Native plants, predominately live oak and sabal palms were planted in large numbers because of the belief that they came through the hurricane better then non-native plants. Pines were being planted to reforest the destroyed pine land canopy.

Color was absent in the landscape following the hurricane. Annuals were purchased to liven up the leafless environment. Flowering trees, shrubs and vines were planted for later color. Vines also served to cover new fence installations.

Many sodded areas and irrigation systems were destroyed in the rebuilding process. 'Floratam' sod was the replacement turf of choice. Xeriscape was on many homeowner's minds who were looking for water and energy efficent landscape ideas.

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IMPACT OF HURRICANE ANDREW ON ORNAMENTAL NURSERY PROFITABILITY IN DADE COUNTY, FLORIDA

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Abstract. **The large ornamental nursery industry in Dade County (FL) was devastated by hurricane Andrew in August, 1992. The storm damaged or destroyed approximately 1,300 acres of nursery shadehouses and greenhouses, and over 4,000 acres of woody ornamental nursery crops. The extent of damages to nurseries was surveyed shortly after the storm. A group of 11 nursery managers who suffered extensive losses were interviewed to evaluate effects of the hurricane on individual firms and to identify key elements of management under circumstances of natural disaster. Financial records for these firms were analyzed to document changes in costs and income for 1992 compared to the previous three year period (1989-91). Average net income for these companies fell from $130 thousand for 1989-91 to minus $234 thousand in 1992. Total industry losses were estimated at $206 million, including $120 million in plant inventory losses, $22 million in fixed capital losses for buildings and equipment, $34 million for storm cleanup, and $29 million for the time value of lost sales, replanting and capital replacement costs. Lost export sales for the nursery industry ($85 million) were projected to cause additional losses of $155 million in local economic activity for supporting industries in the Dade County economy. Losses to supporting industries included $54 million in personal income, and 4,139 jobs, based upon economic multipliers for Dade County.**

Dade County is Florida's largest producer of ornamental nursery crops, with over 6,000 acres in production, including 2000 acres of nursery shadehouses and greenhouses, and 4,000 acres of other nursery crops. The 1988 Census of Agriculture for Dade County showed a total value of $145 million for horticultural specialty crops (US Census Bureau, 1989). Ornamentals production in Dade County includes tropical foliage crops, flowering plants, and container and field-grown woody ornamentals. A 1989 economic survey of Dade County's agriculture showed an annual sales value of $171 million for ornamental crops (Moseley, 1990). The ornamental nursery industry in Dade had a total payroll of $37.1 million in 1988 (Fl. Dept. Labor, 1989). A large share of Dade County's ornamental commodities (71%) are sold outside the county and generate additional activity in the local economy (Moseley, 1990). "Export" sales of ornamentals from Dade were estimated to support $221 million in local economic activity, $76 million in personal earnings, and 5,900 jobs in the county (Moseley, 1990).

History of Agricultural Disasters in Dade County

The ornamental nursery industry in Dade County has suffered a series of previous natural and human-caused disasters. Nursery production systems used in South Florida have several characteristics which increase the industry's vulnerability to natural disasters. Open shadehouse structures are commonly used for production and acclimatization of large tropicals, grown in containers and on marl soils. High winds often tear-away shadecloth coverings, exposing sensitive plants to full sun. Water for crop irrigation is drawn from shallow wells into the Biscayne aquifer, which already has extensive saltwater intrusion in many areas, and could be contaminated further by tidal and rain-borne salts in the event of a hurricane. Besides Andrew, hurricanes which have caused extensive damage in Dade County

in recent history include Donna in 1960, Betsy in 1965, and Inez in 1966.

In addition to damages caused by hurricanes, many Dade County nurseries produce tropical plants which are sensitive to cool temperatures during winter freeze events that occur about every two years. Clear plastic (polyethylene) sheeting is attached to shadehouse structures for limited cold protection and increased production during winter months. However, very few firms are equipped with heating or irrigation equipment needed to fully protect plants during severe freezes. The freeze that occurred in December, 1989, caused extensive damage to ornamental nursery plants.

Most recently, nurseries throughout Florida, as well as in Dade County, were alleged to suffer damages from a defective fungicide product (DuPont's Benlate) for which over $500 million in damage claims has been paid to-date in Florida (Wall Street Journal, page B1, June 30, 1993).

