Economic Impact of the Florida Apiculture Industry

Economics Report 01-1

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Executive Summary

This study attempted to assess the broad economic impacts of the Florida beekeeping industry in order to support discussion of policy issues currently being considered. Results are reported for mail surveys of Florida beekeepers and Florida growers of selected fruit and vegetable crops, and an economic impact analysis using the *IMPLAN* input-output model.

Florida beekeepers managed over 258,000 honey bee colonies in 1999, nearly 150,000 of which represented migratory beekeeping operations. Revenues from apicultural operations, including sales of honey, beeswax, and live honey bees, totaled $17.6 million and income received for pollination services was estimated at $1.9 million. Cash operating expenses associated with honey bee operations totaled $12.9 million. Net income (pre-tax) for all beekeepers amounted to $1.5 million, average net income per beekeeper was $1,280, and pre-tax net income per colony averaged $5.88. The profit margin was 7.8 percent, and return on non-current assets was 3.03 percent. Total non-current assets amounted to $50 million and total employment was 1,632 persons. The broad economic impacts associated with beekeeping were $30.5 million in output, $15.2 million in value-added and 806 jobs.

Multiple threats are challenging the survival of the apicultural industry of Florida. Over 75,000 honey bee colonies have been lost during the past 5 years. The majority of beekeepers identified natural pests including mites, beetles and the wax moth as a cause of honey bee die-offs. Additionally, Florida beekeepers identified foreign imports of honey, low honey prices, pests, resistance to pesticides for control of mites and the high costs of beekeeping as the most important threats confronting the industry.

More than 31 percent of Florida fruit and vegetable growers reported contracting for pollination services within the past 5 years and 16 percent of respondents reported that they used pollination services but also grow some of the same crops without pollinating honey bees. In total 34,845 acres of fruit and vegetable crops were pollinated by contracted honey bees at a cost of $372,698. Honey bee pollination reportedly increased yields of certain crops by 20 to 62 percent. The marginal benefit of higher yields from pollination services to Florida fruit and vegetable growers was estimated at $26.4 million. The broad economic impacts associated with pollination services were $38.2 million in output, $20.9 million in value-added and 490 jobs.

Keywords: beekeeping, honey, pollination services, economic impact, Florida, IMPLAN.

Introduction

Florida has a large apiculture industry, with an estimated 240,000 honey bee colonies operated by 700 full-time or sideline commercial beekeepers, and an additional 500 hobbyist beekeepers (Florida Department of Agriculture and Consumer Services, 1999). All apiculture operations in Florida are required by law to be registered with the Florida Department of Agriculture for purposes of inspection for pests and diseases once or twice annually. Beekeeping operations are located throughout Florida, but are concentrated in the counties of Brevard, Dade, DeSoto, Hendry, Lake, Polk, and Wakulla, where there are large areas of commercial fruit and vegetable crops or preferred natural vegetation types (National Agricultural Statistics Service, 1999). Because of its mild climate, Florida is the winter home to many migratory beekeeping operations. Beekeepers bring their colonies to Florida during the September to March period to over-winter and work the citrus and winter vegetable crops. Colonies are then moved northward to work other crops and natural plants throughout the spring and summer months.

Florida is a top honey producer with production of 23.26 million pounds valued at $12.3 million in 1999. Florida is ranked fourth in the United States behind California, North Dakota and South Dakota, and represented nearly 10 percent of total U.S. value for honey in 1999 (Florida Agricultural Statistics Service). Ninety percent of the honey produced in Florida is marketed through several packing houses in the state, or through two large cooperatives located outside the state. A small share of honey production is packaged on-farm and sold at local supermarkets, farmers markets or roadside stands. Other minor honey bee products that are marketed by some producers include beeswax, propolis, royal jelly, pollen, and packaged bees and queens which are usually shipped to beekeepers in other states. Costs for maintaining a honey bee colony average about $100 annually, including purchased inputs of corn syrup feed, drugs/pesticides, replacement queen bees, and equipment (Sanford, 1992a).

In addition to honey production, the beekeeping industry in Florida also provides a critical service by pollinating many important fruit and vegetable crops, including specialty citrus, blueberries, strawberries, cucumbers, squash, watermelons, and avocados. Beekeepers may rent their honey bee colonies to growers of these crops for a period of several weeks or months for $20 to $40 per colony, depending upon the time of year, the number of honey bee colonies required to pollinate the crop, and the amount of honey production expected from the crop and other nearby nectar sources. Honey bees are generalist pollinators, able to adapt to a wide variety of plant species. Honey bee pollination is responsible for increased yields of a variety of fruit and vegetable crops, and the regeneration of forage crops that feed livestock (Ingram et al., 1996). In total, the honey bee can pollinate more than 90 North American crop varieties and over 300 worldwide (Sanford, 1998). Honey bees can reproduce quickly (Sanford, 1998).

They are available throughout the entire duration of the growing season and can be concentrated on intensively managed agricultural plots (Sanford, 2000). Lastly, beekeeping enterprises can exist across diverse geographical regions due to the ease and cost-effectiveness involved in transporting honey bee colonies (Sanford, 1992a).

Currently, several existing and potential threats are confronting the Florida apicultural industry, including foreign competition, product adulteration, urbanization, the *Varroa* mite, and Africanized honey bees. World honey prices grew dramatically during the 1970s, which fostered increased foreign competition (Sanford, 1992a). The labor-intensive nature of honey production gives developing nations a comparative advantage in the production of honey, ultimately translating to lower prices for imported honey (Sanford, 1992a). Substitute sweeteners such as high fructose corn syrup have gained strong public recognition, in part due to aggressive marketing efforts as well as their significantly lower costs (Sanford, 1992a). Honey adulteration by these products is also eroding markets for Florida honey products (Sanford, 1992a; 1995). The temptation to adulterate honey leaves "pure" honey producers at an economic disadvantage as their products compete with cheaper adulterated products, resulting in depressed market prices for "pure" honey. The continued adulteration of honey may also damage public perceptions of honey as a pure, natural and healthful sweetener (Sanford, 1995).

Agricultural land scarcity in Florida has pushed agricultural operators to step up pesticide applications in order to maintain or increase agricultural productivity. Between 1992 and 1998, pesticide applications on honey bee-pollinated crops[1] increased by 15% from 818.8 million pounds to 968.2 million pounds[2] (Florida Agricultural Statistics Service). Pesticide exposure is detrimental to honey bee survival as it impairs the reproductive success of honey bee colonies (Ingram et al., 1996). Additionally, urbanization has decreased the viability of locating bee colonies to Florida during the winter season as available sources of nectar are being lost (Ingram et al., 1996; Sanford, 1992b).

The Florida beekeeping industry has also been adversely impacted by the *Varroa* mite (*Varroa jacobsoni*), a honey bee parasite that leads to the eventual decline and death of infested colonies. The *Varroa* mite remains a potent threat to the beekeeping industry, responsible for the destruction of many feral and managed honey bee colonies, and possibly leading to a shortage of pollinators for crops (Sanford, 1998). It is standard practice to treat infested colonies with pesticides (*Fluvalinate* or *Coumaphos)* to control *Varroa* mites, which significantly

[1] These crops include tomatoes, watermelons, snap beans, bell peppers, cucumbers, carrots, strawberries, eggplant, oranges, grapefruit, tangelos, tangerines and temples.
[2] In order to ensure fair comparisons between 1992 and 1998, pesticide applications that were reported in one year but not the other for specific chemicals were omitted altogether for both annual periods.

increases management costs. Use of pesticides in honey bee colonies has also raised concerns about possible contamination of honey and other honey bee products. Recently the Environmental Protection Agency approved the use of CheckMite+® Bee Hive Pest Control Strips following considerable deliberation over possible immunotoxicity and neurotoxicity to beekeepers resulting from *Coumaphos* absorption, an active ingredient in the pest control strips. Pending any reports suggesting improper pesticide application, the EPA is prepared to revoke the pesticide's approval, potentially leaving Florida beekeepers without control against colony outbreaks of *Varroa* mites (Sanford, 2000).

The northern migration and spread of Africanized bees through the United States also poses a threat to the apicultural industry of Florida. Honey bees *(Apis mellifera)* are not native to North and South America, but rather, were introduced to the New World by European colonists. These European honey bees thrived in the temperate regions of North America but struggled in the tropical climates of South America. The more aggressive African honey bee was imported to Brazil from Tanzania in the belief that interbreeding African and European honey bees would yield a docile bee that adapts well to warmer climates, and indeed they did but inherited the aggressive nature of the African honey bees. Africanized bees escaped from a Brazilian apiary in 1957 and since then have migrated northward, recently reaching Arizona and Texas (Los Angeles County West Vector Control District). Florida beekeepers fear that they will eventually reach Florida. Africanized bees deplete nectar resources reserved for honey production by managed honey bees, however some beekeeping authorities believe that interbreeding of Africanized bees with native honey bees may result in genetic re-invigoration, improved resistance to pests and diseases, and increased honey yields. The aggressive nature of Africanized honey bees is life-threatening to neighboring workers and inhabitants, having forced the temporary abandonment of apiary establishments in Latin America (Sanford, 1992b). It is not known if or when Africanized bees will become established in Florida.

