the pattern forecast by the ARIMA models. This pattern is forecast to continue through 1984. The forecast market share values by region are listed in Table 4.

There have been definite changes in the spatial and seasonal marketing patterns of Florida fresh tomatoes, cucumbers, green peppers and eggplant. In the early 1960s Florida clearly dominated all the eastern and midwestern markets, throughout the winter and spring seasons. The shock to the system that disrupted that marketing pattern changed the pattern permanently. Florida's produce dominates the eastern U.S. in the fall and spring, but no longer through the winter as it did in the early 1960s. This is not to say that Florida is marketing less vegetables now. Table 5 shows that, as far as quantities unloaded are concerned, unloads of Florida tomatoes have increased while the other vegetables have remained relatively steady. Referring again to Figures 1 through 8, one can see that except for eggplant, Florida has dominance in some of the winter months but has increased it's share of the early fall market and the late spring market. It could be that Florida's tomatoes, cucumbers and green pepper producers adjusted to the "shock" by aiming for different "market windows". Based on the ARIMA models which forecast on the basis of past occurrences, one can say that the spatial and temporal market shares have changed, but the quantities have remained the same or increased. There will continue to be normal fluctuations in both market shares and quantities unloaded, but unless there is another major shock to the system, the patterns one sees today can be expected to remain stable.

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# TRENDS IN THE CURRENT DOLLAR COSTS OF PRODUCING FLORIDA TOMATOES[1]


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*Additional index words.* inflation, trend analysis.


*Abstract.* **Tomatoes remain as one of the most important vegetables produced in Florida. In the 1978-79 season, 40,800 acres were harvested yielding a total value of $220 million. Over the 11 year period prior to 1979, harvested tomato acreage has declined, but yield per acre has increased. Accompanying this phenomenon is average statewide production and marketing costs per acre increasing by more than 300 percent from 1968 to 1979 when measured in current dollars. This paper examines individually 18 items of the cost of producing and marketing Florida tomatoes with data taken from the annual surveys conducted by Brooke. Results show that some costs have increased at a fairly constant (linear) rate while others have been increasing at a decreasing rate. Land rent, however, has been increasing at an increasing rate, suggesting growing competition for land.**


Tomatoes are one of the most important vegetables produced in Florida. During the 1978-79 season, the 40,800 acres harvested produced more than 10 million cwt. for a total value of $220 million. With respect to all vegetables produced in the state, tomatoes accounted for 14 percent of harvested acreage, 27 percent of total production and 36 percent of total value. This meant tomato production was third in terms of harvested acreage but first in total production and value of the crop (Table 1).

This vegetable is produced throughout the state. During the 1968-79 period, total harvested acreage has declined on

Table 1. Harvested acreage, production and value of selected Florida vegetables, 1978-79.

| Vegetable | Harvested acreage | Total production | Total value |
|---|---|---|---|
| | ..Acres.. | .1,000 cwt. | ..$1,000.. |
| Snap beans | 54,100 | 1,901 | 36,261 |
| Cabbage | 17,800 | 4,456 | 51,907 |
| Celery | 11,700 | 4,481 | 55,142 |
| Sweet corn | 54,500 | 5,087 | 51,423 |
| Cucumbers | 22,000 | 2,882 | 37,635 |
| Eggplant | 2,800 | 541 | 6,784 |
| Escarole | 6,500 | 837 | 13,547 |
| Lettuce | 12,900 | 2,562 | 48,032 |
| Green peppers | 18,100 | 2,014 | 49,413 |
| Radishes | 29,600 | 1,510 | 21,895 |
| Squash | 13,350 | 781 | 13,971 |
| Tomatoes | 40,800 | 10,442 | 220,216 |
| Total | 284,150 | 37,894 | 606,226 |

Source: (2).

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the average (Table 2). Production has also shifted among the different areas with a resulting change in relative acreage shares (Table 3). For example, the Ft. Pierce-Pompano and Dade areas have experienced a decline in their shares while the other areas have increased their relative shares (Figure 1).

