

Prolonging Quality of Ornamental Foliage Plants

Case Study 11

Research goal	To determine the environmental conditions for maintaining quality of foliage potted plants during long distance shipping and storage
Beneficiaries	Horticulture Industry
Activities conducted in order to achieve the objectives	Laboratory and simulated shipping experiments to determine the effects of temperature, soil mixes, humidity and phytohormones on several genera of foliage plants during dark storage.
Funding	1 BARD award: I-289-80; \$180,000
Publications	7 journal publications
Students involved	Undetermined.
Stakeholders' collaboration	Israel: Getzler and Hadaron nurseries, The Israel Flower Board US: Vosters nurseries
Environmental impact	None
Social impact	Establishment of an industry and job opportunities in Florida
Commercial engagement	Establishment of broad US cooperation amongst Florida nurseries
Patents	None
Practical agricultural applications	Development of an international market for foliage plants based upon shipping transportation to Europe.
Economic impact	Net Present Value of BARD's investment is \$119 million, and it has already been attained. The Internal rate of return is 89% Benefit cost ratio is 90, and it has already been attained.

1 Objective: Ship Transportation of Tropical Foliage Plants.

The research aimed to determine best methods for storage and transportation of tropical indoor foliage potted plants.

2 Research Activities

At the time of the research, many foliage growers in the United States were interested in the potential for sales in the European market where more foliage plants were bought on a per capita basis. Methods were devised for shipping foliage plants for 2-3 weeks to the European market and up to 4 weeks for shipping to Middle-Eastern countries. Prior research on tropical foliage plants by Richard T. Poole and Charles A. Conover (U. Florida) showed the importance of production factors on interior plant quality and their acclimatization on arrival to non-native lands. Following a sabbatical of Jaacov Ben-Jaacov with these researchers in 1979, a joint BARD study was initiated to determine the optimal conditions for shipping of a variety of foliage plants with high sales potential in Europe in dark storage conditions. Details of the award are listed in Appendix A.

Experiments were conducted in air-tight, constant relative humidity and simulated dark-storage conditions in which the influence of changes in a number of environmental or plant conditions were investigated.

Changing factors included: temperature, soil mix, production fertilizer levels, oxygen levels and cytokinin application (especially 6-benzylamino-purine (BA)). The effect of different watering regimes immediately prior to dark storage were also investigated.

Plant parameters monitored included: plant height, grade or color, as well as root grade, grade, fresh weight, change in pH, leaf abscission and chlorophyll concentrations (though this was shown not to be an indicator of the plants ability to maintain good quality after storage),

Potted plants from many foliage plant genera were monitored including Calamondin (*Citrofortunella microcarpa*), *Dracaena*, *Ficus benjamina*, Areca palm (*Chrysalidocarpus lutescens*), *Aglaonema*, *Brassaia*, *Schefflera arboricola* and *Spathiphyllum*

The research results demonstrated that plants to be shipped must be acclimatized and have a moist potting at the time of shipping. High humidity (RH = 85-90) must be maintained within the reefer at all times. The optimal temperature to minimize leaf abscission is specific for each foliage crop and a list of recommended temperatures for 36 plants for periods of 1-15 and 15-30 shipping days was compiled, publicized and circulated. Genotypic variations (cultivar differences) in *F. benjamina* were also shown to be a major factor affecting storability and subsequent performance under simulated home conditions.

In addition, the researchers studied the possibility of shipping bare-root plants which could lead to great savings on transportation costs in comparison to shipping potted plants. Bare root plants would also eliminate dangers of transferring soil-borne pests between countries. Bare-root *Ficus benjamina* foliage plants were produced either by growing plants in hydroponic culture or in pots and washing off the soil from the roots prior to storage

The results demonstrated the feasibility of shipment of bare-root foliage plants, and to the possibility of reducing shipping expenses by saving transport of soil and containers.

2.1 Publications

8 publications were derived from the single research award.

2.2 Capacity Building

Due to the long period of time passed since this award was granted (nearly 40 years), we were unable to ascertain the number of students involved in this project.

3 Stakeholder's Collaboration

The majority of foliage plants are indigenous to either the tropics or subtropics and thus suited to grow in the climates of Florida and Israel.

Many nurseries in both Israel and the US were involved in the research advancements and early application of the research results; amongst them: Vosters nurseries in the US and Getzler and Hadaron nurseries in Israel, as well as the Israel Flower Board and the Florida Foliage Association (now defunct).