The beekeeping industry of Florida has suffered a very high number of business shutdowns and beekeeper retirements over the years. In the past, beekeeping attracted entrepreneurial activity because of its low entry costs relative to other agricultural operations (Sanford, 1987). The low returns associated with beekeeping coupled with natural threats such as mites have severely limited the state's ability to recruit new beekeepers. Further compounding this problem, the United States government eliminated honey loan programs beginning fiscal year 1994. These loan programs had been in existence since 1950 (Johnson and Ortego, 1996).

Unstable levels of honey production and honey prices are evident in Florida. Honey production within the past ten years varied dramatically, ranging from 15 million pounds in 1989 to the

record level of 25 million pounds in 1996 (Figure 1, Florida Agricultural Statistics Service). Because the inventory of honey bee colonies remained rather stable, these fluctuations in production represent changes in the average honey yield per colony, ranging from 60 to over 110 pounds, due to natural factors of weather and plant nectar abundance. The costs associated with honey production continue to rise, reducing net returns to beekeepers (Sanford, 1992a). Real prices received for honey by producers also varied significantly, averaging $0.72 per pound in 1997, which was down from $0.84 per pound the previous year, but up from a price level of $0.36 in 1987 and an average $0.44 during the early 1990s (Florida Agricultural Statistics Service). Overall, the real value of honey produced in Florida during 1987-99 ranged from $5.7 million in 1989 to $20.9 million in 1996 (Figure 2).

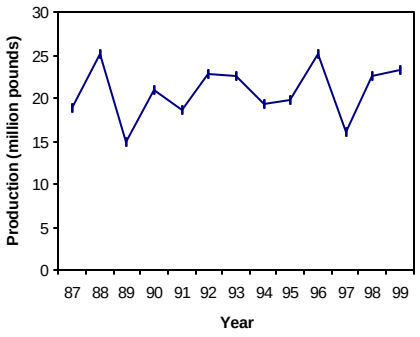
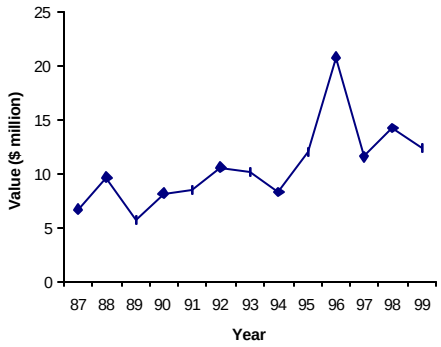


Figure 1. Florida honey production, 1987-99.



1999 Dollars.

Figure 2. Value of Florida honey produced, 1987-99.

Beekeeping has now become a marginal economic enterprise and a decline of the beekeeping industry could have widespread repercussions for the agricultural sector and consumers. Human population pressures are increasing the demand for crops and the need for honey bee pollination services. An estimated 15.1 million individuals resided in the state of Florida in 1999. Between 1992 and 1997, Florida's population grew by 9 percent, from 13.5 million to 14.7 million individuals (U.S. Census Bureau). Over this same period, the volume of Florida crops dependent on insect pollination[3] grew by an average 65 percent[4] per crop (Florida Agricultural Statistics Service). Cash receipts for crops dependent on insect pollination [5] approximated $3.1 million in 1998 (Florida Agricultural Statistics Service). If the increasing crop volume trends persist, the need for insect pollination services on pollination-dependent crops will grow. There is a concern that there may be a shortage of honey bee colonies necessary to sustain Florida crops through pollination services (Sanford, 1992b).

Preliminary attempts have been made to estimate economic values for honey bee pollination services, although these studies were restricted to national value estimations using secondary data sources (Morse and Calderone, 2000; Southwick and Southwick, 1992; Levin, 1983). According to Morse and Calderone (2000), the marginal value of honey bee pollination services in the United States was estimated at $14.6 billion, a sharply higher value than the $1.6-$8.3 billion estimate range of Southwick and Southwick (1992). Levin (1983) estimated the national value of pollination services at $18 billion. The wide range of values estimated reflects uncertainties about yield reductions for different crops under incomplete pollination, the degree of dependence on honey bee pollination, the magnitude of decline in honey bee populations and the degree to which other natural pollinators, such as wild bees, wasps, and bats, may act as alternative pollinators in the absence of honey bees. There is a need for better information about the broad economic impacts of the beekeeping industry to better inform the policy issues currently being considered.

[3] Florida crops dependent on insect pollination include carrots, citrus, cotton, cucumbers, eggplant, green peppers, hay, peanuts, radishes, snap beans, soybeans, squash, strawberries, tomatoes and watermelons.

[4] An overall volume change of honey bee pollinated crops was not estimable because volume units among differing crops were not uniformly reported. Nine of these crops (60% of total) experienced average volume declines of 22% per crop. The remaining six crops experienced average volume gains of 196%. This value is large, in part, because green peppers realized a 1011% increase in volume between 1992 and 1997. When green peppers are omitted, the percentage rate of increase becomes 33% for the remaining crops.

[5] Also includes cash receipts for avocados, blueberries and lettuce that were missing in the original volume statistic due to lack of information.

This project sought to provide an initial assessment of the economic value of the beekeeping industry to the economy of Florida. Specifically, this project addresses the following objectives:

1. To measure the costs and returns for apiculture operations in Florida, at different scales of production, including income from honey and pollination services, and expenses for employee labor and pest control.
2. To describe the market channels for honey produced by Florida beekeepers to final consumers and other business sectors which use honey as an ingredient, to determine the share of product that is marketed locally vs. exported from the Florida state region, and to describe the linkages to other business sectors providing inputs for beekeeping.
3. To determine the value of honey bee pollination for selected major fruit and vegetable crops in Florida, including citrus, blueberries, strawberries, cucumbers, squash, watermelons, and avocados.
4. To compile overall statewide economic values for honey bee products and pollination services, including sales, value added and employment.

Methodology

Surveys

Primary data collection for this project consisted of two separate questionnaires mailed to Florida beekeepers and to Florida farmers of selected fruit and vegetable crops, in order to assess the nature of beekeeping operations and honey bee pollination services, respectively. Both questionnaires were developed in consultation with industry experts. The beekeeper survey questionnaire elicited the following information:

- Beekeeper Experience
- Number of Honey Bee Colonies Managed
- Employment
- Other States Operated In and Months in Florida
- Honey Bee Products Produced and Prices Received
- Market Channels for Products
- Honey Bee Pollination Services Provided for 8 Specific Crops, Including Number Colonies and Prices Received
- Operating Revenues and Expenses during the 1999 Fiscal Year
- Value of Beekeeping Assets
- Honey Bee Colony Losses in the Past 5 Years
- Ranking of Threats to the Beekeeping Industry.

The questionnaire was mailed to 1,188 beekeepers in Florida, using the list of certified beekeepers from the Florida Department of Agricultural and Consumer Services-Division of Plant Industry. The mailing included a return-addressed, postage-paid envelope and cover letter. In order to capture responses from non-resident beekeepers over-wintering in Florida, three separate mailings were done during February, March, and April, 2000. In order to maximize response rates, the beekeeper questionnaire was printed in a convenient and attractive booklet. The cover letter, addressed by the Chief of Apiary Inspection, Florida Department of Agriculture and Consumer Services, emphasized the importance of respondent compliance to the apicultural industry of Florida.

The second questionnaire, administered to Florida fruit and vegetable growers, gathered information related to:

- The Nature of Pollination Service Contracts
- Number of Honey Bee Colonies Contracted
- Prices Paid for Pollination Services
- Acres of Pollinated Crops by Honey Bees

- Benefits Associated with the Use of Pollination Services
- Issues for Contracting Honey Bee Pollination Services.

This questionnaire was mailed to Florida growers of cantaloupes, cucumbers, watermelons, blueberries, strawberries, avocados, and specialty citrus. These crops were specifically targeted because they were determined to benefit substantially from honey bee pollination activities, on the basis of discussions with apiary experts. Addresses for approximately 2,300 growers of these crops were obtained from the Florida Agricultural Statistics Service (Orlando, Florida). This questionnaire was mailed during May, 2000 and included a return-addressed, postage paid envelope and cover letter.

Both questionnaires were approved by the University of Florida Institutional Review Board to assure protection of the rights of human subjects. Although respondents to both questionnaires were not offered cash compensation in exchange for their participation in this study, they were given the option to receive a copy of the final report. The identity of respondent beekeeper firms was tracked from a code number on each questionnaire. Copies of the questionnaires are provided in the appendix of this report.

