*J. Amer. Soc. Hort. Sci.* 109(4):578–583. 1984.

# Determining Marketing Efficiency of Floricultural Production Firms by Market Channel, Market Period, and Size of Firm

**Robin G. Brumfield,[1] Arthur J. Coutu,[2] Paul V. Nelson,[3] Daniel H. Willits,[4] and Robert S. Sowell[4]**
*North Carolina State University, Raleigh, NC 27650*

**Robert G. Anderson**
*Department of Horticulture and Landscape Architecture, University of Kentucky, Lexington, KY 40546*

*Additional index words.* economic efficiency, technical efficiency, price efficiency

***Abstract.*** **Economic efficiencies were greatest in peak sales periods in surveyed floricultural firms selling both to retail florists, and mass markets. Efficiency decreased in intermediate and slack sales periods. About the same procedures were followed in each time period, but sales were reduced in intermediate, and slack periods. Surveyed firms selling to mass markets sold bedding plants during peak periods which required no variable labor or capital marketing inputs; thus, they were more technically efficient than firms selling to retail florists during the peak period. Economies of size were found in the retail florist channel but not in the mass market channel. Maximum economic efficiency was reached at a smaller size by firms selling to mass markets, indicating that the mass market channel was more competitive in the marketing function than was the retail florist channel. Large differences in technical efficiency were found within groups, indicating that increased profit could be made by the least efficient firms adopting the efficient technology of the most efficient firms within the same group. Within groups, the most efficient firms utilized more fully their fixed inputs than did the least efficient, and were thus able to expend a reduced percentage of sales on variable inputs. A persistant problem for the least efficient firms, especially during slack periods, was a delivery cost larger than that of the most efficient firms resulting from an increase in distance and number of stops.**

The 2 major floricultural wholesale marketing channels involve 1) mass market outlets, such as supermarkets and discount stores, and 2 full-service retail florists. Products sold to the 2 markets are different. Plants going to the mass market usually are small, and are grown at a close spacing (5) in plastic rather than clay pots. They are sold before they leave the greenhouse. Plants sold to retail florists are larger than plants sold to mass markets, and are sold after they leave the greenhouse by a truck driver-salesperson.

An explanation of the levels and differences in economic efficiency between the 2 marketing alternatives could assist managers who lack efficiency in making marketing decisions or changes in marketing techniques. Economic efficiency can be sub-divided into technical and price efficiency (6, 15). This efficiency is associated with economies of scale. The most technically efficient firms produce the greatest output from a given set of inputs. The most price efficient firms maximize profits; they equate the marginal product of each input to its price. Price efficiency is associated with adjusting the factor mix to relative factor prices. Economic efficiency is found by combining the technical and price efficiency.

Two different approaches to determine economic efficiency have been used. One method is to estimate a firm's average production function by a statistical method such as the Cobb Douglas production function (7, 10, 13, 14, 15). A 2nd method developed by Farrell (6) is the efficient unit isoquant which defines the smallest amount of one input required to produce one unit of output as a 2nd input is varied. This is called the frontier production function (1, 2, 3, 4, 8, 9, 11, 12), and is the approach used in this study.

Price efficiency, technical efficiency, and economic efficiency indexes were determined in the floricultural marketing process for 3 sizes of firms, 2 market channels, and 3 market periods. Firms with production areas of less than 4500 $m^2$, 4500 $m^2$ to 22,500 $m^2$, and greater than 22,500 $m^2$ were grouped into small, medium, and large size categories, respectively. The markets were either the retail florist market or the mass market. Market periods according to surveyed sales volume were peak, intermediate, and slack. A two-input, single-output model was used with inputs of capital and labor measured in dollars, and output in $100 of sales.

The objectives of this paper are to isolate the inputs used in developing efficiency indexes and explore: (A) components of efficiency and where improvements can be made in economic efficiences; (B) the types of differences in efficiency that exist within and between markets; (C) if firm size and sales periods

Received for publication 25 July 1983. Paper No. 8937 of the Journal Series of the N.C. Agr. Res. Ser., Raleigh, NC 27650, and paper no. 82-10-4 of the Ky. Agri. Expt. Sta. Use of trade names does not imply endorsement by the N.C. Agr. Res. Ser. or Ky. Agr. Expt. Sta. of the products named or criticism of similar products not mentioned. Technical assistance of Ed Estes and Richard Perrin, Dept. of Econ. and Business, N.C. State Univ., Raleigh, NC; Charles Proctor, Dept. of Statistics, N.C. State Univ., Raleigh, NC; The Flower Grow. of N.C. and Ky.; and the allied industry is gratefully acknowledged. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.

