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Cost Estimates of Producing Purple Passion Fruit in South Florida[1]

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Figure 1. Passion fruit (*Passiflora edulis* Sims). Credit: Trent Blare, UF/IFAS Tropical Research and Education Center

Introduction

Passion fruit (*Passiflora edulis* Sims) is a member of the *Passifloraceae* family and originates from the tropical American region of Brazil (Castillo et al. 2020). Passion fruit market opportunities are high due to growing consumer interest and the product's versatility and health benefits. It is a very nutritious fruit having dietary fiber, vitamins A and C, and other important nutrients (Baily et al. 2021; Percival and Findley 2014). The fruit is consumed directly as a raw fruit or a juice. Its pulp and juice are used in ice cream and similar goods. Passion fruit is also used in medical products. Passion fruit extracts, juice, and isolated compounds showed a wide range of health effects and biological activities such as antioxidant, anti-hypertensive, anti-tumor, antidiabetic, hypolipidemic activities, among others (He et al. 2020). Passion fruit is widely used to add a unique aroma to soaps and shampoos. Its husks can even be used in silage instead of whole crop maize silage (Hiep et al. 2020). However, Florida-grown passion fruit will most likely be sold exclusively in the fresh market as it cannot compete with less expensive frozen fruit pulp imported from Ecuador, Colombia, and Brazil (Stanfe 2021).

Passion fruit's commercial cultivation is limited within the tropical and subtropical regions across the world, as the passion fruit vine cannot tolerate severe frost (Bailey et al. 2021). Brazil is the largest producer of passion fruit in the world; however, a high percentage of Brazilian passion fruit production goes to domestic consumption, and therefore there is a low level of exports. Ecuador, Indonesia, and Colombia are the largest producers of fresh passion fruit, with Ecuador being the larger exporter of processed passion fruit. Kenya exports fresh products to Europe. Indonesia has the same seasonal production peaks as Australia, and, while it has a large industry, it only exports a small number of passion fruit in the form of juice (Roberts et. al 2018). Again, Ecuador is the largest exporter of processed passion fruit, marketing 150,000 metric tons internationally in 2019, much of which is sold as frozen pulp. Passion fruit is also grown in Colombia, Peru, Indonesia, the Caribbean, and some African countries. In the United States, it is primarily grown in Florida, Hawaii, Puerto Rico, and California (Bailey et al. 2021). The little imported fresh passion fruit that enters US markets (Baltimore, Boston, Chicago, Dallas, San Francisco, New York, Philadelphia, and Los Angeles) originates from New Zealand and Costa Rica in 2021 (USDA AMS 2020).

In Florida, there are about 150 acres of passion fruit. It was introduced into the United States (in Hawaii) from Australia in 1880. Subsequently, it reached Florida through various sources around 1887 (Morton 1987). Passion fruit is a perennial vine with a relatively short lifespan. There are mainly two distinct types of passion fruit, purple and yellow, which are distinguished based on the color of the skin of the fruit. Florida grows mainly hybrids. Generally, yellow passion fruit varieties make up a larger share of South American markets for fresh and juice exports compared to purple passion fruit, which is favored in some markets of the United States, Europe, and Australia (Bailey et al. 2021).

Because passion fruit is not tolerant to cold, production in Florida is restricted to southern Florida. At least 150 acres across Florida are devoted to passion fruit production. Of these, 100 acres are located in Miami-Dade County. The rest are found throughout the

southeast and central Florida below the freeze line (Crane 2022). The main harvest season extends from June to December. A mature plant (2–3 years old) yields between 7.5 to 15 pounds of fruit per year, depending on the cultivar, prevailing climatic conditions, and cultural practices followed (Bailey et al. 2021).

An estimated 4,060 pounds of fruit per acre per year is expected based on a plant density of about 290 passion fruit plants/acre and a yield of 14 pounds/plant (average mature plant). Factoring in a pack out rate of 70%, marketable yield is estimated at about 2,842 pounds/acre. With an average estimate price at Homestead (i.e., the farm gate price) for purple passion fruit of $5/lb., the industry is worth about $2.13 million at farm gate level.