Damages Caused by Hurricane Andrew

Damages to nurseries by Hurricane Andrew were mainly the result of extremely high winds, with gusts exceeding 200 miles per hour in some locations. Nearly all structures used for nursery production were completely destroyed, including shadehouses, greenhouses, irrigation systems, fencing, and non-reinforced outbuildings. Concrete and well-built wood-frame buildings used for offices, storage, and packaging operations fared better, often with only roof damage, and in most cases were salvageable. Growing stock in nurseries was, of course, devastated, especially taller specimens such as field-grown trees. Many plants not destroyed directly were damaged or died later as a result of desiccation due to lack of irrigation, and solar exposure due to lack of shade. Many larger nursery specimens and landscape trees are only still beginning to show signs of previously undetected damage to roots, one year later. Fears of plant damage and soil contamination by salt water were unrealized with Hurricane Andrew because of a relatively small tidal storm surge and little accompanying rain (5.7 inches). Nurseries were not affected uniformly throughout the county: less damage was suffered by firms in the northern and central parts of Dade where winds were less intense.

In spite of tremendous adversity, approximately 85% of Dade County's nursery firms have rebuilt their facilities or are now in progress with reconstruction. Many growers moved aggressively to start new crops and resume business immediately. Acreage in nursery production is now at an all-time high in Dade County, and production of many ornamental crops has returned to pre-storm levels. Woody ornamental product growers perceived an important opportunity to meet the large demand for replacement of storm-damaged landscape plantings in the County. Expenses for rebuilding were extremely high due to shortages of labor and lack of community infrastructure.

Analysis of Economic Impacts of Hurricane Andrew

Because of the importance of Dade County's ornamental industry in Florida's economy, and the prevalence of agricultural disasters throughout the country, it is important to understand how events such as these impact upon an industry. Better information on the nature of economic impacts of natural disasters is needed by political leaders and policy makers to provide appropriate assistance for recovery and to take steps to avoid or minimize the adverse impacts of future disasters.

The economic impact of Hurricane Andrew on the ornamentals industry in Dade County was evaluated at three levels: individual firms, the ornamentals industry as a whole, and the broader regional economy supported by this industry.

Economic Impacts on Individual Nursery Firms

The economic impacts of Hurricane Andrew on individual nursery firms were examined in detail for a group of 11 firms which previously participated in the University of Florida's Nursery Business Analysis Program (Hodges, 1992). This sample of firms represented all major types of ornamentals production in South Florida, and all suffered extensive hurricane damage. Nursery firms were visited in July 1993 to interview mangers about storm damage and collect recent financial data and other records. Information was compiled on plant sales, other income, expenses, employment, assets, liabilities, and crop production area, both before and after the hurricane. Similar information was previously collected for the three year period 1989-1991, which was used as a baseline to evaluate the impact of Hurricane Andrew on business performance in 1992. For most firms, financial data examined for the 1992 fiscal year represented a period of approximately 4 months (120 days) after the hurricane (Aug. 28 to Dec. 31).

The direct financial impacts of Hurricane Andrew on the 11 firms studied are summarized in Table 1. In spite of exceptionally strong sales during the first 8 months of 1992, average total sales for the year dropped 7% below the average of previous 3 year's sales ($641 to $594 thousand). The September-December period normally has lower sales than other months, but sales for this period after the hurricane dropped to nearly zero, as shown in Figure 1.

Loss of plant inventories was perhaps the most important impact of Hurricane Andrew to nurseries, since a majority of the assets for a typical South Florida nursery are tied-up in plants (Hodges, 1992). Plant inventory values fell by an average of $162 thousand (22%) during 1992, or $6,500 per acre. If the loss of inventories is considered together with loss in plant sales, the overall impact amounted to a 43 percent decrease in average value produced, or $17,200 per acre (Table 1). Damages to plant inventories were actually greater than reflected in these figures because some firms had already replaced a significant amount of inventory by year's end. Damages to structures and equipment could not be measured accurately for individual firms because much was rebuilt by year's end.

All nurseries which experienced hurricane damage had substantially increased costs for cleanup, new production of plants, and replacement of damaged facilities. Cleanup costs varied widely for different firms, depending upon the extent of efforts made to salvage inventory. Costs for cleanup with thorough salvaging ranged as high as $20,000 per acre. Labor costs for 1992 increased by 9 percent over 1989-91 levels (Table 1). Wage rates for hourly labor increased dramatically after the storm due to a labor shortage. Many employees were unable to report for work because of pressing needs to care for their families and damaged homes, and the difficulty of traveling over roads blocked

Table 1. Summary of economic impacts on 11 nursery firms in Dade County, 1992. Changes in values for 1992 compared to averages for previous three-year period (1989-91) are attributed to impact of Hurricane Andrew.

