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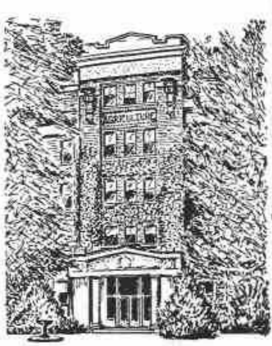

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Long-run Projections of Bartlett Pear Prices and Production

Donald J. Ricks and John A. Edwards

Summary and Conclusions

The advent of pear decline in many Pacific coast producing areas threatened to seriously reduce future Bartlett pear production. The resulting expectations of high farm prices have led growers to establish extensive new plantings. In addition, farm owners in potential pear-producing areas, such as the Willamette Valley, have become increasingly interested in developing new pear orchards. Since the effects of pear decline have diminished in recent years, future production increases from the large acreages of nonbearing trees may result in substantially lower future price levels.

This study was undertaken in an effort to clarify the future economic situation of the Pacific coast Bartlett pear industry by predicting future price and production levels and developing a pattern of future regional production.

In order to predict future price and production, long-run supply and demand equations were developed for the industry. The resulting demand (or price-estimating) equation for farm prices of all Bartlett sales includes the following price-determining variables: (1) per capita production of Pacific coast Bartlett pears; (2) per capita pear production in Michigan and New York; (3) real farm price of California cling peaches; (4) canners' stocks of canned pears per capita; and (5) canned pear exports. These five independent variables accounted for 95% of the annual variation in real farm prices of all sales of Pacific coast Bartlett pears during the postwar period. The supply equation includes price in the previous period and production in the previous period as supply-determining (independent) variables. Statistical results indicate that these supply-determining variables explained about 98% of the variation in the four-year average quantity of the Pacific coast Bartlett pears supplied.

Supply and demand equations, along with projected values of price-determining variables, were combined to project "average" price and production levels to 1985. Because of the uncertainty involved in projections of price-determining variables, several alternative projections were made. All projections indicate that future prices will continue to increase for several years, and then decrease steadily until about 1972-1975 as expanding production from existing nonbearing acreage occurs. In every case, steadily rising price levels from 1975 to 1985 are anticipated in response to population expansion and grower reaction to lower prices.

Price levels of the several series of projections vary with the alternative combination of values of the projected price-determining variables. The highest series of projected prices indicates a level of $83 to $84 per ton during the low-price period from 1972 to 1975; the lowest series shows a price of $60 to $62 per ton during this period. The highest series involves projections which rise to $97 per ton by 1985, while the lowest series indicates a price of $77 per ton in this year. All other alternative combinations of the exogenous variables yielded series of projected prices which are intermediate to the range indicated above.

All alternative production predictions indicate that future production will increase substantially until about 1972, and then decrease slowly until 1985. Predicted production increases until 1972 are similar under all alternatives, with a range of 614,000 to 634,000 tons predicted for 1972. Greater differences in production predictions from the various alternatives are shown in later years, with a range of 543,000 to 587,000 tons predicted by the year 1985.

Changes in the regional production pattern were projected on the basis of (1) trends in bearing and nonbearing acreage, and (2) comparative costs of production in relation to expected future prices.

These criteria clearly point to a substantial increase in production in the Sacramento River and Lake Mendocino areas of California and thus a gain in the future relative position of these areas. Increases in the position of the central Washington and Hood River areas in relation to total production levels are also indicated. Relatively stable production can be expected in the Medford area, which will result in a decline in the relative position of this area as production rises in other areas. Indications point to decreases in production in the Sierra foothills and Santa Clara areas and, therefore, a less important position in relation to future total production.

The future position of the Willamette Valley in respect to Bartlett pear production is not completely clear on the basis of the above criteria. Extremely high percentages of existing nonbearing acreage indicate that production and the relative position of the area will rise in the future, although the area will remain one of relatively minor importance in terms of absolute production. Cost estimates indicate, however, that the Willamette Valley is a relatively high-cost area. A comparison of these high costs per ton to decreasing future prices shows unpromising prospects for further expansion of pear acreage in the Valley.