[1]Assistant Professor, Dept. of Hort., Penn. State Univ., Univ. Park, Penn. 16802.
[2]Professor, Dept. of Econ. and Business.
[3]Professor, Dept. of Hort. Sci.
[4]Associate Professor, Dept. of Biol. and Agr. Eng.
[5]Professor, Dept. of Biol. and Agr. Eng.

have impacts within markets; and (D) specific technical options where improvements in technical efficiency can be made.

## Materials and Methods

Sixteen floriculture production enterprises in North Carolina and Kentucky were surveyed beginning in the fall of 1980, and continuing through the summer of 1981. Firms were selected based on their willingness to share marketing information. Three firms of each market channel and size were selected except for the large and medium florist channel where 2 firms were used because a 3rd firm could not be found in the region surveyed. Since ouput was measured in terms of hundreds of dollars of sales, managers were asked to define peak, intermediate, and slack sales period in terms of dates, plants sold, and volume of sales during those periods. The inputs of labor and capital were determined from surveys at each firm by period.

Labor was determined in minutes per $100 of sales in each sales period. The operations were classified into predelivery (staking, selection, sleeving, foiling, boxing, loading trucks, and disposal of unsold plants), delivery, and overhead labor (posting, billing, advertising, and sales transactions). Each firm was surveyed to determine the labor per $100 of sales, and wages of each employee involved in each marketing function. Time and motion studies were concluded to determine predelivery labor. The delivery time was obtained from forms on which truck drivers determined the distance travelled, and time spent driving and unloading. The types of plants sold and the dollar value of each were determined for the surveyed loads. An estimate of the amount of time spent on each overhead labor function in each period was obtained from the people performing each function.

The predelivery and overhead functions usually occurred in an enclosed structure. A description of these physical facilities used in the marketing process including size, type of construction materials, and age was obtained from each surveyed firm. The percentage of the buildings utilized for marketing was used to determine the cost of capital involved in marketing.

Carts, wagons, and motorized cars, were often used in predelivery processes. The number, size, type, age, and percentage of time the equipment was used for marketing were determined from surveys. The major fixed capital cost was the cost of delivery trucks. Managers were asked the make, age, length, width, height, capacity, annual distance travelled, and maintenance costs for each of the delivery trucks. A market value of depreciation, interest, taxes, insurance, and repairs was assigned to each piece of equipment and physical facility.

Additional trucks were rented by large and medium firms selling to mass markets during peak sales periods. Managers were asked the number of trucks, truck size, and periods for which trucks were rented. The rental cost was obtained from managers, and was included in the overhead costs for periods that truck rental occurred.

The quantity of variable capital components of stakes, sleeves, foil, and boxes were determined per $100 of sales for each observation. Current replacement prices, including freight, were applied to each component.

Several deliveries were sampled at each firm during each market period to determine gas mileage (kilometers per liter) for each delivery truck as well as other operating costs, such as lubricants and maintenance, for the delivery trucks. The variable cost of running the delivery trucks was calculated for each observation using the driver's log of distance and sales.

## Results and Discussion

*Surveyed marketing costs.* The average wage of predelivery employees across all firms was $5.00 per hour. The base wage was $4.03 per hour plus 24% for benefits of social security, workman's compensation, unemployment insurance, 6 annual paid holidays, 5 annual days of sick leave, and one week of paid vacation.

Delivery labor for firms selling to both retail florists and mass markets was performed by the truck driver salesperson who delivered and unloaded plants. The average wage for truck drivers, including base pay plus 24% benefits, was $6.11 per hour for drivers selling to mass markets, and $7.17 for drivers selling to retail florists. The higher wage for drivers selling to retail florists occurred because they were salespeople receiving a commission; whereas, the drivers selling to mass markets merely delivered presold plants.

Capital costs for marketing consisted of a distance cost, variable capital cost, and overhead capital cost. The distance cost included fuel at $0.11 per km (3.4 km per l @ $0.37 per l), lubricants of $0.01 per km, and maintenance of $0.01 per km. Current replacement prices were estimaed using an interest rate of 15%, a tax rate of 0.415%, and insurance rate of 6.6%, for vehicles, 0.6% for buildings, and 0.5% for equipment.