Variable	Average Level 1989-1991 Period	Value for 1992	Percent Change
Plant Sales	$642,000	$594,000	−7%
Value Produced (sales plus inventory change)	$624,000	$355,000	−43%
Production per acre growing space	$41,000	$23,000	−45%
Production per FTE employed	$44,000	$26,000	−41%
Expenses			
Labor	$185,000	$202,000	+9%
Materials	$195,000	$222,000	+14%
Facility & Equipment Operation	$31,000	$84,000	+168%
Administrative Overhead	$76,000	$108,000	+42%
Total Costs	$563,000	$692,000	+23%
Net Income			
(including interest and management costs)	$130,000	−$234,000	−279%
Rate of Return on Net Worth	9.2%	− 32.3%	−450%

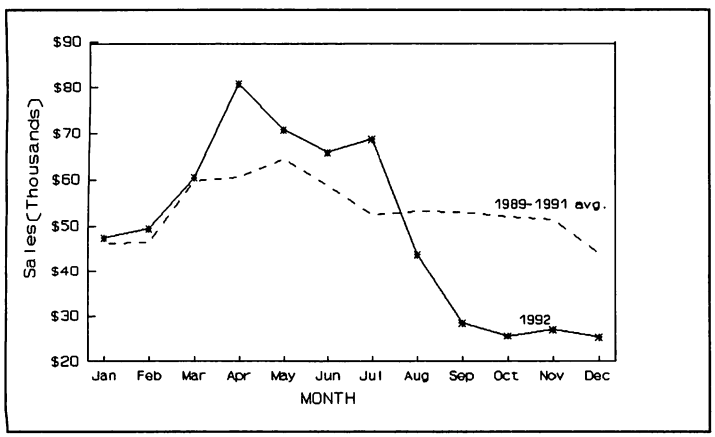

Figure 1. Monthly sales for 11 ornamental nurseries in Dade County, 1989-1992. Drop in sales for Sept.-Dec. 1992 is attributed to Hurricane Andrew.

by downed trees and powerlines. Costs for production materials (containers, soil, fertilizer, chemicals, etc.) increased by 14 percent in 1992, presumably for new production and replacement of damaged supplies (Table 2). Costs for equipment and facilities, including repairs, increased 168 percent, from $31,000 to $84,000 (Table 1). Together, these items represented increased costs of $6,200 per acre. Overhead costs also increased by 42 percent (Table 1).

The effect of increased costs and reduced revenue brought about by Hurricane Andrew resulted in average net income falling from $130 to minus $234 thousand, for the 11 firms studied (Table 1). Rate of return on net worth fell from 9.2 percent to minus 32.3 percent.

Economic Impacts on the Ornamentals Industry as a Whole

Impacts of Hurricane Andrew on the entire ornamental nursery industry in Dade County were estimated based on observations by the investigators and data for ornamentals industry acreage reported by Moseley (1990). Table 2 summarizes these results for four major ornamentals industry categories: container-grown woody ornamentals, field-grown woody ornamentals, greenhouse (flowering plants), and foliage. The acreage of ornamental crops in Dade County affected by the hurricane was 5,500, or 90% of

Table 2. Estimated direct losses to Hurricane Andrew for ornamental nursery industry in Dade County.

	Industry Group				
	Container Ornamentals	Field Ornamentals	Greenhouse[3]	Foliage	Total or Average
Acreage in Production[2]	1,279	3,328	220	1,279	6,106
Acreage affected by Hurricane[1]	90%	90%	90%	90%	90%
	1,151	2,995	198	1,151	5,495
Plant Inventory Per Acre[4]	$59,379	$17,379	$56,013	$27,307	$29,649
Plant Inventory Loss Rate[1]	70%	70%	85%	85%	73.7%
Total Plant Inventory Loss (millions $)	$47.9	$36.4	$9.4	$26.7	$120.4
Fixed Capital Value Per Acre[5]	$8,421	$294	$37,298	$9,033	$5,160
Fixed Capital Loss Rate[6]	69%	61%	80%	80%	68%
Fixed Capital Loss (millions $)	$6.7	$0.5	$5.9	$8.4	$21.5
Cleanup Cost Per Acre[1]	$7,500	$4,000	$10,000	$10,000	$6,206
Total Cleanup Costs (millions $)	$8.6	$12.0	$2.0	$11.5	$34.1
Total Direct Loss	$63.2	$49.0	$17.3	$46.6	$176.0

