Fig. 6A, 6B photographs) and the computer solutions and experimental data in Figs. 3 and 4. Therefore confidence in the bending curves in Fig. 7 seems justified.

Figures 8 and 9 indicate that the max stress would occur at the base in an untapered trunk, while in a tapered trunk the stress would be relatively uniform for about 2/3 the length of the tree and then drop rapidly to the tip. Also, staking below the middle of the trunk would minimize breakage or deformation of the trunk (9). In the tapered trunk the stress is reduced with increasing rapidity as the zone of young, undifferentiated wood is approached.

It is noteworthy that sapling trunks of widely different species *viz. Ginkgo biloba* (a primitive gymnosperm), *Liquidambar styraciflua, Ceratonia siliqua,* and *Betula verrucosa* (angiosperms of varying stages of evolutionary development) will develop a taper parameter of –0.60 (in the crown area) when grown without staking or pruning.

The results of the wind-loading tests suggest that perhaps the taper parameter –0.60 may be a biological parameter for young sapling trees, i.e., that young trees may grow in such a way as to result in uniformly distributed stress under wind load. Further research will be needed to verify this. The mathematical solution *per se* has no biological implication.

Nursery cultural practices can be selected which will produce young trees with a taper parameter of about –0.6. These practices; proper spacing, elimination of staking, pruning for appropriate branch distribution but leaving most lateral branches were described by Leiser, Harris et al. (8).

The nursery and landscape industry grades and standards should specify taper as well as height and caliper parameters. The taper should be relatively uniform from base to tip and the crown configuration should be such that wind loading occurs at about 0.6 the height of the tree, which will result in a taper parameter of –0.60.

Better staking and pruning practices in landscape plantings can be adopted based on these data. Trees with taper parameter of about –0.6 need little or no staking, and if pruning of lateral branches is done gradually they will maintain this taper parameter. Cultural practices can help restore a taper parameter of about –0.60 in trees which have been grown with little or no taper or which have had side branches removed so that the effective point of action of wind-loading is above 0.7 of the tree height. These practices include staking at the lowest possible height in such a manner that the trunk can flex. This allows new lateral breaks to develop on the trunk. Pruning decreases the wind load in the crown of the tree. These practices are discussed in detail by Harris, Leiser, and Davis (5) and Harris et al. (4).

The implementation of the foregoing nursery and landscape practices will produce young trees with taper parameters of approximately –0.6. The stress distribution data clearly show that trees with this taper parameter have uniformly distributed and minimal stress and hence will be less subject to breakage in the landscape.

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Evaluation and Measurement of Characteristics Affecting Fresh Market Blueberry Demand[1]

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Abstract. Fresh market demand relationships were estimated for several major markets for North Carolina, New Jersey, and Michigan fresh blueberries. Demand relationships were estimated from daily price and unload statistics for the 1965-1971 seasons by regression analysis using daily price as the dependent variable. Zero-one variables were used to account for the seasonal and within season effects.

The relationships accounted for 50 to 70% of the variation in daily prices during the 7-year period. The remaining unexplained variation resulted in standard errors of estimate of around 15 cents per flat for most markets. Large standard errors associated with the quantity coefficients appeared to be related in part to the relatively large and discrete intervals used in price reporting by the Market News Service. The quantity coefficients were relatively small. These indicated rather elastic demands for fresh blueberries in the major markets.

A large share of blueberries for the fresh market is produced in New Jersey, North Carolina, and Michigan. Also, most fresh market blueberries shipped from the 3 major supply areas are marketed in a few large metropolitan areas of the Northeast and Midwest. The 5 market areas listed in Table 1 accounted for nearly 60% of total unloads of fresh blueberries in recent years.

Significant price differences occurred in the selected markets

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[4]A complementary study would be an analysis of the forces underlying the demand for processed berries. This is not in the scope of the current study.

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Table 1. Total quantities of fresh blueberries shipped to selected metropolitan areas from North Carolina, New Jersey, and Michigan, (1965-1971).[z]

Market	Supply areas		
	North Carolina	New Jersey	Michigan
	[1,000 (12-pint) flats]		
Boston	461	1,028	68
Chicago	194	141	652
Detroit	212	209	752
New York City	1,449	2,708	69
Philadelphia	460	819	4

[z]Compiled from U.S.D.A. Unload Statistics.

