SIMULATED NET INCOME FOR GEORGIA GROWN SATSUMA MANDARINS

By

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(Under the Direction of Benjamin Campbell)

ABSTRACT

This paper provides an interactive crop budget for producers of Satsuma Oranges in citrus zone A of Georgia as designated by the University of Georgia Cooperative Extension. This paper offers information on the history and marketing of Satsuma Mandarins in the Southeastern United States for prospective producers that are unfamiliar with the crop. Most importantly, this paper incorporates uncertainty within annual prices, yields, and labor costs affecting the farm business. Simulations are used to randomize price, yield, and labor in a competitive market to provide current and prospective growers with feasible numbers for their return on invested capital. Expenditures are determined on a per acre basis. Probability of profit for Satsuma producers was determined to be 86.98 percent. Net present value was found to be $43,633.21 with a four percent discount rate and return on investment was 386.58 percent after simulating over the 12 year mature production horizon.

INDEX WORDS: Satsuma, Budget, Georgia, Citrus, Mandarin

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DEDICATION

I would like to dedicate this Master's Thesis to my late paternal grandfather George Mahr who always loved to grow oranges and drink orange juice at his home in Hobe Sound, Florida.

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I would like to thank my family for supporting me throughout my entire academic career. I would also like to thank teachers along the way that guided my path and encouraged me to never stop learning and seeking new ideas.

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CHAPTER 1

INTRODUCTION

Citrus Unshiu, most commonly known as the Satsuma Mandarin or simply Satsuma, is a cold hardy citrus species. Satsuma Mandarins are classified as a sweet, mostly seedless, peel-able citrus variety of moderate size typically of deep orange color. Satsumas are believed to have originated in China. The Satsuma was introduced to the United States from Japan, where the citrus species is known as Mikan (Anderson and Ferguson, 1996). Satsuma is a recognizable namesake throughout the Gulf Coast region of the United States, as there are townships named after the fruit in Florida, Texas, Alabama, and Louisiana. Satsumas arrived in the United States from the Satsuma region of Japan in 1878 after the Japanese minister at the time sent trees to his wife in Louisiana. Thirty years later, from 1908-1911, a large influx of the *Owari* cultivar of Satsuma was introduced to the United States, which is now the most commonly grown variety in Georgia (Anderson and Ferguson, 1996). Satsumas are known for their cold hardiness and resilience in growing conditions that are typically unfavorable for cultivating other citrus species (Krewer and Powell, 2015). Despite their hardiness, Satsumas can die if sustained temperatures fall below twenty-five degrees. (Ebel et al., 2005; Krewer and Powell, 2015) Satsumas are distinctive from other citrus crops because cooler temperatures during the late fall are necessary for the Satsuma to appropriately ripen (Krewer and Powell, 2015)

These cultural growing requirements present a unique opportunity for South Georgia citrus growers. Florida, Georgia's southern neighbor, has experienced a vast reduction in citrus acres planted from 2008-2017. Acres planted in citrus crops have declined by 16.44 percent nationally since 2008 (USDA, 2018). This reduction is attributed to citrus canker, a bacterial disease that has devastated the Florida citrus industry since 1995 (Gottwald et al., 2002) In 2006, the disease was declared ineradicable and Florida growers have been urged to grow alternative crops (Gaskalla & Putnam, 2017). Additionally, California's citrus industry is feeling the effects of severe drought where over 3000 acres of Satsumas are grown (Campbell, 2014). Given that Satsuma Mandarins require colder temperatures for fruit maturation (Krewer and Powell 2015), coupled with a steady decline in national citrus and continuing production issues in California growers in Zone A (Figure 1) of Georgia are well positioned to meet consumer demand. Seeing an opportunity, Georgia producers have planted approximately 44,000 Satsuma trees with the number steadily increasing (Krewer and Powell, 2015).

As production of Satsumas increases in Southern Georgia, there is a need for production information that incorporates risk into profitability. This paper examines the net present value and other financial performance metrics of establishing a Satsuma Mandarin operation given the intrinsically uncertain nature of revenue and cost variables used to calculate annual net income for a fifteen-year production horizon. This paper is designed to offer baseline data and profit viability for prospective citrus growers and institutional investors in the Southern part of the state of Georgia. After assuming a uniform distribution of ancillary price, yield, and cost data, an iterative approach using Latin Hyper Square (LHS) simulation was conducted in order to find the expected net income for Georgia Satsumas on a per acre basis. The simulations are based off the budget developed by Fonsah et al. (2018) who developed a detailed enterprise budget regarding production costs of Satsuma Mandarins in Georgia. Included in the budget are production components such as establishment costs, fixed cost (FC), variable costs (VC), breakeven (BE) analysis, and probability of profit given current price values and potential yield thresholds

(Fonsah et al., 2018). Market price is contingent upon market supply, demand, and fruit quality. Fruit quality is influenced by management practices of the Satsuma grove. For the purposes of this budget, it is assumed that firms engaging in growing Satsuma Mandarins attempt to mimic best management practices. Fonsah et al. (2018) incorporate costs associated with 2018 best management practices for growing Satsuma Mandarins in Georgia. Costs using best management practices include chemical sprays, irrigation, and site preparation in order to minimize yield risk. It is assumed producers in this simulated scenario employ growing practices to mitigate yield risk, such as freeze protection, due to the novelty of Georgia grown Satsuma Mandarins and the substantial capital investment required to establish a Satsuma grove. First year establishment costs are expected to be approximately $7,087.85, second year establishment costs are expected to be $4,719.41 and third year establishment costs are expected to be $5,987.88 (Table 1 and Table 4) for the typical Satsuma producer in Georgia (Fonsah et al., 2018). These values are used in place of net income for the establishment years one through three for the fifteen-year production horizon (Table 4).

Three variables were determined to potentially influence profitability: the probability of a hurricane or tropical storm event, the value taken by price and yield, and cost of harvesting and hauling the crop based on yield. For instance, the South Georgia region recently suffered significant yield losses across a variety of commodities in the wake of tropical storm Irma in September of 2017. Cotton crop losses in Georgia were estimated between ten and twenty percent. (Thompson et al., 2018). Furthermore, pecan crop losses in the wake of hurricane Irma are estimated to be as much as thirty percent (Thompson, 2017). Given these loses, incorporating risk associated with a hurricane or tropical storm is essential given there is a five percent chance of a hurricane hitting southern Georgia (Landsea, 2014).

