ECONOMIC FEASIBILITY OF NEW KIWIFRUIT CULTIVARS FOR

COMMERCIAL PLANTING IN ALABAMA

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ECONOMIC FEASIBILITY OF NEW KIWIFRUIT CULTIVARS FOR COMMERCIAL PLANTING IN ALABAMA

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THESIS ABSTRACT

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Establishing a new fruit industry brings many challenges and questions before any investment is considered by growers. This research aims to provide an accurate assessment of the feasibility of growing a commercial kiwifruit crop in selected geographical regions in Alabama. This study will exclusively evaluate the cropping systems used in producing *Actinidia chinensis* kiwifruit.

Kiwifruit was first cataloged in 1821 by Nathaniel Wallich in Nepal. The first kiwifruit seeds were planted in New Zealand in 1910 with seeds brought from China. The current industry standard variety, 'Hayward' of the genus *Actinidia deliciosa*, was developed from these seeds by Hayward Wright around 1924. Kiwifruit moved towards commercial production in New Zealand by the 1930's. Oversupply in the 1980's led to a dramatic drop in prices, reducing the value of developed orchards and curtailing any new plantings. Kiwifruit brand name Zespri rose from the collapse along with a new

commercial variety of kiwifruit, HORT 16A, of the genus *Actinidia chinensis.* The development of this new type led to other new varieties for the kiwifruit market.

Using Stella® modeling software, from isee systems inc., a prediction system for yields is developed. This model simulated the biological timeline of a year's fruit crop. The model outputs yields as well as number of frosts, amount of thinning, and fulfillment of chilling requirements. Simulating for different sites in Alabama, viability of those areas can be abstracted. The system evaluates two new varieties of kiwifruit, 'Golden Sunshine' and 'Golden Dragon', which have different bloom and harvest terms. The different bloom times subject the fruit to different frost risk, but they also allow for earlier and later harvests. Data collected from the National Oceanic and Atmospheric Administration and the Alabama Mesonet are used in the model.

Simetar® software by James W. Richardson is used to make an enterprise budget that accounts for variance in time to completion of tasks and applications of various orchard inputs. An enterprise budget is generated, it allows flexibility in inputs as affected by a previous year's crop or current growing conditions. Variability of input prices as well as output prices, and labor completion time in a traditional *Actinida Chinesis* cropping system are accounted for.

Support services for a new fruit farming industry in Alabama could be difficult due to scale requirements for the development of proper post harvest facilities. To aid in small farms participation a kiwifruit cooperative would need to be formed with the main purpose of marketing, sorting of harvested fruit, and packaging. Cooperative orchard management services will provide for a vertically integrated industry which can be self sustaining and allow for growth using non-traditional investors.

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The author would like to thank Dr. Robert G. Nelson for his patience and guidance in this process. I would also like to thank Dr. William Dozier and Clinton P. Wall for their guidance and for sparking my interest in kiwifruit production. Most of this would not be possible without the help of Jim Pitts, Bobby Boozer and Bryan S. Wilkins from Alabama Agricultural Experiment Station, Alabama Cooperative Extension System and Auburn University, respectively. I would like to thank all of my friends and family for their support and help in completing this task. Finally, this is dedicated to those friends and family of mine who have already passed on. Their lives, however short or long, are a constant inspiration and reminder to me that achievement can only come with hard work and dedication to a final goal.

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Computer software used: Microsoft Word 2003, Microsoft Excel 2003, Stella v 9.0.3, Simetar 2005, STATA 10.

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I. INTRODUCTION

HISTORY

Botany

Kiwifruit are native to the forests of South East Asia. Specimens of kiwifruit were first collected by Dr. Nathaniel Wallich in Nepal in 1821 (Ferguson, 1990). The green-fleshed fruit were originally classified as *Actinidia chinensis* and later reclassified as *Actinidia deliciosa*. Yellow-fleshed varieties are classified under the *Actinidia chinensis* species. The vine is dioecious, requiring a male and a female plant for pollination to occur. Vines are most commonly found as part of the lower story of forests, especially along stream beds, at forest margins, or in low scrub (Ferguson, 1990). Kiwifruit occurs naturally as a deciduous fruiting vine, growing vigorously to a height of nine meters or more (Sale, 1990). The plant is a perennial climbing or straggling plant, requiring a trellis system for successful cultivation. Extensive pruning is required for kiwifruit due to the vigorous growth of the plant.

Varieties

Two common commercially-grown species of kiwifruit are *Actinidia deliciosa* (green flesh) and *Actinidia chinensis* (yellow flesh). The kiwifruit plant was not exported from China until the turn of the 20th century, when Isabel Fraser, a native of New Zealand, visited China and returned home with kiwifruit seeds that she gave to Alexander Allison. Allison subsequently grew them successfully in Wanganui, New Zealand and

the vines from these seeds first fruited in 1910 (LaRue, 1994). The most common variety of *Actinidia deliciosa* kiwifruit grown throughout the world is 'Hayward'. Hayward Wright, a nurseryman of Avondale, Auckland, offered plants in his undated catalogue of 1922, and advertised them in 1925 (Ferguson and Bollard, 1990). Wright's vine can be traced to the seeds brought back from China by Isabel Fraser.

The most widely-marketed *Actinidia chinensis* fruit is 'Hort 16A'. 'Hort 16A' was bred by HortResearch in New Zealand and currently controlled by Zespri™, the world's largest marketer of kiwifruit. In this study, the varieties that are evaluated are two within the *Actinidia chinensis* species: 'Golden Dragon' and 'Golden Sunshine'. The Hubei Fruit and Tea Institute, and Auburn University are jointly releasing these two patented varieties 'Golden Dragon' and 'Golden Sunshine' for plant production.

Commercialization

Kiwifruit was first considered a commercial fruit crop in the 1930's when a commercial scale planting was carried out in the Bay of Plenty by Jim McLoughlin of Te Puke, New Zealand (Sale, 1990). Te Puke still claims to be the kiwifruit capital of the world, and has many different companies, cooperatives, and packing operations locally. Te Puke has around 39% of New Zealand's total 'Hayward' acreage and 45% of the country's 'Hort 16A' acreage (Zespri, 2008).

Kiwifruit was first introduced into California in the early 1930's by the United States Department of Agriculture (LaRue, 1994); however, it was not until much later that California growers became interested in producing kiwifruit on a commercial scale. The Tanimoto brothers of Gridley, California are credited with establishing the first commercial kiwifruit vineyard of any notable size in California. They obtained some

seed and scion wood for grafting in 1965. Three years later, these grafted vines were planted in a one-acre block in the Sacramento Valley and they produced their first commercial crop in 1971 (LaRue, 1994). California is now the largest producing area in the United States, with 4,000 acres producing 26,100 tons and a crop value of $23,148,000 in 2006 (California Ag., 2007).

Other production areas in the United States have also been explored. In the 1980s, a New Zealand Company sold approximately 300,000 'Hayward' plants in the Southeast United States. Many of the areas that purchased plants did not receive enough chilling hours to properly develop flower buds and produce fruit. Since the 1980s, a kiwi cultivar evaluation trial has been conducted at the Chilton Area Research and Extension Center in Thorsby, Alabama (Wall, 2006). Currently, Alabama production is limited to small growers of less than one canopy acre.

Overproduction in the 1980's and Creation of the Zespri Brand

By 1988 there were 18,905 hectares (47,262 acres) under commercial cultivation in New Zealand (New Zealand Ministry of Agriculture and Forestry, 2008). New Zealand growers produced approximately 231,000 tons of fruit that year. The rapid expansion of plantings in that decade had ceased, and production in New Zealand reached its peak levels, with annual fluctuations reflecting only seasonal conditions (Sale, 1990). By the end of 1988 the overplanting problem was obvious, and total acreage of kiwifruit plantings in New Zealand declined to a low of 11,640 hectares (28,751 acres) by 1996. Currently there are 13,250 hectares (33,125 acres) of kiwifruit production, including plantings of the yellow-fleshed variety 'Hort16A'. Acreage has increased since 1996; most rapidly (by 1,179 hectares) between 2005 and 2007. Most of the increase in acreage

can be attributed to the development of 'Hort16A', which had an orchard-gate return of NZ$ 22,000 more per hectare than 'Hayward' for the 2007-08 growing season (Zespri, 2008). 'Hort 16A' is a more labor intensive crop to maintain, costing NZ$ 7,000 more than a hectare of 'Hayward' (Wall, C.P., 2008).

Various kiwifruit producers were unable to market fruit economically at the export prices offered in the late 1980's. In response to the overproduction of kiwifruit into world markets, the Kiwifruit Marketing Board of New Zealand opted to emphasize higher quality fruit and larger sizes (Schultz and McNeil, 1994). In 1987, the New Zealand kiwifruit industry was estimated to account for 60% of total world kiwifruit sales (Crocombe, 1991). While the kiwifruit industry was first developed in New Zealand, the barriers to establishing kiwifruit orchards elsewhere were relatively low, and consequently growers in Italy and Chile rushed to plant kiwifruit in the 1980s. This resulted in the supply of kiwifruit greatly outstripping demand and causing prices of kiwifruit in international markets to collapse. In an attempt to differentiate themselves, Kiwifruit New Zealand developed a new organizational structure and created the brand Zespri, a trademark owned by Zespri International Limited which was founded in 1997 (Beaverland, 2001). New standards led to a decline in kiwifruit orchards in New Zealand, but resulted in a higher price and superior fruit quality.

World Supply

Since kiwifruit has extensive production on both hemispheres, and with a maximum fruit storage life of six months, the southern hemisphere and northern hemisphere are complements instead of substitutes. The logical fallacy that is presented in the argument about oversupply is to include Italy, as New Zealand presents its fruit to

the world at the opposite season. Italy is currently the world's largest producer at 390,000 tons in 2002-2003 (USDA, 2008). New Zealand has a production of 292,660 tons and Chile produced 112,660 tons in the 2002-2003 (USDA, 2008) southern hemisphere growing season. The northern hemisphere, consisting of Greece, Italy, France, Spain, Portugal and the United States, produced a total of 534,760 metric tons of kiwifruit in 2002-2003 (USDA, 2008). The United States produced 22,770 tons of fruit but imported 44,573 tons of kiwifruit (USDA, 2008). The US will export an estimated 30% of its fruit.

US Golden Kiwifruit Production

Currently there is one 'Hort 16A' planting in Bakersfield, CA. This planting so far has failed to produce fruit of marketable quality. Zespri will not allow the fruit to be picked from the vines until the interior color is 108° of internal color hue or less. The hue angle is measure by a colorimeter which measures color of a target and returns various data points on the observation. Under these conditions, the fruit produced in California shriveled on the vine, because it would not reach that level of color and aided by the arid climate and the length of time the fruit spent on the vine. One advantage of 'Golden Sunshine' and 'Golden Dragon' is that they are not controlled under a brand name and they do not have to follow specific harvest guidelines. Currently at the Chilton Research and Extension Center in Thorsby, AL all three varieties are picked at 108° of internal color hue or less, and not one has failed to achieve the color requirement.

In an informal test, members of the public were invited to sample both 'Golden Sunshine' and 'Golden Dragon' at Auburn University's annual 'AG Roundup' in 2008. Most of the respondents who disliked 'Hayward' kiwifruit enjoyed the taste of 'Golden

Sunshine'. Although 'Golden Dragon' was also served; however, after having been in cold storage for two months, it was preferred less to the taste of 'Golden Sunshine'. At current predicted yields, if Alabama produced half of the US supply of yellow-fleshed varieties, there would have to be approximately 465 canopy acres in production. At revenues of six dollars per tray and yields of 6,000 trays per acre, the potential revenue would be around sixteen million dollars a year.

Alabama Industry Development

Development of the new industry will require an extensive marketing effort. If Alabama growers are to be successful, a recognizable brand name in select foreign markets needs to be established, as well as have fruit that is appealing in local markets. If it becomes feasible to team up with Zespri in helping their southern-hemisphere fruit get established in US markets, while Zespri aids Alabama growers in marketing in the Far East. Currently, Zespri requires high industry standards which decide which fruit is sold and which is considered non marketable may be unappealing to Alabama producers.

Motivation for Study

Since the failure of the plantings in the 1980's researchers and growers alike are skeptical of planting kiwifruit. Chapter two is a price study which will help demonstrate the potential of the yellow fleshed varieties when compared to green varieties as a premium fruit. This study seeks out the areas in Alabama that are suitable for production where an industry can be successfully established, for varieties 'Golden Dragon' and 'Golden Sunshine'. Using biological computer modeling in chapter three, historical temperature records, for eight areas in Alabama is examined and the growth of the fruit was simulated to determine yield levels. Using Simetar software in chapter four the costs

of the orchard and the revenues were simulated using the geography-specific yields and the location based profitability of orchards was determined. Another concern of growers -- the marketing of the fruit -- is also addressed by the provision of an outline of a cooperative organization that would handle the marketing of the fruit. This study also offers the beginnings of a Production Guide or extension Fact Sheet that covers where to plant, how to grow and what kind of return to expect for a yellow-fleshed kiwifruit orchard in Alabama.

II. KIWIFRUIT PRICE STUDY

Interest in growing non-traditional yellow-fleshed kiwifruit needs to be supported by price information. Therefore, a hedonic pricing model was developed to find the effect of observed characteristics had on the market price of kiwifruit. Economic content of the relationship between observed prices and characteristics becomes evident once price differences among across goods are recognized by equalizing differences for the alternative packages (Rosen, 1974). In the case of Bordeaux wines the market price was explained primarily by the objective characteristics appearing on the bottle (Combris et al., 1997). For kiwifruit pricing using data provided by the USDA marketing service will aid in the development of the model.