Because the high costs per ton in the Willamette Valley area are largely the result of low average yields, possible increases in yields would greatly improve the area's comparative cost position. In this manner, increases in average yields of 25% (with cost conditions remaining constant in other production areas) would change this area from a high-cost area to one of relatively low costs per ton. This would enhance economic prospects for possible expansion into a major pear-producing area.

It seems reasonable to conclude that Bartlett pear production in the Willamette Valley will remain relatively minor in relation to total production in the near future, although the area may develop into a major producing area in the more distant future.

Introduction

Recent developments affecting the Pacific coast pear industry have confronted growers, as well as processors and shippers, of this important crop with a high degree of uncertainty in regard to future economic conditions. The widespread occurrence of a tree disorder known as "pear decline" in certain production areas has been a major industry problem in recent years and has greatly added to uncertainties regarding future production. Beginning in the mid-1950's, pear decline compelled growers to remove large acreages of pears in central Washington. While a portion of the bearing acreage in this area was removed entirely, yields on a large additional acreage were reduced considerably. In more recent years, pear decline has, in a similar manner, seriously affected pear production capabilities in Medford and California production areas. For several years commencing about 1960, pear decline reached epidemic proportions in certain California production regions such as the Sierra foothills area. The prevalence of the disorder has been reduced considerably.

During the first few years following the occurrence of pear decline, little was known regarding its causes or remedies except that it seemed to primarily affect trees on certain types of rootstock. As a consequence, during the late 1950's and probably until about 1961, industry representatives estimated that as much as 25 to 40% of bearing pear acreages in Pacific coast states would succumb to the disorder. This would, of course, mean severe economic hardships for many individual growers and have important economic ramifications for the industry as a whole, as well as for communities in which pear production constituted a primary source of income.

During these years, prospects of a marked drop in future production led to a considerable rise in expectations regarding future pear prices. As a result, large acreages of young Bartlett pears were planted. The most extensive acreages of new plantings occurred in the Yakima Valley of Washington and the Sacramento River and Lake Mendocino areas of California, although substantial new plantings were also made in most other established production areas.

At the same time, landowners in some areas which have not, in the past, been major pear-producing areas, gained considerable interest in planting young acreages of Bartlett pears. Consequently, such areas as the Willamette Valley in Oregon and portions of the Central Valley in California, which have land and a climate which are suitable for Bartlett pear production, gained a sizable acreage of new plantings. These areas also have a potential for greater acreage expansion in the future. Prospects of high future prices for Bartlett pears, as well as relatively unfavorable profit conditions associated with some of the more traditional crops in these areas, have provided special incentives for the areas' landowners to consider development of pear enterprises.

Within the last two or three years, it has become increasingly evident that reductions in pear acreage due to pear decline will not reach the magnitudes which were indicated by earlier predictions. The large extent of new plantings has also become evident from recent tree censuses in each of the Pacific coast states (*1, 12, 29*).[1] There are indications that these new plantings are of sufficient magnitude to provide productive capacity much in excess of that lost through removals from pear decline and from normal causes. These facts have led many in the industry to fear that when these new plantings come into bearing, production levels will be sufficient to lower prices considerably below the levels of recent years.

In addition to future production levels, future price levels will be influenced by conditions affecting competing fruits, export markets, urbanization, and other dynamic factors. Pear growers and managers of pear marketing firms are keenly aware of the importance of future prices and production to their profit position; however, accurate estimates of these future unknowns are extremely difficult to obtain because of complex and ever-changing conditions. Although a lack of

[1] Numbers in parentheses refer to Literature Cited, page 39.

complete knowledge regarding future conditions is a problem which is faced by every agricultural industry, this problem is especially acute for decision-makers in a tree-fruit industry where a sizable initial investment and a number of years are required to develop a bearing orchard.