The information gathered from completed surveys was entered into spreadsheets for analysis. In order to provide estimates for all beekeepers in the state of Florida based on results generated by the beekeeper survey, an expansion factor of 2.179 was utilized to extrapolate population estimates from sample data based on observed survey response rates. For respondents who indicated the number of honey bee colonies owned but failed to report an average price for honey bee products, an industry average price-per-unit was imputed in order to derive estimates of the total value of honey. Likewise, an industry average honey yield per honey bee colony was imputed for commercial and sideline beekeeper respondents who did not report the level of production of honey bee products. When allocating the proportion of sales within and outside the state of Florida for minor honey bee products classified in the category 'other,' the same proportion that existed for honey products was assumed to exist for "other" honey bee products. The value of honey bee pollination services was estimated based on average prices per honey bee colony multiplied by the number of colonies provided for each crop, and the value of services within Florida was estimated for migratory beekeepers based on the share of time the colonies spent in the state.

Economic Impact Analysis

An input-output (I-O) framework was utilized to estimate the direct, indirect and induced economic impacts of the apicultural industry in Florida. Input-output analysis is a technique that captures the regional economic interdependence between different industries, households and

government institutions (Miller and Blair, 1985; Mulkey and Hodges). The premise of input-output analysis is that the structure of the economy is technologically fixed, such that for a given change in the final demand, output or employment for a particular industry or region there will be predictable changes in other linked sectors of the economy. These changes are measured by estimating the regional economic multipliers associated with the particular industry using a matrix inversion procedure applied to the matrix of inter-industry transactions.

The input-output analysis was conducted with the IMPLAN PRO™ software package[8]. IMPLAN was originally developed by the USDA Forest Service in 1979 and was subsequently privatized in 1993 by the Minnesota IMPLAN Group (MIG, Inc., Stillwater, MN). The IMPLAN system consists of database and software components. The database portion offers economic and sociodemographic descriptions for all United States counties across 528 economic sectors. The categorization of sectors relies on the US Department of Commerce's four digit Standard Industrial Classification (SIC) system. The software component of the IMPLAN modeling system performs calculations for a pre-defined study area to assess economic impacts to the region. Multipliers are available from IMPLAN for economic output, total value added, employment, employee compensation, personal income, other proprietary income, and indirect business taxes, and are provided for direct, indirect and induced impact effects. U.S. national data for 1997 was used to develop the complete inter-industry structural tables and coefficients.

The IMPLAN database system does not offer information specific to the apicultural industry, which is classified under the 'miscellaneous livestock' category, and also includes the general crop farms, non-dairy and non-poultry livestock, poultry and eggs not elsewhere classified, aquaculture, and animal specialties sectors. The IMPLAN model of the Florida economy was customized to specifically reflect characteristics of the Florida apicultural industry utilizing operating expenditure information obtained from the beekeeper survey. The economic impacts of the apicultural industry sector were derived by multiplying the value of domestic sales within Florida against the direct effects multiplier and multiplying out-of-state export values against the direct, indirect and induced effects multipliers, and subsequently summing as follows:

$$T = D * M_d + E * M_t$$

where T is total impact, D is domestic sales, E is export sales, M_d is the direct effects multiplier and M_t is the total effects multiplier.

The multipliers associated with beekeeping operations, and fruit and vegetable production are listed in Table 1. The total effects multiplier is the sum of the direct effects, indirect effects and

[8] IMPLAN Professional, Version 2.0, Social Accounting and Impact Analysis Software, User's Guide, Analysis Guide and Data Guide, 1999, MIG, Inc., Stillwater, MN.

induced effects multipliers. For beekeeping, the total output multiplier was $2.292 per dollar output, the total value-added multiplier was $1.227 per dollar output, and the total employment multiplier was $51.6 per million dollars output. The multipliers for output and value added are stated in terms of dollars per dollar of sales to final demand, while the employment multiplier represents jobs per million dollars of sales to final demand. The direct effects multiplier accounted for 44 percent of the total output multiplier while the indirect and induced effects multipliers captured 19 percent and 37 percent of the total output multiplier effects, respectively. The relatively large induced multiplier for output, value-added and employment impacts reflects the high labor intensity of beekeeping.

Since pollination impacts in this study were examined for eight major fruit and vegetable crops in the state of Florida, the multipliers specific to fruit and vegetable growers (which represent multipliers assigned to the IMPLAN sectors 'fruits' and 'vegetables and melons') were weighted by the proportion of pollinated crops classified as fruits or vegetables in the IMPLAN database (Table 1). The total output multiplier for fruits and vegetables was 1.70, the total value-added multiplier was 0.94 and the total employment multiplier was 22.90. The direct effects captured 59 percent of the total output multiplier, 55 percent of the value-added multiplier and 47 percent of the employment multiplier. The indirect effects accounted for 23 percent of the total output multiplier, 23 percent of the value-added multiplier and 34 percent of the employment multiplier. The induced effects represented 18 percent of the total output multiplier, 21 percent of the value-added multiplier and 19 percent of the employment multiplier.

Table 1. Multipliers associated with the output, value-added and employment impacts of honey bee products and Florida fruit and vegetable growers.

Multipliers	Output ($/$ Output)	Value-Added ($/$ Output)	Employment ($/$Million Output)
Florida Beekeepers			
Total Effects	**2.292**	**1.227**	**51.6**
Direct Effects	1.000	0.428	33.6
Indirect Effects	0.424	0.244	5.8
Induced Effects	0.855	0.555	12.2
Florida Fruit and Vegetable Growers			
Total Effects	**1.70**	**0.94**	**22.9**
Direct Effects	1.00	0.52	10.78
Indirect Effects	0.39	0.22	7.73
Induced Effects	0.31	0.2	4.4

Source: IMPLAN, 1997.

Beekeeper Survey Results

Response Rates

A total of 649 beekeepers responded to the survey, yielding an overall response rate of 55 percent of all Florida beekeepers (Table 2). Responses were classified by size of beekeeper operation. Commercial beekeepers were defined as managing 200 or more colonies during 1999, sideline beekeepers managed between 20 to 199 colonies and hobbyist beekeepers managed 1 to 19 honey bee colonies during 1999. Seventeen percent of respondents represented commercial beekeepers, 23 percent represented hobbyist beekeepers and 12 percent of respondents in the 'unknown' category did not report the number of honey bee colonies managed. Responses observed in each class size category are roughly proportional to the share of the Florida beekeeper population and are assumed to be representative of all beekeepers, including non-respondents.

Honey Bee Colonies

A total of 110,737 managed honey bee colonies were reported by beekeeper respondents. In order to estimate the total population of Florida honey bee colonies, an expansion factor was multiplied by the number of colonies reported in the survey (Table 2). The expansion factor was estimated by dividing the population of firms in Florida by the number of survey respondents for each firm size class. A total of 258,696 honey bee colonies were estimated in Florida (using the expansion factor) with 231,861 colonies (90%) managed by commercial beekeepers, 24,135 (9%) colonies managed by sideline beekeepers and 2,701 (1%) managed by hobbyist beekeepers. These results are somewhat higher than the total number of honey bee colonies reported by the Florida Agricultural Statistics Service (230,000 colonies in 1998).

Table 2. Survey respondents and estimated honey bee colonies in Florida, 1999.

Size Class (Number of Colonies)	Number Respondents (percent)	Population Firms*	Expansion Factor	Survey Number Colonies	Expanded Number Colonies
Commercial (200+)	112 (17%)	262	2.339	99,116	231,861
Sideline (20-199)	152 (23%)	362	2.382	10,134	24,135
Hobbyist (1-19)	310 (48%)	563	1.816	1,487	2,701
Unknown	75 (12%)	1			
Total	649	1,188	2.179	110,737	258,696

*Source: Florida Department of Agricultural and Consumer Services, Division of Plant Industry.

Migratory Beekeeping Operations

Florida is an ideal location for migratory honey bee operations due to its mild winters. Some 170 respondents (27%) reported managing their beekeeping operations in other states besides Florida in 1999 (Table 3). Survey respondents reported a total of 68,653 migratory colonies or 62 percent of the surveyed colonies in Florida. The expanded number of colonies transported to other states was estimated at 150,000. Migratory beekeeping operators are primarily large commercial firms that maintain an average of 858 hives. Migratory honey bee colonies remained in the state of Florida an average of 5.9 months. The top ten other states in which Florida beekeepers operated in are ranked in Table 3. Michigan was ranked the number one state with 21 beekeepers followed by Georgia (20), Maine and New York (15), Pennsylvania (14), North Dakota (7), Massachusetts (6), Wisconsin (5), Ohio (4), Mississippi and New Jersey (3), and Alabama, North Carolina and South Dakota (2).

Table 3. Other states in which Florida honey bees are managed, 1999.

