ECONOMIC TRENDS IN THE FLORIDA AVOCADO INDUSTRY

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ABSTRACT

Avocado acreage has been expanding in Florida and California. Planting data indicate a 23 percent increase in bearing acreage for Florida by 1980-81 and a 60 percent increase for California. The combined bearing acreage is expected to increase from 34,550 acres (1976-77) to approximately 52,800 acres by the 1980-81 season, a 53% increase. Yields are also increasing, at slightly over 5 bushels per acre per year. Thus, total production could exceed 10 million bushels by 1980-81. Increasing production will probably result in lower prices for growers.

Favorable prices have contributed to considerable interest in avocado production and in increased plantings in recent years. As with a number of tree crops, the full economic effects of current planting decisions will not be felt for at least three seasons and with some varieties, even four or five.

The primary objective of this report is to provide the avocado industry with information for production and marketing decisions during the next several years. Specifically, acreage and production trends are examined and projections made through the 1980-81 season for both Florida and California. The impact of projected changes in production on Florida growers' prices is then estimated.

Florida and California are the two major avocado producing states in the United States. In 1976, Florida accounted for approximately 20% of the U.S. bearing acreage and California almost all of the remaining 80%. Thus, attention is focused on these major growing areas.

PROCEDURE

All analyses were made using published secondary data for the 2 states which are available from various agencies of the United States Department of Agriculture (1, 2, 4,5,6, 9, 10).

Production trends were analyzed using annual observations for the 1967-68 through 1976-77 seasons. These seasons were viewed as the most relevant for analytical purposes since they encompass recent expansion and technological developments in both states. Further, this period excludes Florida's abnormally low yields of the 1965-66 and 1966-67 seasons which were the result of hurricane damage. The price analysis utilized data from 1955-56 through 1976-77.

Regression analysis (ordinary least squares) was used for projecting most variables

such as yields and Florida prices. For some variables, recent historical averages and published estimates were used.

FINDINGS

Acreage trends and projections

Florida. For many years, Florida avocado acreage was stable at just under 5,000 acres. After extremely slow growth in the early sixties, bearing acreage stood at 5,000 acres in the 1964-65 season. Five seasons later, in 1970-71, acreage had increased by 6% to 5,300 bearing acres. This past season, 1976-77, saw bearing acreage reach 6,900 acre, a 38% increase in 12 seasons.

Total bearing acreage for Florida is expected to increase substantially in *the* next 4 seasons as well. Bearing acreage for 1977-78 is estimated at 7,218 acres and by 1980-81 bearing acreage is expected to approach 8.500 acres (Table 1).

Table 1. Projected avocado bearing acreage, Florida and California, 1977-78 through 1980-81.

| Season | Projected bearing acreage | | Total |
	Florida	California	
1977-78	7,318	32,556	39,774
1978-79	7,663	36,703	44,366
1979-80	8,063	40,649	48,712
1980-81	8,460	44,354	52,814

Projections were made on the basis of statistics published by the Florida Crop and Livestock Reporting Service (FCLRS). New additions to "bearing acreage" were defined as plantings 3 years of age, consistent with FCLRS procedures. Projections were made using reported plantings through 1975, but plantings for 1976 and 1977 were estimated to be 457 acres per year, the average for 1971 through 1975 (5).

Attrition for each season was also estimated and deducted to arrive at net bearing acreage. Attrition was estimated to be 1.15% of all acreage 10 years of age or older. This estimate was based on the FCLRS tree inventories of 1965 and 1976 which utilized both aerial photographs and ground verification.

California. From the mid-fifties until the early seventies, California's bearing avocado acreage fluctuated around 20,000 acres. However, during the past few years acreage has increased sharply. As recently as the 1969-70 season, the reported bearing acreage for the 1969-70 season was only 13,380 acres, but by 1976-77 it had increased by 9,270 acres to 27,650 acres, a 50% increase (4, 7).

Plantings in recent years indicate that substantial increases in bearing acreage are expected. Bearing acreage, as defined by the California Crop and Livestock Reporting Service (CCLRS), includes trees 3 or more years of age for 'Bacon', 'Hass', and 'Zutano' varieties and trees 5 or more years of age for all other varieties. Thus, planting data currently available for the late-bearing varieties should reflect a reasonably accurate

picture of bearing acreage through the 1980-81 season. For the important early-bearing varieties, i.e., 'Bacon', 'Hass', and 'Zutano', preliminary plantings for 1976 were used and plantings for 1977 were estimated to be equal to the average for 1971-75. Attrition data are not presently maintained by the CCLRS, so the attrition factor of 1.15% per year of all acreage 10 years of age or older determined for Florida was used.