Several reasons exist for the differences in sales periods. In both market channels, the peak period constituted 20% of the year. The sales volume during the peak period accounted for 55% of the sales revenue in firms selling to mass markets, but only 30% of the sales revenue in firms selling to retail florists. Sales were distributed evenly in firms selling to retail florists while firms selling to mass markets had sharp peaks and valleys in their sales revenue.

*Economic efficiency.* Observations for all markets, sizes, and market periods were plotted on one graph (Fig. 1), and fitted with an equilateral hyperbola to represent the frontier production function for all of the points. The majority of observations were

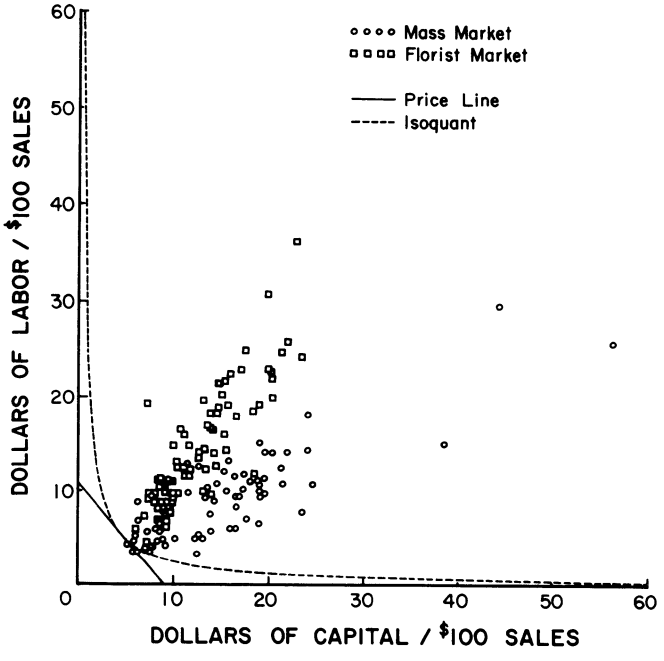


Fig. 1. Frontier production function, price line and scatter of observations for floricultural firms marketing to mass markets and florist markets with a capital cost of 15%.

within a narrow angle, indicating that labor and capital involved in the marketing process were complements rather than substitutes. If only one market channel was considered, the angle was even smaller; firms selling to mass markets used slightly more capital than firms selling to retail florists while the latter used slightly more labor (Table 1).

The firms selling to retail florists paid higher wages to the truck drivers, but received a higher price for their product than did the firms selling to mass markets. Even though firms selling to florists may have spent more dollars on labor, they may not have necessarily spent a higher percentage of sales on labor than did firms selling to mass markets.

The technical efficiency calculations were based on one frontier production function for all observations. When statistically analyzed, F tests were highly significant for interactions of market and sales period, and market and size. The sales period effect was significant within the florist market (Table 2 and Fig. 2). The peak sales period was the most technically efficient followed by the intermediate and slack periods, respectively. Sales were greatest in the peak period; almost all products on the delivery trucks were sold. Thus, less labor and capital were used in the peak period per $100 of sales than in intermediate or slack periods during which some plants loaded onto trucks were not sold.

Firms marketing to retail florists exhibited an economy of size for technical efficiency (Fig. 3). Firms producing plants for retail florists grew a range of species, and the organization of crews was difficult for small firms loading only a few of each species. In large sized firms, several trucks were loaded each day, allowing crews to select increased numbers of plants in the same area. The improved sales volume of large firms allowed the trucks to be utilized more fully than in small firms; thus, labor and capital were employed more effectively.

Firms marketing to mass outlets were able to increase technical efficiency in the peak sales periods (Table 2). Intermediate sales periods were less technically efficient than peak periods, and slack periods were the least efficient. Typically, presold plants were loaded onto trucks going to mass markets. Decreased sales in intermediate and slack periods resulted in trucks with a reduced payload per km which increased capital costs. Drivers deliveries per hour also were reduced which increased labor costs. Differences in efficiency during sales periods were due to changes in sales volume which resulted in differences in ability to utilize capital and labor fully.