Rank	State	Number Respondents
1	Michigan	21
2	Georgia	20
3	Maine	15
3	New York	15
4	Pennsylvania	14
5	North Dakota	7
6	Massachusetts	6
7	Wisconsin	5
8	Ohio	4
9	Mississippi	3
9	New Jersey	3
10	Alabama	2
10	North Carolina	2
10	South Dakota	2

Honey Bee Products

Florida honey bees produce products including honey, beeswax, pollen, packaged bees, queens, queen cells, nucs (small hives), and complete hives (Table 4). Nearly 50 percent of respondents were involved in bulk honey production, 18 percent produced retail packaged honey, 16 percent produced beeswax, 8 percent produced live bee products, and less than 7 percent of respondents reported producing either comb honey, packaged bees, queens or nucs. Total production in 1999 was estimated at 21.0 million pounds of bulk honey, 524,750 pounds of

retail packaged honey, 120,901 pounds of comb honey, and 272,417 pounds of beeswax. Production of live honey bee products included 64,700 queen bees, 10,300 nucs, and 123,100 queen cells. Also, there was incidental production of pollen and complete hives. Prices received for honey bee products, as reported by survey respondents, are summarized in Table 4. The price per pound averaged $2.14 for comb honey, $1.80 for retail packaged honey, $1.41 for beeswax, and $0.67 for bulk honey. For live honey bees, prices averaged $13.63 per pound for packaged bees, $13.82 for queen bees, $1.50 for queen cells, $35.06 for nucs, and $65 for complete hives.

The value of each product was estimated by multiplying the quantity of production against the average price received for each surveyed beekeeper. Again, note that industry average levels of honey yields per colony and prices were imputed for beekeeper respondents who did not report honey production ('unspecified honey production'). An expansion factor of 2.179 was multiplied against beekeeper survey respondent product values to estimate the total value of Florida honey products. Based on these expanded values, the total value of Florida honey products was estimated at $17.6 million in 1999. Bulk honey, retail packaged honey and comb honey were collectively valued at $12.9 million, representing 73 percent of total value, with bulk honey accounting for the majority of this value ($11.9 million). Beeswax was valued at $401,000. The value of all live bees sold exceeded $1 million, including $834,700 for queen bees, $76,000 for packaged bees, and $360,800 for nucs and complete hives.

Table 4. Quantity, price and value of Florida honey bee products, 1999.

Honey Bee Products	Number Respondents (percent)	Expanded Quantity**	Average Price ($)	Expanded Value ($1000)**
Bulk honey (lbs)	321 (50%)	21,010,769	0.67	11,853
Retail packaged honey (lbs)	117 (18%)	524,750	1.80	830
Comb honey (lbs)	36 (6%)	120,901	2.14	213
Unspecified Honey Production*	43 (7%)	3,924,804	0.67	2,800
Beeswax (lbs)	102 (16%)	272,417	1.41	401
Live Bee Products	52 (8%)	86,170	63.00	1,269
Other	7 (1%)	124,606	12.72	198
Total				17,564

*Estimated production for commercial and sideline respondents not reporting production, assuming average yield of 97.6 lbs/colony

**Represents 2.18 times the values reported by survey respondents.

Pollination Services Provided

In addition to the production of honey bee products, many beekeepers also contract with farmers for crop pollination services. A total of 73,234 colony "sets"[6] were contracted for pollination services in 1999 by survey respondents (Table 5). Twenty percent of respondents reported contracting for pollination services for at least one crop. A large share of honey bee colonies contracted for pollination services were for specialty citrus (19,132 colonies or 26% of colonies), watermelons (15,658 colonies, 21%) and cucumbers (13,229, 18%). Other Florida crops served by pollination services to a lesser extent were cantaloupes (7,365 colonies, 11%), blueberries (6,169, 9%), and squash (4,066, 6%). Miscellaneous crops, including avocados, strawberries, apples, Chinese melons, eggplant, lychee, mango, and pumpkins, utilized 3,985 honey bee colonies (5%) for pollination. The price received by beekeepers for pollination services averaged $24 per colony for all crops surveyed (Table 5). The crops that garnered the greatest average value per colony were avocados ($38.33), cantaloupes ($28.53), cucumbers ($26.39), squash ($25.95), and watermelons ($25.24). Citrus had the lowest average honey bee colony price ($11.51), because the strong nectar flows emanating from these crops support high levels of honey production, compelling beekeepers to accept lower payments for pollination services. Total income received by beekeepers for pollination services was estimated at $1.8 million. Income from pollination services was greatest for watermelons ($441,000), cucumbers ($374,000), cantaloupes ($242,000) and blueberries ($232,000).

Table 5. Pollination services to fruit and vegetable crops by Florida beekeepers, 1999.

Pollination Services, By Crop	Number Respondents (percent)	Number Colonies*	Average Price Per Colony ($)	Income ($1000)*
Watermelons	45 (7%)	15,658	25.24	440.6
Cucumbers	19 (3%)	13,229	26.39	373.5
Cantaloupes	16 (3%)	7,365	28.53	241.7
Specialty citrus	61 (9%)	19,132	11.51	240.4
Blueberries	25 (4%)	6,169	19.58	232.4
Squash	19 (3%)	4,066	25.95	112.8
Strawberries	9 (1%)	3,268	19	69.8
Other	20 (3%)	3,985	24.46	31.8
Avocados	5 (1%)	362	38.33	15.2
Any Crop, Total	130 (20%)	73,234		1,758.10

*Expanded for Florida population of beekeepers.

[6] A colony set consists of an instance of a honey bee colony situated at a specific location for the purpose of pollinating crops.

Market Channels

Market channels for Florida honey include wholesale, commercial, cooperative and retail market outlets. The total value of product sales in Table 6 was rationalized across market channels to match the value estimated based on production quantities and prices in Table 4. The majority of honey sales were transacted in wholesale markets, valued at $13.9 million or 79 percent of total value. The non-wholesale market channels accounted for $3.7 million, or 21 percent of total honey value, mainly concentrated in honey cooperatives and local retail stores. Honey bee product sales within the state totaled $9.0 million, or 52 percent of total value, including all Florida wholesale, local retail, roadside stand and friend, neighbor and associate sales. Wholesale sales outside Florida and honey cooperative sales totaled $8.5 million (48%). For the "other" market channel category, this sample proportion of in-state vs. export sales (52%-48%) was assumed.

Table 6. Florida honey bee product sales by market outlet, 1999.

Market Channels for Products	Number Respondents (percent)	Value ($1000)*	Percent Value
Wholesale, Florida	162 (25%)	7,463.80	42%
Wholesale, outside Florida	88 (10.5%)	6,397.90	36%
Honey cooperative	11 (1.7%)	2,068.30	12%
Local retail stores	38 (5.9%)	675.5	4%
Roadside stands/farmers markets	79 (12.2%)	471.3	3%
Friends, neighbors, and associates	213 (32.8%)	424.6	2%
Others	44 (6.8%)	62.4	<1%
Total	635	17,564.30	100%

*Expanded for Florida population of beekeepers.

Beekeeper Revenues

Respondents were asked to indicate the range of revenues that best characterized their income from honey bee product sales and pollination services. The majority of responding firms had honey bee product sales of less than $50,000 (Table 7). The revenue bracket of $10,000 to $49,999 had the greatest total value of $2.2 million for products. Approximately 20 percent of beekeeper respondents (130 firms) reported providing pollination services in Florida in 1999.

The majority of responding beekeepers indicated average revenue receipts for pollination services of less than $1000. Results indicated that 0.6 percent of respondents (7 firms) reported pollination service revenues ranging from $100,000 to $199,999. These results confirm that most beekeeping operations are small enterprises.

Table 7. Revenues received by Florida beekeepers for honey bee products and pollination services, 1999.

	Honey Bee Products	Pollination Services
Revenues received	Number Respondents (percent)	
Less than $1,000	217 (33.4%)	108 (16.6%)
$1,000-$9,999	94 (14.5%)	22 (1.9%)
$10,000-$49,999	73 (11.2%)	15 (1.3%)
$50,000-$99,999	26 (4.0%)	6 (0.5%)
$100,000-$199,999	13 (2.0%)	7 (0.6%)
$200,000-$299,999	7 (1.1%)	0 (0.0%)
$300,000-$399,999	5 (0.8%)	0 (0.0%)
Not available or zero	214 (33.0%)	491 (41.3%)

Operating Expenses

Cash operating expenses were itemized into 18 categories including labor, supplies, equipment operation and overhead expenses such as pesticides, professional services, interest, insurance and taxes (Table 8). Cash operating expenditures associated with honey bee operations totaled an estimated $12.1 million in 1999. Labor and transportation constituted the largest expense categories, collectively accounting for 45 percent of total expenditures. Labor amounted to $3.3 million and transportation (vehicles, fuel, repair and maintenance) amounted to $2.1 million. Other important expenses included taxes and insurance ($817,000), freight shipping ($706,000), supplemental feed ($673,000), packaged bees/ queens ($606,000), and hives and small tools ($587,000). Nearly half of beekeepers (46%) reported expenses for pesticides/antibiotics amounting to $485,000, the majority respondents of any expense category. The total cost of honey production averaged $0.57 per pound.