On the basis of the plantings and estimated attrition, California's bearing avocado acreage is expected to total 32,556 acres in the 1977-78 season and steadily escalate to about 44,354 acres in the 1980-81 season (Table 1) (1, 2, 6, 7).

Yield trends and projections

Florida. Since the 1967-68 season, Florida's yield has ranged from 95.1 to 181.1 bushels per acre and has average 131.8 bushels. While Florida's yields are variable, they are considerably more stable than California's. Variation for the past 10 seasons is 18.4% for Florida and 38.2% for California, as measured by the coefficient of variation.

There has been a distinct upward trend in yields, primarily due to improved varieties and adoption of improved technology. Barring natural disasters such as hurricanes and freezes, Florida's average yield is expected to increase by 5.2 bushels per acre per year. Thus, by the 1980-81 season, the yield per acre is projected to be almost 176 bushels (Table 2). It is possible, however, that this rate of increase in yield may be somewhat reduced during the next few seasons clue to disproportionately large numbers of young trees which will be classified as "bearing", but are not fully mature.

Table 2. Projected avocado yields, Florida and California, 1977-78 through 1980-81.

| Season | Florida | | California | |
	Predicted[x]	Confidence[y] limit	Predicted[x]	Confidence[y] limit
	Bushels per acre			
1977-78	160	±21	114	±15
1978-79	165	±22	187	±15
1979-80	170	±23	125	±16
1980-81	176	±24	199	±16

[x]Based on the regression model: $Y_1 = 41.62 + 5.2 X_1$, where Y_1 = yield per acre, X = season, $r^2 = 0.41$, and d.f. = 8. The coefficient is statistically significant at the 95 percent probability level.
[y]Based on the 60 percent probability level.
[x]Based on the regression model: $Y_2 = -12.7 + 5.5 X_1 + 69.5 X_2$, when Y_2 = yield per acre, X_1 = season and X_2 = a dummy variable to compensate for alternate bearing. $r^2 = 0.90$, and d.f. = 7. The coefficients are statistically significant at the 95 and 99 percent probability levels, respectively.

California. Avocado yields in California have exhibited extreme variability. In the past 10 seasons, the industry average yield per acre has ranged from 54.6 bushels in 1971-72 to 191.7 bushels in 1976-77; the 10-year average was 118 bushels. Much of the variability is due to the alternate bearing pattern, a characteristic of the important

'Fuerte' variety.

In the past 33 seasons, alternate-size yields and crops occurred 25 times; in the past 10 seasons, alternate crop' sizes have been the case each year. Since alternate-bearing has occurred in a high proportion of seasons, over 75% in 33 seasons, it is probable that sizeable season-to-season fluctuations will continue for a few years. However, the extreme variability will probably diminish in the long run.

The primary reason for anticipating that the alternate crop size differential will be reduced is the emergence of the 'Hass' as the predominant variety. Industry average yield data by variety indicate alternate bearing for 'Hass', but less severe than for 'Fuerte'. The season-to-season variability for 'Hass' variety for the 1963-64 through 1972-73 seasons was 32% and 58% for the 'Fuerte' as measured by the coefficient of variation. In addition to more, stable production, 'Hass' yields are substantially greater. Data for 10 seasons show an average annual yield of about 82 bushels per acre for 'Fuerte' and 143 for 'Hass', a yield advantage of almost 75 % (6).

'Hass' also begins bearing at an earlier age. During the period 1974 through 1976, approximately 14,000 acres of avocados were planted in California, of which about 62 percent were 'Hass'. In 1976-77, 'Hass' constituted about 46% of California's bearing acreage, but by 1980-81, the proportion is expected to slightly exceed 54%.

California's yield per acre was found to vary by about 70 bushels from season to season because of alternate bearing. Further, the average yield is expected to increase by about 5.5 bushels per acre per season, independent of alternate bearing. Thus, California's yield per acre is projected to be 114, 187, 125, and 199 bushels, respectively for the next 4 seasons, assuming the same alternate bearing pattern prevails (Table 2).