Following the studies on bare-rooted plants, the Granot Co-operative (a regional organization owned by 43 Kibbutzim and Moshavim in the center of Israel) initiated new nurseries in 5 kibbutzim to advance hydroponic growth of foliage plants. Of these, the nursery in Kibbutz Mei-Ami is still active and thriving (growing soil and hydroponic plants)

In Israel, the research on foliage potted plants provided a foundation for continued studies (1997-2003) on flowering potted plants. Similar experiments were conducted with simulated shipping conditions to determine the effects of shipping temperature on the duration on flower longevity as well as leaf abscission. Agrexco, the major Israeli export agency at the time, was also party to these studies (funding and enabling shipping trials) and encouraged ship transportation to Holland amongst their Israeli nursery clients. Following the dissolution of Agrexco, the Israeli nurseries mostly reverted back to transporting the flowering plants to Europe by air-freight which was judged to be more advantageous for the plant.

4 Commercial Engagement

The gained knowledge was disseminated through horticulture extension services, the Mid-Florida Research and Education Center and export providers. Commercial industry benefited immensely from the new knowledge and know-how. No formal commercial engagement was initiated.

5 Practical Agricultural Applications

The potential for shipping large foliage plants (in 20-cm pots or larger) throughout the world was demonstrated by this research and early commercial experience.

The results from this project was a turning point for the Florida tropical foliage industry and opened up the European market that was previously inhibitive due to high airplane costs for the larger potted plants. Based on observations made during the research and early Florida shipments, Conover and Poole published a suggested list of shipping temperatures and durations for 36 genera. The plants were shipped to Holland; either directly to a buyer or following acclimatization, to participate in auctions. The plants are used in large buildings, shopping malls etc. Following this work the number of US exporters of these plants rose from 5 in the early 80's to 60 in the late 80's. These were dominantly from Florida with a few from California and Texas. To date, Florida leads the States ranking for production of indoor plants and Apopka, the dominant growing region is commonly identified as the Indoor Foliage Capital of the World.

In Israel, the project did not lead immediately to increased exports by shipping, probably due to differences in pricing between aviation exports between the US and Israel. This work, and additional research of J. Ben-Jaacov did however lead to increased activity of nurseries growing tropical foliage plants and greater exports. Between 2006 and 2011 (when the company was dismantled), Agrexco promoted exports of potted flowering and non-flowering plants by ship with tens of containers being shipped weekly, each one containing thousands of plants.

6 Economic Impact

6.1 Investment Cost

BARD contributed \$180,000 in research funds between 1981-1983.

6.2 The Benefits

Florida has led the nation in the production of foliage plants, accounting for more than 55% of the national wholesale value since the 1960s. Today, Florida dominates U.S. production of tropical foliage crops with over 90 percent of nationwide sales.

During the 80's, exports to countries such as Canada, Europe (UK, Netherlands, Sweden and Denmark) and the Bahamas, catered to the growing demand for "interior landscaping" in commercial construction. Transport was by air, truck or sea dependent on the destination

Personal communication with Florida nursery owners confirmed the onset of shipping to Europe in the early 80's, and the change (and excitement) it provided for the industry. However, lack of available data sets makes the quantitative assessment of this change difficult.

Reports on trading of the relevant group of tropical plants (*Dracaena, Ficus, Glaxonia, Schefflera Amata* etc..) is categorized today in the Harmonized System (HS) of tariff nomenclature under HS code 06029090. However, the USA Trade Online from the US Census Bureau, has trade data starting only in 2001, and historic data from the US Commerce Department back to 1950s is only for total trade of all commodities and services, with no details for specific commodities.

Data is available from a USDA – Economic Research Service (ERS) report¹ on exports of potted foliage plants between 1986 - 1998 with dollar value sales of between \$20 million in 1986 to \$44 million in 1998. However, we have no knowledge of the fraction that is exported to Europe, though a publication in the Proceedings of the Florida State Horticultural Society from 1986² states export values for tropical foliage plants of \$40 million, of which most is from exports to Europe. Moreover, we know that plant sales to Canada are not separated from U.S. sales.

From personal communication³ we know that the export by ships to Europe was successful until international competitors got into the market and shipments from the US declined. We do not have a date for this change in trend. However, an EU report on Flowers and Ornamental Plants⁴ that details amounts and monetary value of imports of horticulture by category and country between 2004-2014 already does not include the US in its attribution of imports of potted plants for this time span.

Due to these difficulties in retrieval of data we refer to historic reports to estimate the benefits. BARD conducted an evaluation of its activities in 1988. Documentation within reports of increasing exports to Europe from 0.5 million in 1982 to between \$6 and \$7 million in 1985 to \$10 million in 1987 with projected sales of \$20 million in 1988 (East Marsh Nursery).

¹ Floriculture and Environmental Horticulture Situation and Outlook Report. Market and Trade Economics Division, Economic Research Service, U.S. Department of Agriculture, October 1999, FLO-1999, page 32.

