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# Research Report: Economic Analysis of Producing Satsuma Citrus in Georgia Using an Enterprise Budget

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## Abstract

Spanish explorers introduced citrus to Saint Augustine, Florida, in 1565; since then, Louisiana and Florida have become major producers of satsuma in the United States (Krewer, Powell, and Westerfield, 2015). South Georgians have recently become interested in producing satsuma citrus, which are more cold tolerant than other citrus fruits and have a consistent production cycle. Most importantly, satsuma unique in being "self-fruitful" and having an early maturity. While satsuma acreage in Georgia has increased exponentially, there are serious concerns over whether this emerging industry will generate positive returns on investment. The need for an economic analysis has become paramount for multiple stakeholders.

**Keywords:** citrus, fixed costs, fruits, prices, profitability, satsuma, sensitivity analysis, variable costs, yields

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## Introduction

In 1565, Spanish explorers introduced citrus to the Western Hemisphere in Saint Augustine, Florida. The fruit was later introduced to Arizona in 1707; California in 1769; and the Gulf of Mexico, North Charleston, South Carolina, and the Gulf states around the 1890s. However, the crops were destroyed by extreme freeze. The freeze-resistant satsuma re-emerged in the 1940s and production skyrocketed to 12,000 acres in Louisiana, Alabama, and North Florida before again being destroyed by extreme freeze. Since then, Louisiana and Florida have become established commercial growers of satsuma (Andersen and Ferguson, 1996; Krewer, Powell, and Westerfield, 2015; Mahr, 2018).

Recently, South Georgians have become interested in producing satsuma citrus production (Krewer, Powell, and Westerfield, 2015; Mahr, 2018), which are more cold tolerant than other citrus varieties, have consistent production cycles and yields, and (unlike other citrus cultivars) seldom need cold protection (Krewer, Powell, and Westerfield, 2015). Most important is the cultivar's "self-fruitful" nature and early maturation between September and November (Mahr, 2018). In a very short space of time, satsuma acreage in Georgia has increased exponentially.

However, there are serious concerns as to whether this emerging satsuma industry will generate positive returns on investment (ROI) (Ahmadiani et al., 2016; Awondo, Fonsah, and Gray, 2017; Fonsah, Price and Cantrell, 2019). An economic analysis to determine profitability margins, if any, has become paramount to growers, county agents, specialists, researchers, financial institutions and stakeholders in the Georgia satsuma citrus industry (Fonsah and Hudgins, 2007; Fonsah et al., 2008, 2018). Although climate conditions in Georgia are favorable for satsuma production, quality, overall cosmetic appearance, freshness, and seediness are all marketable attributes that determine consumer purchasing preferences and willingness to pay (WTP) a premium price (Campbell et al., 2004, 2006).

Satsuma citrus (*Citrus unshiu* Marcovitch)—also called satsuma mandarin and satsuma tangerine—is believed to have originated in China. The cultivar was reported in Japan over 700 years ago and has been cultivated in Spain, Central China, Korea, Turkey, Russia, South Africa, South America, Central California, and Northern Florida. Cultivars grown in Georgia are 'Owari', 'Silverhill', and 'Changsha'.[1] 'Owari' is the most preferred because of its availability in nurseries and fruit quality (Krewer, Powell, and Westerfield, 2015). 'Xie Shan'—an early-maturing variety—has been planted in Georgia as well. Although satsuma citrus is grown strictly for the fresh market, they are grown in other parts of the world for canning and fruit juice (Andersen and Ferguson, 1996; Krewer, Powell, and Westerfield, 2015; Mahr, 2018).

[1] However, 'Changsha' (*C. reticulata* Blanco) is not a true satsuma cultivar.

## Material and Methods

A team of University of Georgia (UGA) Extension specialists, researchers, and agents visited various satsuma growers in South Georgia to collect data on various inputs, including land preparation, lime, pre- and post-emergent herbicides, fungicides, trees, and tissue and soil analyses. Other important inputs included scouting, labor, fuel, repair, and maintenance. Inputs were classified as preharvest variable or operating costs (P-VC), harvesting and marketing costs (H&MC), variable costs (VC), and fixed costs (FC). A traditional enterprise budget analysis was adopted to compute profitability margins (Fonsah and Hudgins, 2007; Fonsah et al., 2008, 2018). Secondary data and information was obtained from scientific and Extension publications.

## Results

This study considered five yields: best, optimistic, median, pessimistic, and worst. Our calculations were based on the median; we assumed that producers would achieve the median yield and price 50% of the time (Table 1).