Production projections

Estimates of total avocado production for both states for the next four seasons were made on the basis of acreage and yield projections discussed in preceding sections. Other statistical estimating procedures were used and evaluated for projecting total avocado production, but the simple combination of acreage and expected yields appears to give the most reasonable results.

It should be recognized that the projections incorporate many assumptions and many factors could alter their validity, particularly by 1980-81. The variability of yields and production along with the small number of observations make predictions such as these extremely hazardous. To emphasize the fact that specific estimates for the upcoming seasons may be subject to large error, confidence limits were determined based on yield fluctuations.

Florida. Smooth trend lines are often marred by the realities of nature. Such is the case for the very first season of the projection period. The major freeze which occurred in January of 1977 did not drastically affect Florida's 1976-77 crop because it was nearing completion. However, the carry-over effects are expected to be substantial for the 1977-78 season. Industry sources feel that total production will be only about 50 percent of a normal crop. A "normal" crop is defined here as the projected crop based on the yield

trend derived from the 1967-68 through 1976-77 seasons and the anticipated bearing acreage. On the basis of these estimates, Florida's total avocado production is expected to be about 580,000 bushels (Table 3). The effects of the 1977 freeze are expected to be overcome by the 1978-79 seasons and production could possibly exceed 1.2 million bushels. Production in the 1979-80 season is anticipated at nearly 1.4 million bushels, and by 1980-81 may approach 1.5 million bushels (Table 3).

Table 3. Projected Florida avocado production, 1977-78 through 1980-81.

Season	Projected production		
	Predicted[z]	Confidence limits[y]	
		Lower	Upper
	1,000 bushels		
1977-78[x]	578	501	654
1978-79	1,264	1,095	1,433
1979-80	1,371	1,186	1,556
1980-81	1,489	1,002	1,976

[z]Based on the yield projections and bearing acreage estimates discussed above.
[y]The confidence limits are based on the 60 percent probability level on yields; acreage reported in Table 1 is assumed accurate.
[x]The 1977-78 season is only 50 percent of the trend projections due to the freeze of January, 1977.

California. Alternating crop size is assumed to continue its present pattern through the projection period. If this is the case, production is expected to decrease from 1976-77 levels to 3.7 million bushels in 1977-78. In 1978-79, a probable high-production year, the crop may exceed 6.9 million bushels. The following season is expected to decline to slightly over 5 million bushels, but in 1980-81, production may be well over 8.8 million (Table 4).

ECONOMIC IMPLICATIONS

The avocado industry is continually concerned about the price received. The primary reason for attempting to estimate supplies in future time periods is to determine how price will be affected so that appropriate decisions may be made to alter the quantities supplied or to influence demand.

Table 4. Projected California avocado production, 1977-78 through 1980-81.

Season	Predicted[z]	Projected production Confidence limits[y] Lower	Upper
		1,000 bushels	
1977-78	3,711	3,103	4,319
1978-79	6,922	6,241	7,603
1979-80	5,065	4,235	5,895
1980-81	8,849	7,945	9,753

[z]Predicted values are based on the bearing acreage estimates and yield prediction model discussed above.
[y]The confidence limits are based on the 60 percent probability level on yields; acreage reported in Table 1 is assumed accurate.

A number of alternative mathematical models were formulated and tested which attempted to explain and thus predict the price of Florida avocados. It was hypothesized that the major factors influencing Florida's avocado prices on a season-to-season basis were: 1) Florida's total production, 2) California's total production, 3) total U.S. population and 4) U.S. personal disposable income. Annual data for the period 1955-56 through 1976-77 were analyzed Alternative models tested substituted deflated Florida prices for nominal prices and a time trend variable in lieu of per-capita disposable income. All models were examined using raw data (untransformed) and log transformations. The model which was judged to best explain Florida avocado prices ("packinghouse door" basis) incorporated the 4 major factors mentioned above.

The general form of the model was:

$$P = \alpha\, Y_1^{\beta}\, Y_2^{\gamma}\, I^{\delta}\, \epsilon$$

Where:

P = Florida season price per bushel
Y_1 = Florida production relative to U.S. population
Y_2 = California production relative to U.S. population
I = U.S. per capita disposable income
$\alpha, \beta, \gamma, \delta$ = Parameters
ϵ = Unexplained variation

log transformation (base e) and ordinary least squares estimates of the parameters yielded the following:

$$\ln P = -17.97 - 0.3120\, Y_1 - 0.1544\, Y_2 + 3.4780\, I$$
$$(-4.47)^a \qquad (-1.72)^y \qquad (11.32)^z$$

[a]Indicates statistical significance at the 0.01 probability level.
[b]Indicates statistical significance at the 0.10 probability level.