Of major interest is the fact that, with respect to 1968 and despite the constant average increase in state yields per acre since 1970, harvested acreage has declined on the average during the same time period (Figure 2). The latter trend may have been the result of higher yields not being able to compensate for higher costs of production which have forced some producers out of business.

The effect of inflation on tomato production and marketing costs is a major cause of concern for Florida producers, who face stiff competition from their Mexican counterparts. A U.S.D.A. study (3) has identified a relative net competitive advantage (a total cost advantage plus a price advantage) for Florida. However, increasing inflation on particular items could adversely affect the state's competitive position. The same study has concluded that, although the Florida tomato industry made a substantial recovery between 1973 and 1976, devaluation of the Mexican peso and adverse weather interrupted Florida's recovery leaving "future changes in relative market share for the two production areas unclear" (3, p. 49).

The purpose of this paper was to analyze the past behavior of the cost items of tomato production and marketing in Florida to identify those affected the greatest by inflation. An attempt at forecasting future cost trends was also made.

## Materials and Methods

Data used in the analysis are shown in Table 4. The weighted costs for the different items were developed with the following procedures: First, Florida tomato production was divided into five main areas. Second, per acre costs by item were taken from Brooke (1) for each area and method of production. Third, acreage statistics for the different methods of production were obtained from the Florida Crop and Livestock Reporting Service (2) and the corresponding percentages computed. Finally, the state weighted costs by item were arrived at by multiplying the cost of production in each area times the percentage acreage and adding the resulting costs in the five areas.

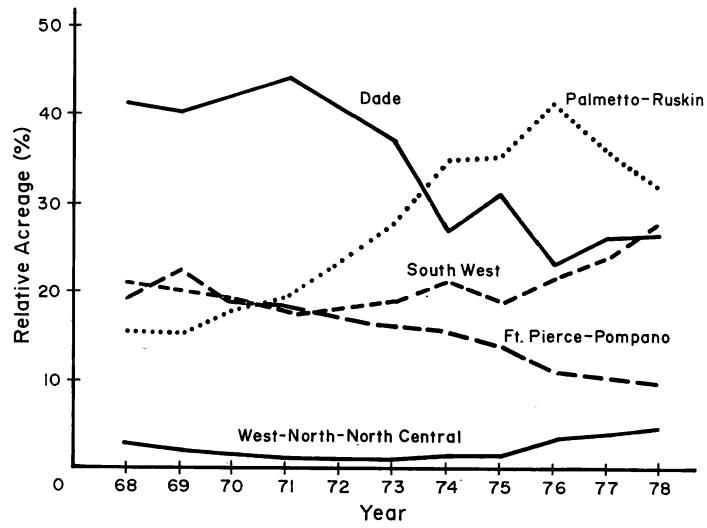


Fig. 1. Relative total tomato harvested acreage, Florida, 1968-78. Source: Table 3.

The data revealed that the different cost items have increased at varying rates over the period of analysis (Table 4). The average annual rate of increase for each item was computed using the relationship

$$Y = X(1 + r)^{10}$$

where Y is the cost in 1978, X is the cost in 1968, and r is

Table 2. Total tomato harvested acreage by area, Florida, 1968-78.

| Area[y] | Year[z] 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | | | | | | | | | | |
| 1 | 1,210 | 860 | 580 | 460 | 410 | 350 | 450 | 520 | 1,100 | 1,600 | 1,800 |
| 2 | 7,360 | 7,295 | 7,360 | 8,370 | 10,700 | 9,450 | 10,950 | 13,420 | 13,990 | 14,950 | 13,050 |
| 3 | 9,140 | 10,580 | 7,750 | 8,010 | 7,840 | 5,550 | 4,990 | 5,330 | 3,765 | 4,400 | 4,000 |
| 4 | 10,000 | 9,555 | 7,820 | 7,560 | 8,205 | 6,550 | 6,670 | 7,170 | 7,330 | 9,800 | 11,200 |
| 5 | 19,790 | 19,110 | 17,190 | 19,200 | 18,645 | 12,800 | 8,440 | 11,860 | 7,815 | 10,750 | 10,750 |
| Total | 47,500 | 47,400 | 40,700 | 43,600 | 45,800 | 34,700 | 31,500 | 38,300 | 34,000 | 41,500 | 40,800 |