**Table 1.** Estimated Yield per Acre and Price per Pound for Satsuma Citrus in Georgia, 2019

| Description | Best | Optimistic | Median | Pessimistic | Worst |
|---|---|---|---|---|---|
| Yield (lb/acre) | 35,000 | 27,000 | 20,000 | 12,500 | 5,000 |
| Price ($/lb) | 1.50 | 1.25 | 1.00 | 0.75 | 0.50 |

Production input in the fourth year included fertilizers, pre- and post-emergence herbicides, insecticides, fungicides, tissue and soil analyses, scouting, labor, fuel, repairs and maintenance, irrigation, and frost protection (Table 2). We do not include land preparation among production inputs for the fourth year, since we had already included this cost in the estimated and establishment costs for the first year of production (Fonsah and Hudgins, 2007; Fonsah et al., 2007, 2008, 2018). We estimate total preharvest variable costs in the fourth year of satsuma production to be $4,484/acre (Table 2).

Harvesting and marketing costs (H&MC) were calculated based on 95% median yields. We assumed 5% field loss during harvesting, although losses could be as high as 25% if a grower fails to adopt good agricultural practices that would reduce culls caused by sunburn and puffy fruits. Total harvesting and marketing cost (TH&MC) was $2,090/acre while total variable cost (TVC) was $6,574/acre.

Fixed costs (FC) included tractor and equipment, irrigation, recaptured establishment costs, overhead, and management, which was 15% of total preharvest variable costs (TP-VC). Our study shows that total fixed costs (TFC) were $4,524/acre, for a total cost (TC) of $11,098/acre to produce satsuma citrus in Georgia (Table 3).

A sensitivity risk rated returns over total costs of producing satsuma citrus in Georgia (Table 4) showed that a grower could obtain a total loss of −$3658 under the worst-case scenario 7% of the time, while a profit of $21,461 could be obtained once in 10 years. Our expected return was $8,902/acre (Fonsah and Hudgins, 2007; Fonsah et al., 2007, 2008, 2018).

**Table 2.** Estimated Input Costs in the Fourth Year of Producing Satsuma Citrus in Georgia, 2019

| **Preharvest Variable Costs** | **Unit** | **Quantity** | **Price ($)** | **$/Acre** |
|---|---|---|---|---|
| Fertilizer (10–10–10) | Acre | 1,000.00 | 0.30 | 300.00 |
| Micro-nutrient sprays | Acre | 2.00 | 10.00 | 20.00 |
| Pre-emergence herbicides | Acre | 2.00 | 40.00 | 80.00 |
| Post emergent herbicides | Acre | 5.00 | 10.00 | 50.00 |
| Insecticides | Acre | 5.00 | 15.00 | 75.00 |
| Fungicides | Acre | 2.00 | 50.00 | 100.00 |
| Trees replacement (15 × 20) | Tree | 5.00 | 15.00 | 75.00 |
| Tissue analysis | Acre | 1.00 | 35.00 | 35.00 |
| Soil analysis | Acre | 1.00 | 6.00 | 6.00 |
| Scouting | Acre | 1.00 | 75.00 | 75.00 |
| Labor | Hours | 200.00 | 10.00 | 2,000.00 |
| Fuel | Acre | 1.00 | 29.98 | 29.98 |
| Repair & maintenance | Acre | 1.00 | 37.00 | 37.00 |
| Irrigation/frost protection | Acre | 1.00 | 1,413.32 | 1,413.32 |
| Interest on operation | | 2,882.98 | 0.07 | 187.39 |
| Total pre-variable costs | | | 4,483.70 | 4,483.70 |

**Table 3.** Estimated Harvesting and Marketing (H&MC), and Fixed Costs (FC) of Producing Satsuma Citrus in Georgia, 2019

| **Harvest and Marketing Costs** | **Unit** | **Quantity** | **Price** | **$/Acre** |
|---|---|---|---|---|
| Harvesting & hauling | Acre | 19,000.00 | 0.10 | 1,900.00 |
| Packing & cooling | Acre | 19,000.00 | 0.01 | 190.00 |
| Total harvesting and marketing costs | $ | | | 2,090.00 |
| Total variable costs | | | | 6,573.70 |
| | | | | |
| **Fixed Costs** | **Unit** | **Quantity** | **Price** | **$/Acre** |
| Tractor & equipment | Acre | 1.00 | 527.75 | 527.75 |
| Irrigation | Acre | 1.00 | 2,077.93 | 2,077.93 |
| Recaptured establishment costs | Acre | 1.00 | 1,246.22 | 1,246.22 |
| Overhead and management | Acre | 4,484.00 | 0.15 | 672.55 |
| Total fixed costs ($) | $ | | | 4,524.46 |
| | | | | |
| Total budgeted cost per acre ($) | | | | 11,098.16 |