Lack of knowledge regarding the competitive position of various established and potential production areas also presents a problem to industry managers in regard to decisions such as acreage expansion or contraction within a given area. At the present time, these problems are complicated and intensified by rapid changes and uncertainties which have arisen with the advent of pear decline and the accompanying expansion of new plantings.

In light of these problems, a study was undertaken with the primary objectives of: (1) predicting future price and production levels by an analysis of the important factors which influence these variables; and (2) analyzing future possibilities for changes in the regional pattern of production.

An analysis of farm price relationships of Pacific coast Bartlett pears in the post-World War II period was made. From this analysis, a demand (price-estimating) equation was developed which expresses the relationship between season-average grower price for Pacific coast Bartlett pears and various factors which have an important influence in determining these prices. An equation to estimate supply of pears was also developed. These demand and supply equations were used, along with projected estimates of various price-influencing factors, to predict future price and production levels. Changes in the regional pattern of production were projected on the basis of bearing and nonbearing acreage trends and on relative cost estimates in the various production areas in relation to future price predictions.

The Price-making Situation

Farm prices of Bartlett pears are determined by supply and demand conditions in both the fresh market and the canning market. Total farm production and amount of farm sales are determined primarily by the amount and age of bearing acreage, amount and quality of variable inputs and cultural practices used, and variations in weather conditions. Demand conditions in both the fresh and the processing markets include such factors as population, consumer income, supply of other fruits, export demand, and the general price level. The demand for processing pears (primarily for canning) would also be expected to be influenced by the amount of canners' stocks on hand at the beginning of the season and by processing costs.

Farm prices for processing pears are determined in a situation in which there are a large number of growers and relatively few processor-buyers. This situation is altered somewhat by the operation of grower bargaining associations—one in California and another in Washington and Oregon.

The fresh market is characterized by a larger number of first handlers than are found in the processing market. Although fresh pears are sometimes sold by growers to packer-shippers for a cash price at the time of delivery, a more common arrangement in many production areas is that of fresh sales on a commission basis, or through cooperative organizations. In this case, growers are paid a return which is based on prices received by the packer-shipper for packed fruit, minus all costs for packing, grading, and shipping.

Because fresh marketings involve a relatively high percentage of commission sales, a larger number of marketing firms, and marketing costs for fresh pears usually represent a smaller percentage of retail price, demand conditions for farm sales of fresh Bartletts can be expected to be more closely associated with changes in consumer demand than is the case in the processing market.

The Demand Relationship

The demand analysis of this study, from which a price-estimating equation was developed, concentrated upon the important variables which affect farm prices of all Bartlett sales. Demand conditions at the farm level which are provided by processor and other first-handler buyers are derived from demand conditions at consumer, retail, and wholesale levels. Because farm demand is ultimately derived from consumer demand, such factors as consumer tastes and preferences, population, consumer income, and prices of competing products would be expected to be important factors affecting the demand for Bartlett pears. Export demand conditions would also be expected to affect demand for pears at the farm level. Processor demand for Pacific coast canning pears would be expected to be affected by carry-in stocks of canned pears, production of pears in other areas, and production of other canning fruits in the United States.

Statistical results of the price analysis indicate that the following variables have been important determinants of grower returns for Pacific coast Bartlett pears during the postwar period: (1) per capita farm production of Pacific coast Bartlett pears; (2) per capita production of all pears in Michigan and New York; (3) grower returns for California cling peaches; (4) per capita stocks of canned pears at the beginning of the marketing year (June 30); and (5) quantity of canned pear exports. Expression of production figures and canners' stocks on the basis of per capita quantities resulted in the inclusion of population as an implicit variable in the analysis. Farm prices of Bartlett pears as well as farm prices of California cling peaches were expressed on the basis of constant dollars (1957-59 dollars). Expression of these prices in constant dollars is equivalent to including the general price level as an implicit variable in the analysis.

