The California-Arizona lemon cycle continues

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Projections of the lemon cycle indicate that average total revenue per acre in 1998-99 will drop to the same level seen in 1984-85, if growers continue to respond as they have in the past.

Cyclical patterns of acreage and production for perennial crops are familiar to growers and others associated with the fruit and nut industries. Two Giannini Foundation economists, Professors B.C. French and R.G. Bressler, documented and analyzed the "lemon cycle" in a 1962 article published in the *Journal of Farm Economics*. They concluded that producers' knowledge of the production-price cycle could lead to better forecasts and to moderation or elimination of the cycle. Despite general awareness of its existence, however, the lemon cycle continues. This report describes cyclical behavior in the lemon industry, discusses some of the underlying causes, and predicts some future developments.

Lemon acreage adjustments

From 1955 through 1985, two peaks in total California-Arizona lemon acreage occurred, the first in 1958 and the second in 1976 (fig. 1). These highs were followed by highs in bearing acreage in 1961 and 1979-81 as nonbearing trees reached bearing age. As the high points in total bearing acreage approached, low returns associated with the resulting increased production discouraged growers from planting new trees and sharply reduced nonbearing acreage. Nonbearing lemon acreage went from a high of 13,239 acres in 1958 to a low of 1,837 in 1964, then increased to another high of 23,967 in 1975, followed by a low of 1,016 in 1981. After a slight increase, nonbearing acreage fell again to 1,594 acres in 1985.

Average lemon yields per acre vary from year to year, depending on weather conditions and other factors, but they have shown an upward trend over time. Since average per-carton lemon prices vary inversely with total lemon production, they also tend to vary inversely with bearing acreage. Lemon prices and the total crop value thus increased through the 1960s and into the early 1970s, when bearing acreage was relatively low. Then the sharp expansion in bearing acreage during the 1970s put significant downward pressure on average prices and returns. Plantings of new groves declined as prices and returns decreased, keeping nonbearing lemon acreage very low during the 1980s. Recent improvements in average returns, however, will stimulate some new planting, so we can expect nonbearing acreage to expand, beginning another cycle.

Causes

The basic cause of cyclical lemon acreage, production, and prices is the time lag of at least five to seven years between the decision to plant trees and any significant production. Producers appear to base their expectations of future returns, however, on recent industry economic conditions and plant accordingly. With improving lemon prices, not only do existing producers decide to expand their acreage, but new producers are encouraged to enter. These new plantings do not affect production until five years later, when the trees begin to produce commercial quantities of fruit. If the economic conditions that encouraged plantings continue for several years, plantings of new trees will also continue or even accelerate because of the delayed impact on production.

Outside events, such as new products, new markets, and changes in government policy may set industry adjustments in motion that intensify a cycle or start a new one. Such is the story of the California-Arizona lemon industry. The development of new processed lemon products in the 1950s encouraged the early growth of production in Arizona and the California desert, but then adversely affected demand for lemons in the fresh market. As real returns declined in response to this increased production, acreage began to decline in the early 1960s. Then in the late 1960s, new lemon plantings increased substantially as investors exploited the income tax shelter advantages of citrus grove development. While the tax advantages of this activity were largely terminated by the Tax Reform Act of 1969 (effective in 1970), expanding export markets helped increase real returns to record levels and encouraged new plantings through the mid-1970s. The time lag between planting and bearing sustained the increases in bearing lemon acreage until it reached a record high in 1981. This increased acreage, combined with decreased export opportunities, resulted in very low returns during the 1981-82 marketing year.

As total production increased and shifted more to the winter producing regions, changes also occurred in the utilization of the crop. When domestic fresh lemon consumption leveled off in the late 1960s and 1970s, increased production was used to supply expanding export markets, and excess supplies were diverted to processing. Domestic fresh utilization thus declined in its share of total production from 55 percent in 1955-56 to 20 percent in 1980-81.

An industry model

These observed relationships and economic behavior formed the basis for specification and estimation of an econometric model of the California-Arizona lemon industry. This model, which included estimated relationships for acreage response, lemon demand, and prices, closely simulated bearing acreage, average f.o.b. prices and total industry revenue during 1962-63 through 1982-83.

The estimated acreage response relationships indicated that lemon growers respond to several factors in making planting and removal decisions, but most important were recent averages of real per-acre total revenue. The demand and price analysis indicated that the price flexibility of demand for fresh lemons is very high at the f.o.b. level while the price flexibility of demand for processed lemons is quite low. That is, a 1 percent change in fresh quantity is associated with a change in fresh price of almost 3 percent in the opposite direction (at average prices and quantities), while a 1 percent change in processed quantity is asso-

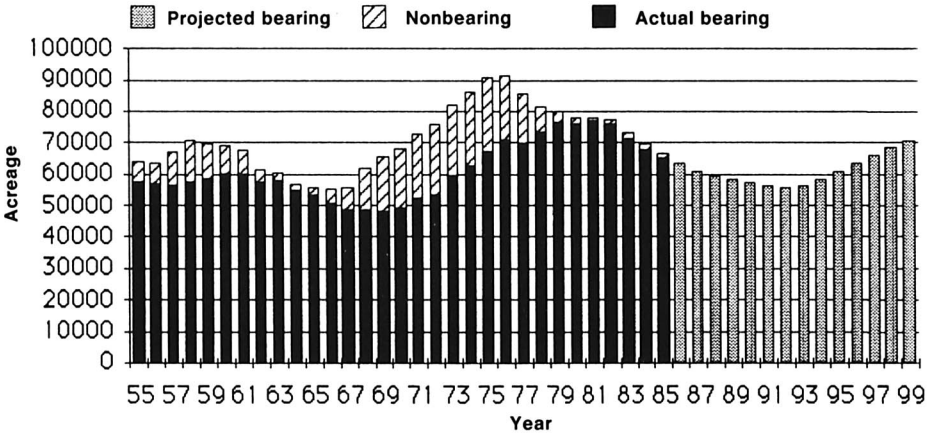

Fig. 1. Although previous studies indicated the long-term lemon cycle in California and Arizona was 25 to 30 years, a study of actual bearing and nonbearing acreage from 1955 to 1985 and projected bearing acreage from 1986 to 1999 indicates that the time from peak to peak and trough to trough is currently about 20 years.