Table 3. Average current wholesale prices in selected metropolitan markets for North Carolina, New Jersey, and Michigan fresh blueberries, (1965-1971).[z]

Market	Year						
	1965	1966	1967	1968	1969	1970	1971
	($/12-pint flat)						
Boston	3.93	4.05	3.90	3.66	4.03	4.31	4.42
Chicago	3.88	4.23	3.98	3.52	3.93	4.08	4.39
Detroit	3.70	3.95	3.76	3.52	3.78	3.88	4.04
New York City	3.54	3.88	3.92	3.34	3.84	3.98	4.34
Philadelphia	3.60	4.01	3.82	3.34	3.69	3.85	4.23

[z]Compiled as weighted averages of midrange of daily wholesale prices quoted by Market News Service.

for blueberries from the 3 supply sources (Table 2). Temporal separability of production periods and geographic concn of producers and consumers apparently account for these differences. For example, the Chicago average price over the 1965-1971 period for North Carolina berries was $4.61 per flat, but only $3.72 per flat for Michigan berries.

Variations in average prices over the 7-year period can be observed from Table 3. Current prices in New York City trended upward from $3.54 per flat in 1965 to $4.34 per flat in 1971. Inflation accounted for a large part of this upward trend in average prices.

The variation in prices of fresh blueberries over the 7-year period in these markets resulted from the interaction of several developments in production and consumption. Per capita consumption of all fruits other than citrus and apples declined from 83.6 lb. in 1960 to 71.4 lb. in 1970. A large share of this decline occurred in fresh consumption. Sufficient evidence is available on blueberry consumption to suggest that per capita consumption is declining and that consumers are shifting from fresh to processed forms of consumption at a much faster rate than for most other fruits. Labor-saving harvesting, packing, and marketing techniques have not been as readily adaptable for handling fruit going to the fresh market as to the processing market. Therefore, costs of production and marketing may have remained much higher for fresh market fruit. Previous studies of production and marketing techniques have been made but the evidence from these studies suggested that further developments in techniques of production and harvesting will continue to shift the supply of berries for processing much more rapidly than the supply for fresh market (1, 2, 3).

Table 2. Average current wholesale prices of fresh blueberries in selected metropolitan areas by supply areas, (1965-1971).[z]

Market	Supply areas		
	North Carolina	New Jersey	Michigan
	($/12-pint flat)		
Boston	4.27	3.93	4.08
Chicago	4.61	4.16	3.72
Detroit	4.52	4.09	3.51
New York City	4.02	3.70	3.94
Philadelphia	4.01	3.65	4.12

[z]Compiled as weighted averages of midrange of daily wholesale prices quoted by Market News Service.

The purpose of this study was to analyze the forces underlying demand for fresh berries in selected markets.[4] The following sections of this paper outline the procedure used and the results obtained from the analysis.

Materials and Methods

A model was specified to estimate wholesale market daily demand relationships for fresh blueberries for the 5 cities listed in Tables 1-3. Demand relationships for North Carolina berries were estimated for each of the 5 cities using multiple regression procedures. Demands were estimated for only 3 eastern markets for New Jersey berries and 2 midwestern markets for Michigan berries. Daily wholesale market price and unload data for the 1965-1971 seasons were used. The midrange of the daily wholesale price range was selected as the dependent variable. The daily unloads, and the unloads received the previous marketing day in a given market, were assumed to be primary price determinants.

Other independent variables included in the model consisted of a set of 0-1 variables accounting for changes in the demand from year to year as well as within years (5). These were included for the purpose of measuring the effects of changes in income, population, prices of closely related products, etc. Each shipping season (1965-1971) was divided into 2 periods. Period 1 included observations in which total unloads from the specified supply area were greater than 10% but less than 50% of the area's total season's unloads. Period 2 included all observations in which total unloads were 50% or greater but less than 90% of the season's total unloads from the area. This definition of time periods eliminated market days with volumes too small for accurate price quotations. In addition, the relatively few price-quantity observations associated with days on which more than one supply area shipped to a given market were deleted from the analysis.

The general form of the assumed relationship is as follows:

$$P_i = f(Q_i, Q_{i,T-1}, S_1, ..., S_{14})$$

where

P_i = daily wholesale blueberry prices reported at market i (dollars per 12-pint flat), using midrange of Federal Market News quotations.

Q_i = daily quantity of blueberries received at Market i coded in 10,000 (12-pint) flats.

$Q_{i,T-1}$ = daily quantity of blueberries received at market i on the previous day.

