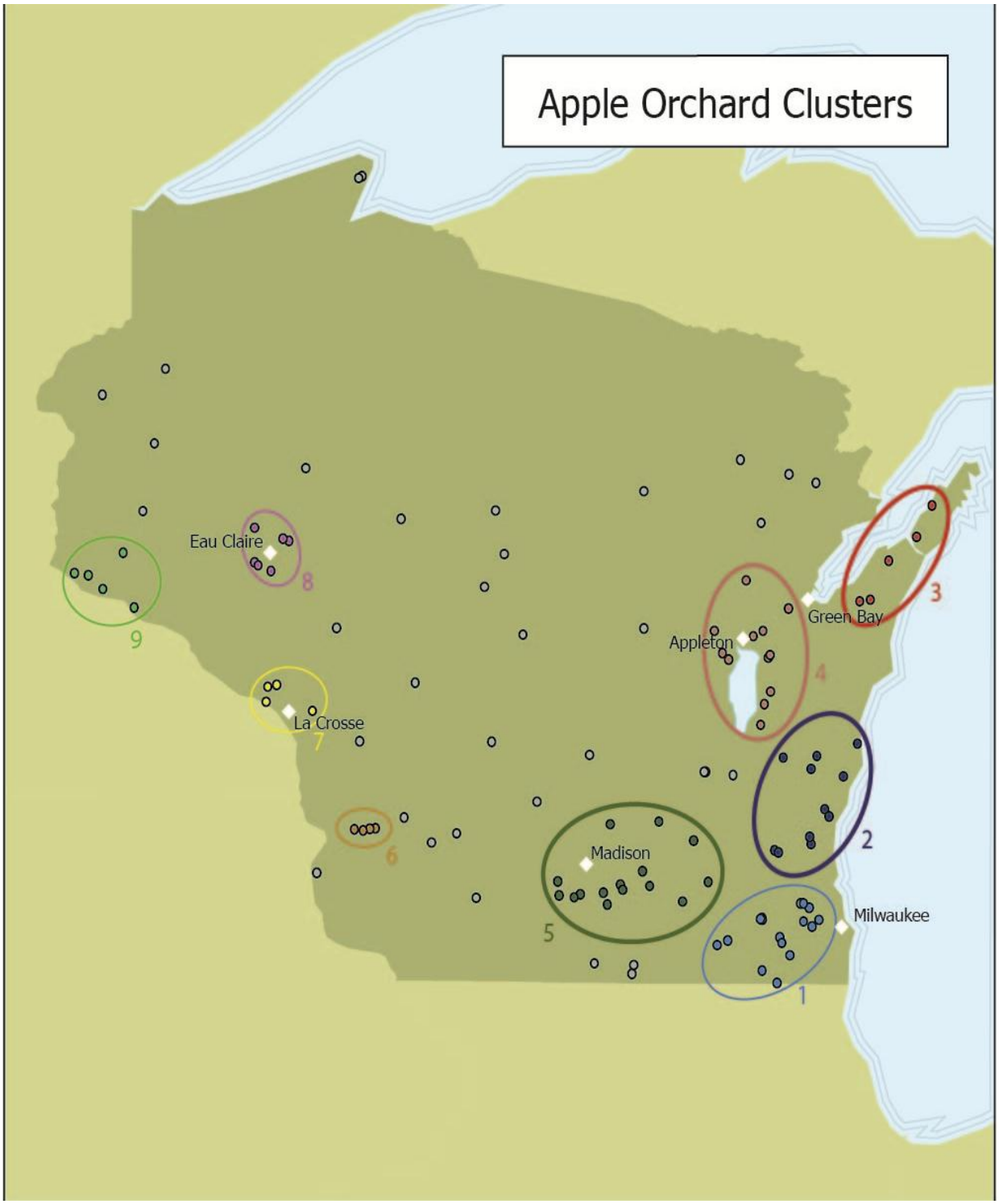

Apple Orchard Clusters
Eau Claire
8
9
La Crosse
7
6
Madison
5
Appleton
4
Green Bay
3
2
Milwaukee
1

Figure 4.


Apple Festivals in WI
Eau Claire
Green Bay
Appleton
La Crosse
Madison
Milwaukee

Figure 5.