Chapter 2

LITERATURE REVIEW

Several papers examining fruit quality and marketing techniques have been published. Campbell et al. (2004) evaluates consumer preference for seven attributes associated with Satsuma Mandarins. They identify three segments with each segment valuing different attributes, such as surface blemishes, price, and seediness. The attributes outlined by Campbell et al. (2004) are factors Georgia growers should consider when assessing the value and competitiveness of their crop. Given there are varying consumer segments, understanding these segments will dictate specific marketing strategies. For instance, most large grocery stores have implemented aesthetic grading standards to appropriately procure fruit from growers. Campbell et al. (2006) analyzed simulated willingness to purchase Satsumas among grocery store customers. Attributes that determine willingness to purchase include the price of Satsumas and other citrus substitutes, packaging type, shelf life, nutritional labeling, and location. They found that a longer shelf life, vitamin C labeling, and a product offering of peeled and segmented fruit are key preferences among grocery store consumers of Satsumas. Market segmentation should be utilized to create preference for Satsumas when faced with competition from other citrus crops such as clementines and tangerines. These studies assist growers appropriately price their product based on common quality ratings and aspects of consumer preference.

Factors that affect yield of different varieties of Satsuma were studied in Tachibana and Yahata (2007). Tachibana and Yahata (2007) study the yield performance of Satsumas contingent upon leaf area index (LAI), growing degree-days, cultivar, and flower-set. Leaf area index measures the volume of vegetative growth on the tree. Their twelve-year study finds that LAI has the most impact on yield for young and mature trees, emphasizing the importance of good establishment methods in the grove. Quality rather than speed of establishment is recommended in the establishment of a Satsuma grove. Findings in Tachibana and Yahata (2007) confirm that if fruit is not culled in order to foster strong vegetative growth during the first three establishment years, yields will likely suffer in mature production years four and beyond. Ebel et al. (2005) design an index model in order to predict freeze induced crop damage. They find that crop susceptibility is determined by the minimum temperature of the freeze as well as the temperature for the five hundred hours prior to the sustained freeze event.

Athearn et al. (2016) developed a enterprise budget for Florida similar to the Fonsah et al. (2018) budget for Georgia. These enterprise budgets have several distinct differences in their assumptions. Athearn et al. (2016) assume a price of $0.45 per pound and a marketable yield of 26,100 pounds per acre. The end market in Athearn et al. (2016) is a cold packing facility, which can be understood as a fruit broker or middleman. In the budget for Florida, net returns were projected to be $1,909 per acre with the assumption that all land was purchased initially. Fonsah et al. (2018) assume a product that is sold fresh and do not account for the price of land as land rent prices in Georgia are known to have considerable fluctuations. Higher prices of $0.75-$1.25 found in Fonsah et. al (2018) reflect a fresh product rather than a product for processing. Though the Athearn et al. (2016) enterprise budget is useful for comparison, the citrus industry is considerably more developed in Florida. Because of packing and storage practices in Florida, the end consumer is usually a packaging facility where Satsumas are transformed into various value added products rather than the fresh market (Athearn et al., 2016). Target market and the scale of typical citrus operations are considerably different when comparing Florida and Georgia production.

With respect to the simulations, Latin Hypercube simulation is an iterative technique used in a variety of disciplines to stratify the sampling methods of a known distribution and was first introduced by Mckay et al. (1979). Methods of simulating random distributions given ancillary information in the environmental science field are discussed in Minasny and McBratney (2006). Minasny and McBratney show that Latin Hypercube simulation methods, also known as Latin Hyper Square, can be used to stratify the sampling of values when bounds on the distribution of a random variable can be set by the researcher using ones prior knowledge on a subject. Minasny and McBratney (2006) emphasize the importance of appropriately stratified sampling methods when attempting to representatively simulate the true variability for the parameters of a random variable. For instance, Minasny and McBratney (2006) simulate slope and soil characteristics of the Hunter Valley in Australia using randomized sampling points to better understand the average characteristics of the entire valley.

The intrinsic risk associated with an appropriate discount rate increases from the near term to the far term as pointed out by Wells (1976) and Richardson and Mapp (1976). Predictions of probability distributions for enterprise budgeting variables become more difficult as the time frame of the capital budgeting horizon increases. Richardson and Mapp (1976) detail how production variables from enterprise budgets can be simulated using a subjectively assigned distribution in order to estimate projected financial performance of an enterprise budget. The findings from these papers led us to adopt the assumptions used in simulated net income analysis of Georgia Satsuma Mandarins.

Chapter 3

METHODS

Economists, agronomists, and agricultural producers have long studied cropping schedules and production budgets. Projected revenue calculations are typically achieved using simulation methods or linear programming such as regression analysis. Linear regressions can be useful for understanding the magnitude by which independent budget variables affect net revenue. Alternatively, iterative simulations can be utilized when subjective bounds can be set on the value taken by variables that directly impact revenue Richardson and Mapp (1976). In this case, the net income value is calculated using the profit equation,

[Profit (π) = Total Revenue (TR) - Total Cost (TC)] **Eq.1**

whereby,

[Revenue = Price*Yield and Total Cost = Variable Costs + Fixed Costs] **Eq.2**

In order to estimate net present value, internal rate of return, and return on investment for individuals and investment firms interested in establishing Satsuma operations in Georgia, a random component was added to price and yield. These values were assumed to have a uniform, otherwise known as rectangular, distribution. Uniform distributions allow each variable to take a value between a lower and upper bound (Weisstein, n.d.). The uniform distribution of values for price and yield in this study were created using a simple Randbetween function in Microsoft Excel. The Randbetween function was applied to price and yield for every mature production year, four through fifteen. The Randbetween function creates a uniform distribution in which there is an equal probability of obtaining any value within the upper and lower bounds of the distribution (Weisstein n.d.). A graphic of the theoretical population density function of the random variables with an assumed uniform distribution can be viewed in figure 2.