The model that was developed using this data is below:

$$P_{ki} = a_i + \beta_{1i} D_{isA} + \beta_{2i} S_{pi} + \beta_{3i} D_{t1i} + \beta_{4i} D_{t2i} + \beta_{4i} PS_{zi} + \beta_{5i} FS_{zi} + \beta_{6i} CA_i + \beta_{7i} IT_i + \beta_{8i} NZ_i + \beta_{9i} CH_i + \beta_{10i} GR_i + \varepsilon_i$$

Where:

P_{ki} = price per kilogram

a_i = intercept

D_{isA} = distance from Atlanta

S_{pi} = Species, yellow flesh or green 'Hayward'

D_{t1i} = date 1D_{t2i} = date 2

PS_{zi} = package size

FS_{zi} = fruit size

CA_i = California

IT_i = Italy

NZ_i = New Zealand

CH_i = Chile

GR_i = Greece

ε_i = error term.

The data set included 19,164 observations of weekly prices during the months of August to February; in the years 2003 through 2009 (January 15, 2009 was the end date). The prices came from many different terminal markets throughout the world. A summary of the data set is available in Table 1.

The dependent variable was calculated as a quotient of the sale price and the weight of the pack on the sale date. Doing this standardized the units for the dependent variable into dollar amount received per kilogram of weight.

The first independent variable listed, D_{isA}, is the distance in miles from the terminal market for the observation was from Atlanta. The other markets in the study listed in distance from Atlanta are: Colombia, SC; St. Louis, MO; Miami, FL; Baltimore, MD; Pittsburgh, PA; Chicago, IL; Detroit, MI; Dallas, TX; Philadelphia, PA; New York, NY; Toronto, Ont.; Boston, MA; Montreal, Que.; Los Angeles, CA; Monterrey, CA; San Francisco, CA; Seattle, WA; Paris, FR; and Rotterdam, NL. The maximum distance was 4537 miles for the Rotterdam market, while the mean distance was 1738 miles.

The variable for species, S_{pi} , was a dummy variable. Observations that reported yellow fleshed fruit were given a value of one and observations that reported 'Hayward'

were given a value of zero. There were 748 observations out of 19,525, or about 4%, were sales of yellow fleshed fruit. This is primarily due to the short storage life of yellow fleshed fruit, its almost exclusive southern hemisphere production leading to the low quantities of yellow fleshed fruit available in August through February.

The date variable, D_{t1i}, serves as a trend variable. The dates have a numerical value assigned to them with the first date August 3, 2003 was assigned a value of 1, the next set of observations, was assigned a value of seven being one week later. This variable was continuous throughout the study reaching a maximum value of 1,961 on January 15, 2009.

The date2, D_{t2i}, variable is a seasonal trend variable. This variable assigned a one for the first week of observations of the season and a seven for the second. The maximum number of days in one period was 183 days in the season.

The weight of the package, PS_{zi}, was a continuous variable that was categorized by kilograms of package weight. The two most common sizes of package are the 3.6 kg flat-packed tray and the 10 kg volume-filled box. The largest size was a 10.8 kg size and the smallest was a 3 kg.

Kiwifruit is categorized in to many different fruit size classes. The size, FS_{zi}, refers to the number of fruit per 3.6kg tray even if the fruit are not packed in a tray. The largest size recorded was 18 (200g fruit) and the smallest was a size 50 (72g fruit).

The region of origin variable was a series of dummy variables. France (783 observations) was the country that the other countries in the study would receive a premium or a discount in relation to. Italy, IT_i, (4,738 observations), New Zealand, NZ_i, (4,662 observations), Greece, GR_i, (605 observations), California, CA_i, (5,535

observations) and Chile, CH_i , (3,202 observations) were the countries of origin that were used in the study.

Results

An OLS regression using the STAT 10 software package was run. All eleven independent variables provided significant explanatory relationship to the dependent variable at the 95% confidence level. The results can be viewed in Table 2.

A matrix of correlation between the variables can be seen in Table 3. The highest correlation of -0.4244 between New Zealand (NZ_i) and date2, D_{t2i} , is a result of the end of the storage life for New Zealand fruit. The correlation between New Zealand and yellow fleshed fruit is .2412 because New Zealand is the largest supplier with California also producing some yellow fleshed fruit.

D_{isA} , distance from Atlanta is significant and negative. The coefficient is -0.000111. For Rotterdam, the furthest market at 4537 miles, there is a discount of $0.504 per kilogram. Most of the markets accessible to Alabama growers are 800 miles or less from Atlanta and would receive a discount of $0.089 per kilogram. So if the Alabama grower were choose to send fruit to a market that was 1738 (the mean distance) miles away, they would expect to receive approximately $0.20 less per kilogram.

The species variable, S_{pi} , was significant and had a coefficient of 0.56, meaning that yellow-fleshed varieties command a $0.56 per kilogram premium over traditional 'Hayward' kiwifruit. With this information, we know that, at wholesale, Alabama growers can expect a premium for their fruit of approximately $1.50 per tray which at a per acre yield of 6,000 trays, equates to an extra $9,000 per acre over what a 'Hayward' planting would provide at the same yield level.

The coefficient for date, D_{t1i}, is significant and amounts to $.000166/kg for every day from August 1, 2003 through January 15, 2009 (the 1,961 days in the data set). Thus the last day pays a premium of $0.331 per kilogram more than the first day in the data set.

The coefficient for date 2, D_{t2i}, was significant and positive at $0.000584, indicating a premium of $0.107 per kilogram on the last day of the season. By that date it would not be possible for the fruit to have been kept in marketable form in cool storage and the inventory would have run out or be thrown out.

Package weight, PS_{zi}, was was estimated to have a penalty of -$0.063384 per kilogram of package weight. Or, a discount for bulk purchased is rewarded. At 10kg (volume filled box) of packed weight a discount of -$0.40 per kilogram of package weight or $4.00 would be given over a 3.6 kg pack (tray).

The region of origin variables were all significant, with Greek fruit receiving a discount (-$0.245/kg) while all others received a premium compared to fruit that was grown in France. The largest premium was received by New Zealand ($0.324/kg), followed by Chile ($0.295/kg), California ($0.259/kg), and global production leader Italy ($0.089/kg), when compared to French fruit. Possible explanations for the premiums received by New Zealand and California are organization of marketing board and, in the case of New Zealand, the brand name Zespri™. Chilean fruit may receive some free-rider effect from the promotional efforts of the New Zealanders as their fruit enters the market from the southern hemisphere at the same time. French, Greek and Italian fruit and California fruit enter the market at the same time and the promotion of the California fruit by the Kiwifruit Administrative Committee could play a role in the higher premium seen in the California sourced fruit over the French, Greek and Italian fruit.

Fruit size, FS_{zi} , is significant and negative, with a discount of -$0.009705 for every size decrease. A chart with the sizes and the associated discounts can be seen in Table 4. This demonstrates that larger sizes receive a proportional premium over smaller sizes.

The model adjusted R^2 is .4 or 40% of the variation in the dependent variable price is explained by the independent variables. The relationship between the significance of the variables and the r-squared value can be reasonable, due to the large amount of noise in the data set and the mix of observable and dummy independent variables. It is very possible that the large size of the sample and the long period of time can contribute to a high level of noise. Since these values are not inputted as a true time series, running econometric test for time series to correct noise levels is difficult. Numerous observations occur on the same day, and factors influencing pricing in different areas of the globe as well as the country are not observed in the data set.

Prices used in the Simetar model to simulate revenues were imputed as empirical values meaning that the chance of receiving any of the following prices was 20%. The prices that were used were: $6.45, 7.15, 7.48, 7.50 and 9.26. These prices were formed using New Zealand orchard gate returns provided on the Zespri annual report adding two dollars a tray for packing and applying the exchange rate, as well as output from the price model. In future studies, the distribution of the different tray sizes can be drawn upon and a more accurate estimate of returns can be predicted.

For a likely scenario, the price model would predict a price of over $9.00 for yellow fleshed fruit sold at the Atlanta market in late September of 2009; if the average fruit size was 36 and packed in a 10kg volume filled box. It was assumed that Alabama

fruit would receive a premium similar to California fruit due to some free rider effect from the Kiwifruit Administrative Committee. The prices used for the Simetar model lead to a more conservative estimate of revenues than using the predicted prices from the price model, although there is a one in five chance of the highest price in the distribution being drawn.

III. SIMULATION OF GOLDEN KIWIFRUIT YIELDS AND SIZE DISTRUBUTION UNDER HISTORICAL TEMPERATURE REGIMES IN ALABAMA

A dynamic modeling system was developed to simulate the temperature dependent risks of a kiwifruit production system, using Stella modeling software from isee Systems Inc. The system is a flow chart that follows the growth and development of the fruit on the vine for a crop year. The system consists of a series of converters, which make probabilistic determinations and draw from a distribution or use a multiplier which affects the fruit yield. Various outputs, particularly yield, are collected from the model and used as inputs in the Simetar model discussed in the next chapter. The process of what has been modeled can be seen in Figure 1.

Kiwifruit, unlike other horticultural crops such as peaches, is a relatively new crop developed for worldwide markets. Peaches have thousands of tested and cataloged varieties, making the selection of the variety for a specific site easier and less risky. Golden, or yellow fleshed, kiwifruit have only two varieties that have been evaluated for planting in the state of Alabama; 'Golden Sunshine' and 'Golden Dragon'. Many areas of Alabama will fulfill the chilling requirement for proper floral development in these two varieties. 'Golden Sunshine' has a 900 hour chilling requirement before proper flowers develop and 'Golden Dragon' has an 800 hour chilling requirement (Wall et al.).

‘Golden Dragon’ blooms three weeks earlier than ‘Golden Sunshine’ because of ‘Golden Dragon’s lower growing degree hour requirement which is fulfilled much earlier. Because of the earlier bloom period, ‘Golden Dragon’ can be harvested a month earlier than ‘Golden Sunshine’, leading to the possibility of a higher price for early harvested ‘Golden Dragon’ fruit. Currently, the price model does not suggest that an earlier harvested fruit will fetch a higher price. As production begins this may change. Most of the data in the price model comes from green or ‘Hayward’ fruit which, because of its storage life (six months), has a constant year round supply, where as the yellow flesh stay marketable for a shorter amount of time (3 months) in cool storage. The chance of an early April frost is quite high through northern and central Alabama, which would cause damage to the crop and also the possibility of a complete crop loss.

The dormant kiwifruit plants cannot handle temperatures below 10°F, long exposures at this temperature will lead to plant death. Alabama has four different USDA hardiness zones 7A, 7B, 8A and 8B. As a general rule zone 7 accepts plants that are cold hardy at 0-10°F and zone 8 at 10-20°F. Two sites are in zone 7B (5 to 10°F); Cullman and Thorsby; and five are in 8A (10 to 15°F); Auburn, Marion Junction, Union Springs, Brewton and Headland; and Semmes is in zone 8B (20 to 25°F) (USNA, 2008). Therefore, since kiwifruit plants are damaged at temperatures below 10°F, in zone 7 it may be necessary to have some system of protection for the trunk of the tree in the early years of orchard establishment. Unprotected plants are subject to death from freeze damage at temperatures below -17.8°C. In field tests, unprotected plants sustained a 92% injury rate, while those with their trunks wrapped had only a 16% rate, and those protected with micro-sprinklers had a 20% rate of injury (Dozier et al., 1992). All plants

are protected from freeze damage for all sights in the study. The spray guards pull double duty as herbicide protection and the micro-sprinklers irrigate as well as provide freeze damage protection.

Commercial viability of a new fruit industry can be highly uncertain as initial production of new agricultural commodities are predominantly restricted to experiment stations and small home gardens. The large initial investment required for many new commodities must be accompanied by expectations of an attractive return to entice possible investors. Once established, a kiwifruit vine can bear fruit for more than thirty years. Production of the vine is highly labor-intensive, and higher labor costs are to be expected than with most other tree fruit crops such as, satsumas, apples or peaches.

The establishment costs for kiwifruits are much higher than alternative crops with the construction of a trellis system being the costliest input. The plants have relatively low pest problems. Common pests of kiwifruit that affect the crops of New Zealand and Italy are not found in Alabama.

One way to quantify the expectation of returns and yields is to use historic data on weather and environmental factors to model various growing conditions. Fruit yields can be simulated over numerous growing seasons, subject to stochastic weather events such as chilling hours, growing degree hours and frost. These models can help growers decide what variety to plant, and provide a probabilistic distribution of enterprise profitability. The simulation data can be used to aid in the selection of orchard locations by predicting expected yields for selected sites in Alabama.

Chilling hours and frost risk to flower buds vary greatly within and between the USDA cold hardiness zones. There are also other factors such as lower elevation, cool

air drainage and types of frost protection that may mitigate the degree of frost damage. A practical way of estimating damage is to use weather data collected by various stations around the state. Bud kill and damage at certain temperatures has been evaluated for kiwifruit and many other crops. Using the estimated frost risk provided by the National Oceanic and Atmospheric Association (NOAA) in a simulation model such as Stella, flower damage can be quantified in a stochastic framework.

Chilling hours are measured in "Richardson" units, which are defined as the accumulation of hours in the range of 0°C to 7°C required to remove a resting organ's inhibition to grow (Samish and Levee, 1962). Uniformity and number of flowers set in the spring are directly related to the amount of chilling received in the winter (Snelgar 1997). Observations from the 1990's in southern areas of Alabama clearly indicated that development of flower buds in the 'Hayward' variety (at only 10 to 30 per plant) and subsequent fruit development (0 to 25 fruit per plant) is extremely limited. Similar observations in central Alabama, where chilling accumulation averages 1,000 to 1,300 hours, found that 'Hayward' to performed optimally, both vegetatively and in flowering and fruiting (at 200 to 300 fruit per plant) (Powell et al., 2000). From the previous data it would be useful to assume that only 10% of the flowers would actually bloom. Since the complexity of the Stella model was not such that it was outputting a certain number of flowers for a range of chilling hours, the model assumed that if chilling is not met for a specific variety then only 25% of the normal flower count will bloom. If the chilling was fulfilled to 95% or more vines would probably still bloom as normal, yet the model will impact the buds negatively. More research needs to be done to establish chilling thresholds for amount of bloom per hour accumulated.