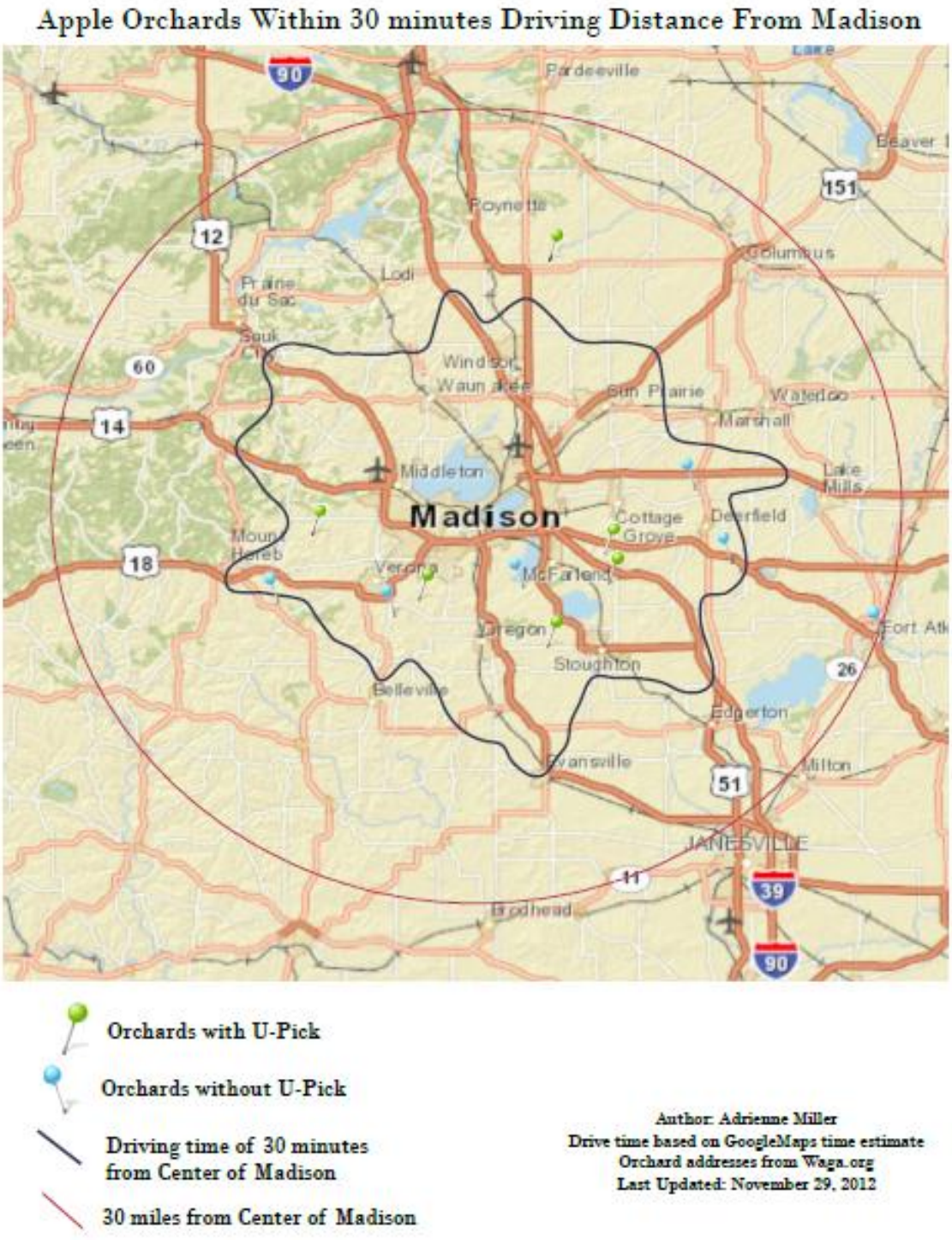