[1]Observation of damages by IFAS personnel and interviews with growers.
[2]Total acreage from 1989 DPI records. Acreage for container crops allocated between woody ornamentals and foliage crops (Moseley, 1990).
[3]Greenhouse crops are primarily flowering annuals.
[4]Plant inventory per acre at market value. Calculated by dividing average inventory values by average production acreage (Hodges, 1992).
[5]Fixed capital includes buildings and equipment at book value (Hodges, 1992).
[6]Fixed capital loss rates represent 95% loss of buildings/structures, 50% loss of machinery/equipment.

total acreage (Table 2). Direct losses to the industry included plant inventories, fixed capital, and costs for storm cleanup. Over all industry groups, 74% of plant inventories were lost, having and estimated value lost of $120 million. A smaller percentage of inventories were lost for container-grown woody ornamentals because plants were less damaged by solar exposure, root exposure, or falling debris. Fixed capital losses, including equipment, buildings, and other improvement, were estimated at 80% of the average current value, for the acreage affected, for a total value of $22 million. Cleanup costs ranged from $4 to $10 thousand per acre, depending upon the type of facility. Total cleanup costs were estimated at $34 million. Altogether, losses of plant inventories and fixed capital, and costs for cleanup resulted in total direct losses of $176 million for the ornamentals industry in Dade County (Table 2).

Over the long run, the ornamentals industry in Dade County will also suffer substantial indirect losses to Hurri cane Andrew. Indirect losses may be attributed to the time value of lost sales, costs for replanting crops, and costs for replacement of fixed capital. Loss of income means that these costs must be financed by nursery owners, which is associated with an interest cost. To estimate these indirect losses, an 8 percent per year cost for capital financing was applied to the total negative cash flow of lost sales and costs for crop replanting and fixed capital replacement over a period equivalent to the average crop turnover time (1.02 years). These calculations are shown in Table 3 for the four major ornamental nursery industry groups in Dade County.

Total cash flows for indirect losses were estimated at $284 million, which has a time value of $29 million over 1.02 years at 8 percent interest (Table 3). Lost sales were equivalent to lost inventory value, and the time value of this represented a large share of indirect costs. Total costs for replanting destroyed crops was estimated at $118 million, based upon average direct production costs per acre divided by average inventory turnover rates (Hodges, 1992). Fixed capital replacement costs net of fixed capital losses, were estimated at $45 million (Table 3). This calculation was based upon average fixed capital original costs per acre (Hodges, 1992), with direct fixed capital losses (Table 2) deducted to avoid double-counting losses.

Total direct and indirect losses to the ornamental nursery industry in Dade County were estimated at $206 million (Table 3), which exceeds the industry's annual sales of $171 million reported by Moseley (1990).

Economic Impacts on the Regional Economy of Dade County

Impacts of hurricane losses in the ornamental nursery industry were felt throughout the entire economy of Dade County because a large share of this industry's sales are outside the county, which brings "new" money into the local economy and supports additional economic activity. For example, nurseries purchase inputs of fertilizers and chemicals, which supports sales, personal earnings, and jobs in these businesses. Also, wages paid to nursery employees are used for personal consumption of goods such as food, clothing, and shelter, which further stimulates the local economy. The impacts of these effects on Dade County's economy by its agricultural industries was quantified by Moseley (1990), using an Input/Output model (RIMS II, U.S. Commerce Dept., 1986). Multipliers were estimated for local sales (1.826), personal earnings (.632), and employment (.049/$1000) impacts in relation to the value of nursery industry sales outside the county, or "exported". Application of these multipliers for evaluating the economic impacts of lost nursery sales due to Hurricane Andrew is shown in Table 4. First, the nursery industry sales lost for one inventory turn (from Table 3) were adjusted to reflect the share of total sales that are made outside the county ($85 million), based on Moseley's (1990) survey which found that 70.5 percent of industry sales were exports. Then, each multiplier was multiplied by the lost nursery export sales to calculate lost sales activity, lost personal earnings, and lost jobs, respectively, in Dade County as a result of Hurricane Andrew: lost sales in Dade

Table 3. Estimated indirect losses to Hurricane Andrew for ornamental nursery industry in Dade County.