There are many important characteristics to consider when selecting a suitable passion fruit variety. These include the fruit's skin color, flavor, yield, and the pollinate type. Generally, cross-pollinated (self-sterile) yellow passion fruit varieties yield a larger-sized fruit, as well as more fruits on a vine in comparison to self-pollinated (self-compatible) purple passion fruit (Morton 1987). In general, hand pollination is used for commercial production, which is expensive and time consuming. Most producers are using a combination of honeybees (not efficient passion fruit pollinators) and hand pollination. There are many passion fruit cultivars available in Florida. Most of them are hybrids of yellow and purple passion fruit. Although there is limited information on the specific characteristics of each of the cultivars, the purple varieties are considered to be sweeter than the yellow varieties (Bailey et al. 2021).

This publication examines the estimated costs and returns of an established purple passion fruit orchard in south Florida. The information presented in this publication was collected through field interviews with growers and industry specialists. It is based on a variety of production practices on small-scale farms (1–2 acres). The information in this publication is intended only as a guide to estimate the financial requirements of running an established passion fruit operation. The information in this publication will be useful to current and potential passion fruit growers, wholesalers, and processors, especially those exploring the economic viability of passion fruit as an alternative minor tropical fruit crop. Specific information on cultural practices for passion fruit cultivation can be found in EDIS publications #HS1406 (The Passion fruit in Florida) and HS1406s (El maracuya en Florida).

Main Assumptions

Production costs and revenues used in this annual budget are based on a one-acre operation. Because growers employ a variety of cultural practices with different costs associated with them, we averaged the costs and returns for this analysis to give an approximation of these costs and returns. The actual costs will vary depending on the practices that a grower adopts. Given the fact that tropical fruit growers in south Florida generally own their land, a rental estimate of $500/acre/year is factored in for the opportunity cost of the land. Table 1 shows the total annual costs and returns incurred while operating a one-acre purple passion fruit operation.

Orchard Layout—Based on the information provided by local growers, under Florida conditions passion fruit is to be spaced at 15 feet between rows × 10 feet between plants in a row, resulting in a planting density of 290 plants per acre (Knight and Sauls 2005).

Yields—Based on the information provided by local growers, average yield for a matured passion fruit plant (2–3 years) is about 14 pounds, at a planting density of 290 plants, and considering a fruit packing rate of 70%, the average marketable yield is 2,842 pounds/acre/year.

Passion fruit prices—The average estimated price of passion fruit (purple skin cultivar) is $5.00/lb in Homestead. This value is calculated from the prices growers received at the farm gate level in 2022.

Irrigation—Mature passion fruit plants (2–3 years) require adequate watering for optimum growth, but overwatering must be avoided (Bada et al. 2018). Average irrigation expenses composed of fuel or electricity costs are estimated at $185/acre/year.

Fertilization—Fertilizer treatments for mature trees include applications of N-P-K fertilizer (nitrogen, phosphate, potash), minor nutrient sprays and soil drench applications of chelated iron (Knight and Sauls 2005). Fertilization costs (materials only) are estimated at $ 3,359/acre/year.

Pest Management—Weed management practices include herbicide applications, hand weeding, and mulching. Passion fruit face similar disease pressure in Florida as elsewhere in the world. Major fungal diseases that can affect passion fruit include anthracnose, scab, fusarium wilt, canker, and root rot (Bailey et al. 2021). Passion fruit woodiness and other viral diseases are the most limiting to production since there is no cure once the vine is infected. Insect pests of passion fruit are usually easily controlled. Stinkbugs (*Chrondrocera laticornis*) puncture the fruit, thrips (*Thysanoptera* spp.) infestations may adversely impact the growth of young seedlings and cause stunting (Morton 1987), and caterpillars (*Lepidoptera* spp.) can easily defoliate entire plants if not controlled. Average agrochemical costs (materials only) are estimated as follows: herbicides at $550/acre/year, and fungicides at $1,007/acre/year, and insecticides at $778/acre/year, respectively.

Hand pollination—Pollination can be done by insects or manually. To have a higher fruit yield, hand pollination is recommended. It takes about 60 hours to hand pollinate an acre of passion fruit. With an average cost of $15/hr., pollination costs are $900/acre/year.

Labor Costs—These include application costs for agricultural inputs (e.g., fertilizers and agrochemicals) and costs incurred for performing various cultural operations (e.g., irrigation, pruning, and mowing etc.) Labor costs (hired labor only) are estimated at $1,514/acre/year.

Interest on capital—This is the cost of borrowing money or the opportunity cost for using equity. A rate of 5% was considered in the given analysis. Interest on operating capital is estimated at $415/acre/year.