Chilling hours are collected yearly at Alabama Experiment stations, and posted on the Alabama Mesonet. These data include the monthly average and standard deviation for the months of November through February from the 1997 to 2008 crop seasons. The data sets collected from Mesonet were used to predict chilling hours for eight locations around the state: Cullman, Thorsby, Auburn, Marion Junction, Union Springs, Brewton, Headland and Semmes (See Figure 2). Potential investors in kiwifruit believe that the ideal place to launch the kiwifruit industry is in Chilton County, which is the central location for Alabama's peach industry. The simulation models were used to evaluate whether this would be a profitable venture. Results showed that only 'Golden Sunshine' can be grown there, but in Marion Junction and Union Springs both 'Golden Dragon' and 'Golden Sunshine' can be grown profitably.

A solution to the lack of chilling is the application of Dormex (hydrogen cyanamide) which aids in bud break. If a variety is planted in an area where chilling is insufficient, the use of Dormex can help that variety develop its flowers.

It was decided not to consider Dormex for several reasons. Reasons that lead to this decision are the possibility of a ban by the EPA of the United States or the possibile banning of fruit for importation to European Union countries. In 2001, 23 hydrogen cyanamide related illnesses were identified in Italy which lead to a temporary suspension of the product until that ban was lifted in 2003 (CDC, 2008). In Italy, 28 hydrogen cyanamide illnesses were reported during 2002-2004. Italy has banned the use of Dormex for current production, leading to concern among many New Zealanders about how long the product will be available in their market (Stevenson C., 2008)

Dormex can be helpful after a mild winter. In Alabama, application of Dormex at 4% solution increased the flowers and fruits produced from less than one to about four per tagged shoot (individual shoots were tagged and counted for a change in flower and fruit vs. a control). Fruit set was increased by all Dormex rates over the control following mild winters (1991 and 1993), but no differences were apparent in 1994 following a high chilling winter in South Alabama (Powell et al., 2000). Studies in 1995 in a second location in southern Alabama resulted in essentially the same level of flowering and fruiting per shoot for 1991 and 1993 (Powell et al, 2000). If a planting has to rely on Dormex for success, the length of the orchards productivity can be greatly decreased if the chemical were subsequently banned.

Chilling Results

Chilling hours were simulated in the Stella model by using data recorded at eight experiment stations. Each months input was modeled as a normal distribution, which simply requires the input of a mean and a standard deviation. Under the assumption that monthly chilling hours are independent events, each month of chilling hours used in the one iteration -- November, December, January and February -- had a draw, and then the seasonal total was accumulated. This process was repeated 1,000 times as each simulation is reflective of one crop year. Chilling hours are not perfectly correlated to latitude, but the general trend is that the more northerly the site is, the higher the chance that the chilling requirement will be fulfilled. Although Dormex is not used in the study, 80% of the chilling requirement is required before Dormex can aid the plant in bud break. Table 5 shows the predicted performance of the two cultivars at selected sites in Alabama, for 100% and 80% of chilling fulfillment.

If Dormex is no longer an option considered for commercial production, it is not reasonable to plant south of Brewton for commercial production. Cullman, Thorsby, and Marion Junction fulfill chilling requirements with both varieties. Union Springs and Auburn fulfill chilling requirements for 'Golden Dragon', but only marginally fulfill chilling requirements for 'Golden Sunshine'. Brewton is only marginal for 'Golden Dragon'. All places north of Brewton would be suitable if Dormex applications were to be considered standard practice. However, with the hazards previously stated it may be desirable to avoid the application of this chemical.

Bloom Period

After fulfilling the chilling requirement the plants must accumulate a certain number of Growing Degree Hours (GDH) before bloom. GDH for first bud break and first flower development were calculated daily using a base temperature of 4.4 °C and a maximum temperature of 25°C. 'Golden Sunshine' requires 16,000 hours for flowers to show and 'Golden Dragon' requires 12,000 hours (Wall et al., 2008). Because of this, the average bloom dates for 'Golden Sunshine' and 'Golden Dragon' differs. While more chilling hours accumulate the further north the orchard is, growing degree hours (GDH) accumulate faster in a more southerly direction. Because of this, the dates of frost exposure come earlier for areas south of Thorsby, and later for areas north of Thorsby. GDH is similar for Thorsby, Union Springs, Marion Junction and Brewton. There is no data reported on the Alabama Peach IPM website for Cullman, and Auburn. Since Headland and Semmes failed to make chilling above 650 hours this year, their growing degree hours have not been reported. A more sophisticated model will show at what amount of GDH accumulation that flowers show and then it will predict when they are

susceptible to frost. At the Thorsby experiment station the bloom of field-grown 'Golden Dragon' is from April 9th and April 15th for 10% bloom and 90% bloom respectively. For 'Golden Sunshine' it is from April 29th for 10% bloom to May 10th for 90% bloom (Wall, 2008). The bloom periods differ for each site in the study. Bloom periods are estimated in Table 6 for the other sites. While the model does not predict when the GDH are met for each variety, this functionality could be added at a later date. Another reason for an earlier frost date is that if 'Golden Dragon' were to flower at the same time for all of the sites it would have less than actual frost exposure at some sites and more than it should at others.

Frost Damage

When buds push and flowers form, flowers are exposed to a major frost risk. At temperatures at or below -3.0° degrees Celsius there is a 100% kill rate of buds. The incidence of frost kill increases as temperature decreases; from -3.0° to -2.5° degrees Celsius there is a 95% bud kill, from -2° to -2.5° Celsius there is a 70% bud kill and from -2.0° to - 1.5° Celsius there is a 10% bud kill rate (Snyder, 1994). These statistics along with probabilities of frost events from the National Oceanic and Atmospheric Administration (NOAA) tables make it possible to evaluate "frost risk." In the Stella model the death rates were used per frost event of -2°C . Frost events are drawn from the historical data and multiplied by the discrete distribution of bud kill in Table 7. NOAA has predicted probabilities of frost events occurring and the temperatures of the frost. Using these probabilities and the range of dates that the new flowers bloom are susceptible to frost damage, the model can simulate multiple frosts and the damage that can be sustained in that period. Taking an average for number of flowers per foot and

calculating the death rate of the buds determines the reduction in yields. However, a light frost event can reduce or eliminate the need for costs related to orchard activities such as fruit thinning, which will be discussed in the economic chapter.

'Golden Sunshine' is the best performer in terms of frost risk. The only region that faces significant frost is Cullman. 'Golden Dragon' is much more susceptible to frost risk. Because of its earlier blooming and ripening variety a higher price for the fruit was thought to be a possibility, but such an early-season price premium was not supported in the price model, possibly due to lack inventory carryover from yellow fleshed fruit and inventory carryover of green fleshed fruit southern hemisphere crop. While Headland and Semmes are relatively frost free, they do not have enough chilling hours for sufficient bloom on a regular basis. 'Golden Dragon' cannot be grown in Cullman or Thorsby on a commercial basis, as will be confirmed later in the economic modeling. This variety may be marginal at Brewton and Auburn, but shows potential for success in Union Springs or Marion Junction.

Pollination

All members of the genus *Actinidia* appear to be functionally dioecious, with pistillate and staminate flowers occurring on separate plants (Ferguson, 1990). Kiwifruit unlike many fruit crops, does not have a perfect flower. In the male plant the anthers are functional yet they lack a functional ovary. The opposite is true for the female plants. Therefore, the flowers must be pollinated by external means.

The kiwifruit flower is relatively unattractive to honey bees (Johnson, 1988). Kiwifruit can be pollinated by wind, free pollination (wind and bees), or by artificial methods. The latter include hand pollination done by rubbing anthers of collected males

(Gonzalez et al., 1998), by spraying a mix of pollen with an extender (Hopping and Hacking, 1983), or using an airflow pollinator that sucks pollen from male flowers and simultaneously blows pollen onto female flowers (Gonzalez et al., 1998). 'Golden Sunshine' and 'Golden Dragon' have bloom periods of six and twelve days respectively for blooms of 10% to greater than 90% of flowers open (Wall, 2006). Artificial pollination in Alabama is currently carried out using hand held tank sprayers. Using these artificial pollination methods assures fruit set. Kiwifruit planted without the aid of artificial fertilization may not produce a sufficient amount of fruit that is of market quality.

For commercial production the use of an air shear boom sprayer is recommended. The air shear sprayer can cover an acre in about twenty minutes, whereas it would take approximately eighteen hours using hand held sprayers. This is a new technology and only one unit is currently in operation worldwide. Although it is in early development, there appears to be good fruit set with the technology. By budgeting for this technology, ninety-seven percent (97%) fruit set was used as the base number for calculations in the simulation model.

Once fruit set is accomplished, a decision to thin or not thin the fruit is made in the model. Fruit thinning is necessary for fruit to reach potential marketable size, if the fruit load on the vines is more than desirable. The type and amount of thinning varies with the fruit load, initial amount of flowering and the carrying capacity of the plant. A thinning mechanism to lower fruit numbers down to the ideal fruit set is to have workers traverse the orchard removing fruit. Once thinning is completed, the number of fruit on one fruiting cane may be reduced to a normal distribution. Using data from thinned fruit

at Thorsby, a mean and a standard deviation was reached. Since the length and amount of fruit carrying capacity will vary per cane, a standard deviation of 12% of the mean is applied. A light frost could be beneficial by killing a few buds that would be thinned anyway.

Output in Total Trays

Kiwifruit is internationally marketed by the 3.6 kilogram flat pack tray. The model uses data on the distribution of sizes from a commercial production orchard in New Zealand growing 'Hort 16A', even though size comparisons from Alabama between 'Golden Dragon', 'Golden Sunshine' and 'Hort 16A' show that both Auburn varieties grow to larger sizes in Alabama than 'Hort 16A'. The number of fruit per acre multiplied by the frequency of each size determines the total number of trays. The size distributions are currently built into the Stella model, but they are not interpreted into the Simetar model currently.

Fruit distributions would be much more comparable to New Zealand if the growth regulator 'Benefit PZ' was used. Fruit size can be enhanced with the application of a growth regulator called 'Benefit PZ'. Previous work shows that when 'Benefit PZ' was applied to 'Golden Dragon', average fruit size increased by 15% and when applied to 'Golden Sunshine' by 27%, in comparison to controls (Wall, 2006). According to the price model, for extra fruit size per 3.6 kg pack (which is one less fruit per pack 36 to 34 is two fruit per pack and two 'sizes' different), approximately $0.036 is earned. With yields of 6,000 trays per acre, $216 per acre is received by this premium. If initial fruit size was 100g before the application of 'Benefit PZ' 'Golden Sunshine' would increase to 127g or eight sizes for a per acre increase of $1,728 at 6,000 trays per acre and

approximately 3% increase in revenue. ‘Golden Dragon’ would increase to 115g, for a per acre increase of $864 at 6,000 trays per acre or approximately 2% increase in revenue.

Table 8 shows the mean and standard deviation for the tray outputs for all sites for the two varieties. Marion Junction has the highest average yield for ‘Golden Dragon while Thorsby has the highest average yield for ‘Golden Sunshine’. Table 5 demonstrates the fulfillment of the chilling requirement and it also has the fulfillment of the 80% requirement if Dormex were considered an option. Tables 9 and 10 show the frost risk for all sites by variety. The areas with least variability in the difference between ‘Golden Dragon’ and ‘Golden Sunshine’ are Auburn, Marion Junction and Union Springs.

IV. ESTIMATING INTERNAL RATE OF RETURN (IRR) USING AN INTERACTIVE ENTERPRISE BUDGET

An established kiwifruit planting can produce high output levels for thirty years or more. Production of the vine is highly labor-intensive and has several production characteristics not found in other crops. For example, construction of a trellis system is a very costly input, and establishment costs are much higher than alternative crops.

Variability of costs can be accurately simulated using Simetar software developed by James Richardson (Simetar, 2009). Decision makers must make risk-reduction choices that are both effective and economically feasible given the operation's particular objectives, constraints, assets, and time horizons (Lindsey, 2008). Unlike standard budget scenarios, Simetar allows for variability in each input factor. For example, new developments in integrated pest management strategies permit farmers to spray more or less pesticide depending on their unique situation. Since many factors can influence the growth of weeds and outbreaks of pests, it is more realistic to assume that the amount of spraying varies as well. The primary distribution used in this model is the triangular distribution, which calls for minimum, maximum and most likely values of the input. For many of the inputs, these values were elicited from experts in the growing of kiwifruit in Alabama, as well as from established professional growers in New Zealand. The enterprise budget was constructed based on suggestions by these experts.

Model Assumptions

This model assumes that the grower will pay all of the fixed costs in the orchard establishment year and that the grower has a water source available that is 500 feet from the planned planting. It also assumes the grower is part of a cooperative association that processes the fruit. Alternatively, the grower could sell the fruit by the roadside or at a local market. However, by being part of a cooperative organization growers can share the cost of a packing operation, which is essential in selling the fruit wholesale. Proper grading equipment for kiwifruit can cost approximately $200,000 used and considerably more new. *A. chinesis* varieties 'Golden Sunshine' and 'Golden Dragon' can be kept from spoiling for three months in a proper cool storage facility. It would be difficult for one grower to justify the cost of such facility.