Bounds on the values taken by price and yield were confined to the pessimistic and optimistic values found in Fonsah et al. (2018). In the Fonsah et al. (2018) budget, the average harvest and cooling costs per pound of yield was $0.10. Multiplying the cost of harvest and cooling by the pounds of yield for the corresponding year allowed us to obtain costs related to harvesting and cooling the harvested Satsuma crop with varying yields. The cost associated with harvest and cooling was then added to $4,484, which is the average pre-harvest variable cost in the Fohsah et al. (2018) enterprise budget. Interacting harvest and cooling cost with yield was done to more accurately reflect costs incurred in years with above or below average yields and the associated costs arising from varying yields. This was an important step, as harvest costs comprise approximately forty percent of total projected variable costs (Fonsah et al., 2018). Fixed costs were held constant for mature production years four through fifteen. Disregarding differences in quality and the producer's attempt to differentiate their product via packaging, point of sale, etc., Georgia grown Satsumas are, in this study, considered homogenous. As such, Satsuma producers are price takers. This means, without collective bargaining power, producers will sell their crop for the going market price, and are unable to set prices themselves. This was an additional reason for incorporating price variability into net income simulations. Because each year on the production horizon took a different set of values, the average net income for each year also took a unique value. Unique values for years four through fifteen on the production horizon made the capital budgeting metric of net present value more representative of uncertain fluctuations in price, yield, and variable cost.

To account for a catastrophic yield loss due to a hurricane, a hurricane component was included in the yield vector for revenue using a nested uniform distribution. The nested uniform distribution within the yield distribution was obtained using the **(=If)** statement in Microsoft Excel. If a random number between zero and one fell below the five percent hurricane probability, zero yield was recognized during that simulated production year. The five percent probability used was based on Landsea (2014) (Figure 3). A theoretical graphic of the uniform distribution with a nested uniform distribution of hurricane likelihood can be viewed in Figure 4.

After acquiring random values for price and yield, 1,000 simulated iterations for each production year were conducted using Simetar (College Station, TX). A LHS sampling method was used for the simulation. LHS sampling was utilized in order to more systematically draw samples from the entire distribution of randomly assigned values than that of Monte Carlo simulations (Chrisman, 2014). This approach is discussed in Minasny and McBratney (2006) with regard to spatial sampling. Both Monte Carlo simulations and LHS are iterative random sampling methods, but LHS is distinct from Monte Carlo because it groups the feasible values in the distribution into a series of squares. In these squares, theoretical values and their probabilities reside. LHS picks values systematically from each grid within the distribution. Thus, LHS better reflects the true stratification of the random variables for all iterations, rather than only their cumulative distribution function for a single iteration (figure 5) (Minasny and McBratney, 2006). This is a useful statistical tool in iterative statistical analyses when numerous random values are nested into a single function. LHS is particularly important in agriculture, as the tails of a distribution must be simulated representatively (Richardson and Mapp, 1976). The resulting mean and standard deviation for net revenue found using 1,000 iterations of LHS for each year of mature production were then used to calculate capital budgeting metrics such as net present value (NPV), internal rate of return (IRR), return on investment (ROI), and annualized return on investment. A table of formulas used to calculate NPV, IRR, ROI, and annualized ROI can be seen in Figure 7. NPV was calculated assuming a twelve, eight, and four percent discount rate. A twelve percent discount rate is the commonly understood S&P 500 return over the past twenty years on the total United States stock market (S&P 500 Dow Jones Indices, 2018). A four percent discount rate was used to reflect a typical agricultural loan (Kansas City Fed, 2018) and an eight percent discount rate was used for sensitivity analysis between the stock market rate and a feasible interest rate for an agricultural loan.

Chapter 4

RESULTS

After conducting simulations using LHS sampling for both price and yield, the average annual net income was determined to be $7,215.58 per acre with an average standard deviation of $6,410.56 for production years (years 4+), as can be seen in Table 4. Random values for price and yield components for each of the twelve years in mature production can be seen in Table 5. Because the LHS simulation is statistically unbiased (Chrisman, 2014), the LHS iterations will approach the true population mean. This is known as the law of large numbers (Feller, 1962), meaning that after conducting a sufficient number of iterations for the simulations, the average mean and standard deviation from the sample of random values should approach the theoretical mean of the population density function. The equation to calculate the theoretical mean for a uniform distribution can be seen in Figure 2. Based on the expected values for price, yield, and cost, the average net income from the LHS simulation, $7,215.58, differed from the theoretical mean value of $7,214.07 by .02 percent. The theoretical mean for yield was 19,000 pounds, which is 20,000 pounds multiplied by the five percent chance of a hurricane. The theoretical mean for price in the uniform distribution was $1.00 per pound, and the theoretical mean for total cost was $11,785.93; these values can be seen in Table 5. Because the mean net income acquired using the statistically unbiased sampling method of LHS simulation was nearly identical to the theoretical population mean for net income; a normal cumulative density function can be used to calculate the probability of profit. A breakeven probability, the probability that a grower will make a positive profit in any single year of the production horizon, was found to be

86.98 percent. This value was found using the average mean and standard deviation from the LHS simulations for all mature production Figure 6. This was done using a normal cumulative density function to calculate the area under a normal bell curve exceeding a value of zero given a mean of $7,215.58 and a standard deviation of $6,410.56.

Using a twelve, eight, and four percent discount rate in the Net Present Value (NPV) calculation found in Figure 7, the net present value for a Satsuma operation was calculated using the average mean and standard deviation for each year of the mature production horizon (Table 4). The NPV is $17,371.87 using a twelve percent rate, $27,716.23 using an eight percent, and $43,633.21 using a four percent rate. The discount rate can be interpreted as a producer or investor's opportunity cost of capital, or the rate at which he or she can acquire additional capital. Net present value (NPV) is the difference between present cash inflows and cash outflows. Net present value represents the value of an investment today, based on projected net income in the future, while accounting for the time value of money (Kurt, 2003). As the anticipated opportunity cost of capital in the NPV calculations goes down from twelve to four percent, NPV increases (Table 4). For all discount rates used in the NPV calculations, NPV is positive, signaling to growers and investors that entering the Georgia Satsuma industry would be profitable.