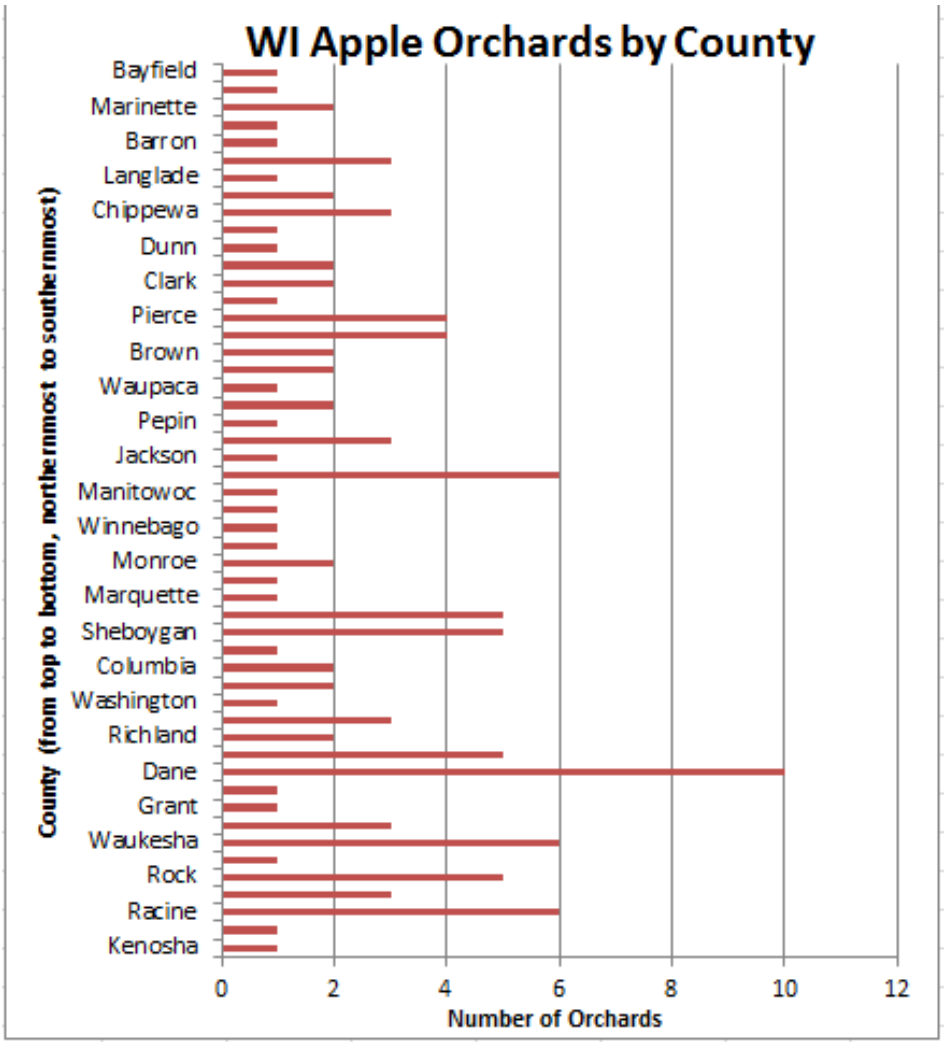