**Table 4.** Sensitivity Risk-Rated Returns over Total Costs of Producing Satsuma Citrus in Georgia, 2019

| | Best | Optimistic | | Expected | Pessimistic | | Worst |
|---|---|---|---|---|---|---|---|
| Returns ($) | 21,461 | 17,275 | 13,088 | 8,902 | 4,715 | 529 | −3,658 |
| Chances | 7% | 16% | 31% | 50% | 0.69% | 0.84% | 1% |
| Chances | 93% | 84% | 69% | 50% | 31% | 16% | 7% |
| Chances for profit = | 86% | | | Base budgeted net revenue ($) = | | | 8,902 |

A sensitivity analysis and economic risk-rated returns of price and yield over total cost of producing satsuma citrus in Georgia reveal that a grower could expect a return of −$1,867/acre 50% of the time (an expected yield of 20,000 lb/acre, with a drop in price from $1 to $0.50). In the worst-case scenario, the grower could obtain −$10,358/acre 7% of the time. Even with a price of $1.00 and expected yield of 20,000 lb, a grower could still obtain −$4,466/acre in the worst-case scenario (Table 5).

**Table 5.** Sensitivity Analysis and Economic Risk-Rated Returns for Price and Yield over Total Costs of Producing Satsuma Citrus in Georgia, 2019

| Price/lb | Best ($) | Optimistic ($) | ($) | Expected (20,000) | Pessimistic ($) | ($) | Worst ($) | Chance of Profit (%) |
|---|---|---|---|---|---|---|---|---|
| 0.50 | 6,785 | 3,901 | 1,017 | −1,867 | −4,697 | −7,528 | −10,358 | 37 |
| 0.75 | 13,533 | 10,053 | 6,573 | 3,093 | −387 | −3,867 | −7,346 | 67 |
| 1.00 | 20,653 | 16,466 | 12,280 | 8,092 | 3,907 | −280 | −4,466 | 83 |
| 1.25 | 28,004 | 23,034 | 18,063 | 13,093 | 8,123 | 3153 | −1,817 | 91 |
| 1.50 | 35,482 | 29,692 | 23,893 | 18,093 | 12,294 | 6,494 | 694 | 94 |

Table 6 shows that the preharvest costs in year 1 were $4,828/acre, while TC were $7,088/acre. In year two, preharvest costs reduced to $2,769/acre, while TC were $4,719/acre. In year four—which is considered full production—P-VC were $4,484/acre, TVC were $6,684/acre, and TFC were $5,112/acre, for TC of $11.786/acre.

**Table 6.** Summary of Different Costs Component for Producing Satsuma Citrus in Georgia, 2019

| Years | Preharvest Variable Costs (P-VC) | Total Variable Costs (TVC) | Total Fixed Costs (TFC) | Total Costs (TC) |
|---|---|---|---|---|
| 1 | $4,828 | $4,828 | $2,260 | $7,088 |
| 2 | $2,769 | $2,769 | $1,951 | $4,719 |
| 3 | $3,872 | $3,872 | $2,116 | $5,988 |
| 4 | $4,484 | $6,684 | $5,112 | $11,786 |

A breakeven (BE) analysis finds that a minimum yield of 12,000 lb is required to stay in business. BE costs were \$0.60/lb (\$0.33/lb in variable costs and \$0.27/lb in fixed costs) (Table 7).

**Table 7.** Breakeven (BE) Analysis for Satsuma Citrus Production in Georgia, 2019

| | |
|---|---|
| BE harvesting & marketing costs per lb | \$0.22 |
| BE fixed costs per lb | \$0.27 |
| BE total costs per lb | \$0.60 |
| BE variable costs per lb | \$0.33 |
| BE yield per acre (lb) | 12,000 |

## Conclusion and Remarks

Results from this study show that satsuma citrus production can be a lucrative business in Georgia if sustainable good agricultural practices (SGAP) are maintained. Our sensitivity analysis based on total costs predicts an expected fresh market net return of \$8,092/acre, assuming an expected yield of 20,000 lb/acre and expected price of \$1.00/lb. The price sensitivity analysis also shows that profitability varies based on price and yield fluctuations. Finally, our study shows a breakeven yield of 12,000 lb/acre. Our studies depict that with a price drop from \$1 to \$0.50, a grower could expect a return of −\$1,867/acre 50% of the time. In a worst-case scenario, the grower could also obtain −\$10,358/acre 7% of the time. Even with a price of \$1.00 and expected yield of 20,000 lb, a grower could still obtain −\$4,466/acre in the worst-case scenario.

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