Firms selling to mass markets showed no differences in technical efficiency between sizes (Fig. 4). Since only presold plants were selected, loaded and delivered, firm size offered no advantage to the marketing process.

Table 1. Estimated average total dollars of capital and labor used per $100 of sales in the marketing process of floricultural firms by size of firm, market channel and market period.

| Size of firm | Market channel | Sales period | | | | | |
|---|---|---|---|---|---|---|---|
| | | Peak | | Intermediate | | Slack | |
| | | Labor | Capital | Labor | Capital | Labor | Capital |
| Small | Mass | 4.92 | 6.91 | 10.36 | 16.00 | 15.95 | 26.10 |
| Medium | Mass | 7.59 | 10.62 | 10.70 | 19.72 | 13.24 | 25.22 |
| Large | Mass | 5.20 | 9.80 | 7.52 | 18.26 | 12.26 | 19.36 |
| Small | Florist | 13.54 | 11.20 | 17.25 | 14.31 | 21.46 | 19.36 |
| Medium | Florist | 12.49 | 8.61 | 13.21 | 12.18 | 20.83 | 16.16 |
| Large | Florist | 8.14 | 8.64 | 8.95 | 8.93 | 14.11 | 13.41 |

Table 2. Comparison of technical efficiency coefficients of the marketing process of floricultural firms differentiated by size of firm, market channel, and market period.

| Size of firm | Market channel | Period | | |
|---|---|---|---|---|
| | | Peak | Intermediate | Slack |
| Small | Florist | 0.41 | 0.33 | 0.24 |
| Medium | Florist | 0.49 | 0.42 | 0.27 |
| Large | Florist | 0.60 | 0.55 | 0.36 |
| Small | Mass | 0.86 | 0.44 | 0.28 |
| Medium | Mass | 0.63 | 0.46 | 0.36 |
| Large | Mass | 0.74 | 0.43 | 0.33 |

Avg LSD (0.01 one-tailed) = 0.13. This average LSD can be used to compare sets of 2 coefficients.

The technical efficiency decreased in the order of peak, intermediate, and slack sales periods, respectively, between markets. Firms selling to mass market outlets were significantly more efficient than firms selling to florists during the peak sales period. Surveyed firms selling to mass outlets sold primarily bedding plants during the peak period. Bedding plants did not require variable capital costs, such as sleeves, boxes, or foil; no additional labor was required to apply these variable capital costs. Also, producers for the mass market used less of both labor and capital during the peak sales period, and were more technically efficient than firms producing for retail florists in all 3 sizes.

Economies of size occurred in the channel of firms selling to retail florists but not in the channel of firms selling to mass markets. This difference indicated that the mass market channel was more competitive in the marketing function than was the retail florist channel. Maximum efficiency was reached at a smaller size in firms selling to mass markets as compared with firms selling to retail outlets.

A change in relative prices had little effect on differences in economic efficiency since differences were due to technology

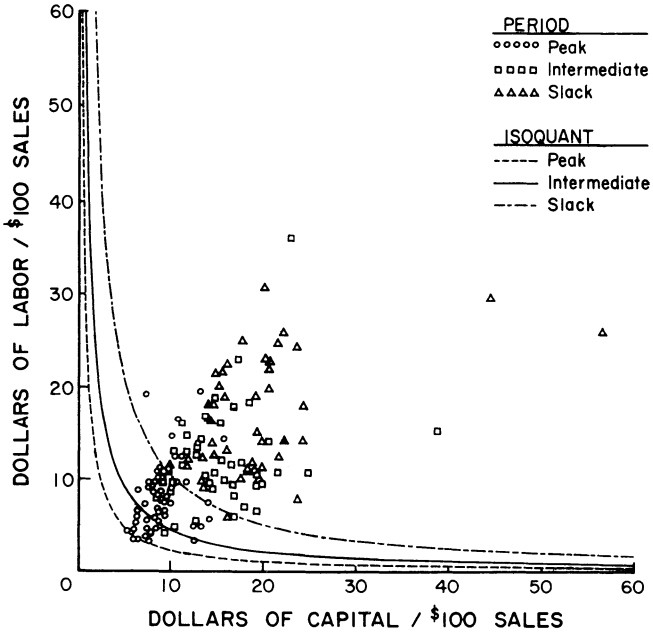


Fig. 2. Frontier production function and scatter of observations for floricultural firms by sales period.

