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2012 Cost Estimates of Establishing and Producing Papaya (*Carica papaya*) in South Florida[1]

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Introduction

Production of papaya occurs in more than 60 countries worldwide, with the vast majority being grown in developing countries. The fruit is considered to be one of the most economically important and nutritious fruits, being rich in antioxidants such as carotenes, vitamins, and flavonoids. In 2010, global production was estimated to reach 11.22 million (M) metric tons (t) (FAOSTAT 2012). Asia is the leading papaya-producing region, accounting for 52.2 percent of global production, followed by South America (23.8%), Africa (13.16%), Central America and the Caribbean (10.92%), North America (0.13%), and Oceania (0.12%) (FAOSTAT 2012). The main papaya-producing countries are India, Brazil, Indonesia, Nigeria, and Mexico. The top two producing countries accounted for more than 55 percent of global production during the period 2008–2010. Mexico is the largest exporter of papaya and the United States is the largest single-country importer (Evans, Ballen, and Crane 2012).

The United States is not considered a major producer of papaya, with production output totaling less than 15,000 t in 2011. Production occurs mainly in the Hawaiian Islands and to a lesser extent in Florida, California, and Texas.

Of the three continental US areas, Florida offers the most potential for commercial production of the crop. This is because, unlike California and Texas, South Florida's tropical/subtropical climate is suitable for year-round papaya cultivation. Both mature and green (immature) papayas are produced in Florida, with most of the production occurring in the southern part of the state, specifically in Miami–Dade County. Production in Florida is currently estimated at about 300 acres, down from close to 500 acres in the early 1970s (Balerdi 2012). This noticeable decline in production can be attributed to several factors, such as increased competition from Mexico and Central America, rising production costs (unit costs), declining yields, and the introduction and spread of papaya ringspot virus (PRSV) disease. To remain profitable, many of the remaining US growers have sought to target the green (immature) papaya market (green papayas sell at a 50% discount to ripe ones but have lower production costs and yields) and/or intercropping.

However, with the recent spike in papaya prices due to phytosanitary restrictions on papayas from Mexico, many growers in South Florida are considering getting back into papaya production to target the ripe papaya market. Still, there are a lot of concerns as to whether the crop

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can be profitable in light of declining yields. Based on this discussion, the objective of this article is to provide needed information on the costs and returns associated with establishing and operating a five-acre papaya orchard in South Florida, and to assess the prices and yields that must be obtained to make a papaya orchard profitable.

Information presented in this article was obtained from interviews carried out with several growers, state and county faculty, and industry experts. As such, the information herein should only be considered as a guide, and the reader should examine closely the assumptions used to make adjustments in the costs and returns as necessary. Furthermore, it should be noted that the focus of this article is less on cultural practices and more on production economics. Readers interested in more information on the cultural aspect of papaya production might wish to see EDIS document PI053 (CIR 1402), Florida Crop/Pest Management Profile: Papaya (Mossler and Crane 2009).

Main Assumptions

Land—Since most of the growers in South Florida already own the land, a rental cost of $500 per acre was used in this analysis to reflect the opportunity cost of land. The budget and production cost items are based on a five-acre orchard.

Orchard Layout—Most commercially-grown papayas are propagated from seed. Two or three seeds are planted in peat pots or trays, which are directly transferred to the ground when the seedlings maintain a height of 6–8 inches. Each planting is rogued to one plant (hermaphroditic [self-pollinating]) once the sex has been determined. Rows are maintained between 12 and 15 feet apart, and the distance between plants in any given row is approximately 7–8 feet (Mossler and Crane 2009). For this analysis, we used a spacing of 12 feet by 8 feet (12′ × 8′) to grow approximately 454 plants per acre. The cost per tree is estimated at $0.25, resulting in a total cost of $340 (454 × 3 × $0.25).

Varieties—Although there are numerous varieties of papaya, the main varieties produced in South Florida are Red Lady, Tainung-1, and Exp-15.

Fertilization—Fertilizer treatments include applications of 8-3-9 or 6-6-6 fertilizer, foliar-applied micronutrients (e.g., manganese, zinc, and boron), and soil drench applications of chelated iron. Because there were such wide variations among the rates applied by the growers we interviewed, we reported the average cost for our analysis.

Weed Management—Predominant weed species in groves are grasses, sedges, and broadleaf weeds. Controlling weeds includes spraying weed control chemicals several times a year, combined with hand weeding and mowing. Treatments consist of about six applications of a generic glyphosate-type material for weed control, mainly within rows. Spaces between rows are also mowed about six times per year at a total cost of $120 per acre. As the young plants are susceptible to herbicides, a considerable amount of hand weeding is done within the rows during the first three to four months. Some producers establish papaya on beds (15–20 centimeters high × 1 meter wide; 6–8 inches high × 3 feet wide) covered with plastic, with drip irrigation lines under the plastic. This reduces the necessity of weed control within plant rows.