[z]Year when the crop season started. It includes both ground and staked tomatoes.
[y]1: West-North-North Central, 2: Palmetto-Ruskin, 3: Ft. Pierce-Pompano, 4: South West, 5: Dade.
Source: Computed from (2).

Table 3. Tomato acreage harvested as a percent of total by area in Florida, 1968-79.

| Area[z] | Year 1968 | 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Percent | | | | | | | | | | |
| 1 | 2.55 | 1.81 | 1.42 | 1.05 | 0.89 | 1.01 | 1.43 | 1.36 | 3.23 | 3.85 | 4.41 |
| 2 | 15.50 | 15.39 | 18.08 | 19.20 | 23.36 | 27.23 | 34.76 | 35.04 | 41.15 | 36.02 | 31.98 |
| 3 | 19.24 | 22.32 | 19.04 | 18.37 | 17.12 | 15.99 | 15.84 | 13.92 | 11.07 | 10.60 | 9.80 |
| 4 | 21.05 | 20.16 | 19.21 | 17.34 | 17.91 | 18.88 | 21.17 | 18.72 | 21.56 | 23.61 | 27.45 |
| 5 | 41.66 | 40.32 | 42.25 | 44.04 | 40.72 | 36.89 | 26.80 | 30.96 | 22.99 | 25.92 | 26.36 |
| Total | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

[z]1: West-North-North Central, 2: Palmetto-Ruskin, 3: Ft. Pierce-Pompano, 4: South West, 5: Dade.
Source: Computed from Table 2.

Table 4. Total costs of growing, harvesting and marketing tomatoes per acre by cost item, weighted by areas, Florida, crop seasons 1968-69 to 1978-79.

| Cost item | Crop season | | | | | |
|---|---|---|---|---|---|---|
| | 1968-69 | 1969-70 | 1970-71 | 1971-72 | 1972-73 | 1973-74 |
| | Dollars | | | | | |
| Growing: | | | | | | |
| Land rent | 23.27 | 27.22 | 31.30 | 32.90 | 31.81 | 39.16 |
| Seed | 7.42 | 9.41 | 22.68 | 16.81 | 28.28 | 45.75 |
| Fertilizer | 130.51 | 133.10 | 156.75 | 152.78 | 152.02 | 176.32 |
| Spray and dust | 77.25 | 93.02 | 116.99 | 154.64 | 160.11 | 205.95 |
| Cultural labor | 135.07 | 169.81 | 258.86 | 244.89 | 261.64 | 354.50 |
| Machine hire | 37.90 | 41.72 | 43.08 | 46.89 | 42.65 | 43.15 |
| Gas, oil and grease | 23.11 | 26.12 | 36.71 | 30.92 | 34.42 | 56.42 |
| Repair and maint. | 34.46 | 42.26 | 57.04 | 58.26 | 58.35 | 79.60 |
| Depreciation | 26.07 | 32.37 | 42.26 | 41.76 | 40.11 | 60.70 |
| Licenses & insurance | 11.30 | 15.13 | 23.44 | 24.88 | 31.17 | 38.20 |
| Interest on prod. cap. | 12.44 | 14.36 | 19.72 | 19.97 | 21.42 | 44.05 |
| Interest on cap. inv.[z] | 2.61 | 3.24 | 4.22 | 4.17 | 4.01 | 9.11 |
| Miscellaneous | 17.32 | 16.76 | 42.14 | 36.53 | 56.61 | 135.52 |
| Total | 538.73 | 624.52 | 855.19 | 865.40 | 922.60 | 1,288.43 |
| Harvesting and marketing: | | | | | | |
| Picking | 180.25 | 163.86 | 301.88 | 256.02 | 275.81 | 386.62 |
| Grading and packing | 178.55 | 159.05 | 302.41 | 261.65 | 335.70 | 557.31 |
| Containers | 102.94 | 87.83 | 145.84 | 137.21 | 173.28 | 291.29 |
| Hauling | 38.40 | 30.88 | 55.92 | 48.97 | 52.38 | 91.84 |
| Selling | 37.91 | 32.45 | 56.59 | 83.30 | 78.92 | 116.98 |
| Total | 538.05 | 474.07 | 862.64 | 787.15 | 916.09 | 1,444.04 |
| Total crop cost | 1,076.78 | 1,098.59 | 1,717.83 | 1,652.55 | 1,838.69 | 2,732.47 |