ciated with a change in processed price of less than 0.5 percent in the opposite direction.

Putting these relationships in terms of elasticities, the f.o.b. price elasticity of demand for fresh lemons is −0.34; for processed lemons, −2.11 (measured at average values for price and quantity). That is, if the f.o.b. price for fresh lemons dropped by 10 percent, quantities demanded would increase only about 3 percent; while in the processed market, the same percentage decrease in price would lead to a 21 percent increase in quantities demanded.

The model was used to simulate future patterns of acreage, production, and prices from 1985-86 through 1998-99 by assuming a set of values for the model variables and six different constant levels of prorate allocations to the domestic fresh market. The projected bearing acreage (fig. 1) is based on an annual domestic fresh market allocation of 2.3 pounds per capita. Smaller fresh market allocations (2.05 to 2.2 pounds per capita) would generally result in higher levels of bearing acreage during each year of the projection period, while larger fresh market allocations (2.4 to 2.5 pounds per capita) would result in lower levels. The pattern of acreage adjustment is similar, however, regardless of the fresh market allocation, and the continuation of the lemon cycle is evident. Bearing acreage is projected to decline from 66,502 acres during 1984-85 to 55,705 acres during 1991-92 and then increase to 70,893 acres in 1998-99. The cyclical low point for each of the six projections occurs in the 1991-92 crop year.

The behavioral basis for the projected continuation of cyclical patterns of adjustment in lemon acreage, production, and prices is again the significant time lags. Bearing acreage will decrease over the next several years because of the current very low level of nonbearing acreage. Trees will continue to be removed each year because of age, disease, low yields, economic losses, low profit expectations, and urbanization. If one assumes that a lemon grove has an average life of 40 years, then annual plantings of approximately 1,500 acres and nonbearing acreage of about 7,500 acres (five years of planting) would be required to maintain a total bearing acreage of 60,000 acres. A shorter average tree life would, of course, require a higher level of annual plantings to maintain a given bearing acreage. Total nonbearing California-Arizona lemon acreage has remained below 4,000 acres since 1979. Prices and return will improve, however, as bearing acreage declines, and this improvement will lead to new plantings. These new plantings will lead to the projected increase in bearing lemon acreage and production after the 1991-92 crop year.

Concluding comments

French and Bressler's projections suggested a long-term lemon cycle of 25 to 30 years. While our data and projections indicate that the time from peak to peak and trough to trough is shorter (about 20 years), the cycle continues.

Cyclical acreage, production, and prices in the California-Arizona lemon industry involve significant adjustment costs. The decision to develop lemons, for example, requires a long-term commitment of land and an investment in establishing trees that may exceed $3,000 per acre. Once in production, annual cash cultural costs are estimated to be almost $1,000 per acre. Overexpansion of the industry during the 1970s, with total acreage peaking at 91,316 acres in 1976, caused a long period of depressed returns and a steady decrease in acreage as groves were abandoned and trees removed. The total 1985 lemon acreage of 66,829 acres was 28 percent below its 1976 peak, putting it back to the pre-expansion level of 1969. The capital losses and waste of resources associated with removal of lemon groves is obvious. Not so obvious, but very important, are the adverse effects of low returns on the entire producer sector of the industry.

Lemon producers' planting and removal decisions during the next several years will have important long-term effects on industry returns. Average returns are expected to improve as lemon acreage continues to decrease. Improved returns can be expected to lead to decisions to increase plantings, but the production increases associated with these plantings will eventually decrease returns. Our projections indicate that average total revenue per acre for lemons in the 1998-99 crop year will drop back to the level observed in 1984-85 if producers continue to respond as they have in the past.

Our projected acreage adjustments for the 1990s may not occur. External shocks to the system could occur, such as impacts on supply and/or demand caused by changes in weather, technology, or government programs, that would alter the projected patterns of adjustment. And producers may modify their behavior and not expand acreage to the degree expected as returns improve. Timely data on various aspects of the California-Arizona lemon industry are collected under the federal marketing order. Producers might make better use of such data. The Lemon Administrative Committee could discuss the longer term implications (four to eight years) of changes in bearing and nonbearing acreage with regard to expected returns as part of its marketing policy statements. If such information were widely publicized through media likely to reach producers and potential producers, it might affect their decisions.

While the focus here has been on the cyclical patterns of acreage, production, and prices in the California-Arizona lemon industry, factors responsible for these cyclical patterns exist in varying degrees in other perennial crops. Changes in weather, technology, government programs, consumer income, tastes and preferences, and production of competing crops may mask existing long-term cyclical patterns, and producer awareness can dampen long-term cycles. The lagged adjustments underlying cycles are present in all perennial crops, however, and producers making planting decisions must be aware of recent new plantings, nonbearing acreage, and yield trends when assessing profit potentials.

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