Fixed Costs—This constitutes the costs that are incurred regardless of the level of production. It includes cash overhead costs (e.g., insurance and taxes), non-cash overhead costs (e.g., land rent), and other overhead costs (e.g., machinery use, electricity, telephone, computer, and other miscellaneous office expenses). Total fixed costs are estimated at $1,650/acre/year ($0.61/pound), representing 14% of the total costs.

Harvesting and Marketing Costs—The main harvest season stretches from June to December based on the particular variety. Passion fruit are generally picked when they show signs of ripeness, either a smooth or a wrinkled peel depending on the variety. Fruit ripen on the vine and can be eaten immediately after harvest (Putnam 2017). Passion fruit vines may also drop fruit.. Fruit drops when it is ripe; fruit drop does not damage the fruit (Shiniohara et al. 2013). Harvesting and marketing costs are estimated at $1,080/acre/year ($0.39/pound), representing 14% of the total cost.

Variable Costs—Variable costs amount to $8,708/acre/year (about $3.11 per pound) representing 76% of the total costs. The major components from the variable costs are fertilizers (39%) hired labor (17%), fungicides (12%), and hand pollination (10%), respectively. Variable costs (costs for hired labor, irrigation, fertilization, pollination, and pest control) account for 73% of the total cost. Fixed or overhead costs constitute 14% of the total cost. Harvest and marketing costs are 9% of the total cost. Finally, interest on capital represents 4% of the total cost (Figure 2).

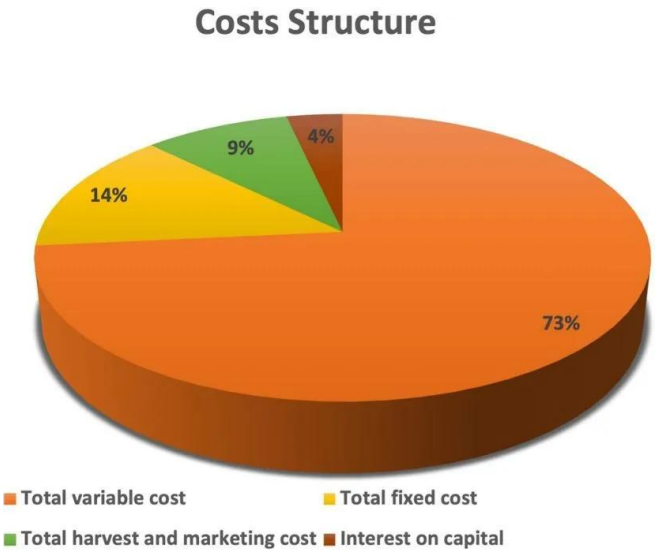

Figure 2. Annual cost distribution for purple passion fruit production in south Florida.
Credit: UF/IFAS

Returns and Profitability Analysis

The total cost to produce and market one acre of purple passion fruit is estimated at $11,438/acre/year ($4.09/pound). Based on an average marketable yield of 2,842 lbs./acre and the average estimated price in Homestead of $5.00/pound, total receipt is $5,502/acre/year.

Subtracting total variable cost (variable cost plus harvesting and marketing cost) from total revenue, we obtain a gross return of $ 4,422/acre/year, or $1.56/pound, which is similar to many of the other tropical fruits, such as mangos, lychee, and pink guava, grown in central and south Florida. The gross margin provides a useful indicator of short-term profitability. A positive gross return implies that all variable costs are covered by the income generated and those additional funds can be utilized to cover some or all of the remaining fixed costs.

A negative gross profit implies that a business is not viable in the short term, and changes are needed to continue operating. Many growers are only concerned with the gross margin. However, while the gross margin provides an indication of return to the grower, it does not include fixed costs and, hence, is not a true indicator of the long-term feasibility of the business.

Net return is obtained by subtracting the fixed costs from the gross margin and is used to measure the long-term profitability of the farming operation. Table 1 show a net return of $2,772/acre/year, or $0.98/pound, still a very attractive economic return compared to other tropical fruit crops in south Florida.