S_k = 0-1 variable representing particular year and period during which observation occurred, K = 1,2, ..., 14 resulting from each of the seven shipping seasons being divided into 2 periods.

Negative signs were expected for the quantity variable coefficients. Expectations for the coefficients of the year-period shift variables were not as strong although demand might logically be expected to be lower in period 2 than period 1 for any given year because of some saturation of tastes and perhaps changes in the quality of the product. For purposes of estimation, period 1 in 1965 was selected as the base period and therefore all other periods are contrasted to this period in terms of average price differences. Positive coefficients of the year-period variables suggest that the demand was relatively higher than during the base period. The opposite is true for negative coefficients.

Results and Conclusions

Coefficients of the daily wholesale demand relationships for the 5 metropolitan areas are presented in Table 4. In most cases, the relationships accounted for 50 to 70% of the variation in daily prices over the 7-year period. The remaining unexplained variation for these relationships resulted in a standard error of estimate of around 15 cents or less per flat, but ranged up to 19 and 29 cents per flat for the 2 relationships with the lowest R^2 coefficients (4). Although these large errors imply that considerable uncertainty would be involved in any daily price prediction based on such a model, magnitudes are small relative to the usual range in daily prices reported in a given market by the Market News Service.

Prices were relatively insensitive with respect to variations in quantities shipped to individual markets. Negative relationships were estimated in 8 of the 10 cases. The flatness of the demand relationships is not readily apparent since the coefficients of the quantity variable in column 4 of Table 4 are coded in 10,000 flats. The flatness becomes more apparent by changing to 1,000 flats since the volumes shipped to most markets are considerably less than 10,000 flats per day. For example, the daily price in Boston declines by about 9 cents per flat for each additional 1,000 flats received from North Carolina. During the time New Jersey ships blueberries, the daily price in Boston would decline by approximately 3 cents per flat for each additional 1,000 flats.

Table 4. Demand relationships for selected markets for major supply areas using 1965-1971 daily wholesale price-quantity observations for fresh blueberries.

Supply area and market	R^2	Constant[z]	Q[z]	Q_{T-1}[z]	Season 1965 Period[y] 2	1966 1	1966 2	1967 1	1967 2	1968 1	1968 2
North Carolina											
Boston	.58	4.62	-.8987* (.1972)[x]	-.6563* (.1907)	.22	.81*	.32	.21	.63*	.06	.08
Chicago	.45	4.39	.1205 (.4912)	-.2193 (.4676)	-.33	1.06*	-.11	.60	.20	.02	-.63
Detroit	.57	4.37	-.2281 (.3250)	-.0991 (.3378)	-.53*	—	-.01	.30	.47*	-.02	.01
New York	.61	4.36	-.1507* (.0660)	-.1836* (.0634)	-.19	.80*	-.05	.10	.38	-.18	-.48*
Philadelphia	.67	4.02	-.6913* (.1708)	-.9201* (.1719)	.48*	1.35*	.65*	.94*	1.02*	.43	.19
New Jersey											
Boston	.27	4.16	-.3013 (.1850)	-.4340* (.1873)	-.02	.31	-.21	.03	-.27	-.14	-.31
New York	.53	3.45	.0164 (.0612)	.0299 (.0592)	-.29*	.18	-.15	.56*	-.09	-.23	-.48*
Philadelphia	.51	3.72	-.1642 (.1560)	-.2084 (.1571)	-.26*	.29*	-.04	.03	-.31*	-.20	-.44*
Michigan											
Chicago	.63	3.88	-.2151 (.1593)	-.3989* (.1542)	.05	.39*	.04	-.05	-.42*	-.25*	-.40*
Detroit	.88	3.44	-.1266* (.0295)	-.0800* (.0292)	.03	.50*	.25*	.21*	-.18*	-.04	-.19*

Table 4 (cont.)

Supply area and market	Season 1969 Period[y] 1	1969 2	1970 1	1970 2	1971 1	1971 2	Number of observations	Q^w
North Carolina								
Boston	.57*	.41	.48	.81*	.88*	.59*	72	4,725
Chicago	.10	.23	-.32	.18	.70	.02	64	2,710
Detroit	.27	.29	.19	.27	1.07*	.31	65	2,766
New York	.41	.40	.02	.00	.62*	.31	80	14,378
Philadelphia	.88*	.91*	1.19*	.60*	1.20*	.94*	83	4,389
New Jersey								
Boston	.10	.17	.57*	.01	.27	.12	186	4,418
New York	.20	.11	.44*	.28*	.77*	.46*	178	12,351
Philadelphia	-.01	-.05	.35*	-.03	.59*	.18	183	3,606
Michigan								
Chicago	.28*	-.37*	.27*	.01	.32*	.22*	156	3,102
Detroit	.07	-.05	.30*	.21*	.46*	.36*	143	3,979

[z]Constant values represent dollars per 12-pint flat, but quantity is measured in 10,000 (12-pint) flats.