IRR is 29 percent using the estimated cash flows for years one through fifteen in Table 4. Because the IRR calculation used for capital budgeting can be done in numerous ways, the simple (**=IRR)** command in Microsoft Excel was used so that the methods in this study can be replicated. An internal rate of return of 29 percent can be represented as the highest interest rate that would cause net present value to equal zero. If the supposed discount rate was greater than 29 percent meaning the prospective Satsuma farmer or investor was earning greater than 29 percent returns on capital elsewhere, a Satsuma enterprise is not a worthwhile investment. If the supposed discount rate is lower than 29 percent, Satsuma production is expected to be profitable and net present value is greater than zero (Ross, 2017). The equation used for IRR can be found in Figure 7.

Return on investment and annualized return on investment were calculated using the equations shown in Figure 7. Return on investment is an efficiency metric used in capital budgeting to determine how efficiently an investor can recapture invested capital based on total proceeds over the life of an investment. This can be thought of as how much growers and producers expect to get back over the proposed fifteen year production horizon shown in Table 4 based on the three year establishment period with an estimated total investment of $17, 995.14 per acre. Annualized return on investment is calculated using the equation in Figure 7. Projected annualized ROI using the simulation results for the production horizon is 11.12 percent. Annualized ROI is the annual ROI over the life of an investment if returns are compounded annually. Annualized ROI is a performance metric used to compare multiple investments (Ross, 2017). Performance metrics such as ROI and annualized ROI are projections, actual ROI cannot be known until real values from the business are realized.

The metrics in this budget in no way reflect the practices of all growers but are intended to provide a benchmark cost and revenue analysis for producers utilizing the best management practices as prescribed by the Fonsah et al. (2018).

Chapter 5

CONCLUSION

Though Satsuma production in Georgia is at an early stage, there are high hopes for the citrus fruit and potential growers considering a Satsuma enterprise. Climatic and soil conditions in the South Georgia region are ideal for the *Owari* cultivar that has been in the United States for over a century (Krewer and Powell, 2015). With the steady national decline in citrus acres under production, Georgia is well positioned to increase citrus production to meet consumer demand. The objective of this analysis is to determine reasonable income expectations for growers and investors that are new to Satsuma cultivation. Data in Fonsah et al. (2018) provide bounds to construct uniform distributions for three variables that directly impact net income. These variables included price, yield, and variable costs. Harvesting costs varied with yield; as yield increased, the proportion of variable cost representing labor also increased by ten cents per pound of yield. A LHS sampling method was employed in conjunction with the individual distributions of these variables in order to simulate net income over a fifteen-year production horizon.

After averaging the results of the fifteen-year simulation, average net revenue of $7,215.58 with a standard deviation of $6,410.52 was obtained. The purpose of using simulation methods is to sample a distribution so that statistically unbiased sampling methods will eventually approach the true population mean. Assuming the convergence to normality of the values simulated using LHS due to the law of large numbers, the probability of profit was determined to be 86.98 percent, this can be interpreted as a Georgia Satsuma producer having an

87 percent chance of making a profit on any given year. Using a twelve, eight, and four percent discount rate for the net present value calculation found in Figure 7, the NPV for a Satsuma operation based on the average mean and standard deviation for each year of the mature production horizon in Table 4 is $17,371.87 for a twelve percent rate, $27,716.23 for an eight percent, and $43,633.21 for a four percent rate (Table 4). The discount rate can be interpreted as a producer or investor's opportunity cost of capital.

For all discount rates used in the NPV calculations, NPV is positive, signaling to growers and investors that entering the Georgia Satsuma industry would be profitable. IRR is 29 percent using the estimated cash flows for years one through fifteen in (Table 4). An estimated return on investment of 386.58 percent is calculated over the fifteen year simulated production horizon with an annualized return on investment is 11.12 percent. Despite a producer's best efforts, price and yield are inherently uncertain variables in most all-agricultural situations. Current and prospective producers should tactfully utilize simulated net revenue in order to fully comprehend risk factors associated with production. It is important to consider that even the most thorough revenue simulations can omit items that are presently unforeseen or exogenous such as weather, labor, or pest pressures that can have significant effects on production. As Georgia Satsuma producers gain more cropping experience, additional information may be provided or amended to this budget simulation in order to properly reflect the current industry standards in the State of Georgia for the Satsuma Mandarin.

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TABLE 1- 1st year estimated establishment and maintenance

Cost Per Acre For Georgia Satsuma, 2018				
ITEM	**UNIT**	**QUANT.**	**PRICE**	**AMOUNT**
OPERATING COSTS				
Land prep 1/-	Acre	1.00	500.00	500.00
Lime (DOL.)	Ton	1.00	30.00	30.00
Fertilizer (10-10-10)	Acre	730.00	0.30	219.00
Herbicides Pre-emergent	Acre	2.00	40.00	80.00
Herbicides Post-emergent	Acre	2.00	10.00	20.00
Insecticides	Acre	4.00	15.00	60.00
Fungicides	Acre	0.00	50.00	0.00
Trees (15 x 20)	Tree	145.00	15.00	2175.00
Scouting	Acre	1.00	75.00	75.00
Tissue analysis	Acre	1.00	35.00	35.00
Soil analysis	Acre	1.00	6.00	6.00
Labor	Hrs	70.00	10.00	700.00
Fuel	Acre	1.00	29.98	29.98
Repair & Maintenance	Acre	1.00	37.00	37.00
Irrigation/Frost Protection	Acre	5.00	220.67	1103.36
Interest on operation	Acre	3966.98	0.065	257.85
Total Operating Costs	$			**4828.19**
FIXED COSTS	**UNIT**	**QUANT.**	**PRICE**	**AMOUNT**
Tractor & Equipment	$	342.78	1.00	342.78
Management Overhead	$	4828.19	0.15	724.23
Irrigation	Acre	1	1192.65	1192.65
Total Fixed Costs				**2259.66**
Total Establishment Costs				**7087.85**

1/- Landprep vary significantly from $0 - $1,000 per acre.