Sensitivity Analysis

Table 2 presents a sensitivity analysis ofthe gross margin, which considers the short-term economic viability of apassion fruit operation based on variable yield and price. Under the best-case scenario, where both price and yield are assumed to increase by 10%, gross margin would increase from $4,212/acre to $7,152/acre. Under the worst-case scenario, where both price and yield decrease by 10%, gross margin would decrease from $4,212/acre to $1,552/acre. Price changes (keeping the production constant) havethe same level of impact on gross marginas do quantity changes (keeping the price constant). A 5% increase in the base price (base yield, 2,800lb.) has the sameimpact on gross margin ($700 more) to a 5% increase in yield (base price, $5.00/pounds) ($700 more). It should be notedthat gross margin does not factor in the fixed cost component of the total cost.

Table 2. Sensitivity analysis of the annual per-acre gross margin for purple passion fruit in south Florida.

Yield (pounds/acre)		Wholesale Price (dollars/pound)				
		4.50 (–10%)	4.75 (–5%)	5.00 (base)	5.25 (+5%)	5.50 (+10%)
2,558	(–10%)	1,723	2,363	3,002	3,642	4,281
2,700	(–5%)	2,362	3,037	3,712	4,387	5,062
2,842	(base)	3,001	3,712	4,422	5,133	5,843
2,984	(+5%)	3,640	4,386	5,132	5,878	6,624
3,126	(+10%)	4,279	5,061	5,842	6,624	7,405

Table 3 presents a similar analysis based on annual net returns per acre. Under the best-case scenario, where both price and yield are assumed to increase by 10%, net return would increase from $2,562/acre to $5,502/acre. Under the worst-case scenario, where both price and yield decreased by 10%, net return would be a loss of $98/acre. Other combinations of prices and yields and their impact on net return are also depicted in Table 3. The information presented in Table 3 can be interpreted in a similar manner to that presented in Table 2. However, it should be considered that at a broader industry level any significant increase in production would decrease the price received by the growers.

Table 3. Sensitivity analysis of per-acre annual net returns for purple passion fruit in south Florida.

Yield (pounds/acre)		Wholesale Price (dollars/pound)				
		4.50 (–10%)	4.75 (–5%)	5.00 (base)	5.25 (+5%)	5.50 (+10%)
2,558	(–10%)	73	713	1,352	1,992	2,631
2,700	(–5%)	712	1,387	2,062	2,737	3,412
2,842	(base)	1,351	2,062	2,772	3,483	4,193
2,984	(+5%)	1,990	2,736	3,482	4,228	4,974
3,126	(+10%)	2,629	3,411	4,192	4,974	5,755

Conclusions

The estimated net return of an established purple passion fruit plantation in south Florida is approximately $2,562/acre, or $0.92/pound. This return makes this minor tropical fruit an attractive investment option. However, growers need to be cautious when using this information to make production decisions, as we only estimated the cost to manage an established operation. We have not considered the costs involved to establish a new passion fruit operation, which includes land acquisition and development, planting infrastructure (e.g., irrigation systems and trellises), and amortized capital. An increase in passion fruit production may result in market saturation and reduced prices. A comprehensive analysis must be done before establishing a new passion fruit operation.

The primary barriers to passion fruit production in south Florida are the high initial cost to build the trellis system for passion fruit vines and the cost of hand pollination. Pollination for passion fruit largely depends on hand pollination or bee species like carpenter bees which are rare in south Florida (Bailey et al. 2021). To minimize the loss in the first production cycle, it is recommended to plant a small area. If you are new in the industry, starting with a low area will help you to learn how to manage your cultivar and adapt the processes to your specific needs.

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Tables

Table 1. Annual production costs of purple passion fruit on a south Florida one-acre orchard.

Item	Quantity (pounds)	Value per acre ($/acre/year)	Value per pound ($/pound)
Revenue			
Marketable yield (lbs./acre)	2,842		
Farm gate price			5
Total revenue		14,210	
Variable COST			
Irrigation		185	
Fertilizer		3,359	
Herbicide		550	
Insecticide		778	
Fungicide		1,007	
Hand pollination		900	
Labor cost		1,514	
Interest on capital (5 %)		415	
Total variable cost		8,708	3.06
FIXED COST			
Cash overhead			
Insurance		100	
Taxes		100	
Non-cash overhead			
Land rent		500	
Other overhead		950	
Total fixed cost		1650	0.58
TOTAL PRE-HARVEST COST		10,358	3.64
HARVEST AND MARKETING COSTS			
Picking and sales cost		1,080	0.38
Total harvest and market cost		1,080	0.38
TOTAL COST		11,438	4.02
GROSS MARGIN		4,422	1.56
ESTIMATED NET RETURNS		2,772	0.98

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