| Cost item | Crop season | | | | |
|---|---|---|---|---|---|
| | 1974-75 | 1975-76 | 1976-77 | 1977-78 | 1978-79 |
| | Dollars | | | | |
| Growing: | | | | | |
| Land rent | 37.53 | 37.52 | 40.20 | 46.97 | 56.35 |
| Seed | 59.42 | 55.17 | 57.25 | 66.92 | 71.32 |
| Fertilizer | 277.31 | 235.91 | 195.55 | 187.19 | 171.90 |
| Spray and dust | 280.25 | 247.80 | 226.14 | 287.66 | 295.17 |
| Cultural labor | 393.81 | 399.59 | 436.15 | 463.38 | 462.45 |
| Machine hire | 49.48 | 35.16 | 27.10 | 25.24 | 31.21 |
| Gas, oil and grease | 71.01 | 55.12 | 60.52 | 74.95 | 74.51 |
| Repair and maint. | 76.25 | 86.69 | 79.94 | 106.87 | 113.65 |
| Depreciation | 67.33 | 60.75 | 66.46 | 83.74 | 87.44 |
| Licenses & insurance | 53.85 | 43.82 | 60.71 | 72.09 | 82.26 |
| Interest on prod. cap. | 54.44 | 49.12 | 48.67 | 57.06 | 58.29 |
| Interest on cap. inv.[z] | 10.10 | 9.11 | 9.97 | 12.56 | 13.12 |
| Miscellaneous | 152.93 | 113.05 | 114.34 | 190.44 | 195.64 |
| Total | 1,583.72 | 1,428.81 | 1,423.00 | 1,675.08 | 1,713.31 |
| Harvesting and marketing: | | | | | |
| Picking | 402.22 | 312.69 | 263.18 | 376.33 | 409.83 |
| Grading and packing | 754.31 | 605.99 | 492.96 | 639.16 | 684.43 |
| Containers | 397.10 | 338.10 | 258.57 | 323.33 | 336.22 |
| Hauling | 103.50 | 77.74 | 76.39 | 102.56 | 127.27 |
| Selling | 102.48 | 85.13 | 65.61 | 91.03 | 115.10 |
| Total | 1,759.61 | 1,419.65 | 1,156.71 | 1,532.41 | 1,672.85 |
| Total crop cost | 3,343.33 | 2,848.46 | 2,579.71 | 3,207.49 | 3,386.16 |

[z]Other than land.
Source: (1)

the average annual rate of increase. Thus, r represents the average rate of increase compounded annually.

Solving for r yields

$$r = \left(\frac{Y}{X}\right)^{.1} - 1$$

The tool used to analyze the effect of inflation on production and marketing costs and to forecast future cost trends was trend analysis. It involves estimating the effect of time on annual production and marketing costs. In this study, the effects were assumed to be represented by the following trend model:

$$PC_{iT} = a_{io} + a_{i1}T + a_{i2}T^2$$

where $PC_{iT}$ is the cost of item i in year T, $a_{io}$ is the estimated initial cost of item i, and $a_{i1}$ and $a_{i2}$ show the impact of time on the estimated cost of item i. Trend models for each cost item were estimated using ordinary least squares regression. If the ratio of the estimated coefficient to the estimated standard error (the "t-ratio") was less than one for $a_{i2}$, the squared term was deleted and the equation was reestimated as a linear model.