Source: Fonsah et al., 2018

TABLE 2 - Cost of Establishing drip irrigation (Summer months)

	NEW COST	**YRS.LIFE**	**DEPREC.**	**INTEREST**	**TAX & INS.**
PIPE & FITTINGS	10300	20	515	335	77
Tubing & Emitters Inline	475	10	48	15	4
WELL (4")	1440	25	58	47	11
Pump & Motor	11000	15	733	358	83
Filter & Auto	130	10	13	4	1
Misc.	700	20	35	23	5
Installation	40000	20	2000	1300	300
TOTAL INVESTMENT	**64045**		3401	2081	480
TOTAL ANNUAL FIXED COSTS					**5963**
ANNUAL FIXED COSTS PER ACRE					**1192.65**
OPERATING COSTS					
MOTOR SIZE (HP)			8		
REPAIRS			199		
ANNUAL PUMPING HOURS			1820		
ELECTRICITY					
Demand (standby charge) per YEAR			90		
Rate $ per KWH			0.08		
ANNUAL ENERGY COST			905		
ANNUAL ENERGY COST PER ACRE					180.93
OPERATING COST PER ACRE PER YEAR					**220.67**
TOTAL ANNUAL COSTS PER ACRE					**1413.32**

Source: Fonsah et al., 2018

TABLE 3- Net Returns for Satsumas using simple sensitivity analysis

(serving as a baseline for variability in cost used for simulation)

SATSUMA RETURNS						
	This example assumes very good management practices.					
				Return over		Return over
Year	Yield	Price	Var. Cost	Var. Cost	Total Cost	Total Cost
1	0	$ 0.00	4828.19	-4828.19	7087.85	-7087.85
2	0	$ 0.00	2768.68	-2768.68	4719.41	-4719.41
3	0	$ 0.00	3871.70	-3871.70	5987.88	-5987.88
4	20000	$ 1.00	6683.70	13316.30	11785.93	8214.07
5	18000	$ 1.10	6683.70	13116.30	11785.93	8014.07
6	20000	$ 0.90	6683.70	11316.30	11785.93	6214.07
7	22000	$ 0.80	6683.70	10916.30	11785.93	5814.07
8	15000	$ 1.00	6683.70	8316.30	11785.93	3214.07
9	17000	$ 0.90	6683.70	8616.30	11785.93	3514.07
10	18000	$ 0.80	6683.70	7716.30	11785.93	2614.07
11	20000	$ 1.00	6683.70	13316.30	11785.93	8214.07
12	25000	$ 0.80	6683.70	13316.30	11785.93	8214.07
13	25000	$ 0.70	6683.70	10816.30	11785.93	5714.07
14	23000	$ 1.00	6683.70	16316.30	11785.93	11214.07
15	25000	$ 0.90	6683.70	15816.30	11785.93	10714.07

Source: Fonsah et al.,(2018)

TABLE 4- Results from simulation using 1000 iterations of randomly generated price, yield, and cost values (within specified bounds)

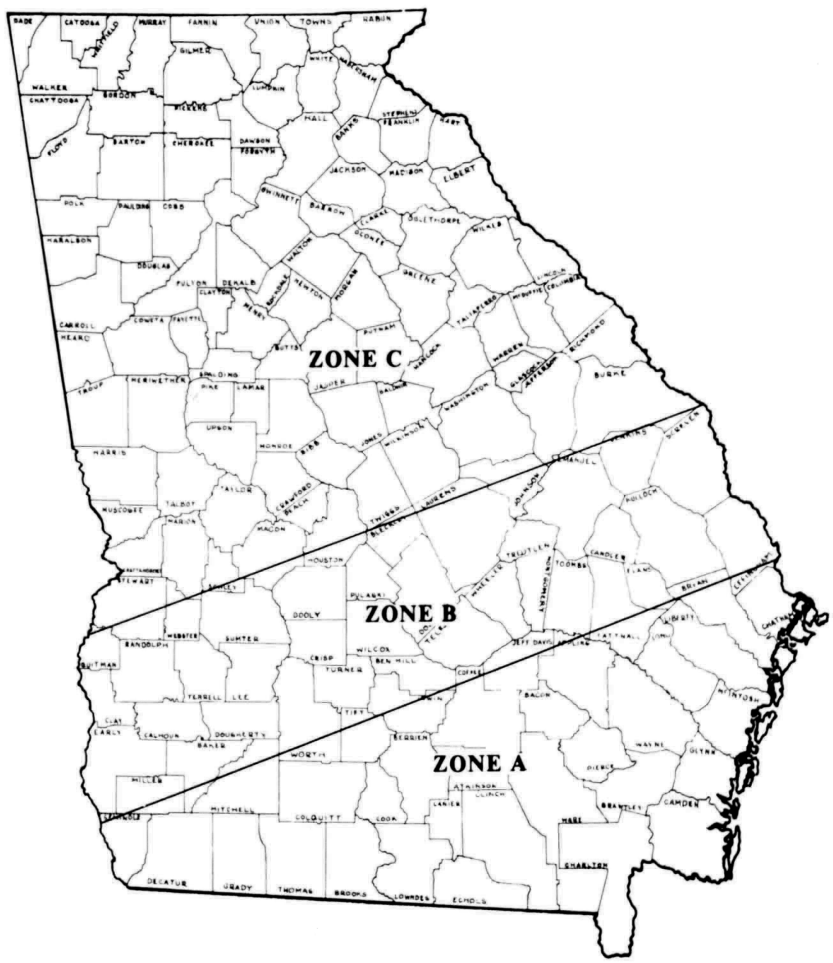
Year	Net Income	St. Dev of Profit		
1	-7087.85			
2	-4719.41			
3	-5987.88		Discount rate	**NPV**
4	7074.31	6502.25	12%-	$17,371.87
5	7177.49	5913.53	8%-	$27,716.23
6	7285.82	6271.78	4%-	$43,633.21
7	7527.88	5786.38		**ROI**
8	6903.97	6372.55		386.58%
9	6938.07	6460.97		**Annualized ROI**
10	7341.55	6408.42		11.12%
11	6909.70	7062.72		**IRR**
12	7344.26	6631.66		29%
13	7356.74	6228.781		
14	7183.42	6748.944		
15	7543.70	6538.206		
Average	7215.577	6410.516		

TABLE 5 – Revenue simulations using set upper and lower bounds prior to running simulations. Values generated using rectangular distribution (Randbetween function- Microsoft Excel)