Table 8. Cash operating expenses for Florida beekeepers, 1999.

Operating Expenses	Number Respondents (percent)	Amount ($1000)*	Percent Amount
Labor	93 (14%)	3,313	27.4%
Transportation (vehicles, fuel)	203 (31%)	2,095	17.3%
Taxes, insurance	108 (17%)	817	6.8%
Freight shipping	80 (12%)	706	5.8%
Supplemental feed	186 (29%)	673	5.6%
Packaged bees/queens	188 (29%)	606	5.0%
Hives & small tools	237 (37%)	587	4.9%
Building maintenance & repair	99 (15%)	495	4.1%
Pesticides, antibiotics	300 (46%)	485	4.0%
Honey extraction	102 (16%)	408	3.4%
Office expense	105 (16%)	378	3.1%
Interest	35 (5%)	349	2.9%
Other	41 (6%)	321	2.7%
Leasehold on land, buildings	58 (9%)	210	1.7%
Product packaging an marketing	111 (17%)	205	1.7%
Travel, entertainment, meetings, education	103 (16%)	201	1.7%
Professional services	86 (13%)	131	1.1%
Beeyard fencing	66 (10%)	111	0.9%
Total		12,090	100

*Expanded for Florida population of beekeepers.

Assets

The value of beekeeping assets in the state of Florida was estimated at $50.1 million (Table 9). Hives accounted for the largest share of assets at $17.3 million (35%) followed by buildings at $14.7 million (29%), trucks/trailers at $9.8 million (20%), and machinery/equipment at $8.3 million (17%). These values suggest that beekeeping enterprises require significant capital investments. Total investment per colony averaged $183.

Table 9. Value of non-current assets for Florida beekeepers, 1999.

Assets	Number Respondents (percent)	Value ($millions)*	Percent Value
Hives	415 (64%)	17.3	35%
Buildings	153 (24%)	14.7	29%
Trucks/trailers	193 (30%)	9.8	20%
Machinery / equipment	317 (49%)	8.3	17%
Total		50.1	100%

*Expanded for Florida population of beekeepers.

Profitability

Florida beekeepers realized an estimated $1.5 million in pre-tax net income during 1999, representing an average profit of $5.88 per honey bee colony and $1,280 net income per beekeeper (Table 10). Revenues totaled $19.5 million or $75.19 per colony. Expenditures, which included an annual asset depreciation rate of 10 percent, summed to $17.9 million or $69.31 per colony. The profit margin, or ratio of pre-tax net income to revenue sales, averaged 8 percent. Return on non-current assets (net income / total non-current assets) was 3 percent. Commercial beekeepers accounted for 85 percent of total revenues and 88 percent of total expenditures. Surprisingly, net income was slightly greater for sideline beekeepers at $820,000 as opposed to commercial beekeeper net returns of $781,000. Hobbyist beekeepers realized negative net returns.

Table 10. Income and expenses for Florida beekeepers by size class, 1999.

Income and Expenses	Commercial	Sideline	Hobbyist	All Beekeepers	Amount Per Colony ($)**
Total Sales Revenue ($1000)	**16,621**	**2,696**	**133**	**19,450**	**75.19**
Product Sales	14,981	2,461	123	17,564	67.90
Pollination Services	1,641	235	10	1,887	7.29
Total Expenses ($1000)	**15,840**	**1,876**	**215**	**17,931**	**69.31**
Cash Expenses	11,549	1,212	160	12,921	49.95
Depreciation*	4,291	664	55	5,009	19.36
Net Income, Pre-Tax ($1000)	**781**	**820**	**(81)**	**1,520**	**5.88**
Profit Margin (%)	5	30	(80)	8	
Return on Non-Current Assets (%)	1.8	12.3	-14.8	3.0	
Pre-Tax Net Income Per Colony ($)**	3.37	33.98	(30.13)	5.88	
Average Net Income Per Beekeeper ($1000)	2.98	2.26	(0.14)	1.28	

*Estimated annual depreciation at 10% of total assets.
**Based on estimated 259 thousand colonies.

Employment

Employment figures reported by survey respondents represented beekeeper/owner and family members as well as hired employees. Florida beekeeping operations employed an estimated 1,632 total employees; 1,089 part-time and 543 full-time employees (Table 11). Approximately 25 percent of operations had full-time employees. Employees of Florida beekeeping operations worked a total of 95,572 working days, 69,405 days by full-time employees and 26,166 days by part-time employees. Total work time averaged 0.37 days per colony, and an average of 159 colonies were managed per person employed.

Table 11. Employment and number of days worked in the Florida beekeeping industry, 1999.

Employment	Number Respondents (percent)	Number Persons*	Number Days Worked (percent)*
Full Time	161 (25%)	543	69,405 (72.6%)
Part Time	274 (42%)	1,089	26,166 (27.4%)
Total		1,632	95,572

*Expanded for Florida population of beekeepers.

Honey Bee Colony Losses

Surveyed beekeepers were asked *"Have you experienced large die-offs of honey bee colonies due to pests or other causes within the last 5 years?"* Within the past 5 years, 57 percent of respondents (373 firms) indicated experiencing honey bee die-offs. Respondents estimated that 75,586 honey bee colonies succumbed to die-offs resulting from pests or other causes during this time. This represented 29 percent of the colony stock in 1999, or an average annual turnover of 5.8 percent. Thirty seven percent of beekeepers surveyed reported losing 51 percent or more of their colonies over the past 5 years, and 11 percent of respondents lost 81 percent or more, based on their 1999 colony numbers. These losses are in addition to the normal 10 to 20 percent of colonies that are lost during overwintering. Industry experts reported that the rate of colony losses due to pests in recent years is significantly greater than was experienced historically.

Beekeepers were asked to state in their own words the nature of bee die-offs in their managed colonies (Table 12). The majority of beekeepers (57%) cited mites as the cause for bee die-offs (213 responses). In addition Florida beekeepers reported problems, with beetles (89), the wax moth (64), pesticides (39), queen acceptance/loss (28), ants (24), foulbrood (22), mite resistance to treatment (19), weather (16), floods (14), theft/vandalism (13) and bears (12). The remaining listed causes of bee die-offs received less than 10 responses each.

Table 12. Listed causes of Florida honey bee die-offs, 1999.

Rank	Reason for Loss	Number Respondents (percent)
1	Mites (Varroa, Tracheal)	213 (57%)
2	Beetles	89 (24%)
3	Wax moth	64 (17%)
4	Pesticides	39 (10%)
5	Queen acceptance/loss	28 (8%)
6	Ants	24 (6%)
7	Foulbrood	22 (6%)
8	Mite resistance to treatment	19 (5%)
9	Weather	16 (4%)
10	Floods	14 (4%)
11	Theft/vandalism	13 (3%)
12	Bears	12 (3%)
13	Poor management	9 (2%)
13	Poor care	9 (2%)
14	Fires	7 (2%)
15	Pests	5 (1%)
16	Starvation	4 (1%)
17	Weak hive	3 (1%)
17	Viruses	3 (1%)
17	Disease	2 (1%)
18	Swarming	2 (1%)

Threats to the Florida Beekeeping Industry

Beekeepers were asked to rate the most important threats confronting the Florida beekeeping industry on a 5-point Likert scale where a score of 5 signified “extremely important” and a score of 1 signified “unimportant” (Table 13). The 13 threats listed in the survey included low honey prices, pesticide exposure and low recruitment of new beekeepers, among others. Seven threats received above average scores (>3). They included foreign imports of honey (4.3), low prices for honey (4.1), decline of honey bee populations due to pests (4.0), resistance to pesticides for control of mites (3.9), high cost of beekeeping (3.8), losses to honey bee diseases (3.5), and potential contamination of honey by pesticides (3.1). The threats to the Florida beekeeping industry that the majority of respondents (>50%) assigned a score of 4 or 5 (e.g. very important and extremely important, respectively) were low prices for honey (70.4%), foreign imports of honey (68.2%), decline of honey bee populations due to pests (65.7%), resistance to pesticides for control of mites (52.5%), and lack of skilled or willing workers (52.3%)(Table 13).

Table 13. Ratings of threats to the Florida beekeeping industry, 1999.