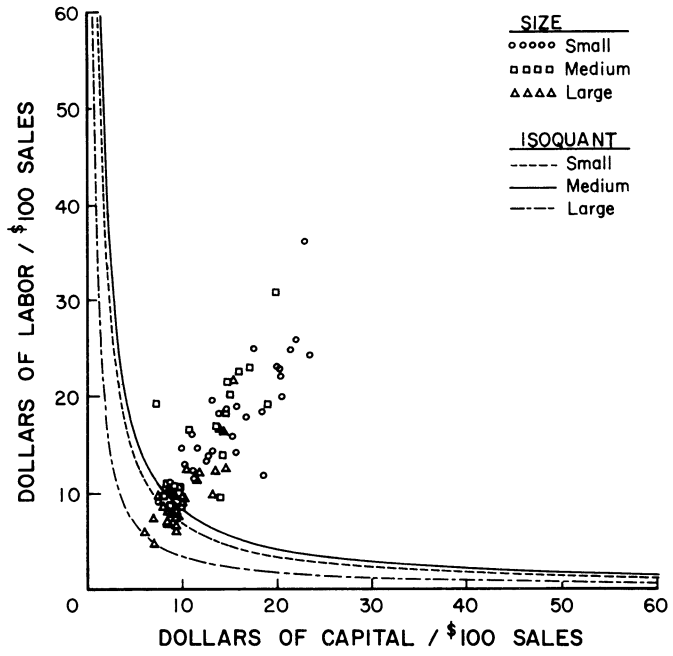


Fig. 3. Frontier production function and scatter of observations for flower shop firms by size.

rather than the way price entered into the allocation of resources. The inability to substitute capital for labor suggested that new types of machinery may be needed in the marketing process to replace labor. Some equipment exists, such as sleeving machines and carts for loading selected plants, but use of this equipment involves labor. Use of packaging materials, such as sleeves and boxes, eased the delivery process, and reduced delivery labor. Application of these materials in the selection process required additional predelivery labor, however, and both labor and capital increased. Investing in equipment and supplies to be used in the marketing process does not mean a corresponding reduction in labor. Engineering or floriculture firms who develop machinery or systems to reduce marketing costs must be sure the equipment or system reduces labor as well.

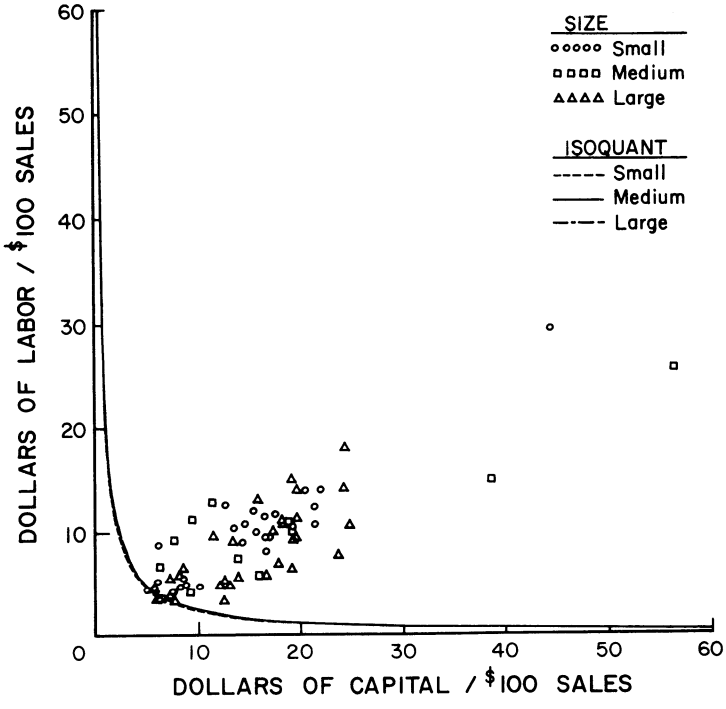


Fig. 4. Frontier production function and scatter of observations for mass market firms by size.