## Results and Discussion

The results of computing r for each cost item appear in Table 5. They ranged from a small decrease for machine hire to a 27.4 percent average annual increase for mis-

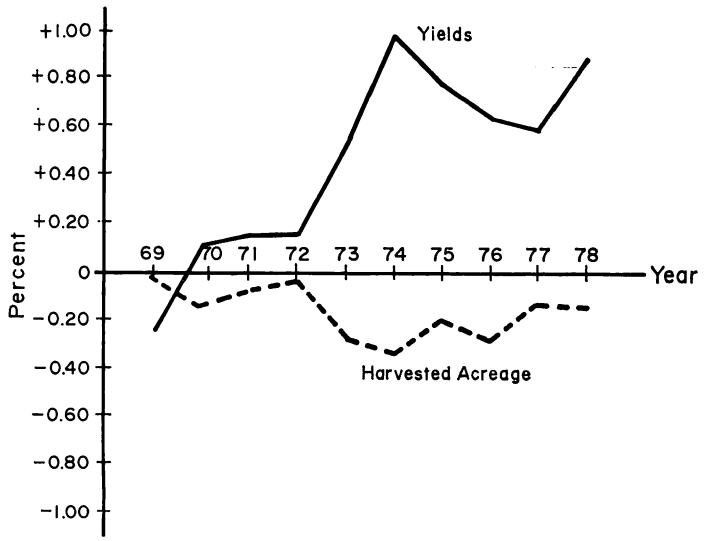


Fig. 2. Percentage changes in yields and harvested acreage for Florida tomatoes, 1969-78.

Table 5. Average annual inflation rates for different items of tomato production and marketing in Florida, 1968-79.

| Item | Percent[z] |
|---|---|
| Land Rent | 9.2 |
| Seed | 25.4 |
| Fertilizer | 2.8 |
| Spray and Dust | 14.3 |
| Cultural Labor | 13.1 |
| Machine hire | −1.9 |
| Gas, Oil, and Grease | 12.4 |
| Repair and Maintenance | 12.7 |
| Depreciation | 12.9 |
| Licenses and Insurance | 22.0 |
| Interest on Prod. Capital | 16.7 |
| Interest on Capital Invest. | 17.5 |
| Miscellaneous Expenses | 27.5 |
| Total Growing Cost | 12.3 |
| Picking | 8.6 |
| Grading and Packing | 14.4 |
| Containers | 12.6 |
| Hauling | 12.7 |
| Selling | 11.7 |
| Total Harvesting and Marketing Cost | 12.0 |

[z]See text for manner of computation.

cellaneous expenses. Cultural labor, spray and dust, picking expense, and grading and packing expenses, which account for a large percentage of total costs and are often blamed as items whose costs are "out of control", did not show excessively large rates of increases relative to other items. The annual rates for all these items, except picking expense, however, exceeded 12 percent, and as such have grown rapidly over the period of analysis.

Two items which showed large average annual increases (seed and licenses and insurance) are worth note. The rapid growth of theft losses from farm operations and in the magnitude of capital investment, both caused higher insurance rates. Higher seed costs can be attributed to the adoption of more expensive varieties, which require more care as seedlings, increasing labor costs to produce the seed.

The cost of fertilizer, despite its oil base, has increased at a small rate. Machine hire, as stated above, showed a slight average decrease.

Total growing costs showed a 12.3 percent and total harvesting and marketing costs showed a 12.0 percent average annual increase over the 1968 to 1978 period. Both figures far exceed the general inflation rate over the same period. Thus Florida tomato producers have experienced a period of rapidly rising production and marketing costs.