Pest Management—The principal pests on papaya crops in Florida are papaya fruit fly, two-spotted spider mite, and papaya whitefly. Scales (*Philephedra*, soft brown), aphids, *Diaprepes* weevil, and papaya mealybug are other pests that occasionally limit papaya production. Papayas are also susceptible to several diseases such as anthracnose, *Corynespora* leafspot, powdery mildew, and *Phytophthora* blight, as well as several viruses. Pesticide usage varies greatly among plantings and ranges from an as-needed basis to frequent calendar-based applications (every 2–4 weeks for example). There are numerous insecticides and fungicides registered for papaya production (Crane and Mossler 2009). Average insecticide treatment costs (material only) were estimated at $356 and $469 in years one and two, respectively. Average fungicide treatment costs are $404 (year one) and $584 (year two), respectively.

Irrigation—Papaya thrives under warm conditions with abundant rainfall or irrigation. Adequate water supply is essential to prevent growth retardation, flower abortion, and premature fruit drop; hence the crop has a fairly high water requirement. Most of the growers we spoke with have installed some type of sprinkler or drip irrigation system, and/or use an existing system previously installed (e.g., high volume under-tree sprinklers). Irrigation costs, which include the cost of pumping water and labor for maintenance, are estimated at $250 per acre, per year.

Labor Wage Rates—The hourly wage rate was assumed to be $15.00 for skilled workers and $11.00 for field workers. These rates include fringe benefits such as worker's compensation, social security, Medicare, and health insurance. Piece-rate wage rates were used for harvesting.

Harvesting and Marketing Costs—Papaya fruits are picked by hand from the ground and occasionally with the

aid of a ladder when plants become too tall for picking from the ground. The cost for harvesting, packing, and transporting papaya is estimated at $0.10 per pound.

Yields—The harvesting of papaya can occur 7–9 months after the tree is transplanted. On the basis of information provided by the growers, average marketable yields, based on a 90 percent pack-out rate, were about 6,500 pounds and 22,500 pounds per acre in years one and two, respectively.

Papaya Prices—The average F.O.B. (Homestead) price per pound for papaya was estimated at $0.40 per pound for ripe fruit. This estimate was calculated from the prices growers reported receiving from the packing houses during 2012. Deducting the cost for picking, packing, and hauling ($0.10 per pound) results in a farm gate price (the price growers receive after deducting harvesting and marketing costs) of $0.30 per pound.

Interest on Pre-Harvest Costs—This is the cost of borrowing money or the opportunity cost for using equity. A nominal rate of three percent was used in the calculations.

Overhead Charges—These represent other fixed costs (besides taxes, rent, and establishment costs) that the growers incurred in operating the business, including the annual cost for use of any machinery owned, electricity, telephone, computer, and other office expenses. These costs were estimated at $250 per annum.

Summary of Results

Although papaya is capable of bearing fruits for more than 20 years, the life cycle of the commercial papaya tree is generally only two years (24 months). The shortened life span is due to the impact of the PRSV disease as well as the limit in tree height for efficient harvesting; papaya can grow as high as 30 feet (10 meters), which would be extremely difficult and costly to maintain and harvest (Mossler and Crane 2009). As such, the standard approach of calculating costs and returns for perennials, which involves calculating separate budgets for establishment and production phase (Evans 2009), will not be used. Rather, the approach adopted will be somewhat similar to that used in computing costs and returns for row crops. Consequently, land preparation, planting materials, and planting/labor cost will be considered as part of the variable costs. Table 1 presents a summary of the costs and returns on a per-acre basis for producing papaya in South Florida under the current conditions. Column 1 in Table 1 shows the expenses and returns associated with the first year, which can be considered as the establishment year, while column 2 shows the costs and returns associated with the second year of production, which is regarded as the full-production year. Column 3 summarizes the total costs and returns computed over the entire two-year period.

The information provided in Table 1, column 3, shows that the total cost to produce and market one acre of papaya is estimated at $11,322, or about $0.39 per pound. **Pre-harvest costs**, comprising the pre-harvest variable and fixed costs (i.e., total costs less harvesting and marketing costs), are estimated at $8,422 per acre (about $0.29 per pound), representing 74.4 percent of the total cost of production.

Pre-harvest variable costs amounted to $6,820, representing 60 percent of total production costs. The major cost components among the pre-harvest variable costs were fertilizers (14%), hired labor (13%), fungicides (9%), and insecticides (7%).

Fixed costs comprise land rent, property tax, and other overhead charges (e.g., electricity, insurance, telephone, etc.) and were estimated at $1,608, representing 14 percent of the cost of production. Although growers own the land, the going rate of $500 per acre for land rental was used to reflect the opportunity cost of the land. The amount attributed to land rental accounts for about 9 percent of the cost of production.

Harvesting and marketing costs were estimated at $2,900 ($0.10 per pound), representing 26 percent of the total cost of production. The main contributor to the harvesting and marketing costs is the cost associated with picking and packing for delivery to the packing houses. Papayas have to be handled with care as they bruise easily. Consequently, the fruit is picked by hand. Ladders and hydraulic lifts may occasionally be used to enable pickers to reach the fruit (Mossler and Crane 2009).