Threats to Beekeepers	Number Respondents	Average Score*	Percent Respondents Scored Extremely or Very Important
Foreign imports of honey	428	4.3	68.2%
Low prices for honey	439	4.1	70.4%
Decline of honey bee populations due to pests	452	4.0	65.7%
Resistance to pesticides for control of mites	427	3.9	52.5%
High cost of beekeeping	420	3.8	45.5%
Losses to honey bee diseases	434	3.5	48.8%
Potential contamination of honey by pesticides	379	3.1	47.0%
Potential adulteration of honey by other sweeteners	359	3.0	43.5%
Pesticide exposure to bees from nearby ag. operations	370	3.0	41.1%
Lack of suitable bee pasturage and colony sites	360	2.9	49.7%
Low recruitment of new beekeepers to the industry	345	2.7	49.6%
Lack of skilled or willing workers	329	2.3	52.3%
Losses to bears and other predators	338	1.9	65.4%

*Scored on a scale of 1-5, with 5 being extremely important, 4 very important, 3 somewhat important, 2 slightly important, and 1 unimportant.

Beekeeper Experience

Respondents reported a mean of 16.7 years and a median of 11.5 years experience in the beekeeping business. The number of years experience ranged from a low of 1 year to a high of 70 years. The majority of beekeeping respondents (450 or 78%) indicated between 2 to 30 years experience (Figure 3). The 2 to 5 year range received the most responses with 158 beekeepers (28% of respondents). Seventy five respondents (12%) reported no honey bee colonies and it is presumed that these beekeepers are now out of business due to complete loss of colonies, or beekeeper retirement.

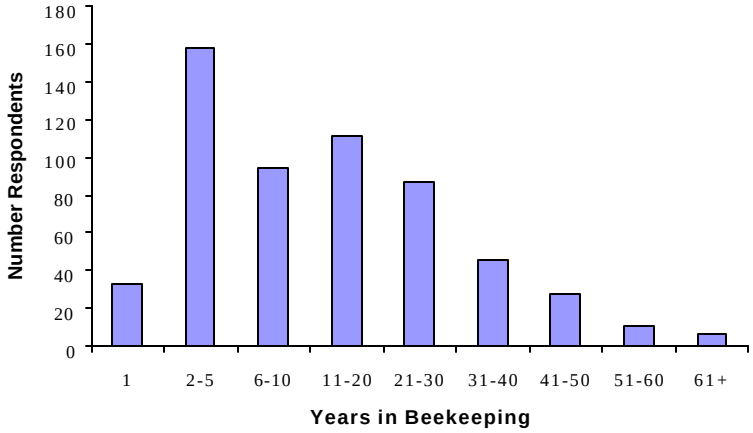


Figure 3. Years experience of Florida beekeepers, 1999.

Florida Grower Survey Results

Response Rates

The second questionnaire was administered to all Florida growers of cantaloupe, cucumber, watermelon, blueberry, strawberry, avocado and specialty citrus. From the Florida population of 2,300 growers of these crops, 425 responded to this questionnaire yielding an overall response rate of 18.5 percent. More than 31 percent of respondents (133 growers) reported contracting for pollination services within the past five years while 292 growers (69% of respondents) have not contracted within the past 5 years. Sixteen percent of respondents reported that they used pollination services but also grow some of the same crops without. When growers were asked to indicate the most recent year they contracted for pollination services within the past 5 years, a total of 125 growers responded, and the vast majority of these respondents (94%) cited either the years 1999 or 2000. Pollination contracts averaged 13.1 years, which does not necessarily signify 13 consecutive seasons.

Fruit and Vegetable Crop Pollination

The number of acres pollinated by honey bees totaled 34,845 among all crops reported. More acreage of specialty citrus were pollinated than any other crop in Florida (Table 14). Over 17,000 acres of specialty citrus crops (50% of surveyed acreage), 7,834 acres of watermelons (22%), 3,207 acres of cucumbers (9%), 2,197 acres of squash (6%) and 2,072 acres of avocados (6%) contracted for pollination services in 1999. Overall, an average of 1.89 acres were pollinated by each honey bee colony contracted. Watermelons were pollinated by more hives than any other crop surveyed with 6,748 honey bee colonies or 37 percent of 18,477 total reported bee colonies contracted (Table 14). Honey bee colonies contracted included 4,034 for specialty citrus, 3,834 for cucumber crops, and 1,431 colonies for avocado crops. The number of colonies contracted per acre was highest for strawberries (2.57), blueberries (1.77), cucumbers (1.20) and cantaloupe (1.01), compared to the overall average of 0.53 colonies per acre across all crops.

Table 14. Acres pollinated, number of honey bee colonies and cost of pollination services for Florida fruit and vegetable growers, 1999.

Crops Pollinated	Number Respondents	Acres Pollinated	Number colonies	Average Colonies Per Acre	Average Rental Price ($/Colony)	Cost of Services ($)	Average Cost Per Acre Pollinated ($)
Watermelons	58	7,834	6,748	.086	27.20	191,535	24.45
Cucumbers	18	3,207	3,834	1.20	22.80	90,950	28.36
Avocados	20	2,072	1,431	0.69	20.20	23,138	11.17
Squash	19	2,197	1,108	0.50	22.90	22,799	10.38
Cantaloupe	27	689	698	1.01	27.30	18,799	27.28
Specialty citrus	13	17,475	4,034	0.23	8.50	12,879	0.74
Blueberries	17	262	464	1.77	26.00	9,923	37.87
Strawberries	6	408	105	2.57	27.50	1,425	3.49
Eggplant	3	68	55	0.80	22.50	1,250	18.38
Other Miscellaneous		633	-			-	
Total		34,845	18,477	0.53		372,698	10.7

Expenses for Pollination Services

The cost of pollination services for each crop surveyed was estimated by multiplying the number of honey bee colonies contracted for pollination by the rental price per colony reported by each grower. The average rental price paid by growers per honey bee colony ranged from $20.20 to $27.50, except for specialty citrus, which had an average rental price per colony of $8.50 (Table 14). The total cost of pollination services by honey bees was $372,698 in 1999. Watermelons had the highest cost at $191,535 (51% of total cost) followed by cucumbers ($91,950), avocados ($23,138), and squash ($22,799). Collectively these four crops accounted for 88 percent of total pollination services costs. Dividing cost of services by the total number of acres pollinated gives the average cost per acre pollinated (Table 14). The cost per acre averaged to $10.70 across all fruit and vegetable crops surveyed. Blueberries commanded the greatest cost per acre pollinated ($37.87) followed by cucumbers ($28.36), cantaloupes ($27.28), watermelons ($24.45), and eggplant ($18.38). Specialty citrus and strawberry crops received the lowest cost per acre pollinated at $.74 and $3.49, respectively. The majority of growers surveyed (91%) reported total pollination service expenses under $10,000 with 56% of respondents reporting pollination service expenses under $1000 (Table 15). Less than 9 percent of respondents reported expenditures ranging between $10,000 and $99,999 and no

growers indicated pollination service expenses greater than $100,000. These results suggest that pollination services constitute minor expenses for Florida farmers.

Table 15. Expenditures on pollination services by Florida fruit and vegetable growers, 1999.

Expenses per grower	Number Respondents	Percent Respondents
Less than $1,000	71	55.5%
$1,000-$9,999	46	35.9%
$10,000-$49,999	9	7.0%
$50,000-$99,999	2	1.6%
Total	128	

Value of Honey Bee Pollination for Fruit and Vegetable Production

Respondents were asked to indicate the typical yield increases associated with pollination service contracts on their crops (Table 16). Watermelon crops benefited the most from pollination services with an estimated 60.1 percent yield increase. Additionally, pollination services were associated with a 58.6 percent yield increase in cucumbers, a 36.4 percent increase in cantaloupes and a 32.1 percent increase in blueberry yields. On average, the Florida crops considered in this survey experienced a 37 percent increase in yields. Marginal value in the present context represents the value of crop yield increases attributable to honey bee pollination activities, in other words, the difference in value of crops with and without pollination activity. This value was determined by taking the change in yield per acre associated with the pollination services multiplied by the price per unit, multiplied by the number of pollinated acres for each crop less the cost of pollination services. These results assume that there are no market supply or price adjustments associated with marginal changes in crop yields due to honey bee pollination. The total marginal value benefit of pollination services was estimated at $26.4 million (Table 16). Cucumbers had the largest marginal value of pollination at $7.4 million (28% of total) followed by watermelons at $5.9 million (22%), specialty citrus at $5.3 million (20%), and squash at $3.7 million (14%). The marginal value for the remaining crops totaled $3.7 million (14% of total marginal value).

Table 16. Marginal value benefit of honey bee pollination services, 1999.

Crop	Average Yield per Acre *	Average Percent Increased Yield	Marginal Production Due to Honey Bees (units/acre)	Price per unit ($)*	Cost of Pollination Services ($)	Marginal Benefit of Pollination Services ($1000)
Cucumber (55 lb. bushel)	579	58.6	222	10.52	90,950	7,389
Watermelons (cwt)	300	60.1	113	6.9	191,535	5,899
Specialty Citrus (boxes)	208	20.3	35	8.75	12,879	5,333
Squash (42 lb. bushel)	280	65.0	110	15.25	22,799	3,673
Strawberries (12 lb. flat)	2500	27.5	539	9.72	1,425	2,137
Avocados (bushels)	149	25.3	30	18.7	23,138	1,144
Blueberries (lbs.)	1210	32.1	294	4.84	9,923	362
Eggplant (33 lb. bushel)	811	20.0	135	10.35	1,250	94
Total						26,385

*Source: Florida Agricultural Statistics Service.