The results of the trend analysis appear in Table 6. They can be useful in projecting future production costs changes, but care must be taken in interpreting the results. These models only capture trends in the data, and thus do not account for the various economic, biologic, and climatic factors which influence tomato production and costs of production.

The estimated trend models showed that, over the study period, the profile of costs for each item fell into one of three major categories. In the first category, the estimated trend model was linear in time, suggesting a steady, constant rate of increase over time. In the second, the coefficient of the quadratic term was negative, indicating that costs have been increasing at a decreasing rate. In the third category, the quadratic term was positive, indicating increasing costs at an increasing rate over the range of the data.

Table 6. Results of the estimated trend models.[z]

| Item | Constant | T | $T^2$ | $R^2$ |
|---|---|---|---|---|
| Growing: | | | | |
| Land rent | 25.08<br>( 3.59) | 0.79<br>( 1.37) | 0.15<br>(0.11) | .90 |
| Seed | − 1.48<br>( 4.03) | 6.92<br>(0.59) | | .94 |
| Fertilizer | 77.52<br>(37.61) | 33.48<br>(14.41) | −2.16<br>(1.17) | .52 |
| Spray and dust | 30.94<br>(27.68) | 35.47<br>(10.60) | −1.06<br>(0.86) | .92 |
| Cultural labor | 81.34<br>(26.08) | 51.80<br>( 9.99) | −1.45<br>(0.18) | .97 |
| Machine hire | 35.79<br>( 5.69) | 3.89<br>( 2.18) | −0.45<br>(0.18) | .66 |
| Gas, oil and grease | 16.23<br>( 5.04) | 5.53<br>( 0.74) | | .86 |
| Repair and mainten. | 28.60<br>( 4.37) | 7.25<br>( 0.64) | | .93 |
| Depreciation | 19.90<br>( 3.68) | 5.91<br>( 0.54) | | .93 |
| Licenses and insurance | 8.93<br>( 5.15) | 2.90<br>( 1.97) | 0.33<br>(0.16) | .97 |
| Interest on prod. capital | 4.78<br>( 4.28) | 5.26<br>( 0.63) | | .88 |
| Interest on cap. invest. | 0.76<br>( 0.80) | 1.12<br>( 0.12) | | .91 |
| Miscellaneous | −14.38<br>(17.24) | 18.61<br>( 2.53) | | .86 |
| Harvesting and Marketing: | | | | |
| Picking | 130.73<br>(64.69) | 45.21<br>(24.78) | −2.16<br>(2.01) | .62 |
| Grading and packing | 7.04<br>(118.19) | 106.77<br>(45.27) | −4.25<br>(3.67) | .79 |
| Containers | −0.09<br>( 64.27) | 59.37<br>(24.62) | −2.62<br>(2.00) | .77 |
| Hauling | 24.11<br>( 9.69) | 8.19<br>( 1.43) | | .78 |
| Selling | 14.64<br>(21.10) | 18.71<br>( 8.08) | −1.05<br>(0.66) | .63 |

[z]Figures in parentheses are standard errors of the estimated coefficients.

Items falling in the first category included seed; gas, oil and grease; repair and maintenance; depreciation; interest on production capital; interest on capital investment; miscellaneous expenses; and hauling expenses. The second category included fertilizer; spray and dust; cultural labor; machine hire; picking; grading and packing; containers; and selling expenses. As noted above, machine hire costs in 1978 had decreased from their 1968 level. Only two items (land rent and licenses and insurance) fell in the third category.

To illustrate the estimated trend models, the equations for land rent, repair and maintenance, and fertilizer are shown in Figure 3. Note the plot of the estimated trend for repair and maintenance is a straight upward sloping line. The plot of the estimated trend for fertilizer projects that fertilizer costs were increasing at a decreasing rate and have begun to decline. The plot of the estimated trend for land rent shows this cost increasing at an increasing rate.