	Industry Group				
	Container Ornamentals	Field Ornamentals	Greenhouse	Foliage	Total or Average
Acreage affected by Hurricane	1,151	2,995	198	1,151	5,495
Total Lost Sales for Inventory Turn (millions $)	$47.9	$36.4	$9.4	$26.7	$120.4
Direct Production Costs Per Acre Annually[3]	$44,491	$4,252	$197,542	$38,728	$26,863
Direct Cost Per Acre for Crop Replanting	$43,632	$12,227	$41,134	$20,120	$27,431
Total Cost for Replanting New Crop (millions $)	$50.2	$36.6	$8.1	$23.2	$118.2
Fixed Capital Replacement Cost Per Acre[4]	$26,671	$1,710	$121,837	$24,733	$16,087
Total Fixed Capital Replacement Cost (millions $, net of Fixed Capital Loss above)	$14.6	$2.6	$13.3	$14.5	$45.0
Total Lost Sales, Replanting, & Capital Replacement Costs (millions $)	$112.7	$75.6	$30.9	$64.4	$283.6
Time Value of Cash Flows for Lost Sales, Replanting, and Capital Replacement Costs (millions $)[5]	$8.8	$17.4	$0.5	$2.7	$29.4
Total Direct and Indirect Losses (millions $)	$72.1	$66.4	$17.8	$49.3	$205.5

[1]Gross sales divided by acreage (Hodges, 1992).
[2]Inventory turnover is annual sales divided by average plant inventory value; is a measure of number of "crops" per year (Hodges, 1992). Turnover period, in years, is reciprocal of inventory turnover ratio (1/T).
[3]Direct costs include labor, materials, and equipment and facility operations. Costs per acre for replanting one crop estimated by dividing annual direct costs per acre by inventory turnover.
[4]Fixed capital replacement cost estimated from original cost (undepreciated) value of buildings and equipment (Hodges, 1992).
[5]Time value of lost sales, replanting, and capital replacement calculated at 8% interest, over period of average inventory turn.

Table 4. Regional economic impacts of Hurricane Andrew resulting from losses in nursery industry.

Lost Nursery Sales for Inventory Turn (see Table 3)	$205,798,954
Percentage of Industry Sales Exported[1]	70.5
Lost Export Sales for Inventory Turn	$145,088,263
Output Multiplier (local sales generated per $1 nursery export sales)[1]	1.826
Lost Revenues in Dade County	$264,858,624
Earnings Multiplier (personal income generated per $1 nursery export sales)[1]	0.632
Lost personal income in Dade County resulting from damage to Nurseries	$91,739,309
Employment Multiplier (jobs generated per $1000 nursery export sales)[1]	0.049
Jobs lost in Dade Co. resulting from damage to nursery industry	7,073

[1]Multipliers are multiplied by lost export sales to estimate lost local revenues, lost personal earnings, and lost employment. Multipliers developed from U.S. Commerce Dept. Input/Output Model (RIMS; Moseley, A., 1990).

were estimated at $155 million; lost personal income at $54 million; 4,139 jobs were lost (Table 4).

Discussion and Conclusions

Hurricane Andrew severely damaged the ornamental nursery industry in Dade County, with estimated losses on the same order as the industry's annual sales. The loss of cash flow was considered a very significant impact of this natural disaster by nursery managers. Other vital losses not evaluated included human resources and plant genetic stocks. After the storm, many key nursery industry employees were forced to leave the area because of insurmountable personal losses. Many collections of plant material which had been gathered from around the world over a lifetime of exploration, were irreplaceably lost. Perhaps the most serious intangible consequence of Hurricane Andrew for the Dade nursery industry, is the loss of markets to competitors. In recent years, the ornamental plant industry has become extremely competitive, due to increasing production and relatively flat demand (Hodges, and Haydu, 1989). Many nursery producers outside of Dade County moved aggressively to increase production in attempt to fill the perceived void in the marketplace. Conventional wisdom holds that natural disasters play a role in structural adjustment of industries with excess capacity by "weeding out" marginal firms that are less capable of recovering. However, the long term effect of the Hurricane on land values and land use development in South Dade County also remains to be seen.

In the wake of Hurricane Andrew, many managers realize the need to more carefully evaluate costs and benefits of better insurance coverage. Insurance coverage for nursery crops and business interruption is very expensive, but insurance payments and government assistance programs are critical to rapid recovery from a major loss and to minimize loss of markets to competitors. Fortunately, many firms in Dade County were in a *strong financial* position at the time of Hurricane Andrew because of recent large payments received for settlement of product liability claims against DuPont's Benlate fungicide.

The experience of Andrew showed that contingency plans are important for a business in case of natural disaster. For nursery operations, plans should include provisions for temporary employee housing, food, and water, because employee's needs for security and survival for themselves and their families must be met first. There should also be a plan for salvage of plant inventories, including means for temporarily maintaining plant material with a backup irrigation system (large sprinklers) and power supply. The rebuilding strategy should be consider the scarcity and increased cost of materials and labor immediately following a natural disaster. Finally, the occasion of a disaster is an opportunity for managers to carefully assess their long term business strategy. In many ways, it is a chance to start anew, to do things differently, without the weight of investment in past practices.

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