Issues for Honey Bee Pollination Service Contracts

Farmers surveyed were given a list of seven commercial pollination issues and asked to rate their importance on a Likert scale of 1 to 10 where a score of 1 signifies “not important” and a score of 10 signifies “most important” (Table 17). Respondents assigned greater than average scores (>5.5) to the issue items “effectiveness of pollination services” (7.8), “availability of pollination services” (7.2), “cost of pollination services” (6.2), and “constraints on pesticide application” (6.0). The issues ‘unpredictability of timing for pollination,’ ‘reliability of other native pollinators,’ and ‘hazard to workers in vicinity’ were perceived as much less important.

Table 17. Importance of issues surrounding pollination contracts for Florida fruit and vegetable growers, 1999.

Issues for Pollination Contracts	Number Respondents	Average Score (1-10)
Effectiveness of pollination services	106	7.8
Availability of pollination services	112	7.2
Cost of pollination services	114	6.2
Constraints on pesticide application	106	6.0
Unpredictability of timing for pollination	107	5.3
Reliability of other native pollinators	104	5.0
Hazard to workers in vicinity	105	3.5

Regional Economic Impacts of the Florida Apicultural Industry

Three types of regional economic impacts are associated with the apicultural industry of Florida: direct, indirect and induced economic effects. The direct economic impacts involve output, value-added and employment contributions directly affiliated with apicultural operations in Florida. Purchases from other industries support additional levels of employment and wages (indirect effects). Personal consumption purchases made by employees of the apicultural industry and related sectors further boost the economy (induced effects). The total impact is the sum of direct, indirect and induced effects.

The sum of product sales and pollination services for Florida beekeepers was $19.3 million (Table 18). Product sales totaled $17.6 million with $8.4 million (48%) of sales exported from Florida and $9.1 million (52%) of sales transacted inside Florida. The total value of pollination services was $1.8 million with $281,000 (16%) representing out-of-state sales and $1.5 million (84%) within-state sales. Forty five percent ($8.7 million) of aggregated product sales and pollination services were outside of Florida while 55 percent of total sales ($10.6 million) occurred within the state. The marginal benefit of pollination services was $26.03 million with $17.2 million (66%) representing out-of-state export sales and $8.8 million (33%) sold within the state.

Table 18. Sales and export value of Florida honey bee products and marginal value of pollination services to growers, 1999.

Income Source	Estimated Total Value ($ million)	Export Value from Florida ($ million)	Within Florida Sales ($ million)
Beekeepers			
Total	**19.32**	**8.71**	**10.61**
Product Sales	17.56	8.43	9.13
Pollination Services	1.76	.28	1.48
Growers			
Marginal Benefit of Pollination Services	26.03	17.23	8.80

Total economic impacts were calculated by multiplying total industry out-of-state exports (Table 18) against the total effects multiplier (Table 1), and multiplying the value of industry sales within Florida (Table 18) against the direct effects multiplier, then summing these two values together. Direct effects were estimated by multiplying the sum of export and within Florida sales by the

direct effects multiplier. Indirect and induced effects were calculated by multiplying total export sales by the indirect and induced effects multipliers, respectively. The employment multiplier is expressed in terms of jobs per million dollar output so impact estimates were adjusted accordingly to reflect this unit specification. The output and value-added multipliers are expressed in dollars per dollar output. The proportion of domestic and export honey bee product sales were derived from survey results while multiplier values for honey bee product sales and pollination services, and the proportion of in-state and out-of-state export pollination service sales were provided by the IMPLAN system for 1997. Total output impacts were $30.5 million, total value-added impacts were $15.2 million, and employment impacts were 806 jobs (Table 19). Total output impacts averaged $118 per colony and total value-added impacts averaged $59 per colony. The direct effect accounted for 63 percent of total output impacts, 54 percent of value-added impacts, and 81 percent of employment impacts. The indirect effect captured 12 percent of total output impacts, 14 percent of value-added impacts, and 6 percent of employment impacts. The induced effect accounted for 24 percent of the output impact, 32 percent of the value-added impact and 13 percent of the employment impact.

The direct, indirect and induced impacts associated with marginal benefit of pollination services for Florida fruit and vegetable growers appear in Table 19. Total output impacts were $38.2 million, value-added impacts were $20.9 million and employment impacts amounted to 490 jobs. The direct effects accounted for 68 percent of total output impacts, 65 percent of value-added impacts and 57 percent of employment impacts. The indirect effects captured 18 percent of output and value-added impacts, and 27 percent of employment impacts. The induced effects represented 14 percent of output impacts, 17 percent of value-added impacts and 16 percent of employment impacts.

Table 19. Total economic impacts of the Florida apicultural industry and marginal benefits to Florida fruit and vegetable growers by pollination services, 1999.

Multipliers	Output ($ Million)	Value-Added ($ Million)	Employment (Jobs)
Florida Beekeepers			
Total Effects	**30.46**	**15.23**	**806**
Direct Effects	19.32	8.27	649
Indirect Effects	3.69	2.13	51
Induced Effects	7.45	4.83	106
Florida Fruit and Vegetable Growers			
Total Effects	**38.17**	**20.85**	**490**
Direct Effects	26.03	13.57	281
Indirect Effects	6.79	3.83	133
Induced Effects	5.35	3.45	76

Discussion

In total, Florida beekeepers managed over 258 thousand honey bee colonies in 1999, nearly 150 thousand of which represented migratory beekeeping operations. Revenues from apicultural operations were generated from honey bee products (including honey, beeswax, packaged bees, queens and nucs) and pollination service contracts. Total sales revenues accruing to Florida beekeepers in 1999 from product sales and pollination services amounted to $19.5 million, of which 90 percent represented honey bee product sales. Honey sales amounted to $15.7 million or 89 percent of total product sales. The majority of product sales (79%) were transacted in wholesale markets. Income received by beekeepers for pollination services was estimated at $1.9 million, primarily derived from service contracts for watermelons, cucumbers, cantaloupes and blueberries. Although more honey bee colonies were contracted to pollinate specialty citrus than any other crop surveyed, citrus had the lowest average honey bee colony price. Beekeepers are willing to accept lower prices for specialty citrus pollination because the strong nectar flows associated with these crops support greater honey bee populations, and consequently contribute to higher levels of honey production.

Cash operating expenditures associated with beekeeping operations totaled an estimated $12.9 million in 1999. Labor and transportation represented 45 percent of total expenses. Expenditures on pesticides and antibiotics were reported by 46 percent of respondents. Although beekeeping is a very labor-intensive enterprise, apicultural operations require significant capital investments in hives, trucks/trailers, buildings and machinery/equipment, which totaled $50 million in 1999. Pre-tax net income amounted to $1.5 million for all beekeepers. Hobbyist beekeepers realized negative returns. Commercial beekeepers (managing 200 or more colonies annually) and sideline beekeepers (managing 20-199 colonies annually) realized similar levels of pre-tax net income. The profit margin or ratio of net income to sales revenues for all beekeepers in 1999 was 7.8 percent, the return on non-current assets was 3.03 percent, pre-tax net income per colony amounted to $5.88 and pre-tax net income per beekeeper averaged $1,280.

In rating the importance of 13 threats confronting the state's apicultural industry, the most severe threats included foreign imports of honey, low honey prices, pests, resistance to pesticides for control of mites and the high costs of beekeeping. Apiculturists assigned relatively uniform rating scores to all threats, with the exception of a low concern for losses of

honey bee colonies to bears and other predators. Most beekeepers identified natural pests including mites, beetles and the wax moth as a cause of honey bee die-offs. Respondents reported a mean of 16.7 years beekeeper experience. The cumulative experience and training of beekeepers represents a significant human capital investment. The combination of low returns, colony losses, and other threats portrays the Florida apicultural industry as a marginal economic enterprise.

More than 31 percent of grower respondents reported contracting for pollination services within the past 5 years. Sixteen percent of respondents reported that they used pollination services but also grow some of the same crops without them. In total 34,845 acres of fruit and vegetable crops were pollinated by honey bees, consisting mostly of specialty citrus and watermelons. The total cost of pollination services by honey bees was $372,698 in 1999, with watermelons accounting for 51 percent of this total cost. The majority of fruit and vegetable growers (92%) reported expenditures under $10,000, and 56 percent of respondents indicated expenditures under $1000. This suggests that pollination service charges represent minor expense categories for Florida fruit and vegetable growers. The marginal value benefit to growers of using pollination services totaled $26.4 million. The combination of low expenses and high marginal value benefit associated with pollination services suggests that growers benefit from the surplus value of pollination services, especially for crops such as cucumbers and watermelons, which demonstrated especially high yield responses to pollination. According to fruit and vegetable growers, the two items rated highest in importance regarding pollination service contracts were the effectiveness of pollination services in maintaining yields and the availability of pollination services. This suggests that growers recognize the importance of honey bee pollination services. The item ‘cost of pollination services’ received a slightly above average importance rating, signifying that growers are mostly satisfied with the cost of these services.