A. chinensis (yellow fleshed) cropping systems are more orderly than *A. deliciosa* (green fleshed) systems because of the way fruiting wood is organized. *A. chinensis* replacement canes begin to grow from the leader while *A. deliciosa* replacement canes grow from a lateral that is put out by the leader. Thus, *A. chinensis* are organized in rows that are evenly spaced in a straight line. A. *chinensis* fruit may also be picked at night. While less efficient than picking in the day, it allows for a shorter harvest period. Once an *A. chinensis* orchard is double-planted, and replacement canes are trained to strings, they are even faster and easier to prune than *A. deliciosa* systems. Currently there are fewer hours spent pruning *A. deliciosa* than *A. chinensis*, but *A.chinensis* with bi-annual cropping systems may become more efficient than *A. deliciosa* (Wall C., 2008).

Establishment Costs

It takes three seasons before kiwifruit plants will produce a crop. In the establishment year the trellis is constructed, the irrigation is installed and the plants are planted. The next two years are spent training the plants onto the trellis system, so that the fruit can be easily cropped and pruned. Cropping and pruning will be repeated in the same way for many more years. Table 11 outlines the establishment costs for one acre of kiwifruit.

Site Preparation

The land for a kiwifruit orchard can be contoured, but it needs to be smooth enough to allow machinery to pass through easily. Before a kiwifruit orchard can be planted it is suggested the land be cleared, and old debris removed from the soil. If pasture land is used, weed problems can be reduced by following a good cover crop plan. After the land is cleared, plowed, sub-soiled to reduce the hard pan, and once the land is smooth enough for all non-tracked equipment, the orchard layout begins.

Trellis Construction

The trellis must be constructed with the installation of the end posts and the deadmans. In a square orchard layout there are fifty-four end assembly sides per acre. All of these have deadman posts that are inserted at an angle into holes, with some of the posts five feet under ground. The end post is drilled two feet into the ground and anchored to the deadman post. Internal posts are pressed into the ground one foot and then the lead wire that spans from endpost to endpost is installed. The end assemblies cross the side assemblies 154 times, requiring an internal post at each crossing. There are four corner-end assemblies. An end assembly in New Zealand costs approximately $20

for materials and installation. When establishing a new orchard one internal post costs $5 (Wall C., 2008). In this budget, materials were estimated at $35 and labor at 20 minutes at $15 an hour for an end assembly. For an internal post $7.54 for materials, and 5 minutes at $15 an hour for labor were used. Since orchard development is a competitive business in New Zealand unlike Alabama, materials and trellis installation in Alabama will be higher.

Irrigation Installation

The irrigation systems for this kiwifruit planting consist of punch-style tubing that is fastened to the interior bars of the trellis system. There is an emitter system with two emitters per vine that are connected to the main tube in the row by a strand of spaghetti tube. These emitters serve as an added protection in a severe freeze by acting as micro sprinklers.

Planting

Planting should occur in the fall after the plants have become dormant. All plants should be grafted-female or own-root propagated nursery plants. All plants need to have a tree guard to protect against herbicide damage when applying the herbicide strip; also it can keep the temperature around the trunk higher, which protects against damage from severe low temperatures. A bamboo pole placed inside the guard provides a support for the vine to reach the trellis.

Establishment Training and Pruning

Once the kiwifruit are planted and the plants begin to leaf, the goal is for them to "mop" or grow haphazardly up and on to the trellis. Then after leaf drop, the mop is cut off and the cane is pruned to the first two nodes above the trellis height. Ideally, leaders are established sprouting laterally from the first two nodes on the main trunk. These leaders will produce the fruiting canes that fruit laterally on the first six nodes of growth from the previous year (Dozier W.A., 2008). These canes are trained up strings and spaced at 0.85 feet apart, and each plant provides for 34 fruiting canes every other year in a "double-planted" orchard. Decreasing the space between the pants and doubling the number of plants per acre is a newer method developed to reduce the amount of selective pruning and the need for highly trained orchard workers. The use of this system allows for the orchard to be more adaptable to change, as new varieties can be grafted on to half of the vines while the other half remain in production. This method is also supposed to increase the dry matter (% of non water in fruit) as well. In the fall, after harvest all canes on the leaders are cut off. The new fruiting canes that have grown up on strings above the fruiting canopy form the next set to replace the ones in the canopy that just completed fruiting.

Shelter Belt

Kiwifruit canes can be broken and damaged by winds. To prevent some of this injury a shelter belt of fast-growing trees is planted. *Cryptomeria japonica* trees are selected for this as they provide year-round protection and grow quickly to protect the orchard from high winds.

Yearly Costs

In years zero through the end of year two, the plants are maintained and pruned lightly and the establishment costs are much less. The yearly costs of a kiwifruit orchard for a crop year (years 3 through 20) are in excess of twenty thousand dollars an acre in a cropping year. In a year of a crop failure, costs of around ten thousand dollars will still be incurred. The activities described below are ones that are vital to the production system. In the event of a crop failure, some of these costs will not be incurred. Some costs are treated as stochastic because they vary from year to year. Table 12 shows the yearly costs of production for a full production year.

Yearly Pruning

In year four, after the replacement canes grow up the strings they are laid onto the trellis. Once the canes have fruited, all canes are pruned back to the leader, and the canes from the opposite side of the trellis bay will be laid down to fruit. The new growth from the leader that was pruned back will have grown up strings to crop after the current canes have fruited. This process will happen every year and each vine will alternate between cropping and growing replacement canes.

Pollination

Artificial pollination is essential to produce marketable fruit of adequate size and shape. A good-sized fruit should contain between 1,000 and 1,400 seeds, whereas a small fruit may only contain 50 to 100 seeds (Sale, 1990). Since kiwifruit plants have very little nectar, the bees may not pollinate the kiwifruit as bees can easily be distracted by another flower nearby. Also, if there is constant rainfall bees will fly less, thus limiting pollen transfer even further.

Artificial pollination techniques have been used by Auburn University in their experimental orchards for many years. This system is operated behind a tractor and can cover an acre at the same speed (1.5 mph) that it would take to apply any other canopy spray over an acre, which is approximately twenty minutes. The cost of materials for application is $600 per acre (Hamlyn, 2008). For successful pollination of one hectare of kiwifruit the recipe of 750g pollen, 5L Pollenaid® and 300 gallons of deionized water is required. This works out to a cost of approximately $600 per acre.

Weed Control

Weed control should be done on a regular schedule using a proper herbicide rotation. Currently, the established kiwifruit vines in Thorsby are sprayed between three and seven times per year. The planting of ground-cover crops is essential to the success of a good weed management strategy. It is beneficial to plant a mix of white clover and crimson clover to cover the ground for most of the weed season and suppress the growth of weeds between the rows. These clovers also fix nitrogen and when mulched they increase the nitrogen content of the surrounding soils. A five foot weed-free strip on each side of the vines is most important in the early years of establishment. The row middles are mowed by a mulching mower. All of the prunings that have been placed in the row middle from the winter pruning are mulched by the mower as well. The mulcher also cuts the ground cover to reduce the amount of resources that it would take from the kiwifruit.

Pest control

There are few pests that attack kiwifruit, so fruit and vine damage due to insect pests is relatively low. European red mite populations can build up in late summer in hot,

dry areas. Scale insects and leaf rollers can also be pests. Leaf diseases may affect plants some years, and fungicide sprays may be useful in eliminating them (Himelrick and Powell, 1998). At Thorsby the vines can be sprayed two to three times for scale, or even more if needed. Applying fire ant control is also important. Fire ants tend to promote scale and encourage the growth of their population. The model uses the triangle distribution to describe spraying for scale, using horticultural oils between two and eight times with three times most likely. The spraying of a systemic insecticide for scale can occur from zero to four times with two times most likely. Controlling fire ants was simulated with zero to three applications with one application most likely of fire ant bait.

Fertility

Plants are fertilized based upon tests of the soil, and of the plants' leaves, compared to their nutrient requirements. Application of two thirds of annual nitrogen is required at bud break, which helps foster fruit set. A second application is recommended for the additional growth of fruit and replacement canes (Beutel et al., 1994). Kiwifruit have a well-documented need of up to 100 pounds per acre of potassium (Marsh et al., 1991). In this study potash and ammonium nitrate were the fertilizers of choice. If there is a crop failure, there is no need for a second application of fertilizer in the model. In an acre of peach production, 60 to 100 pounds of potassium, five to ten pounds of phosphorus and 60 to 70 pounds of nitrogen are removed in the fruit each year (Lockwood, 2009). But if there is no fruit on the plant these elements are not removed and over-fertilization can occur the next year if the growers do not adjust the applications. If a fruit-limiting frost occurs, the amount of fertilizer that would have been removed in the crop does not have

to be replaced. In the model fertility treatments for the next year are adjusted for the previous year's fruit amounts.

Harvest

When kiwifruit is harvested, the entire crop is harvested at once. Strip harvesting aids with the organization of labor and the quick flow of labor through the field. An average picker can harvest 117 bushels per day. The fruit is taken out of the orchard in 22-bushel or smaller bins on a tractor and transported to an area where a forklift operator can load them onto a truck and deliver the fruit to a packing facility. Close supervision of the crews is needed to minimize fruit damage. In the event of a crop failure, no harvest costs are incurred with a savings of $800 per acre.

Packing

The fruit is graded at a facility where it is then packed into boxes and palletized. The pallets can be shipped directly or put into cold storage. Again, this cost would not be incurred if there is a crop failure, without the costs for packing $12,000 per acre are saved when compared to a yield of 5,000 trays.

Fixed Costs

Sprayers and fertilizer spreaders are common equipment on a fruit farm. If some of this equipment is already present, it would not have to be purchased. This model assumes that there is no equipment present on the farm. A specialty tractor that is less than six feet tall (including the height of the operator) however, is not a common piece of equipment. Currently the only company that sells a tractor with a pressurized cab that meets that requirement in Alabama is Antonio Carrera. Their cab tractor that is

appropriate for kiwifruit production costs $42,300 (Bannister, 2008). These fixed costs appear in Table 13.

Packing House Costs

Among yearly costs, each grower has to pay his/her share of operating the cooperative packing association. They will divide the cost of electricity, manager, maintenance on the equipment, and any applicable taxes. Cooperatives are still liable for all local and ad-valorem taxes that would apply to any regular business. Growers are individually responsible for their share of boxes, pallets and banding to pack and ready their fruit for shipping or storage. Growers' individual costs are yield-dependent, but they still have to pay to run the cooperative for the year. The costs of the packing house can be seen in Table 14.

Operation of the Model

Distributions of rates of return can be determined by letting the model iterate 500 times for each location and each variety at that location. A twenty-year time horizon is used. The orchard establishment cost is the first cash flow at period zero, followed by two no-crop years. In cash flow years three through twenty the vines attempt to produce crops.

To estimate probability of profits, internal rates of return for the 500 simulations were sorted in descending order. Since each output had a probability of .002, the probabilities were cumulated so that the lowest IRR represented 100% probability of that IRR or more. A table of the probability of a 20% IRR for 'Golden Sunshine' and 'Golden Dragon', as well as the mean IRR for all of the selected sites can be seen in Table 15.

Marion Junction, Union Springs and Auburn provide excellent opportunities for successful cultivation of both varieties. Thorsby and Cullman are acceptable for growing only ‘Golden Sunshine’, while areas south of Brewton are not areas than can be successful for either variety unless Dormex is applied. Golden Dragon cannot be cropped for commercial purposes outside of the Marion Junction-Union Springs-Auburn area.

V. ESTABLISHING AN AGRICULTURAL COOPERATIVE AS A MODEL FOR SUPPORTING A STARTING INDUSTRY

A new specialized fruit industry being established in Alabama will face many hurdles. Even with a farm set up, the post harvest facilities and other processes are vital to industry survival. Organizing farms and growers together toward a common goal will stabilize the industry. Some farmers may plant a small planting and would lack sufficient harvest quantities from their orchard to have their own packing and cooling operation.

While golden kiwifruit does not need to be placed in a cold storage facility to ripen, it does extend the market window for the fruit. Golden kiwifruit can be stored for up to three months in a cool store facility. To meet export quality standards the fruit must be graded and stored accordingly. A proper grading system costs almost $200,000 for used equipment. For this to be truly feasible, there must be a large number of growers involved to pay for this system. Total cost of a post harvest system to be installed at a small operation is around $310,000 with used equipment, Table 16 outlines some of the costs for a post harvest facility. If there were five growers who grew ten acres of fruit each, sharing this cost would only increase the cost per acre by 20%.

Plant material providers (nurseries) and builders of trellis systems are vital to the start of the industry. Members of a cooperative can ask for assistance in the training of workers to prune and properly train the plants. The cooperative can even assist the

grower in the entire process of growing the fruit. However, the main goal of a cooperative is to promote the industry. An example is set forth in Appendices A-F. The cooperative must maintain high quality standards to assure premium price for the fruit and to keep customers pleased with the product.

Each year, another hurdle facing commercial kiwifruit production is the pollination of the flowers. The artificial method of pollination uses pollen collected from male kiwifruit vines that is then stored until it is to be used in the next spring. The process of collecting the pollen is very labor intense and the only option for a commercial source of pollen is from Kiwi Pollen NZ. A key benefit of an Alabama-based cooperative could be to provide pollen collection for its members as well as the machinery and application expertise to pollinate in the field.

Many growers in New Zealand did not start traditionally, nor were they educated as horticulturists. Instead, they had the support of pack houses who were interested in packing the fruit grown in their regions. Many pack houses offer a full line of orchard services, from managing labor, to upkeep of the orchard, to spraying and mowing services. Setting up an organization like the one outlined below can help attract people who would not traditionally invest in an orchard. This organization is outlined as a cooperative structure; however it is also feasible to form an LLC or another type of organization.

The following documents in the appendices are an example of the proper documents that a person considering a cooperative would need to compile, plus a survey that would need to be sent out to potential growers/investors. Included are a mission

statement, a survey, Articles of Incorporation, By-laws, a State of Alabama application form, and an application form for membership.

Kiwifruit production is projected to be profitable in certain areas in Alabama. South central Alabama has the best opportunity for production of both varities. A thriving industry possible of producing 600,000 trays is very possible. But at that volume, the market would have to be better established.