*Reasons for surveyed inefficiences.* Another way to characterize these results is to identify the least and most technically efficient firms. Identification of these firms within market type, sales period, and size permits an explanation of differences in efficiences in terms of the 3 components of capital, and the 3 components of labor (Tables 3 and 4). In many categories there were large differences between the least and most efficient firms per $100 of sales. When this is multiplied by thousands of dollars of sales it suggests areas where substantial profit could be made by changing technology.

Least efficient firms expended a higher percentage of their marketing inputs on overhead labor and capital, and less on the variable inputs than did the most efficient firms. The most efficient firms utilized their fixed inputs more effectively, and were able to spend a higher percentage of their marketing costs on overhead labor and capital in comparison to the least efficient firms. They spent fewer dollars on variable inputs even though a higher percentage of marketing costs was spent on variable costs.

The most efficient large firm selling to retail florists during the peak period spent $1.58 in predelivery labor while the least efficient spent $6.38 on predelivery labor (Table 3). Costs for both of these firms were calculated using the same prices, yet the least efficient firm used 4 times as much predelivery labor as the most efficient firm. The crew size may have been too large, the labor inefficient or improperly managed in the least efficient firm. The least efficient firm used 2.5 times as much overhead labor as the most efficient firm suggesting that the overhead labor was allocated inefficiently. The manager should review the management structure, and delegate responsibilities of lesser importance to other employees.

The most efficient firm used $2.35 of delivery labor, while the least efficient firm used twice that amount. Capital spent on the distance factor by the least efficient firm was twice that of the most efficient firm. Producers for the retail markets ran route trucks with few presold items, except during peak periods. Trucks often stopped at many flower shops where no purchases were made, thus increasing the labor and capital distance costs. Perhaps managers should instruct the truck drivers in sales efficiency, consider advertising to boost sales, eliminate florists who consistently purchase small volumes, seek retailers close to the greenhouse, reduce the frequency of deliveries to increase sales per trip, presell the plants, or change for low volume stops. The least efficient firm used 3 times as much variable capital per $100 of sales as did the most efficient firm. The least efficient firm did not obtain the best rate of return from investment in these inputs. The high cost of this factor and the high predelivery cost suggest that many of the plants which were loaded onto the truck were sold. Low sales per truckload also would account for the high delivery labor cost, and distance capital costs. The overhead cost was the same for both the most efficient and least efficient firms; thus, improved management of variable costs is needed by the least efficient firm.

The least efficient small firm selling to mass markets used 17 times as much predelivery labor and 10 times as much distance capital during the slack sales period as did the most efficient small firm selling to mass markets (Table 4). This was the result

Table 3. Comparison of labor and capital per $100 of sales used in the most efficient and least efficient firms marketing to florists.

| Size of Firm | Sales period | Level of efficiency | Input (Dollars per $100 of sales) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Labor | | | Capital | | |
| | | | Predel. | Del. | Overhead | Distance | Variable | Overhead |
| Small | Peak | Most | $1.28 | $5.41 | $2.35 | $0.94 | $0.20 | $6.33 |
| Small | Peak | Least | 3.40 | 14.62 | 1.55 | 3.69 | 1.75 | 7.63 |
| Medium | Peak | Most | 3.09 | 2.46 | 2.07 | 1.76 | 2.10 | 4.75 |
| Medium | Peak | Least | 3.68 | 8.41 | 4.35 | 4.93 | 2.12 | 3.67 |
| Large | Peak | Most | 1.58 | 2.35 | 0.67 | 1.91 | 0.80 | 4.58 |
| Large | Peak | Least | 6.38 | 4.20 | 1.75 | 3.55 | 2.23 | 4.55 |
| Small | Inter. | Most | 0.96 | 8.75 | 1.94 | 4.04 | 2.38 | 4.79 |
| Small | Inter. | Least | 7.28 | 25.51 | 3.33 | 13.34 | 1.37 | 8.08 |
| Medium | Inter. | Most | 1.23 | 4.43 | 2.94 | 2.78 | 1.27 | 5.76 |
| Medium | Inter. | Least | 3.52 | 10.38 | 2.94 | 4.03 | 3.77 | 5.76 |
| Large | Inter. | Most | 3.16 | 2.35 | 2.50 | 0.78 | 1.94 | 5.55 |
| Large | Inter. | Least | 3.47 | 3.59 | 2.50 | 2.47 | 1.97 | 5.55 |
| Small | Slack | Most | 2.39 | 7.12 | 2.24 | 5.47 | 2.00 | 11.03 |
| Small | Slack | Least | 6.17 | 15.76 | 3.89 | 6.70 | 0.00 | 15.21 |
| Medium | Slack | Most | 1.70 | 7.00 | 5.18 | 4.63 | 1.14 | 8.49 |
| Medium | Slack | Least | 4.26 | 21.88 | 4.53 | 11.05 | 3.23 | 5.53 |
| Large | Slack | Most | 1.24 | 4.26 | 4.27 | 4.39 | 0.78 | 7.93 |
| Large | Slack | Least | 7.28 | 9.97 | 4.41 | 3.19 | 4.00 | 8.14 |