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Questionnaire for Survey of Florida Beekeepers

Please fill-out this questionnaire and return to the investigators using the addressed postage-paid envelope provided. Your answers will remain strictly confidential and information will be presented only in summary form. If you have questions about the survey, please feel free to contact the investigators.

Characteristics of Beekeeping Operations

1. How many honey bee colonies do you manage currently in Florida? _____ colonies

2. Please list any other states besides Florida in which you manage honey bees, with your home state first:

_____
_____

3. How many years have you been a beekeeper? ____ years

4. If your beekeeping operations are migratory, how many of your colonies were moved between Florida and other states last year, and for how many months did these colonies remain in Florida?

_____ colonies moved between Florida and other states
_____ months that these colonies were in Florida

5. How many fulltime or part-time persons were employed in your beekeeping operation last year (1999), including yourself and other family members, and how many days did they work?:

	full time	part-time
Number of persons	_____	_____
Number of days worked	_____	_____

Honeybee Products and Markets

6. What was your production of the following honey bee products in Florida last year (1999) and the average price received?:

Product	Production	Average Price
Bulk honey	_____ lbs.	____ ($/lb)
Retail packaged honey	_____ lbs.	____ ($/lb)
Comb honey	_____ lbs.	____ ($/lb)
Beeswax	_____ lbs.	____ ($/lb)
Packaged bees	_____ lbs.	____ ($/lb)
Queens	_____ units	____ ($unit)
Nucs (young colonies)	_____ units	____ ($unit)
Other (specify)	_____	

7. Please indicate the percentage of your total honey sales last year to each of the following market outlets:

wholesale honey packer in Florida	_____%
wholesale honey packer outside Florida	_____%
honey cooperative	_____%
commercial sweetener users in Florida	_____%
commercial sweetener users outside Florida	_____%
local retail stores	_____%
roadside stands/farmers markets	_____%
friends, neighbors and associates	_____%
other (specify _____)	_____%
	100%

Honeybee Pollination Services

8. Did you provide crop pollination services in Florida last year (1999)? (*circle one*): yes no

9. If you did provide crop pollination services, how many colonies were contracted for each of the following crops and what was the average rental price per colony?:

Crop	Number. colonies	Avg. price ($/colony)
specialty citrus	_____	_____
cucumbers	_____	_____
squash	_____	_____
watermelons	_____	_____
cantalopes	_____	_____
blueberries	_____	_____
strawberries	_____	_____
avocados	_____	_____
other (specify _____)	_____	_____
other (specify _____)	_____	_____

Operating Expenses and Assets

10. What were your cash operating expenses last year for the following cost categories?:

labor (incl. taxes, insurance and fringe benefits)	$_____
packaged bees/queens	$_____
supplemental feed	$_____
beeyard fencing	$_____
pesticides, antibiotics	$_____
hives & small tools	$_____
transportation (fuel, repair & maintenance)	$_____
freight shipping	$_____
honey extraction	$_____
product packaging & marketing	$_____
building maintenance & repair	$_____
office expense (telephone, computer, etc.)	$_____
leasehold on land, buildings	$_____
professional services (legal, accounting)	$_____
taxes, insurance	$_____
travel, entertainment, meetings, education	$_____
interest	$_____
depreciation	$_____
other (specify _____)	$_____
other (specify _____)	$_____

11. What is the the current value of your beekeeping assets?

Item	Value
Trucks/trailers	$_____
Buildings	$_____
Machinery/equipment	$_____
Hives	$_____

Honeybee Colony Losses and Threats to the Industry

12. Have you experienced large die-offs of honey bee colonies due to pests or other causes within the last 5 years? (*circle one*): yes no

12a. If yes, how many colonies were lost? _____ colonies

12b. Please explain briefly the nature of you losses:

_____
_____
_____

13. In your opinion, what are the most important threats facing the beekeeping industry in Florida? *Please rate the following possible threats on a scale of 1 to 5, with 5 being "very important" and 1 being "unimportant"*:

_____ low prices for honey
_____ foreign imports of honey
_____ high cost of beekeeping
_____ potential adulturation of honey by other sweeteners
_____ potential contamination of honey by pesticides
_____ pesticide exposure to bees from nearby agric. operations
_____ decline of honey bee populations due to pests
_____ losses to honey bee diseases
_____ losses to bears and other predators
_____ resistence to pesticides for control of mites
_____ lack of skilled or willing workers
_____ low recruitment of new beekeepers to the industry
_____ lack of suitable bee pasturage and colony sites
_____ other (specify _____)

Total Income

14. What were your total revenues from sale of honey bee products and pollination services last year? (*check appropriate category* for each):

Honey bee Products	Pollination Services
_____ Less than $1,000	____ Less than $1,000
_____ $1,000 to $9,999	____ $1,000 to $9,999
_____ $10,000 to $49,999	____ $10,000 to $49,999
_____ $50,000 to $99,999	____ $50,000 to $99,999
_____ $100,000 to $199,999	____ $100,000 to $199,999
_____ $200,000 to $299,999	____ $200,000 to $299,999
_____ $300,000 to $399,999	____ $300,000 to $399,999
_____ $400,000 to $499,999	____ $400,000 to $499,999
_____ $500,000 or more	____ $500,000 or more

Please check here if you wish to receive a copy of the final project report _____

Thank you for completing this questionnaire. Please insert in the addressed postage-paid envelope provided and mail.

Revised January 7, 2000

Questionnaire for Survey of Florida Farmers
Using Honeybee Pollination Services

1. Have you contracted for honeybee pollination services within the last 5 years?:
yes no *(Circle one*)

If answer to above question is "no", skip to end of questionnaire. If "yes", continue.

2. What was the most recent year in which you contracted for honeybee pollination services, and how many years have you contracted for honeybee pollination services since you have been farming?: most recent year: ____ number of years : _____

3. In what Florida counties are your agricultural operations located (*list all*):
_____
_____

4. Please indicate which of the following crops were serviced by honeybee pollination contracts in the most recent year, how many acres were serviced, how many honeybee colonies were contracted, and the average rental price paid per colony:

Crop	Acres Pollinated	Number Colonies	Average Rental Price ($/colony)	
specialty citrus	_____	_____	_____	
cantalopes	_____	_____	_____	
cucumbers	_____	_____	_____	
watermelons	_____	_____	_____	
blueberries	_____	_____	_____	
strawberries	_____	_____	_____	
avocados	_____	_____	_____	
other	_____	_____	_____	specify crop _____
other	_____	_____	_____	specify crop_____

5. Do you grow any of these crops without use of honeybee pollination services?
Yes No *(Circle one)*

If yes, what are your reasons for not using honeybee pollination services?
_____
_____

6. Based on your experience, what is the typical increase in yield for any of the following crops when serviced by honeybee pollination contracts? *(Specify yield increase either as a percentage or a quantity per acre, and specify units, e.g. bushels, boxes, etc.*).

Crop	Yield Increase (% or quantity)
specialty citrus	_____
cantalopes	_____
cucumbers	_____
watermelons	_____
blueberries	_____
strawberries	_____
avocados	_____
other	_____ specify crop _____
other	_____ specify crop _____

7. In your view, what are the greatest issues surrounding use of contracted honeybee pollination services? *Please rate the following issue on a scale of 1 to 10, with 10 being "most important", and 1 being "not important".*

_____ cost of pollination service contracts
_____ effectiveness of pollination services
_____ availability of honeybee pollination contractors
_____ reliability of other native pollinators (e.g. wasps, ants, other bees, bats, birds)
_____ constraints on pesticide application while honeybees are present
_____ hazard to workers in vicinity of honeybee colonies
_____ unpredictability of timing of critical period for pollination

8. What were your total expenses for honeybee pollination services in the most recent year? (*check appropriate category*)

_____ Less than $1,000
_____ $1,000 to $9,999
_____ $10,000 to $49,999
_____ $50,000 to $99,999
_____ $100,000 to $149,999
_____ $150,000 to $199,999
_____ $200,000 to $249,999
_____ $250,000 or more

9. Company name/address (optional)

Company name	_____
Owner/Manager name	_____
Street address	_____
City, State, Zip code	_____
Telephone	_____

____ Check here if you wish to receive a copy of the final project report

Please return the completed questionnaire to the project investigators using the enclosed postage-paid envelope. Thank you.