Based on interviews with growers, average yield is estimated at about 29,000 pounds per acre (assuming a pack-out rate of 90%) over the two-year period. Using the estimated F.O.B. market price (delivered to the packing house) of $0.40 per pound, the **total receipt or gross revenue** is $11,600 per acre. Subtracting total variable costs (pre-harvest variable costs plus harvesting and marketing costs) from total receipts gives rise to the **gross margin** of $1,880 ($11,600 – $9,720) per acre. The gross margin provides a useful indicator of short-run profitability. A positive gross margin implies that all variable costs have been covered by the income generated and there is additional funds remaining to cover some or all of the fixed costs. A negative gross profit implies that a business is not viable in the short run,

so changes are needed to make it viable. Most 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, such as rents, insurance, electricity, and the cost of using machinery owned by the grower, and hence is not a true reflection of the long-term profitability of the business. **Net profit** is obtained by subtracting the fixed costs from the gross margin and is used to measure the long-term profitability of the farming operation. The data in Table 1, column 3, show a net profit of $278 per acre.

Prices and yields are likely to fluctuate over time. A sensitivity analysis was performed to see how different combinations of prices and yields affect the gross margin and net profit. Table 2 shows the impacts on the gross margin and net profit as yields and prices increase and decrease by 10 percent. As shown in Table 2, a 10 percent increase in prices while keeping yield the same (29,000 pound per acre) would result in the gross margin increasing from $1,880 to $3,040 and the net profit increasing from $278 to $1,438 per acre. If, on the other hand, prices were to remain the same ($.40 per pound) and output increased by 10 percent (from 29,000 pounds to 31,900 pounds per acre), the gross margin would rise only to $2,750 while the net profit would increase to $1,148 per acre. While higher returns can be expected with an increase in either price or yield, the data show that the magnitude of the impact is generally much greater for a given increase in price. This implies that while all efforts should be made to increase yield, successfully increasing the prices received through better pre- and/or post-harvest practices will contribute noticeably to the grower's profitability.

Conclusions

Demand for papaya in the United States has been growing due to many factors, including more awareness of the fruit's health benefits and Asian and Hispanic population growth. Tropical fruit growers in South Florida are in search of profitable alternatives to increase revenue and to ensure that their operations remain profitable. While there appears to be an opportunity for these growers to take advantage of this growing market, given their closer proximity to the market and in light of recent restrictions being placed on papaya imported from Mexico (the number one US papaya supplier), our analysis suggests that they are less likely to do so because of the relatively unattractive returns associated with producing the crop under current conditions. As our analysis shows (Table 1), the average grower would invest $11,322 per acre for a net return of only $278 per acre over the first two-year period. Even with a singular focus on gross margin only (not advisable), the return would be $1,880 per acre, or $940 per acre, per year. Since not much can be done about increasing growers' prices, growers would need to increase their output for this to become an attractive alternative. A 10 percent increase in output at current prices, for example, would cause net profit to increase by more than 300 percent. At present, growers are severely constrained by the widespread presence of PRSV, which has severely reduced output and has limited the production cycle to only two years, thus increasing the unit cost of production. Preliminary results from the UF/IFAS Tropical Research and Education Center (Migliaccio et al. 2010) indicate that with modest increases in production costs and growing PRSV-resistant GM varieties (now in the final development stages), growers could increase their output three to fourfold and extend the harvesting season by another year to compete and be profitable.

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Table 1. Cost per acre of establishing and producing papaya on a South Florida five-acre orchard.

	Unit	Year 1 (establishment)	Year 2 (full-production)	Years 1 & 2 Total
Estimated Yield	lb/acre	6,500	22,500	29,000
Estimated Price	$/lb	0.40	0.40	0.40
Total Receipts	dollars	2,600	9,000	11,600
COSTS				
Pre-Harvest Costs	$/acre			
Soil preparation (disc and bed)		100		100
Trees		338		338
Planting and other costs		225		225
Irrigation		250	250	500
Fertilizers		663	866	1,529
Herbicides		100	200	300
Insecticides		356	469	825
Fungicides		404	584	988
Mowing		120	120	240
Labor (weeding, fertilizing, etc.)		684	812	1,496
Repairs		40	41	81
Interest on pre-harvest costs		98	100	198
Harvesting and Marketing Costs				
Picking, packing, and hauling		650	2,250	2,900
Total Variable/Establishment Costs	$/acre	4,028	5,692	9,720
Gross Margin		(1,428)	3,308	1,880
Annual Fixed Costs	$/acre			
Land (rental price)		500	500	1,000
Property tax		50	52	102
Other overhead charges		250	250	500
Total Fixed Costs	$/acre	800	802	1602
TOTAL COSTS	$/acre	4,828	6,494	11,322
NET RETURNS	$/acre	(2,228)	2,506	278

Table 2. Changes in gross margin and net profit for various combinations of prices and yields.

Yield (lb/acre)	Price ($/lb) F.O.B. Homestead					
	0.36	0.40	0.44	0.36	0.40	0.44
	Gross Margin ($/acre)			Net Profit ($/acre)		
26,100	(–34)	1,010	2,054	(1,636)	(592)	452
29,100	702	1,880	3,040	(882)	278	1,438
31,900	1,474	2,750	4,026	(128)	1,148	2,424