Year	Hurricane Probability	Yield Hurricane	Yield Varied	Price Varied (lb)	Revenue ($)	TVC 10%	Net Income ($)
1	0	0	0	0	0	4828.19	-7087.85
2	0	0	0	0	0	2768.68	-4719.41
3	0	0	0	0	0	3871.70	-5987.88
4	0.71	19664	19664	0.77	15087	6115	3228.68
5	0.96	19566	19566	1.06	20827	7311	9457.39
6	0.24	14075	14075	1.22	17102	7307	5119.03
7	0.55	13290	13290	1.17	15545	6909	4563.09
8	0.23	19533	19533	0.96	18690	6748	7588.47
9	0.17	22594	22594	0.86	19359	7214	8172.28
10	0.28	19588	19588	1.10	21507	6884	8668.71
11	0.79	26012	26012	1.22	31627	6296	19646.37
12	0.50	18857	18857	1.11	20775	6613	8937.63
13	0.97	20308	20308	1.12	22655	6578	11029.75
14	0.28	21903	21903	1.05	23043	6526	11249.94
15	0.71	26521	26521	1.02	27298	7018	16020.65

Source: (Author, 2018)

FIGURE 1-University of Georgia Agricultural Extension Citrus Production Map



Krewer et al. (2015)

FIGURE 2 - Illustration of a uniform distribution, corresponding population density function, and theoretical mean

	Net Income Variables		
	Upper Bound	Lower Bound	
Price	0.75	1.25	
Yield	27500	12500	* Revenue values are pessimistic and optimistic values found in UGA budget
			*Costs varying 10% for VC and FC from that of extension projections
Probality Density Function			
F(x)= 1/ (Upper Bound- Lower Bound			
For the interval (Lower Bound <= x <= Upper Bound			
E(X)=mean= (Upper bound + Lower bound)/2			