VI. RESEARCH IMPLICATIONS AND FUTURE RESEARCH

A temperature model for the whole state, with weather stations positioned along specific lines of latitude would be highly useful for the future development of crop production in Alabama. With better temperature recording, we can draw line where certain events such as, lack of chilling requirement and probabilities of frost could occur. If the weather stations were set at specific lines of latitude, the variations at that latitude could be recorded and lines connection areas with similar characteristics could be drawn. With the addition of more temperature locations, a better system of maps could be drawn which would show growers the appropriate variety to plant there.

More research in production practices would be helpful, the Stella® model would be able to integrate effects of the new techniques and aid in the change on fruit size or whatever variable that it impacts the most. Once the Simetar® model is integrated for different fruit payments for different size fruits, the impact of the added cost of the new techniques or the reduce cost on the orchard profit can be analyzed.

Other areas in which to the Stella model could be improved by the addition of growing degree hours that would simulate the start of frost susceptibly more accurately. Incorporation of temperature, humidity and entomological data into the Stella model would help in simulating IPM developments. With a yield prediction system using photosynthesis readings, nutrient readings and overall fruit quality and output, the impact of management practices on yield could be measured as well as their impact on the

distribution of fruit sizes. The ideal model would be able to estimate the production feasibility of any given crop in any area.

The establishment of a cooperative or marketing alliance for Alabama kiwifruit would help Alabama-grown fruit establish recognition in the market as well as a reliable price. The establishment of a brand name would lead to a product that it recognizable and serves as a locus for building brand equity.

The development of such model for 'AU Fitzgerald' green kiwifruit would also be helpful in assessing its place in an Alabama kiwifruit industry.

Many growers in Alabama rely on Dormex to force development in their crops. If the EPA were to impose a ban, it could be helpful to develop a model that would show the potential economic losses that growers would face it the product was banned.

Eventually a system could be developed that would tell potential growers the appropriate types and varieties of crops that they should plant, as well as the expected risk-adjusted return for a particular location. This type of modeling system shown here has applications well beyond kiwifruit. Stochastic and simulations can be used in all types of production models. Use of the two programs simultaneously allows for economic and horticultural variances to be integrated.

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APPENDIX A

KIWIFRUIT COOPERATIVE

Mission Statement

The Alabama Kiwifruit Cooperative, hereinafter referred to as the ALKC, will provide packing and storing services for growers as well as orchard management tools and supplies for successful orchard management.

Purpose

ALKC's main purpose is to help organize and grow the Kiwifruit industry in Alabama. ALKC will move fruit into channels of distribution and offer a uniform product to the consumer.

Requirements

Initially a grading system will be required for grading of the fruit, as well as a cool storage facility on hand will also be required in the original system. A laboratory with a spectrometer, refractometer, penetrometer, digital scale and dehydrator, as well as a trained technician will need to be in place. A system of moving the fruit from the farm to the cooperative will need to be implemented.

In the second stage of the cooperative, there will be someone on staff to help growers with orchard management. Fertilizer applications, fertility testing, and fertilizer sales

would be possible at this point. A team of legal migrant laborers will be engaged to help growers with harvest, pruning and planting orchards.

In the third stage of the cooperative pesticide spraying services will be offered. Also nursery/nursery services will be established to provide growers with new plant material and orchard establishment services.

APPENDIX B

Questions for Planning Committee, Alabama Kiwifruit Cooperative

Operating Costs and Volume of Business

How much will the operating costs be and how will they be met?

Rental (building and equipment)

Manager

Key Employees

Laboratory Technician

Bookkeeper-Secretary

Professional Fees (attorney, accountant)

Labor

Benefits (FICA, Workman's Comp, Health Care)

Other Monthly Costs

Trucks (operation and depreciation, or rental)

Utilities (electric, gas, cable/internet, phone, water, garbage, sewer)

Office Supplies

Operating expenses-manager

Director Expenses

Employee Training

Taxes and licenses

Loan Repayment (principal and interest)

Other costs

1. What is the least volume necessary to meet costs and overhead? Are there enough producers and acreage to support this?

2. What will be the policy on purchasing supplies for members? Price to members? Delivery to members?

3. Will members' produce be picked up at the farm? Or delivered by the farmer?

4. In what order will harvest crews be sent to farmers?

5. How will the order of spraying and other timely activities be decided upon?

6. How much capital will be required?

Transportation equipment:

Auto

Truck (number and kind)

Office Equipment:

Office

Computers

- Document Management Center
- Network Server
- Desks
- Filing cabinets
- Audio Visual Equipment

Laboratory equipment

- Laboratory attached to office
- Spectrometer
- Penetrometer
- Refractometer
- Digital Scale
- Digital caliper
- Dehydrator
- Computer
- Printer

Post harvest system

- Packing shed
- Electric Forklift
- Grading line
- Pallet jacks
- Packing monitoring system
- Juicing operation

Cool Storage

Cool Storage building

Electric forklift

Inventory monitoring systems

Orchard management

Sprayers

Propane Forklifts for orchard handling

Harvest bins

Bin trailers

Tractors for moving bins

ATV for scouting

Irrigation

Compact Trencher

Other Costs

Accounting System management

Attorney's fees

Recording fees

Miscellaneous

I. Outlets and Proposed Marketing Methods

1. Sales to the School Lunch Program?

2. Wholesale to retailers i.e. Wal-mart, Kroger, Winn-Dixie, Piggly Wiggly, Publix, Bruno's etc.?

3. What relationship will the cooperative have with other packers of kiwifruit?

4. Will the cooperative have its own sales force or will it hire on a contract basis?

5. Will the cooperative market a branded good?

6. What is the price policy on sales?

II. Organization and financing:

1. Headquarters establishment in Alabama.

2. How many pounds of fruit will it require to successfully run the ALKC?

3. Will members be accepted from other parts of the United States or World?

4. Is the cooperative form the best form of business?

5. Financing, Capital stock, preferred stock as an option?

How much money is required to start at the simplest level?

6. Membership: Is there a minimum or maximum limitation of the volume of business that members may put into the cooperative?

How many potential members are to join?

What are the capital stock requirements?

Is there a plan to recruit the maximum number of members?

What is the minimum number of members that need to join?

7. How will the cooperative handle business with non members?

8. How will the board of directors be chosen?

Will the seats on the board be divided on volume or on geographic location?

What expenses are paid for the Board of Directors?

9. Management: What types of managers will be employed?

How will the salary of the managers be decided on?

What duties and authorities will the manager be able to conduct without board authorization?

How often and what type of reports will they have to present?

III. Marketing Agreements

1. For successful establishment of the ALKC there need to be regulated agreements that guarantee the ALKC a certain volume of fruit. How will contracts with members be written?

2. Meeting the operational cost requires a deduction from gross returns. Will deductions be on per unit retains, percentage retains or other means?

3. How long will marketing agreements last?

4. Will there be penalties for noncompliance of members? Will there be escape clauses in contracts for the cooperative or members?

APPENDIX C

ARTICLES OF INCORPORATION FOR

THE ALABAMA KIWIFRUIT COOPERATIVE

We, the undersigned, all of whom are producers of kiwifruit do hereby voluntarily associate ourselves together for the purpose of forming a non-profit cooperative association, with capital stock organized under provisions of Title 2, Chapter 10, Article 4 (section 2-12-98) of the Code of Alabama 1975.

Article I

The name of this association shall be The Alabama Kiwifruit Cooperative, hereinafter referred to as the ALKC.

Article II

The place where the principal business of The Alabama Kiwifruit Cooperative will be transacted is _____.

Article III

This ALKC shall have perpetual corporate existence.

Article IV

The purpose of the ALKC is to provide packing and promotion of kiwifruit produced by members. It shall have the power to contract and be contracted with, borrow and lend money, issue notices, bonds and other obligations and secure the payment of same by

mortgage or otherwise; to buy, contract for, own, sell, convey, pledge, and otherwise have, use and dispose of property of all kinds, insofar as not prohibited by law; to market the kiwifruit cooperatively in pools or otherwise, and collect for the same; to purchase kiwifruit from its members; to act as an agent for its members; to purchase and distribute to its members, and purchase and sell to its members equipment, fertilizers, chemicals, containers, packages, labels, and any other goods, wares or merchandise that are crucial to the production of kiwifruit: and to provide for processing, packaging, conditioning, manufacturing, storing, shipping or distributing of such products to members or customers. In addition to the foregoing, the ALKC shall have and enjoy all powers, rights, privileges and immunities given, allowed, or contemplated by or under Chapter 10, Article 4 (Sections 2-10-90 through 2-10-108) of Title 2, Code of Alabama 1975, or other laws of Title 2 of the Code of Alabama 1975, or any other laws of the State of Alabama and amendments thereto. The ALKC may render the services mentioned in this section to non-members as well as to members, provided that the ALKC shall not deal in agricultural products of non-members or purchase supplies and equipment for non-members in an amount greater that the value of the agricultural products handled, and supplies purchased, for its members.

Article V

Section 1. The authorized capital stock of the ALKC shall be $1,000,000, of which the sum of $500,000 shall be common stock divided into 100 shares of par value of $5,000 each, and $500,000 shall be preferred stock divided into 50,000 shares of par value of $10 each.

Section 2. The common stock of the ALKC shall only be held by growers of kiwifruit in Alabama who are members of the ALKC. No single member can hold more than one share of common stock. The common stock shall bear no dividends. The holders of common stock shall have all the voting rights in the transacting of business at meetings of member stockholders and each member shall have one vote only. No purported transfer of common stock shall pass any right or privilege on account of such stock; or any voice or vote in the control of the association unless it is the recipient thereof shall be a grower of kiwifruit. When a holder of common stock fails to patronize the ALKC for a period of one year where there has been no harmful frost damage reported in their growing area, or violates any terms and conditions of the ALKC membership agreement, by-laws, or rules and regulations of the ALKC, such member may be suspended by action of the Board of Directors. When any holder of common stock is suspended by action by the Board of Directors, all right to vote at meetings of member stockholders shall cease, and the ALKC shall have the right to purchase the common stock held by such member stockholders at its par value or book value which ever is less, as determined by the Board of Directors, and on failure of the holder to deliver the certificate evidencing such stock on demand, the ALKC may cancel such certificate on its books by providing for the payment thereof on demand.

Section 3. The preferred stock of the association shall be non-cumulative as to dividend and the dividend rate shall not exceed eight percent per annum, if earned and when declared payable by the Board of Directors, and such dividends shall have preference over any and all other dividends declared in any year. The preferred stock shall not be vested with any voting rights, and such preferred stock, or any part thereof

shall be callable and retired upon action taken by the Board of Directors, provided such preferred stock is called and retired based on decision of the Board of Directors of which preferred stock is to be retired first. When the preferred stock is retired it shall be paid for at par value plus any unpaid capital dividends declared thereon. In the event of dissolution or liquidation of the ALKC, the holders of preferred stock shall be entitled to receive the par value thereof in addition to any dividends declared thereon and unpaid before distribution shall be made on common stock of the ALKC.

Section 4. The ALKC shall have a lien on all outstanding stock and all payments on its capital stock and on any dividends declared thereon for any and all indebtedness due to the ALKC by the holder of such stock.

Section 5. All transfers of stock shall be made on the books of the association only on surrender of the certificate evidencing the same properly authorized, and only upon the approval of the Board of Directors.

Section 6. The property rights and interest of the members and other patrons of the ALKC, except such property rights and interest as are evidenced by outstanding capital stock, shall be unequal and shall be in the same proportion as the patronage of each member and other patrons have contributed to the funds and the property of the ALKC. The property rights and interests of each member-stockholder and other patrons shall be determined at least annually and shall be entered upon the records of the ALKC, and such interest credits may be entered upon the records of the ALKC, and such interest credits may be evidenced by certificates of equities or revolving fund certificates in such form as may be prescribed by the Board of Directors. Such certificates issued in evidence of member's interests in the ALKC shall not be transferred to anyone except by

the approval by the Board of Directors and may bear such rates of interest, but in no event to exceed eight per cent as the Board of Directors to declare, or the ALKC to pay, interest thereon.

Section 7. Stockholder's Liability. No Stockholder or member of the ALKC shall ever be liable for any of the indebtedness of the ALKC in any amount exceeding the sum remaining unpaid on his/her subscription to the capital stock of the association, including any unpaid balance on any promissory note or notes given in payment of such stock. This provision, however, shall not in any manner affect debts lawfully contracted between the ALKC and such stockholders.

Article VI

The affairs of the ALKC shall be conducted, controlled and managed by the board of directors, consisting of not less than five members, which shall have authority to exercise all the corporate powers, and control, regulate and operate the business and property of the ALKC under its Articles of Incorporation and By-Laws without specific or particular authorization by its members.

Members of the Board of Directors shall be elected by the members, appointed by the Governor of the State of Alabama or the President of Auburn University. Directors shall serve the term of office as provided in the By-Laws.

IN WITNESS WHEREOF, we have hereunto set our hands and seals this the XX day of Month, 20XX.

S/_____

S/_____

S/_____

S/_____

S/_____

State of Alabama, XXXX County

Personally appeared before me (XXX), a Notary Public in and for said state and county (Name of President), who after first being duly sworn deposes and says that he/she is one of the signers of the foregoing Articles of Incorporation and that he/she signed and executed said Articles of Incorporation on the day and date thereof as his/her act and deed.

S/_____

Sworn to and subscribed to before me this XX day of Month, 20XX.

_____

Notary Public (Seal)

State of Alabama

XXXX County Office of Judge of Probate Court

I hereby certify that the within instrument was filed in this office for record on the XX day of Month, 20XX, and was duly recorded in book XX, record of Private Corporation, page XX et seq, and examined.