[y]The marketing season for each supply area was divided into 2 periods each year: 1) daily observations in which unloads from the particular supply area totaled 10 to 50% of the total season's volume from that supply area; 2) daily observations in which unloads totaled 50 to 99% of total season's volume from the particular supply area. The first period of 1965 was selected as the base period to estimate coefficients of variables associated with the periods from the various seasons.

[x]Numbers in parentheses under selected coefficients are their standard errors.

[w]Average daily quantities (number of 12-pint flats) marketed in each market during the 7-year period.

*The one-tailed t-test at the .05 level was used to test significance of the quantity coefficients, but the two-tailed t-test at the .05 level was used to test all other coefficients.

Significant price responses to shipments were observed in 4 cases, 3 of which occurred for the North Carolina supply area. Although all of the relationships are extremely flat, a comparison of coefficients for the same city between alternative supply areas shows a tendency for prices to be slightly less responsive to New Jersey and Michigan shipments than in the case of North Carolina shipments. For example, the quantity coefficient for Boston was (–.8987) for North Carolina berries but only (–.3013) for New Jersey berries.

Blueberry prices appear to be responsive to quantities received on the previous day. In the case of Boston, a price decline of 6.6 cents per flat was estimated to be associated with an extra 1,000 flats received the previous day from North Carolina. All but 1 of the coefficients of the lagged quantity variables for the 10 relationships had the expected sign with 6 of the 10 coefficients being significantly different from zero. All but 1 of the significant coefficients of the lagged quantity variable were associated with North Carolina and Michigan relationships. Inclusion of the lagged quantity variable for New Jersey increased total explanation very little except in the case of Boston. An extra 1,000 flats to Boston on the previous day from New Jersey would have resulted in approximately a 4 cent per flat decline in price.

The remaining coefficients in Table 4 measure the shifts in demand for fresh blueberries between and within marketing seasons. Changes associated with different marketing years can be observed by comparing either the coefficients associated with period 1 or period 2 for all years. The positive coefficients for all markets during period 1 in 1966 and 1971 suggest that demand for blueberries is generally greater for all markets in these years than in the first period of the 1965 base season.

Demand in Boston for North Carolina berries was approximately 88 cents per flat higher in 1971 than in 1965. The same general pattern is true for 1967 and 1969 with the exception of 1 market each year having a slightly negative coefficient. A number of cities appeared to have lower demand especially for New Jersey and Michigan berries for 1968 than in the base year.

The sign and magnitude of period 2 coefficients in Table 4 indicate how demand in the last part of a given season compares to period 1 in 1965. For example, the second half of the North Carolina blueberry marketing season in the 1971 Boston demand was estimated to be 59 cents per flat higher than period 1 in 1965. Similarly, the difference between period 1 and period 2 coefficients for a given year measure the difference in demand in the last part of a given season relative to the demand in the first part of the same season. Again examining the 1971 demand in Boston during the North Carolina marketing season indicates that demand was 29 cents per flat greater during period 1 than in period 2. The difference between period 2 and period 1 was more stable across years for New Jersey and Michigan than for North Carolina.

An overall comparison of demand relationships for fresh blueberries by cities indicates that demand is greater and price more responsive to changes in quantity for North Carolina berries than for New Jersey and Michigan berries. Both the constants and coefficients for North Carolina demand relationships are larger than their New Jersey and Michigan counterparts. This implies that North Carolina has a competitive advantage in the fresh market. This may be 1 reason that North Carolina production has apparently not been turning from the fresh to the processing market as rapidly as Michigan and New Jersey. It would also suggest that North Carolina may stay with the fresh market outlet longer than the other 2 states unless relative costs shift greatly.

The relatively elastic demand relationships for fresh blueberries in all markets also suggest that larger volumes of fresh blueberries could be marketed without greatly affecting market prices. At least, the percentage decreases in prices would be relatively less than the percentage increases in quantities. This implies that gross income could be increased through larger shipments of blueberries to the fresh market.

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