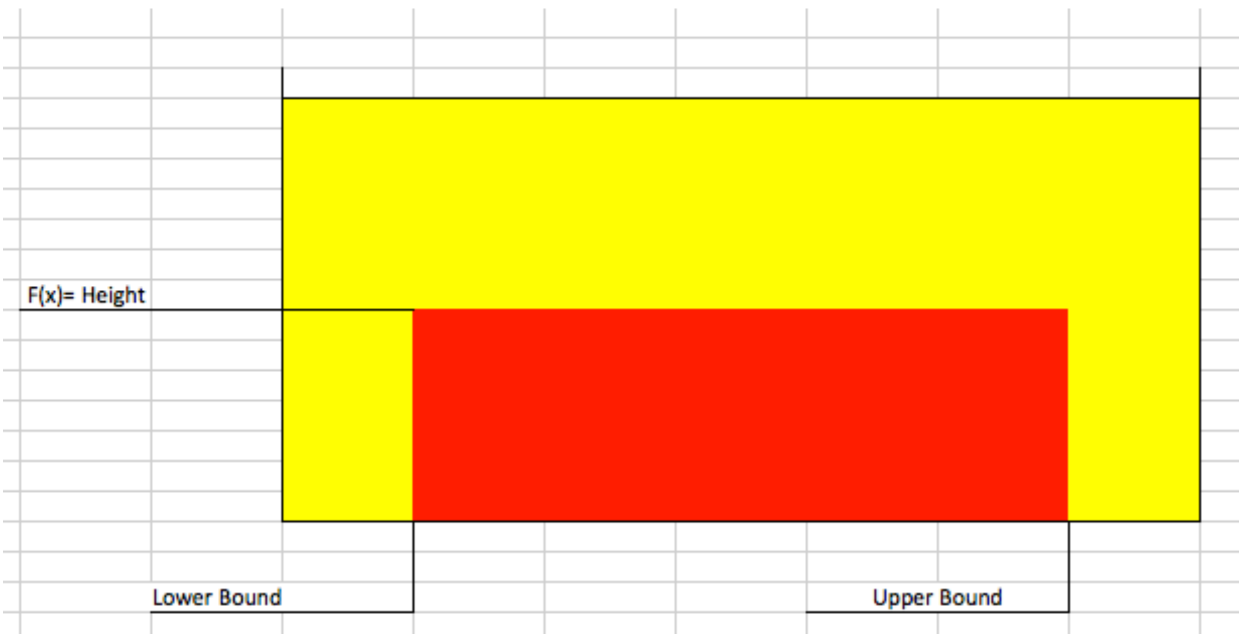


FIGURE 3- Map of annual probability of a named storm-making landfall by region

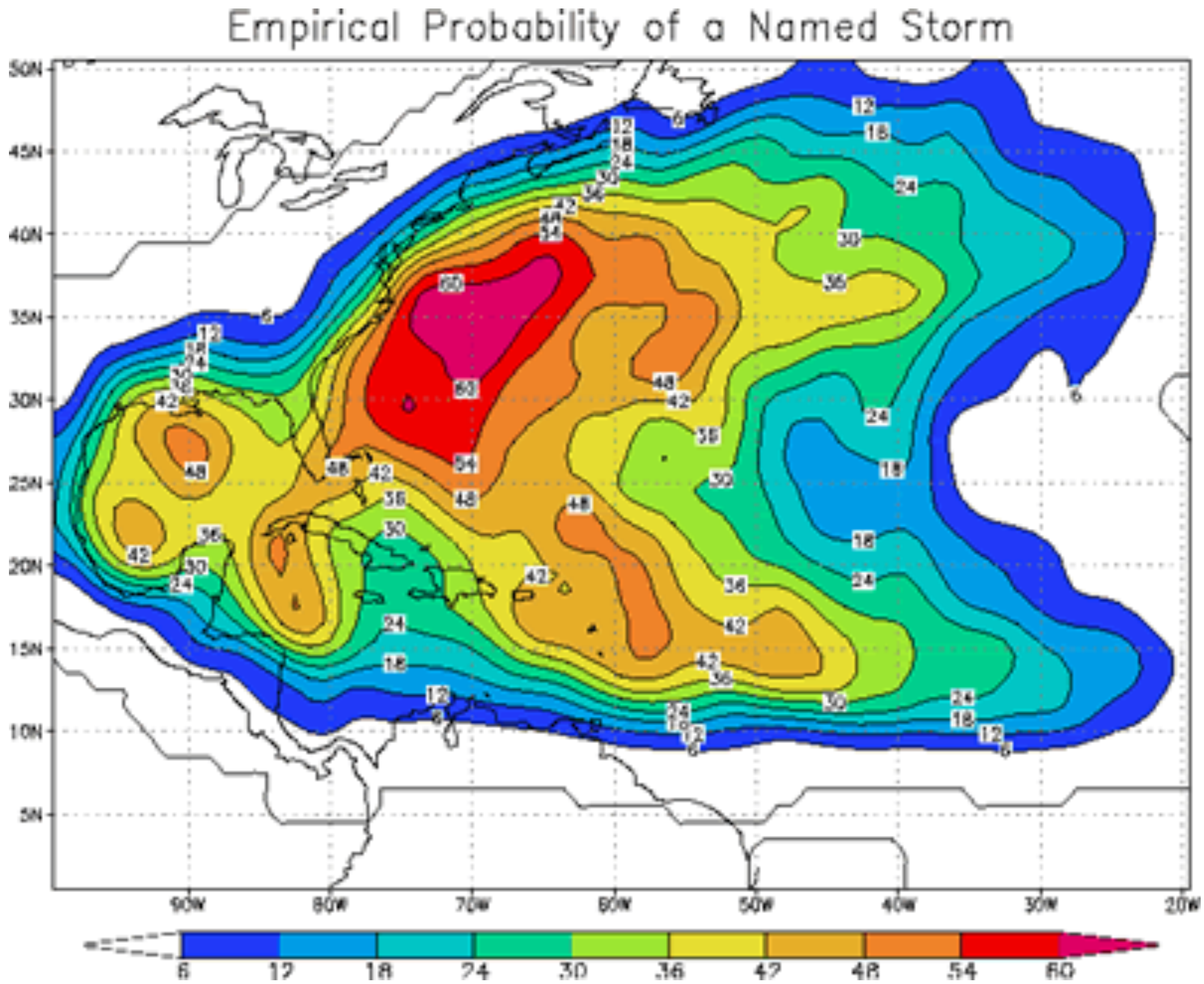


FIGURE 4- Theoretical illustration of the nested hurricane probability with a uniform distribution within the uniform distribution depicting yield variability