_____

Judge of Probate

APPENDIX D

BY-LAWS OF

THE ALABAMA KIWIFRUIT COOPERATIVE

ARTICLE I. PURPOSE

The powers and purposes of The Alabama Kiwifruit Cooperative hereinafter referred to as the ALKC, are those set up in the Articles of Incorporation.

ARTICLE II. COMMON STOCK

Sec 1. The authorized common stock of the Alabama Kiwifruit Cooperative are those set forth in the Articles of Incorporation and each stock certificate electronic or paper copy shall have reference to restrictions imposed by the Articles of Incorporation and the By-Laws of The Alabama Kiwifruit Cooperative.

ARTICLE III. MEMBERSHIP

Sec 1. Members of the Alabama Kiwifruit Cooperative will be growers of Kiwifruit that reside in the state of Alabama who may apply for membership, purchase common stock and be approved by the Board or by a person authorized by the Board. Membership is open to growers in other states, but distribution of fruit and final sale price may differ from that received by Alabama growers.

Sec 2. Applications for membership will be in the form set forth by the Board, but each application shall state that the applicant will abide the By-Laws and to patronize

the ALKC and use the services if applicable. Upon approval of the application, the applicant will become a member and they will be issued the corresponding amount of common stock with the amount of capital contributed. Membership is to be renewed twelve weeks after the last fruit is put through the post harvest process.

Sec 3. When a member is found in breach of the by-laws or a contract with the ALKC, or does no longer produce Kiwifruit's within the state of Alabama, the Board may declare the membership to be in default or terminated, and cancel it and such member will lose membership, such cancellation shall not effect the force of validity of an contract existing between such member and this ALKC. Upon death of any member or the termination of his/her membership as herein provided, his/her common stock may be retired at par, and any other amounts due may be paid in accordance with Article XI hereof.

Sec 4. Each member shall hold one share of common stock of the ALKC and all membership shall be personal to the member and equal in right, and shall not be transferable, assignable, vendible, inheritable, divisible, or sizable, and each member shall have one vote only.

ARTICLE IV. MEMBERSHIP MEETINGS

Sec 1. All membership meetings, eight percent of the membership, but not less than ten members shall constitute a quorum. At any meetings, regular or special, a quorum or less than a quorum may adjourn the meeting from day to day, and a quorum may adjourn to a later date.

Sec 2. The regular annual membership meeting will be held on the third Friday in February, every year. The location of the meeting will be sent in an official notice to the

membership at least two months prior to the occurrence of the meeting. The notice will contain the place of the meeting, time of meeting, and the date of the year that the meeting is on.

Sec 3. Special meeting of the membership will be held at any time at the principal office of the ALKC. All members will be notified by e-mail 72 hours in advance of the meeting happening. It is the responsibility for the member to check his/her e-mail it is the official form of communication of the ALKC. Notification of meetings will also appear on the ALKC website at least 72 hour prior to the meeting.

ARTICLE V. BOARD OF DIRECTORS

Sec. 1. The affairs of the ALKC shall be conducted, controlled and managed by a Board of Directors, which shall have full authority to exercise all the corporate powers, and control, regulate and operate the business and property of this ALKC under its Declaration of Incorporation and these By-Laws, without specific or particular authorization by the members. But the Board of Directors shall not have authority to sell, convey, or encumber any real property owned by the ALKC without being authorized by a membership meeting. The enumeration of specific powers of the Board of Directors shall not be taken as an exclusion of other powers.

Sec. 2. The Board of Directors shall consist of not more than five (5) members, who shall be elected from the membership at the annual membership meeting or at a special meeting called for the purpose.

Sec. 3. At the first annual meeting of the members of this ALKC, directors shall be elected to succeed the incorporating directors. Thereafter each director shall be elected for a three (3) year term. No Director can serve more than four (4) consecutive terms. Directors shall hold office until their successors have been elected and qualified and have entered upon the discharge of their duties. No person shall be eligible for the office of director if he/she is in competition with or is affiliated with any enterprise that is in competition with the ALKC, and if a majority of the Board of Directors of the ALKC finds at any time following a hearing that any director is so engaged or affiliated he/she shall thereupon cease to be a director. Any director who ceases to be a member of, or who violates any contracts with this ALKC shall cease to be a director as soon, as the Board of Directors passes a resolution to that effect.

Sec. 4. Whenever a vacancy occurs in the Board of Directors, other than from the expiration of a term of office, the remaining directors shall appoint a member to fill the vacancy until the next regular meeting of the members.

Sec. 5. The Board of Directors may require that members making use of any service offered shall enter into a contract with the ALKC in such terms as the Board may prescribe.

Sec. 6. The members of the Board of Directors shall receive no compensation for their services as members of the Board, but may receive refund of necessary expenses while engaged in the business of the ALKC. Directors must present receipts and documentation to prove expenses that they claim. Directors are expected to minimize cost in regards to travel arrangements when they are on business for the cooperative. Any upgrades above basic accommodations, or travel methods will come from the pockets of such Directors. No

member of the board of directors and no member of his/her immediate family shall be employed by the ALKC for more than thirty days in any year, unless such employment is unanimously approved by the Board of Directors. No member of the board of Directors shall, during his/her term of office, have any contract, arrangement or agreement for profit with the ALKC differing in terms or purpose from contracts, arrangements and agreements accorded other members.

ARTICLE VI. MEETINGS OF BOARD OF DIRECTORS

Sec. 1. Immediately, or as soon as possible, after each election of directors, the directors shall hold a regular meeting, organize the board, elect officers for the ALKC, and transact any other business which may be transacted at a regular meeting of the Board of Directors. Notice of such meeting shall not be required if the meeting be held immediately after the membership meeting which elected such directors; otherwise, it shall be upon the same notice as that required for a special meeting of the Board.

Sec. 2. Regular meetings of the Board of Directors shall be held bi-monthly after not less than 72 hours electronic notice to the last known e-mail address of each director. Notice of meetings will also appear on the ALKC website 72 hours before the meeting. Board members are expected to check their e-mail as it is the official method of communication for the cooperative. These meetings may be held at such time and place as may be fixed by the Board of Directors, for the transaction of any and all business that may come before the Board.

Sec. 3. Special meetings of the Board of Directors may be held for any and all purposes whenever called by the President, any other two officers of the ALKC, or a majority of the Board of Directors. Notice of such meeting, setting forth the person or persons calling it, and the time, place and purposes of the meeting, shall be e-mailed to each director at his/her e-mail address, at least 72 hours prior to the date of such meeting.

Sec. 4. Special meetings of the Board of Directors may be held for any and all purposes, without notice, at any time and place, when all directors are present and assent to the meeting.

Sec. 5. No director shall vote by proxy, mail, or email. However, directors may vote by web meetings if they are linked with the ALKC at the time of the meeting.

Sec. 6. A quorum at all meetings of the Board shall be a majority of the directors, and a quorum may adjourn any meeting from day to day or to a future day, and less than a quorum may adjourn any meeting from day to day.

ARTICLE VII. OFFICERS AND EMPLOYEES

Sec. 1. The officers of the ALKC shall be a president, secretary, and a treasurer. The minor officers and employees shall be such as may be elected or employed by the Board. The president and vice-president must be members of the Board of Directors; other officers and employees need not be members of the Board or of the ALKC.

Sec. 2. The Board of Directors may employ a manager, with such duties and powers as the Board may commit to him.

Sec. 3. The powers and duties of the president shall be such as are usual to those officers, and they shall be officers of the Board of Directors as well as of the ALKC.

Sec. 4. The powers and duties of the secretary shall be such as are usual to the office of the secretary. The powers and duties of the treasurer and the office of the treasurer, and he/she shall be an officer of the Board of Directors, as well as of the ALKC. The secretary-treasurer shall keep minutes of the meetings of the members, Board of Directors, and the Executive Committee; he/she shall keep a corporate seal, if any, and membership records; he/she shall affix the corporate seal to all papers requiring it; he/she shall make the membership records show the name of each member, the number of his/her stock certificate, the date of issuance of the certificate and its surrender, cancellation or forfeiture; he/she shall maintain proper records, vouchers, etc., concerning the issuance, cancellation, and retirement of all common and preferred stock; he/she shall receive and deposit all funds of the ALKC not ordered by the Board to be otherwise received and deposited, which shall be paid out only on checks or drafts drawn in the name of the ALKC by a properly authorized officer; he/she shall account and be responsible for all receipts and disbursements by him/her and for all balances in his/her hands; and he/she shall sign and execute contracts, notes, papers, and documents as secretary-treasurer according to the directions of the Board. The Board of Directors may designate other agents to discharge said duties or any part thereof.

Sec. 5.. The secretary, treasurer, or other officers or employees designated to handle funds of the ALKC shall furnish a surety bond in such form and amount as the Board may require to guarantee his/her fidelity, the premium thereon to be paid by the ALKC.

Sec. 6. The Board of Directors may add to or take from the powers and duties of any of the officers; and the powers and duties of the minor officers and employees shall be such as the Board may provide.

Sec. 7. The officers shall be elected by the Board for a term of two years or until their successors are elected and take office, but they shall be subject to removal by the Board at its will and pleasure.

ARTICLE VIII. EXECUTIVE COMMITTEE

Sec. 1. The Board of Directors may in their discretion appoint from their own membership an executive committee of three (3) members, determine their tenure of office and their powers and duties. The executive committee shall have such powers and duties as may, from time to time, be prescribed by the Board of Directors, and these duties and powers may be all of the duties and powers of the said Board of Directors, subject to the general direction, approval, and control of the Board of Directors.

Sec. 2. The executive committee may hold special meetings for all purposes, at any time and place, necessary to carryout the proper operations of the ALKC, and shall report its actions at the next meeting of the Board of Directors.

Sec. 3. The Board of Directors may provide for the necessary expenses of and a fair remuneration for the time actually spent by the members of the executive committee in the services of the ALKC.

ARTICLE IX. DISTRIBUTIONS OF EARNINGS

Sec. 1. AUDIT. As soon as practicable after the close of each fiscal year, the Board of Directors shall have a complete audit made of the books and accounts of the ALKC by a competent and disinterested public auditor or accountant who shall render a report in writing thereon, which report shall show the results of the operation under review.

Sec. 2. ALLOCATION OF NET INCOME. The net income of each department, determined in the manner provided in Section 1 of this article, shall be allocated and distributed in the following manner:

a) The common stock shall bear no dividends The preferred stock of the association shall be non-cumulative as to dividend and the dividend rate shall not exceed eight percent per annum, if earned and when declared payable by the Board of Directors, and such dividends shall have preference over any and all other dividends declared in any year.

b) The remainder of the income of each department shall be allocated to the patrons based on general patronage for services and inputs, and based on packing results for post harvest services. In the event the operations of any department result in a loss, such loss shall be absorbed by the other departments in a manner to be determined by the Board of Directors.

c) There shall be deducted from each individual allocation an amount determined by the Board of Directors for preferred and common stock retirement and other capital purposes. The amount so deducted

shall be evidenced by book credits and by certificates of equity as provided in these By-Laws.

d) The remainder of the patronage allocation, if any, after the deductions for corporate purposes as herein provided, shall be paid to the respective patrons in cash, paying the packing patronage before general patronage.

Sec. 3. APPLICATION OF CASH DISTRIBUTIONS TO INDEBTEDNESS. Cash patronage distributions, and/or cash payments for retirement of stock or book credits or interest on book credits payable to any stockholder or patron may be applied, at the discretion of the Board of Directors, to the payment of any indebtedness of such stockholder or patron to be ALKC, that may be due.

ARTICLE X. CACULATION OF PACKING PARTONAGE

Sec. 1 Post harvest patronage will be decided by the following formula. Total dollars received for fruit-[{1-(Total weight of packed fruit/total weight of fruit onto the grader)*Average cost of packing 1lb of fruit for the year}+{Months in cool storage + cost of operating cool store per month}+{1-(total weight of fruit after repack/total weight fruit to be repack)*Average repacking costs}]. The ALKC will not organize members into risk sharing pools for longer cool storage rewards, but such pooling is encouraged for members to do on their own volition.

ARTICLE XI. REVOLVING CAPITAL

Sec. 1. Whenever in the opinion of the Board of Directors the capital funds of the ALKC are in excess of the amount deemed necessary for its sound financial operation, the Board may call and redeem or retire by payment in cash or an equitable pro rata basis

an amount of the outstanding stock, or the oldest book credits and certificates evidencing same, equal to such excess.

Sec 2. In the event of death or the termination of membership, common stock will be returned at par value to the estate or to the individual in a period no shorter than 2 years and no longer than 15 years.

ARTICLE XII. LIQUIDATION AND DISTRIBUTION OF ASSETS

Sec. 1. In the event of dissolution or liquidation of the ALKC, any assets remaining after the payment of all debts, insofar as they are sufficient for that purpose, shall be distributed in the following order and manner:

(a) Retirement of all outstanding preferred stock and credits on preferred stock at par or face value plus any dividends declared thereon and unpaid. Retirement of all outstanding common stock par value. The remaining assets shall be distributed for any allocated surplus retained to that member.

ARTICLE XIII. FISCAL YEAR AND AUDITS.

Sec. 1. The fiscal year of the ALKC shall begin on the first day of January, and end on the thirty-first day of December of each year.

Sec. 2. The books and business of the ALKC shall be audited annually by an auditor selected by the Board of Directors and the audit reported at the next annual meeting of the members. Special audits may be ordered at any time by the Board of Directors.

Sec. 3. The Board of Directors may borrow money and incur indebtedness for and in the name of the ALKC, and may secure the payment of the same with such

property or assets as this ALKC may own, subject, however, to the restriction contained in Section 1, Article V hereof.

ARTICLE XIV AFFILATION WITH OTHER FARM ORGNIZATIONS.

Sec. 1. The Board of Directors, acting for the ALKC, may assist in organizing, applying for membership in, or affiliate or make contracts for correlated service with any other ALKC, federation or corporation created for purposes consistent with those of this ALKC and for the benefit of producers of agricultural products, and may pay the membership dues required by such association, federation or corporation, and may subscribe to stock therein.