² Proc. Fla. State. Hort. Soc. 99:232-1986; L. A. Risse et. al Export of potted ornamental foliage plants to Europe in refrigerated van containers with an under-the load air delivery system.

³ Personal Communication; Alan Hodges and Lynn Gustafson

⁴ European Commission, Working Document, Civil Dialogue Group - Horticultural Products, Flowers and Ornamental Plants, 02/10/2015.

We note that when comparing the BARD report data and the ERS data stated above, the value of the total exports of potted foliage plants in 1986 are three-fold the value attributed to export to Europe in the BARD evaluation (\$20 million vs. \$6-7 million). A 1987 newspaper reporting⁵ that quotes industry estimates provides similar numbers, that is: since 1981, Florida's ornamental-plant sales to Europe jumped from about \$500,000 annually to \$12 million a year (correct to 1987) and that the USDA estimates are lower, at \$10 million for 1987.

We calculate the benefits till 1989 according to the data above, taking 1989 also as \$20 million. We calculate export value for the next decade based on a Florida Extension Services report stating exports of ornamental plants through 1989- 1999 for a subset of Florida nurseries⁶. To derive the export values for the entire industry, rather than just the surveyed nurseries, we use the ratio of the stated export sales for each year relative to the stated sales in 1989, whilst taking the entire industries sales in 1989 as \$20 million. This report already shows a steady decline in exports to Europe between 1989-1999 and we terminate our benefit evaluation in this year.

The early BARD evaluation report calculates a benefit based on a 15% profit rate to the industry. From personal communication with industry members today we were told this is very low and that the profit rate should be attributed as between 25-35%. We calculated according to 25%.

6.3 Economic Results

The project was part of an intensive effort of the researchers at University of Florida's, (IFAS) Agricultural Research Center to provide scientific data to support the growing Florida foliage plant industry. The 10-year BARD evaluation report attributed the full benefits of the ensuing exports to the BARD award. In line with our current methodology, we believe it more appropriate to apply a conservative estimate and to attribute 75% of the benefit to BARD.

- The Net Present Value of BARD's investment is \$119 million, and it has already been attained.
- The Internal rate of return is 89%
- Benefit cost ratio is 90, and it has already been attained.

The US economy benefit is calculated according to the export estimations. In Israel the methodology was adopted later on, combined with other developments.

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⁶ A. W. Hodges and J.J Haydu; Decade of Change in Florida's Ornamental Plant Nursery Industry, 1989 to 1999, EDIS Document FE 177, a Department of Food and Resource Economics, IFAS, 2000

Table 1: Main Results, 2018 Million Dollar-Terms

	The Project	BARD	BARD Attained	Thereof to the US	Thereof to Israel	Other Countries
BARD's Share in the Cost	50%					
Share in the Benefit		50%				
Cost	1.4	1.4	1.4	0.7	0.7	
Benefit	160	120	120			
Net Present Value	158	119	119	119	-1	0
Internal Rate of Return	98%	89%	89%	112%		
Benefit Cost Ratio	120	90	90	178	-1	

6.4 Sensitivity Analysis

The low and high alternative assumptions used in the sensitivity analysis were brought together to estimate results under pessimistic and optimistic scenarios. Table 3 displays the net present value sensitivity results, between the low result: \$51 million, to the high result: \$202 million.

Table 2: NPV - Sensitivity Analysis, 2018 Million Dollar-Terms

			<u>BARD's Share in the Benefit</u>		
			Low	Central	High
			65%	75%	85%
<u>Change in Benefit</u>	Low	50%	51	59	67
	Central	100%	103	119	135
	High	150%	154	178	202

7 Appendix A: BARD Awards

Table 3: Details of the BARD award

Project No	Full Title				
	Investigators	Institutes	Budget	Duration	Start Year
I-289-80	Factors affecting Shipping and Storage of Ornamental Foliage Plants				
	J. Ben-Jaacov C.A. Conover R.T. Poole B. Steinitz	ARO U. Florida U. Florida ARO	\$180,000	2 years	1980

8 Appendix B: Information providers: Personal communication

- Yaacov ben Yaacov - PI on BARD grant, Department of Ornamental Horticulture, ARO
- Oren Shaked - USDA Foreign Agricultural Service, in the past worked at Agrexco.
- Irit Mashiach - Nursery Owner, Tzur Moshe, Israel
- Alan Hodges – Economic Analyst, Food and Resource Economics Department, University of Florida (Retired)
- Ben Bolusky – CEO, Florida Nurseries and Growers Landscape Association (FNGLA)
- Lynn Gustafson - LG Plants, Florida (previously at family's East Marsh nursery)