A word of caution is in order. The data used was expressed in current dollars and did not take into account adjustments for the quantities and qualities of inputs. It could also be argued that the cost of some items may have declined in terms of real dollars. Thus, differential inflation rates could have benefited the tomato producers—particularly if tomato prices have increased at a faster rate.

The latter, however, does not seem to be the case. During the study period, tomato prices showed an average rate of increase, compounded annually in current dollars, of 5.17 percent (2). That figure is far below the 12 percent rate of increase for total costs. Therefore, Florida producers should be particularly concerned with those items which have risen most rapidly and with those which displayed similar recent trends.

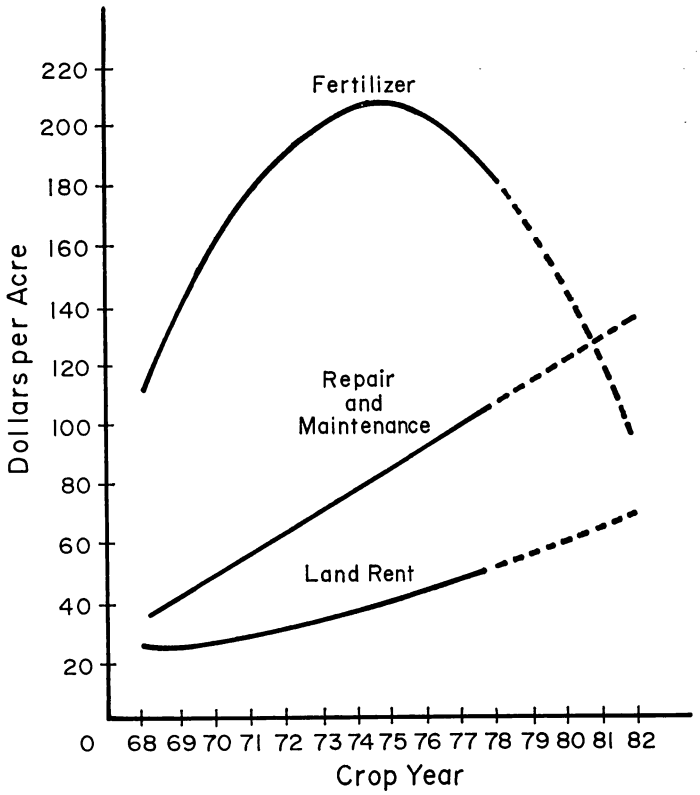


Fig. 3. Plots of three of the estimated trend models.

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# A PRODUCTION AND MARKET FORECASTING MODEL FOR FLORIDA WATERMELONS BY REGION[1]


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*Additional index words.* interactive forecasting.


*Abstract.* **A causal model as well as time series models are derived and employed to predict the planted acres and monthly prices for Florida watermelons. The different techniques are used to generate forecasts from each and a *composite* forecast, which may be more accurate. These forecasts can be derived before the production decisions are made by Florida producers and will thus provide Florida producers information they can use in their production decision process.**

**A demonstration of the forecasting technique is given for the 1981 season and is compared with realized values. Finally, a forecast for the 1982 season is derived.**


The state of Florida is a major producer of spring and early summer watermelons. Florida produced 72.3% of the total U.S. spring watermelon production in 1980 (Table 1) and 34.8% of total U.S. production. The 1980 watermelon crop was valued at approximately 48.5 million dollars or 7.8% of the total value of fresh vegetables in Florida. Areas competing with Florida for the spring watermelon market include Georgia, Texas, Alabama, California, Arizona, and Mexico.

Table 1. Spring watermelon production by state.[z]

| State | Percent of total |
|---|---|
| Florida | 72.3 |
| Georgia | 4.8 |
| Texas | 11.0 |
| Alabama | 2.0 |
| California | 7.8 |
| Arizona | 2.0 |

[z]Source: Crop Reporting Board, *Vegetables 1980 Annual Summary*. ESS, USDA, December, 1980.

[1]Florida Agricultural Experiment Stations Journal Series No. 3450.