of a round trip of over 180 miles to deliver a payload of only $120. The average distance traveled by surveyed small firms selling to mass markets during slack periods was 58 miles per $100 of sales with an average payload of $514. The manager acknowledged that he lost money on this trip, but had to deliver the plants to keep a customer whose purchases increased in other periods. This was a persistent problem during slack sales periods. The alternative seems to be the elimination of sales during slack periods, thus incurring only fixed, and not variable costs. To hire and train a new work crew in the other periods has a cost, however, and it is necessary to keep a steady clientele. The cost of delivering during slack periods was considered by floricultural firms to be, in part, an advertising cost. Techniques to reduce this cost would require minimum orders, charging a delivery fee, or trying to group orders to make as few trips as possible with small payloads.

The least efficient, medium-sized firms selling to mass markets for slack sales periods (Table 4) had invested more than normal in overhead capital. The firm used the greatest amount of overhead capital in this period (Fig. 2). The owner had purchased equipment and facilities which could be utilized during the busy bedding plant season, but could not be utilized fully during the remainder of the year. Equipment rental during the peak period should be considered. This firm used more delivery labor and distance capital than the most efficient firm and was overextended in overhead labor.

The least efficient, large-sized firm selling to mass markets used $5.39 in predelivery labor during the peak sales period as

Table 4. Comparison of labor and capital per $100 of sales used in the most efficient, and least efficient firms marketing to mass outlets.

| Size of Firm | Sales period | Level of efficiency | Input (Dollars per $100 of sales) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Labor | | | Capital | | |
| | | | Predel. | Del. | Overhead | Distance | Variable | Overhead |
| Small | Peak | Most | $1.39 | $1.13 | $0.89 | $1.22 | $0.00 | $4.93 |
| Small | Peak | Least | 5.77 | 1.40 | 1.60 | 1.12 | 0.00 | 5.11 |
| Medium | Peak | Most | 0.49 | 2.60 | 0.46 | 1.92 | 0.55 | 3.81 |
| Medium | Peak | Least | 2.95 | 5.16 | 2.77 | 7.60 | 0.00 | 11.18 |
| Large | Peak | Most | 0.70 | 1.96 | 0.82 | 2.59 | 0.00 | 3.26 |
| Large | Peak | Least | 5.39 | 3.53 | 0.73 | 5.81 | 0.00 | 5.74 |
| Small | Inter. | Most | 1.36 | 2.41 | 1.07 | 1.26 | 0.00 | 8.96 |
| Small | Inter. | Least | 2.38 | 8.00 | 3.59 | 12.57 | 2.33 | 5.49 |
| Medium | Inter. | Most | 2.84 | 0.40 | 0.96 | 0.34 | 1.24 | 7.57 |
| Medium | Inter. | Least | 3.67 | 3.78 | 7.60 | 10.86 | 3.36 | 24.37 |
| Large | Inter. | Most | 1.64 | 1.27 | 2.43 | 2.00 | 5.32 | 5.29 |
| Large | Inter. | Least | 1.55 | 6.49 | 2.61 | 8.07 | 10.37 | 6.26 |
| Small | Slack | Most | 1.18 | 2.32 | 5.90 | 3.43 | 0.00 | 13.88 |
| Small | Slack | Least | 20.03 | 1.83 | 7.76 | 34.61 | 0.12 | 9.50 |
| Medium | Slack | Most | 3.65 | 2.95 | 4.56 | 2.22 | 0.00 | 7.25 |
| Medium | Slack | Least | 1.98 | 7.47 | 16.40 | 9.22 | 0.00 | 47.05 |
| Large | Slack | Most | 4.48 | 1.19 | 3.50 | 0.69 | 0.00 | 12.68 |
| Large | Slack | Least | 5.54 | 6.88 | 5.63 | 9.84 | 3.86 | 10.48 |

opposed to only $0.70 used by the most efficient large firm selling to mass markets. The former firm had many small greenhouses with narrow aisles, and carts could not be used to speed the selection process. Each employee hand carried 2 to 4 plants at a time to a doorway. Trucks traveled to each greenhouse to load plants, and loading time was greater than in a firm with large blocks of greenhouses connected to a central loading area. When considering new construction or replacement of old greenhouses, managers should plan the layout of the facilities to allow the use of an internal transportation system in the selection process, and in production functions.