Apple Orchards Within 30 minutes Driving Distance From Madison
Madison
Middleton
Verona
McFarland
Oregon
Stoughton
Cottage Grove
Deerfield
Sun Prairie
Waterloo
Marshall
Lake Mills
Columbus
Poynette
Lodi
Prairie du Sac
Windsor
Belleville
Evansville
Edgerton
Milton
JANESVILLE
Brodhead
Fort Atk
Orchards with U-Pick
Orchards without U-Pick
Driving time of 30 minutes from Center of Madison
30 miles from Center of Madison
Author: Adrienne Miller
Drive time based on GoogleMaps time estimate
Orchard addresses from Waga.org
Last Updated: November 29, 2012

Figure 6.



Appendix 1.

1. What is the address of your farm/orchard?
2. What is the acreage of your farm/orchard? And how much of that is used specifically for apples? Please insert response in form “60, 30 acres” where you would have a total of 60 acres and 30 of them are used for apples.
3. How long has your farm/orchard been in operation?
4. What are the primary cultivars your orchard grows? And why?
5. What process of pest/disease management do you use (if any)?
6. What methods of training and pruning do you use (if any)?
7. What is your family heritage?

Table 1.

Orchard	Acerage	Years in Operation	Family Heritage	Cluster (0-none)
1	28, 8	18	German Farmers	4
2	83, 25	173	German settlers in 1839,	2
3	40, 1	7	GERMAN	0
4	143, 40	100	retired Navy	8
5	?, 3	18	Danish/Norweigan	0
6	6, 3	27	German, Cornish, Scot-Irish	8
7	15, 7	7	Irish, German, Bolivian	0
8	80, 8	28	Welsh/Irish	5
9	22	60	Irish, French	2
10	5, 2	20	Swiss, German	5
11	20, 7	7	scandinavian	0
12	40, 20	107	Primarily German plus Dutch and Czech	0
13	35.49, 14	34	scotch-irish, german	5
14	200, 7	3	no answer	
15	11, 4	16	German and Norwegian ancestory	2
16	200, 40	17	no answer	
17	1	36	second generation family run business with second third and forth generation working a city orchard	2
18	2	6	American. Polish and German	0
19	15, 8	8	Polish and German dairy farmers	0
20	5, 4	30	German	5
21	268, 60	61	no answer	7
22	250, 200	80	Norwegian	6
23	140,25	120	German	4
24	36, 8	61	Belgian	3
25	26,21	27	Has no bearing on the orchard.	0
26	15, 9	0	no answer	4
27	70, 5	14	Irish	0

Table 2.

Orchard	Cultivars	Why Those Cultivars
1	Dwarf m9 bud9 14 varieties mostly honeycrisp and jonagold	Based on info at the time of planting
2	Honeycrisp, Cortland, Golden Delicious	Retail demand
3	honey crisp	popularity
4	35 + varieties including Honeycrisp, cameo, crimson crisp, zestar, fuji, macintosh, cortland, redfree, pristine, enterprise, Topaz, haralson, Regent, Gala, Galarina, Macoun, Empire, Wolf river, Connel Red, Snow sweet, Little Jewel, Shizuka, Dandee Red, Golden Crisp, Chestnut Crab, Jonagold, Idared, Honeygold, Snappy Mac, plus several other minor varieties	Retail roadside benefits from variety and fresh avail. throughout the season
5	We grow Cortland, Red Macs, (these two are because they are old favorites and well known, We thought the Red Macs would be redder, we were wrong but they have good flavor) Fulford & Buckeye Gala,(We think Fulfords have better flavor than most of the other Galas) Empire,(We like the flavor and they are finally catching on) Honey Gold,(we thought a yellow apple would have apeal) Wolf River,(Because they originated from our area and they are know here for being a good baker) Honey Crisp, They were the new upcoming thing and people like a crisp apple) Sweet 16, Sun Crisp& Connell Red,(They sounded good from their description) Williams Pride,(We got a couple shipped to us by mistake) Macoun,(also a well known apple here) Whitney Crab.(We needed a pollinator and they are good for jelly)	see cultivars
6	Duchess, PaulaRed, McIntosh, Cortland, HoneyCrisp, Empire, ConnellRed, HoneyGold	We thought they would be popular and we like them.
7	Cortland, Wolf River, Connel Red,	no answer
8	Cortland, Honeycrisp, Jonagold, McIntosh, Empire, Golden Delicious, Jonafree, Earliblaze, Jonamac, Zesstar, Ginger Gold, Crimson Crisp	Customer appeal in the fresh market
9	cortland, macintosh	no answer
10	200 primarily antique cider to make certified orgainic cider and brandy	no answer
11	Honeycrisp, Honeygold, Fireside, McIntosh, State Fair, Zestar, Haralson, Red Regent, Wealthy, Sweet 16, Snowsweet, Macoun, and Akane	no answer
12	McIntosh, Cortland, Haralson, Connell Red plus about 35 others	no answer