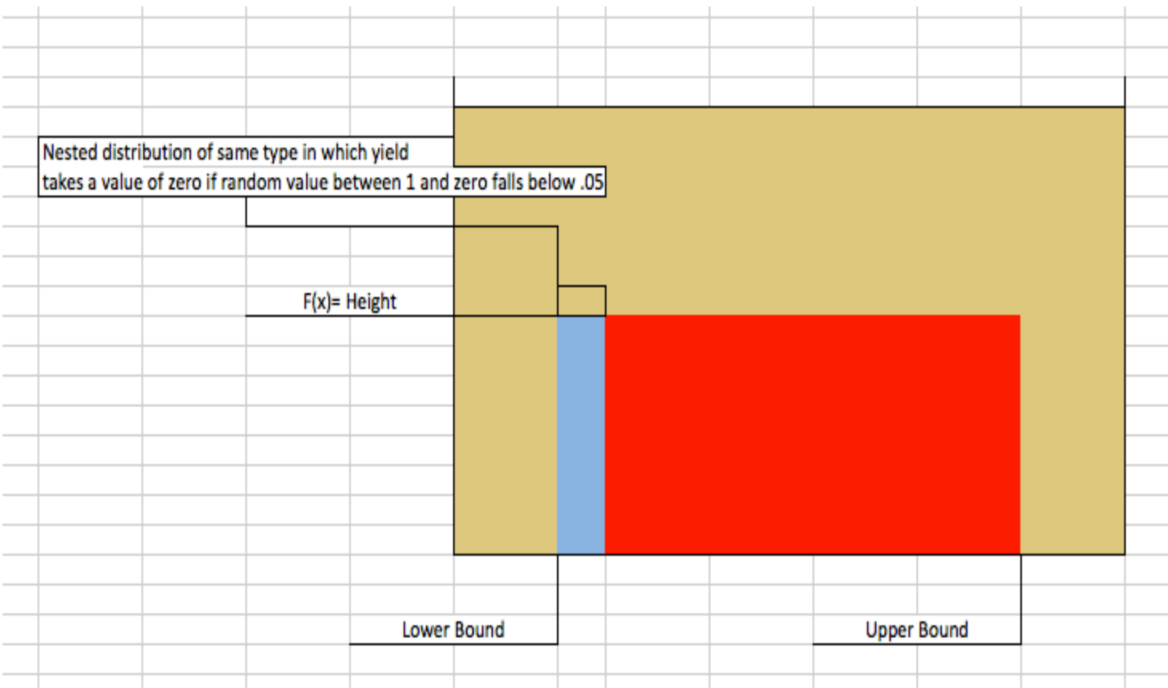


FIGURE 5- Theoretical illustration of Latin Hypersquare sampling

****LHS(X) Monte Carlo (0)****

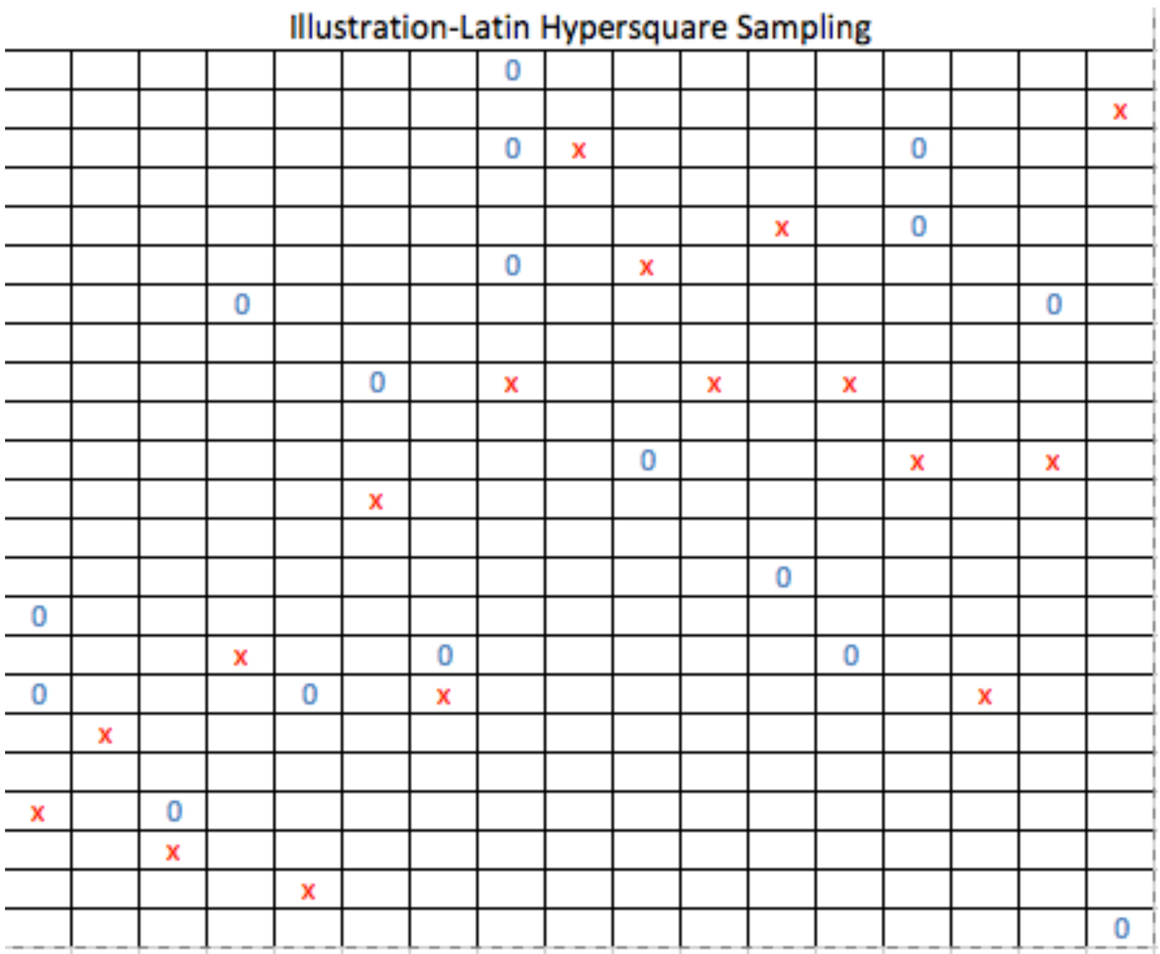
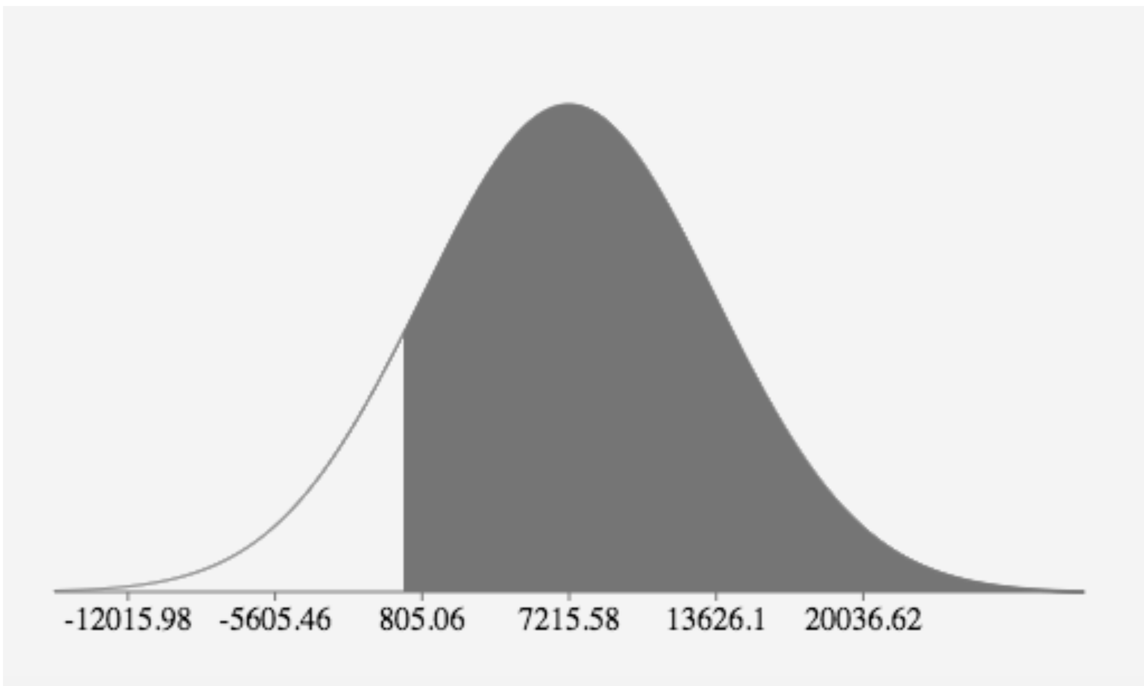


Figure 6- Probability of Profit Shown Graphically assuming average sample population mean and standard deviation for net income will approach the theoretical population mean



** Probability of Profit 86.98% after conducting LHS using prior distribution assumptions**

FIGURE 7- Equations for Net Present Value, , ROI, and Annualized ROI

A.) Net Present Value

$$NPV = \sum_{t=1}^{T} \frac{C_t}{(1+r)^t} - C_o$$

C_t = net cash inflow during the period t
C_o = total initial investment costs
r = discount rate, and
t = number of time periods

B.) IRR- IRR can be calculated numerous ways, IRR in this study was calculated using excel (**=IRR)**. This formula is provided by the author to provide an intuitive understanding of the IRR metric used in capital budgeting.

$$\text{NPV} = \sum_{t=0}^{N} \frac{C_t}{(1+r)^t} = 0$$

C_t = net cash inflow during the period t
C_o = total initial investment costs
r = discount rate, and
t = number of time periods

C.) Return on Investment = (Gain from Investment – Cost of investment)

Cost of Investment

D.) Annualized Return on Investment= (1+ Return on Investment)^ (1/t) – 1

Where: Return on Investment= total return calculated in (C.)

t= Length of investment in year