ARTICLE XV. CONSTRUCTION OF BY-LAWS AND CONTRACTS.

Sec. 1. These By-Laws and any contracts or agreements of this ALKC which may be in conflict with any law of the United States or the State of Alabama, shall be taken and interpreted as amended and modified by those laws to the extent necessary to uphold the validity of such by-laws, agreements or contracts.

ARTICLE XVI. SEAL AND OFFICE OF THE ALKC.

Sec. 1. The seal of the ALKC shall be in such form as the Board of Directors may prescribe and shall be identified by the imprint thereof on the margin of the minutes of the meeting of the Board of Directors adopting same.

Sec. 2. The principal office of the ALKC shall be at XX County, Alabama.

ARTICLE XVII. AMENDMENTS.

Sec. 1. These By-Laws may be amended at any annual membership meeting, or at any special membership meeting called for that purpose, by a majority of the members

or may be amended by a majority vote of the members if the proposed amendment be submitted by the Board of Directors for vote by mail.

I, the undersigned, Secretary of The Alabama Kiwifruit Cooperative do hereby certify that the foregoing By-Laws were unanimously adopted as the By-Laws for The Alabama Kiwifruit Cooperative at a meeting of the membership duly noticed, called and held at Town/City, XX County, Alabama, on the XXth day of Month, 20XX.

GIVEN UNDER MY HAND AND THE SEAL OF THE CORPORATION, this the XX th day of Month, 20XX.

_____

(SEAL)

Secretary

APPENDIX E

Application for Permit to Conduct a Cooperative

MARKETING ASSOCIATION

TO THE COMMISSIONER OF AGRICULTURE AND INDUSTRIES

STATE OF ALABAMA

MONTGOMERY

Application is hereby made for a permit to conduct a Cooperative Marketing Association as required by Title 2, Section 2-10-21. Code of Alabama 1975. The name of the Association is The Alabama Kiwifruit Cooperative hereinafter referred to as the ALKC and its principal place of business is XX Address, XX City, AL XX Zip code.

The Alabama Kiwifruit Cooperative has been or will be organized in accordance with the provisions of Title 2, Chapter 10 of the Code of Alabama 1975, under authority of Article 4.

The following are named as the officers of this Association to have charge of and to control the business of such an Association:

President,

Manager,

Names and Addresses, Board of Directors:

1.

2.

3.

4.

5.

6.

7.

Incorporated, Yes; $1,000,000; $ 500,000 in 100 shares of Capital Stock; $500,000 in 50,000 shares of Preferred Stock.

The officers of the ALKC hereby agree to conduct the affairs of the Association in accordance with the provisions of Title 2, Chapter 10, Code of Alabama 1975, the statute under which it is organized (Article 3 or Article 4 of said Chapter), and to submit an annual report as required by Title 2, Section 2-10-28, Code of Alabama 1975, which annual report shall include- a general statement of business operations, the sources of capital, the expenses of operation, its balance sheet, and such other information as the State Board of Agriculture and Industries may require within sixty (60)days after the closing date of the year's business.

The permit fee of XX dollars is herewith enclosed together with a certified copy of our Articles of Incorporation and by-laws.

President_____

Secretary_____

Month XX, 20XX

APPENDIX F

MEMBERSHIP APPLICATION FOR

THE ALABAMA KIWIFRUIT COOPERATIVE

I here by apply for membership in The Alabama Kiwifruit Cooperative and agree to abide by the Articles of Incorporation and the By-Laws of the ALKC, now and hereafter in effect, copies of which have been presented to me for my inspection. After my membership shall have been in effect one year from the date of its acceptance by ALKC, either party hereto may terminate it any year in the last day of the anniversary month in which this agreement was so accepted by notifying the other party in writing or by e-mail of this intention, such notice to be given between the first and fifteenth of the month immediately prior to the effective date of termination. If neither of the parties hereto so notifies the other, it is hereby mutually agreed that this shall constitute conclusive evidence that the parties hereto have renewed this agreement for another year. By submitting this application electronically I agree to physically sign this document as soon as reasonably possible.

Member's Signature_____

(Name of member)

(Address of member)

(Official email address of member)

(Telephone numbers of member)

Accepted this XX day of 20XX

Return application to:

(Name of President), President

The Alabama Kiwifruit Cooperative

Address Town, AL ZIP

name.of.president@alkc.coop

The Alabama Kiwifruit Cooperative

President's Signature_____

Secretary's Signature_____

APPENDIX G

Figure 1

Seasonal Process

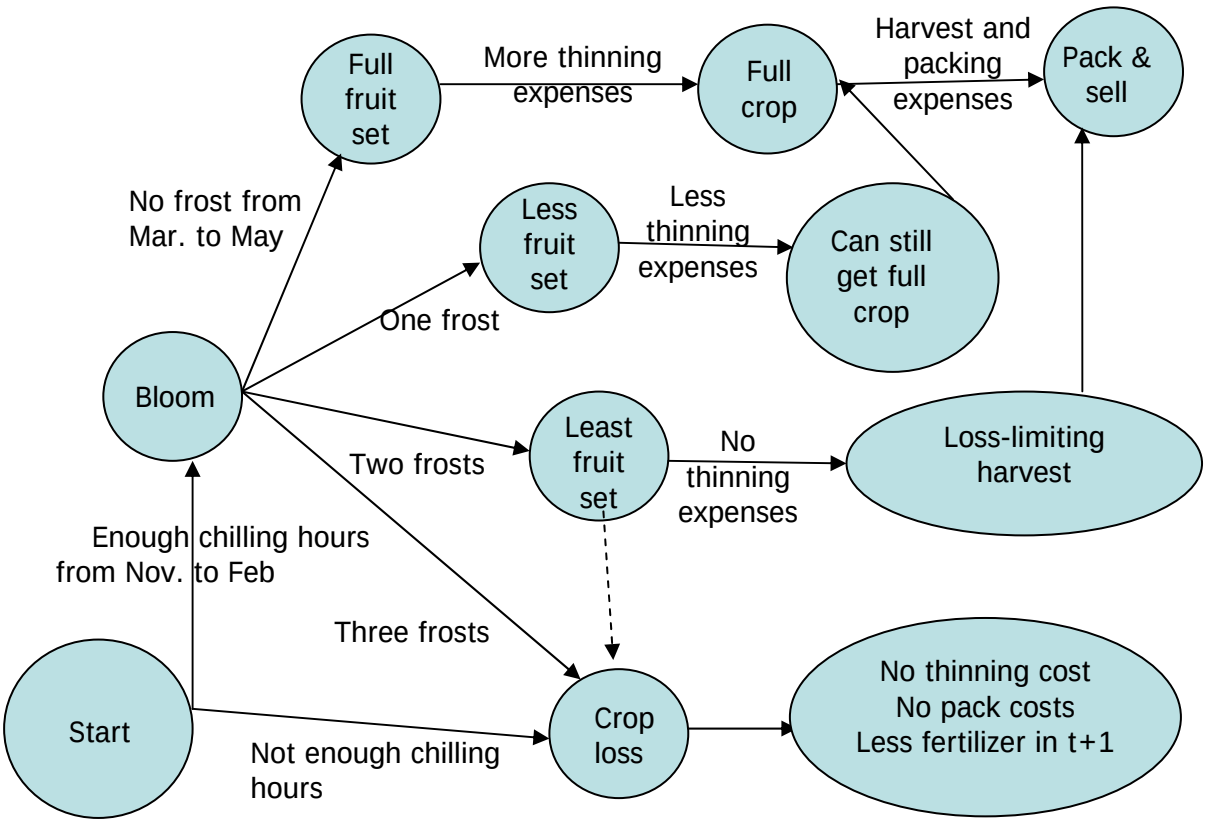
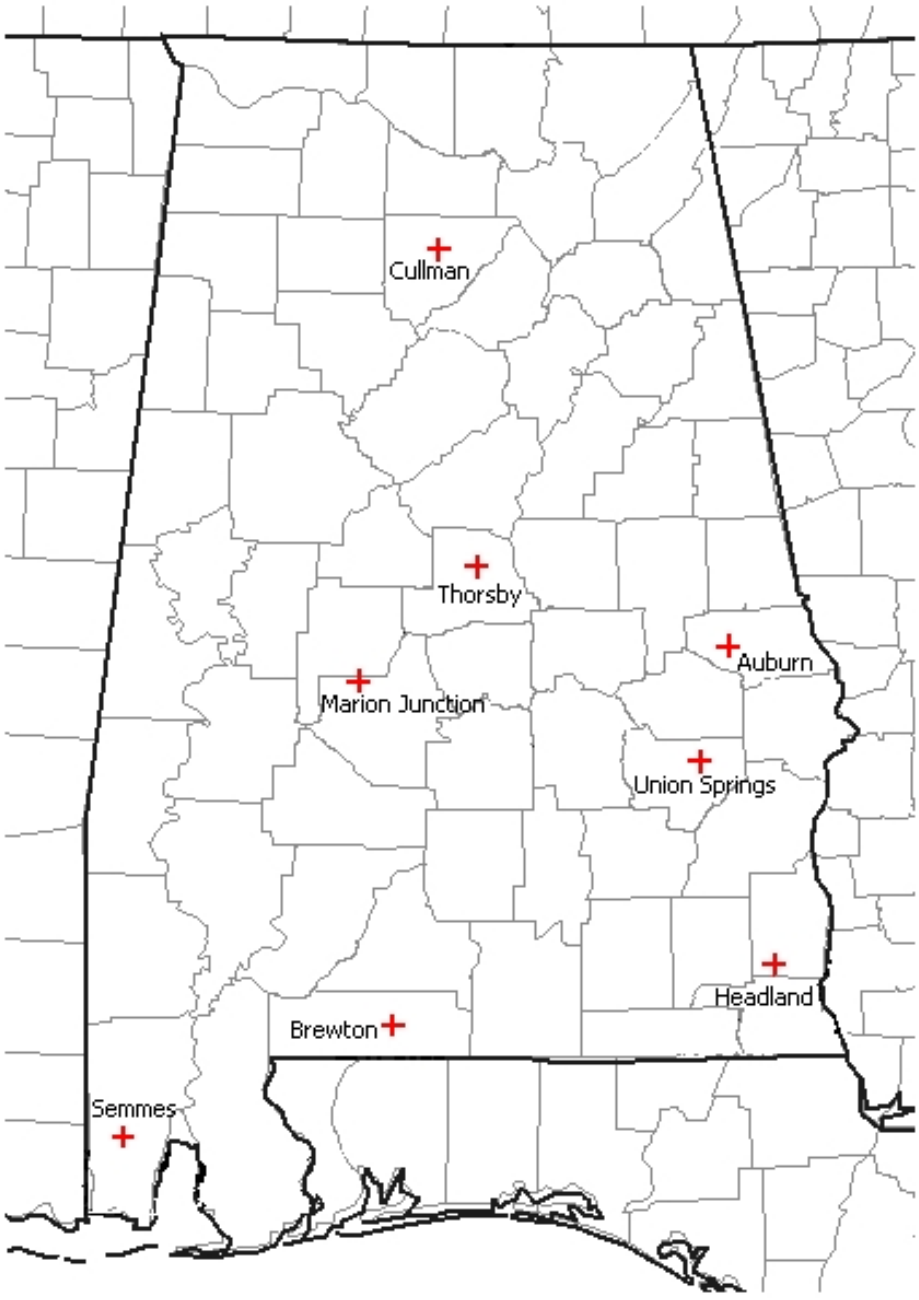


Figure 2

Locations of Weather Collection Sites



APPENDIX H

Table 1

Descriptive Statistics of Variables from Price Regression

Variable	Observations	Mean	Std. Dev.	Min	Max	Number of Dummy Observations
priceperkg	19525	2.030343	0.523447	0.1	6.17	
Distance from Atlanta	19525	1737.964	1432.297	0	4537	
species	19525	0.03831	0.191948	0	1	748
date	19525	972.6054	601.2837	1	1961	
date2	19525	88.76799	52.22987	1	183	
package weight	19525	7.636787	2.820951	3	10.8	
California	19525	0.283483	0.4507	0	1	5535
Chile	19525	0.163995	0.37028	0	1	3202
France	19525	0.040102	0.196205	0	1	783
Greece	19525	0.030986	0.173284	0	1	605
Italy	19525	0.242663	0.428704	0	1	4738
New Zealand	19525	0.238771	0.426343	0	1	4662
itemsize	19525	33.75933	5.220038	18	50	

Table 2

OLS Output from Price Study

Source	SS	df	MS
Model	2144.643	11	194.9675
Residual	3204.862	19153	0.164242
Total	5349.505	19164	0.273996

Number of Observations	19525
F(11, 19513)	1187.07
Prob > F	0
R- Squared	0.4009
Adj R-squared	0.4006
Root MSE	0.40527

Price per KG	Coefficent	Std. Err.	t	P > ltl	[95% Conf. Interval]	
Distance ATL	-0.000111	2.29E-06	-48.54	0.000	-0.001154	-0.000106
Species	0.563959	0.015751	35.8	0.000	0.5330852	0.594833
date	0.000166	4.19E-06	33.9	0.000	0.001568	0.000176
date 2	0.000584	7.78E-05	7.51	0.000	0.004318	0.000737
Package Wt	-0.063384	0.001043	-60.8	0.000	-0.0654271	-0.06134
California	0.259322	0.016978	15.27	0.000	0.2260439	0.2926
Italy	0.089276	0.016542	5.4	0.000	0.568525	0.121699
Greece	-0.244945	0.022106	-11.08	0.000	-0.2882744	-0.201615
New Zealand	0.324161	0.018575	17.45	0.000	0.287752	0.360569
Chile	0.294707	0.01922	15.33	0.000	0.257034	0.33238
item size	-0.009705	0.000564	-17.19	0.000	-0.010811	-0.008598
Constant	2.58617	0.029199	88.57	0.000	2.528936	2.643403