13	honeycrisp,cortland,gala,mcintosh,macoun,empire,liberty,jonagold,jonathan,ginger gold, fuji, zestar,arlet,jonamac	customer demand
14	none	no answer
15	Honeycrisp, zestar, macintosh, cortland, jersey mac, granny smith, wealthy	
16	none	no answer
17	MacIntosh, Cortland, Zestar, Honeycrisp, Sansa , Williams Pride, Jonathan, Liberty, Freedom, Sweet Sixteen, Scarlett O Hara, Snowsweet, Johagold , Pristine, Gala, Prima, Priscilla, russet, Wolf River, Goldrush	no answer
18	Dwarf, over 35 varieties	no answer
19	Honeycrisp, Zestar, McIntosh, Cortland.	They grow very well in our area of the state and are the most popular.
20	Originally: McIntosh, Cortland and Northwestern Greenings. We have some younger trees of the new popular varieties such as Honeycrisp, Zestar, Snowsweet and Jonagold.	That is what people wanted 30 plus years ago.
21	Honeycrisp	It's what the customers prefer.
22	McIntosh apples, Honeycrisp and Cortland	very sellable
23	McIntosh, Cortland, Honeycrisp, Zestar, Paulared, Jersey Mac. Jonamac, Emmpire, Spartan, Red Delicious, Yellow Delicious, Gala, Russets, Harleson, Molly Delicious	hardiness, customer demand
24	red delicious, macs, cortland, paula red, viking, spartan, honey crisp,	no answer
25	Haralsons, Honeycrisp, RedFree.	We purchased the orchard and march 2012 and we don't know the reasoning behind varieties except that they are relatively popular among consumers.
26	honey crisp	We wanted to focus on the variety that has the greatest demand now and for the foreseeable future
27	Chestnut Crab Connell Red Goodland Haral Red Harelson Honey Crisp Liberty Nova Parkland RedCort Red Free Snow Sweet Sweet Sixteen Wolf River Zestar	We planted trees that would grow in our climate We have a few Plum Trees but find that they blossom too early for our climate and do not do well.

Table 3.

Orchard	Pest Management	Training Management
1	Eco imp	Central leader
2	High level IPM, scouting, monitoring, computerized weather stations, insect/disease modeling, resistance monitoring, soil moisture monitoring with ET to schedule drip irrigation demand,	intense vertical axis, v-trellis training and management. Pruning - completely transitioned to renewal pruning. Planting new blocks at ~ 2000 / trees per acre.
3	CURATIVE MGMT. USE ONLY ORGANIC CERTIFIABLE PRODUCTS LISTED IN "OMRI"	WE TRAIN WITH STICKS, WE PREFER CUTTING NOTCHES RATHER THAN USING NAILS
4	We are aa True Earth Certified orchard. We use all available IPM procedures and the least toxic chemicals and procedures for each application. Mire details would take 5 hours of typing, Please lookup True Earth!~!	Approx 35 % of our trees are on simple three/four wire trellis. All but maybe 2% are on semi dwarf roots and arepruned to approx 12 - 15 feet in height and six foot in row width and 3 ft either side aisle width. Quite severe
5	We have an air blast sprayer and use pesticides and fungicides. We have also tried to keep a very clean orchard removing all leaf litter from the ground early each spring to keep down scab and any pest that might have overwintered.	We have all of our trees are slender spindle. We do mostly dormant pruning, but some summer pruning.
6	Integrated Pest Management	Central Leader
7	no answer	center post support and early spring pruning every 3 years
8	IPM	central leader on our semi-dwarf trees, tall spindle with our dwarf trees
9	IPM	no answer
10	IPM, organic, weather monitor, scouting	limited training; prune to open to sunlight
11	IPM- not organic	corrective pruning and removal of low branches only- mid winter
12	Insecticides and fungicides	Open center, controlled height
13	ipm	central leader on semi-dwarfs, tall spindle on dwarfs
14	no answer	no answer
15	IPM and organic	Central leader, tall spindle
16	no answer	no answer
17	IPM	Slender spindle with minimal pruning
18	Spraying	Pruning and minor training
19	IPM	All of our trees are supported with stakes and or trellis. We have some trees on super spindle

20	IPM - We try to keep pesticide use to a minimum. We do spray as necessary	? It has changed as we have gone through the years. We try to keep the height down
21	no answer	no answer
22	IPM	Tall spindle
23	IPM-Conventional	oldest(72 years) standard trees/ spacing----most are planted high density/ vertical axe---most recent are planted to tall spindle system
24	spraying	hand pruning
25	We are developing an integrated pest managment plan with the help of a horticulturist	We will utilize standard pruning techniques with combination of manual and chainsaws for the areas with deferred maintenance. These methods are effective and most cost-efficient. We would like to do more mechanized pruning in the future.
26	We are following the best management program that is recommended by UW-Madison experts.	High density/tall spindle system
27	bug balls	We have dwarf trees - pruning is important to keep the trees in context, to their size, We prune our trees in the spring and suckers are cut off as they grow.

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