The least efficient firm used about twice as much delivery labor, and twice as much distance capital as the most efficient firm. The truck went farther than the other large firms selling to mass markets during the peak sales period. The least efficient firm used $5.74 overhead capital, almost twice that of the most efficient firm. The cost of delivery vehicles was the largest component of overhead capital, and a large marketing radius would require additional delivery trucks.

It should be noted that only the cost of marketing has been considered, and production costs have been ignored. If production costs were constant per $100 of sales for all firms, time, and species of plants, production costs could be ignored. However, a firm which is the most economically efficient in marketing may not be the most efficient overall.

Results of this work could be used by agricultural engineers, agricultural economists, and plant geneticists as well as horticulturalists in conducting research to improve the efficiency of production and marketing systems. If labor costs continue to rise relative to capital, labor reducing options need to be considered. Use of conveyors, carts, or moveable benches throughout production and marketing systems need to be developed further. Other methods of packaging plants could be considered. Perhaps breeding can produce plants which are stronger, and do not require sleeving. Production and marketing of plants in units of several plants to reduce handling should be considered. Leasing space to reduce the large overhead costs should be considered. Managers should conduct their own cost analysis to determine where their inefficiencies lie, and what improvements should be made. This marketing analysis could serve as a guide in that process.

## Literature Cited


1. Aigner, D.J. and S.F. Chu. 1968. On estimating the industry production function. Amer. Econ. Rev. 58:826–839.
2. Boles, J.N. 1967. Efficiency squared—efficient computation of efficiency indexes, p. 137–42. In: Western Farm Association 1966 Proc. Pullman, Wash.
3. Bressler, R.G., Jr. and R.A. King. 1970. Markets, prices and interregional trade. Wiley, New York.
4. Brumfield, R.G. 1982. A test of economic, pricing, and technical efficiency of marketing potted plants in terms of size of firm, market channel and market period. PhD Thesis, NC State Univ., Raleigh.
5. Brumfield, R.G., P.V. Nelson, A.J. Coutu, D.H. Willits, and R.S. Sowell. 1981. Cost of producing Easter lilies in NC. J. Amer. Soc. Hort. Sci. 106(5):561–64.
6. Farrell, M.J. 1957. The measurement of production efficiency. J. Royal Stat. Soc. Vol. 120, Part III, Series A:253–81.
7. Hoch, I. 1962. Estimation of production function parameters combining time-series and cross-section data. Econometrica 30(1):34–53.
8. Kelly, P.D. 1977. A frontier production function approach to measuring technical efficiency in the new South Wales Egg Industry. Quarterly Rev. Agr. Econ. 30(3):254–272.
9. King, R.A. 1980. The frontier production function: a tool for improved decision making. J. Northeastern Agr. Econ. Council. 9:1–10.
10. Lau, L.J. and P.A. Yotopoulos. 1971. A test for relative efficiency and an application to Indian agriculture. Amer. Econ. Rev. 61:94–108.
11. Seitz, W.D. 1970. The measurement of efficiency relative to a frontier production function. Amer. J. Agr. Econ. 52(4):505–511.
12. Timmer, O.P. 1971. Using a probabilistic frontier production function to measure technical efficiency. J. Political Econ. 79:776–94.
13. Trosper, R.L. 1978. American Indian relative ranching efficiency. Amer. Econ. Rev. 64(4):503–16.
14. Yotopoulos, P.A. 1974. Rationality, efficiency, and organizational behavior through the production function, darkly. Food Res. Inst. Studies 13(3):263–74.
15. Yotopoulos, P.A. and L.J. Lau. 1973. A test for relative economic efficiency: some further results. Amer. Econ. Rev. 63(1):214–23.