Table 3

Correlation Matrix

	Distance from Atlanta	species	date	date2	Package weight	California	Chile	France	Greece	Italy	New Zealand	Item size
Distance from Atlanta	1											
species	0.0368	1										
date	0.0671	0.05	1									
date2	0.1277	-0.1093	0.0149	1								
Package weight	-0.0237	-0.0787	-0.0046	-0.0344	1							
California	-0.1351	-0.0261	-0.0874	0.2168	-0.0851	1						
Chile	-0.1068	-0.0862	-0.0706	-0.4063	-0.0399	-0.2786	1					
France	0.3394	-0.0408	-0.0261	0.2097	-0.0415	-0.1286	-0.0905	1				
Greece	0.2442	-0.0357	0.0237	0.0828	-0.0009	-0.1125	-0.0792	-0.0366	1			
Italy	0.0805	-0.1049	0.1133	0.4156	0.0556	-0.356	-0.2507	-0.1157	-0.1012	1		
New Zealand	-0.1008	0.2412	0.0421	-0.4244	0.0882	-0.3523	-0.2481	-0.1145	-0.1001	-0.317	1	
Item size	-0.0766	-0.0248	-0.0984	-0.0027	-0.0128	0.0661	0.0987	-0.063	-0.0358	-0.0356	-0.0763	1

Table 4

Kiwifruit Sizes and Discounts

Number of Fruit per 3.6 Kg tray	Discount	Number of Fruit per 3.6 Kg tray	Discount
18	-0.1747	45	-0.4367
20	-0.1941	46	-0.4464
22	-0.2135	48	-0.4658
23	-0.2232	54	-0.5241
25	-0.2426	56	-0.5435
27	-0.2620	75	-0.7279
30	-0.2912	90	-0.8735
33	-0.3203	99	-0.9608
36	-0.3494	108	-1.0481
39	-0.3785	117	-1.1355
40	-0.3882	126	-1.2228
42	-0.4076		

Table 5

Fulfillment of Chilling Requirements for Selected Sites

Location	Mean Number of Hours	Standard Deviation	Golden Sunshine Fulfillment	80% Fulfillment for Golden Sunshine	Golden Dragon Fulfillment	80% Fulfillment for Golden Dragon
Cullman	1372	177	100%	100%	100%	100%
Thorsby	1183	180	94%	99%	99%	100%
Auburn	994	158	73%	96%	89%	93%
Marion Junction	1055	158	89%	99%	95%	100%
Union Springs	999	159	72%	96%	91%	99%
Headland	883	140	45%	87%	72%	96%
Brewton	791	133	21%	70%	49%	87%
Semmes	716	127	7%	51%	26%	78%

Table 6

Frost Exposure Bloom Periods for ‘Golden Dragon’ and ‘Golden Sunshine’

Location	Golden Dragon Frost Exposure	Golden Sunshine Frost Exposure
Cullman	April 14- May 4th	April 30- May 4th
Thorsby	April 9th- April 19th	No frost after April 29th
Auburn	April 5th- April 21st	No frost after May 5th
Marion Junction	March 30th- April 6th	No frost after April 10th
Union Springs	March 30th- April 4th	No frost after April 10th
Brewton	March 30th- April 14th	No frost after April 14th
Headland	March 25th- April 3rd	No frost after April 3rd
Semmes	March 20th- April 2nd	No frost after April 2nd

Table 7

Death Rate of Kiwifruit Buds

Number of -2°C frost events	Death Rate
1	50%
2	87.5%
3 or more	100%

Table 8

Total Yields of Sites in 3.6 kg Trays and Revenue at $7.00 Per Tray

Location	Golden Sunshine Mean	Revenue at $7.00/tray	Golden Sunshine Standard Deviation	Golden Dragon Mean	Revenue at $7.00/tray	Golden Dragon Standard Deviation
Cullman	5017	$35,119	1162	2117	$14,819	2035
Thorsby	5258	$36,806	1120	3394	$23,758	1958
Auburn	4369	$30,583	1838	4583	$32,081	1582
Marion Junction	4821	$33,747	1605	5258	$36,806	1128
Union Springs	4368	$30,576	1889	5122	$35,854	1333
Headland	3295	$23,065	2018	3925	$27,475	1943
Brewton	2343	$16,401	1664	3391	$23,737	2059
Semmes	1791	$12,537	1032	2458	$17,206	1766

Table 9

Frost Performance of ‘Golden Sunshine’ at Selected Sites

Location	Mean Number of Frosts	Standard Deviation	Three Frosts or More	Two Frosts	One Frost	No Frost
Cullman	0.26	0.50	0%	3%	20%	77%
Thorsby	0	0	0%	0%	0%	100%
Auburn	0.02	0.14	0%	0%	0%	100%
Marion Junction	0	0	0%	0%	0%	100%
Union Springs	0	0	0%	0%	0%	100%
Headland	0	0	0%	0%	0%	100%
Brewton	0	0	0%	0%	0%	100%
Semmes	0	0	0%	0%	0%	100%

Table 10

Frost Performance of ‘Golden Dragon’ at Selected Sites

Location	Mean Number of Frosts	Standard Deviation	Three Frosts or More	Two Frosts	One Frost	No Frosts
Cullman	1.89	1.29	29%	28%	30%	13%
Thorsby	1.07	0.95	8%	21%	40%	31%
Auburn	0.30	0.52	1%	3%	24%	73%
Marion Junction	0.03	0.18	0%	1%	3%	97%
Union Springs	0.01	0.11	0%	0%	2%	98%
Headland	0.30	0.53	0%	3%	23%	74%
Brewton	0.06	0.24	0%	1%	6%	94%
Semmes	0.07	0.27	1%	1%	6%	93%

Table 11

Per Acre Orchard Establishment Costs

Orchard Establishment	Number of Units	Time Estimate	Cost Per Unit	Total Cost
Contract Land Clearing	**3.04**		120.72	500.00
Contract Plowing and Cultivation	**0.65**		99.05	300.00
Planting of Cover Crops	**1.00**	0.5	50.00	56.00
Stake and Layout	**1.00**	1.5	2.00	20.00
Fertilizer (Tons)	**1.42**		725.00	1,029.50
Lime	**1.50**		20.00	30.00
Posts and trellis				
Internal Posts	**154.00**	5.0	7.54	1,236.16
End Assemblies	**54.00**	20.0	35.00	2,190.00
Wire				
Wire Strainers	330.00		375.00	825.00
14 Strands * 208 Ft. Across Rows (no. 12 Wire)	6,160.00		0.05	184.80
11 Strands * 208 Ft Row (No. 12 Wire)	2,420.00		0.03	72.60
4 diagonal Strands * 295 Ft Row (No. 12 Wire)	314.00		0.04	9.42
Cable Tiebacks 1/2 in Tiebacks	54.00		9.95	537.30
Total Time for wire setup		8.0		96.00
Planting of vines				
Drilling of holes	**290.00**	3.5		52.50
290 vines at(XX per vine)	290.00	14.0	15.00	4,490.00
Bamboo Stakes (3/4" * 7') (Bale of 100) $56 Am Leonard	290.00	0.0	162.40	162.40
Winter Trunk Wraps, Spray guards	290.00	0.0	3.00	870.00
Shelter Belt Planning				
# of Cryptomeria trees at 5ft space 2.5 ac per shelter belt	167.00	1.8	11.25	1,896.25
Winter Trunk Wraps, Spray guards	167.00	0.0	2.25	375.75
stake and layout of planting	1.00	0.8		11.25
Drilling of holes		1.5		22.50
Irrigation				
PVC Pipe 500 Yards form source Schedule 80			1875.00	1,000.00
Pump cost			4875.00	500.00
Valve assembly (valve, filter and pressure regulator)				
Valve	1.00		90.00	90.00
Filter	1.00		14.35	15.00
Pressure Regulator	1.00		55.00	55.00
Spaghetti tube 1.5ft per vine	435.00		195.75	300.00
Emitters	580.00		1450.00	1,595.00
Irrigation Tube Punch style	2420.00		6050.00	6,292.00
Total Cost				**-24,814.43**

Table 12

Example of Production Year Costs Years Four through Twenty

Yield in Trays	5000				
Revenue	$35,000				
Costs	$24,235				
Net Income Before Interest and Taxes	$10,765				
	Number of Units	Hours Per Acre	Price Per Unit	Equipment Cost	Total Cost
Land Rent					100.00
Strip weed control					
Three to seven applications	4.33	0.25	4.91	1	11.07
Pest Sprays					
Dormant Oil for Scale	4.83	0.25	3.44	2.75	48.25
Systemic For Scale	1.91	0.25	4.02	2.75	21.13
Fire Ant Control	0.80	0.25	4.24	2.75	9.38
Fruit sprays					
Benefit PZ	3.00	0.25	2.75	2.75	10.43
Pollen System	1.00	0.25	600.00	2.75	825.00
Yearly Pruning					
Winter Pruning	160.00	10			1600.00
Kiwi ties	4930.00	0.005			24.65
Stringing	3545.00	0.25			886.25
String 17 strands per bay at 16 ft per strand (40000 ft)	44880.00	0.04	0.05		1795.20
Removal of Fruit stalks	22.00	10			220.00
Tipping	30.00	10			300.00
removal of blank shoots	22.00	10			220.00
fruit and flower thinning	175.00	10			1750.00
male pruning	55.00	10			550.00
Cane management	13.00	10			130.00
Bay management	14.00	10			140.00
Zero Pruning	28.00	10			280.00
Hang up fruit	60.00	10			600.00
Mowing/mulching					
one pass per row	2.70	3.75		3.97	10.13
Fertilizer					
Lime	1.00	15	20.00	3.97	238.20
Spring application .5 lb per vine N 2lb vine K	290.00	15		3.97	585.73
Summer application .5 lb per vine N 2lb vine K	290.00	15		3.97	585.73
Harvest Costs					
Cotton Gloves	2.08		0.18		4.50
Fuel and Maintenance for Tractors	1.50	15			22.50
Fuel for Hravest Tractors	2.25		3.50		35.89
Set up Maintenance (Per day of harvest)	0.50	15			7.50
Harvest Labor					
Pickers	12.00	10	120.00		546.90
Harvest Supervisor		15	15.00		68.36
Load out Crew	1.00	15	15.00		68.36
Tractor Drivers	2.00	12	12.00		24.00
Packing Variable					
Packing trays 3.6kg lbs. per bundle of 25	220.00		52.00		11440.00
Steel Banding 1/2" one roll	1.00		129.00		129.00
Metal seals (5,000)	1.00		75.00		75.00
Plastic Pallets	2.00		55.00		110.00

Table 13

Capital and Equipment Costs of a Kiwifruit Orchard

Fixed Costs	Cost
Pump, Panel, Well (No Smaller than a 6" well)	10,000
Equipment	
Shop Tools	5,000
Air Compressor and Air Tools (IR 60 Gal)	1,079
Forklift	1,000
Pruners and Loppers (20 Loppers, Hand Pruners,)	1,200
Picking Sacks (20)	983
Tractor and Machinery	
Antonio Carrerra TGF 9400 65" 83 HP	42,300
Airsear sprayer KiwiPollen NZ	21,000
Post Driver POSTDRIVER.COM PD12	6,952
Harvest tractors 2 (Massey Ferguson 50)	17,200
Sprayer	
-Herbicide Kings PTO type 100 gallon	1,705
-Air blast Air-o-fan Predator 500	22,000
Mower mulching type Seppi	12,000
Broadcast spreader Pot Type 1000LB Capacity	500
Harvest Trailers (2)	10,000
LP Gas Cannon	792
Total	143,711
Per Acre for 10 AC	14,371

Table 14

Costs Associated with Packing House Operation and Establishment

Grading and Packing	
Buildings (42'W x 96'L)	35,490
22 Bu Bins (80 bins)	12,000
Grading Line (Used Compac InVision 5000)	122,000
Electric Forklift (used)	7,500
Pallet Truck (1)	379
Banding EquipmentCellophane wraping (1)	500
Cellophane wraping tool (1)	100
Cold Storage	
Capacity for 250,000 trays	125,000
Total	302,969
Per acre cost of Cooperative Share	-3,030
Yearly Packing House Costs	
Energy Costs Yr	5,051
Coolstore Energy	25,000
Repair and Maintenance	1,775
Employees and other overhead	54,400
Yearly Total	86,226
Per acre share in Cooperative Association	862

Table 15

IRR Returns

	90% probability IRR Greater Than 20%		Mean IRR	
Location	Golden Dragon	Golden Sunshine	Golden Dragon	Golden Sunshine
Cullman	2%	99%	25%	14%
Thorsby	37%	99%	26%	19%
Auburn	92%	86%	22%	23%
Marion Junction	99%	99%	24%	26%
Union Springs	99%	86%	22%	25%
Headland	19%	33%	18%	17%
Brewton	33%	3%	15%	19%
Semmes	1%	3%	14%	13%

Table 16

Costs Associated with Packing House Operation and Establishment

Grading and Packing	
Buildings (42'W x 96'L)	35,490
22 Bu Bins (80 bins)	12,000
Grading Line (Used Compac InVision 5000)	122,000
Electric Forklift (used)	7,500
Pallet Truck (1)	379
Banding EquipmentCellophane wraping (1)	500
Cellophane wraping tool (1)	100
Cold Storage	
Capacity for 250,000 trays	125,000
Total	302,969
Per acre cost of Cooperative Share	-3,030
Yearly Packing House Costs	
Energy Costs Yr	5,051
Coolstore Energy	25,000
Repair and Maintenance	1,775
Employees and other overhead	54,400
Yearly Total	86,226
Per acre share in Cooperative Association	862