The coefficient of determination (r^2) was 0.89, and the Durbin-Watson statistic was 1.72. The t-statistics for the respective coefficients are in parentheses and there were 19 degrees of freedom.

This model indicates that a one percent change in Florida production relative to U.S. population (Florida per capita production) changes Florida's season price by 0.31 percent in the opposite direction. Similarly, as California's per capita production changes by one percent, Florida's price is expected to change in the opposite direction by 0.15%. The remaining variable in the model, U.S. per capita personal disposable (PCPDI) was found to have a positive effect on Florida avocado prices. As PCPDI changes log transformation (base e) and ordinary least squares estimates of the parameters yielded the following: by one percent, Florida price changes by approximately 3.48 percent in the same direction. These price-production relationships appear to be logical, as one would expect price and production to be inversely related. However, per capita personal disposable income is such a generalized variable the specific deductions drawn from it may be tenuous. A prior*i,* one would expect Florida avocado prices to respond to changes in PCPDI in a positive direction" as the model indicates, but the values of PCPDI may reflect similar changes in other variables not included in the model such as shifts in consumer tastes and preferences over time, or changes in avocado advertising and promotion. In any case, PCPDI is a variable which is relatively stable, readily available, and which apparently increases the explanatory powers of the model.

Since the price prediction model incorporates U.S. population and per capita personal disposable income, these variables also had to be estimated for the next four seasons, population estimates were obtained from the U.S. Bureau of the Census (8). PCPDI was estimated using statistical techniques similar to those employed for estimating yields, for expediency, these point estimates are assumed to be accurate.

If the Florida and California production estimates that appear previously are achieved, Florida's price per bushel is expected to be approximately fll.33, 8.64, 9.46, and 9.04, respectively for the next 4 seasons. Effects of departures from predicted production on predicted prices can be calculated using the price model discussed above. However, predicted prices at various production levels are reported elsewhere (3). It is important to note that these price estimates reflect point estimates derived with the price model and the yield model discussed above. The variance associated with the price equation results in confidence limits which are approximately plus or minus S3.00 per bushel, at the 95 percent probability level.

The price model indicates some softening of grower prices as larger volumes are marketed in coming seasons. A further consideration is that these are nominal prices; no allowances have been made for inflation. If inflation persists at rates experienced in recent seasons, a dollar price of approximately $9.00 per bushel along with inflated production costs may present growers with serious economic problems by the 1980-81 season.

Conclusions

Avocado acreage has been expanding in Florida and California. Recent planting data

indicate a 23 % increase in bearing acreage for Florida by 1980-81, and a 60% increase for California. The combined bearing acreage is expected to increase from 34,550 acres (1976-77) to approximately 52,850 acres by the 1980-81 season, a 53% increase.

In addition to increased acreage, the yields have been increasing as well. During the past 10 seasons, yields have increased by over, 5 bushels per acre per year. This trend is expected to continue as improved growing technology is adopted and as better varieties replace older ones. The shift to better varieties is especially evident in California. During the period 1974 through 1976, 62 percent of the plantings have been of the 'Hass' variety, one that has demonstrated superior yield potential. Plantings of 'Hass' are expected to have an important effect on Florida's avocado marketing efforts, because the harvest season overlaps Florida's. Combined increases in acreage and yields may increase Florida's total avocado production in 1980-81 by 28% over the record 1975-76 crop and by 76% over the 1976-77 season.

California's production, subject to wide swings due to alternate bearing, may reach 8.8 million bushels by 1980-81 if the present trends and patterns continue.

The increases in total production are expected to be partially absorbed by population increases and perhaps by increases in consumers' incomes. However, prices are apt to decline slightly from present levels.

The avocado industry can take steps to uphold present prices by increasing demand. Although avocado consumption on a per capita basis has increased dramatically in the past few years, it is still only 1.3 pounds per person per year (10). Dynamic marketing efforts will be the key to moving larger production at prices favorable to growers in the seasons ahead.

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