By comparison, previous studies of Pacific coast pears by Pubols (*13*) and by Schneider (*14*) have indicated that the following factors are important determinants of farm prices of pears: (1) total production of Pacific coast pears; (2) disposable personal income; (3) stocks of canned pears; and (4) production of Pacific coast pears other than Bartlett. In a study of f.o.b. price relationships for Pacific coast canned pears, Hoos (*11*) found that the following variables have an important influence upon price: (1) canners' commercial domestic movement of Pacific coast canned pears (a measure of supply); (2) index of United States disposable personal income; and (3) an index of prices of competing canned fruits (California cling peaches, California apricots, Pacific coast freestone peaches, fruit cocktail, and Hawaiian pineapple).

Basic data

Data developed by the United States Department of Agriculture on farm production of pears, cling peaches, and other fruits, as well as farm prices of these fruits, provided a primary source of data for the analysis. Data on canned pear exports, which include quantities of pears exported in the form of fruit cocktail, were also based on information published by the United States Department of Agriculture.

Data on farm prices, as well as farm production, for pears and other fruits and for most of the other demand-influencing factors are available on an annual basis from 1925 until the present time. Preliminary analysis of price determination in the pre-World War II period and the post-World War II period indicated that substantial changes have occurred in the relative importance of various demand-influencing factors as well as in the magnitude of the effect of each upon pear prices. Therefore, the most recent postwar period was selected for further analysis because of the greater likelihood that market conditions in the more recent past will reflect conditions in the future.

The demand equation

The relationship of various demand-influencing factors to farm prices of Pacific coast Bartlett pears during the 1947-1962 period can be summarized by the following equation obtained by least squares regression procedures:

$$\hat{Y}_1 = -1.6675 - 43.47234\,X_1 - 77.60454\,X_2 + 0.98502\,X_3$$
$$\qquad (-5.958)^{*} \quad (-2.292)^{\dagger} \quad (5.391)^{*}$$
$$-46.52603\,X_4 + 0.00196\,X_5$$
$$(-5.312)^{*} \quad (1.945)^{\ddagger 2}$$
$$R^2 = .945$$

Standard error $Y.X = 10.35559$

where: $\hat{Y}_1$ = first difference average annual grower returns per ton for Pacific coast Bartlett pears—all sales, expressed in real terms (1957-59 dollars),

X_1 = first difference total farm production of Pacific coast Bartlett pears (tons per 1,000 persons),

X_2 = first difference production of all pears in Michigan and New York (tons per 1,000 persons),

X_3 = first difference average annual grower returns of California cling peaches for canning, expressed in real terms (1957-59 dollars),

X_4 = first difference canners' stocks of canned pears at beginning of year (June 1) (1,000 cases—24 No. 2½ basis per 1,000 persons), and

X_5 = first difference two-year moving average of canned pear exports the preceding period (t-1) (tons).

The variables in this price-estimating equation are expressed in terms of first differences which measure year-to-year change in the respective variables. Use of first differences yielded an equation which explained a substantially higher proportion of the variation in farm prices than an equation which was based upon actual data. Statistical results indicate that the above equation explained 94.5% of the variation in year-to-year change of annual grower returns for Pacific coast Bartlett pears during the 1947-1962 period.

Several quantity indices of competing canning fruits were analyzed as alternative measures of the variable expressing grower prices of California cling peaches. None of these indices, however, provided satisfactory statistical results.

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[2] Figures in parentheses are t-ratios of the regression coefficients. The t-ratio of the coefficient for X_1, X_3, and X_4 is each significant at the 1% level (*) while that for X_2 is significant at the 5% level (†) and that for X_5 is significant at the 10% level (‡).

The term R^2 is the coefficient of multiple determination. In this case an R^2 value of .945 means that the five independent variables (price-determining factors) explain 94.5% of the variation in year-to-year change (first difference) in average annual grower returns per ton for Pacific coast Bartlett pears—all sales.

Several variables were analyzed which do not appear in the final price-estimating equation. These include: (1) total production of Pacific coast pears other than Bartlett; (2) a measure of quantities of competing fresh fruits; (3) a measure of canners' costs or profit from the preceding period (year t-1)[3]; and (4) United States disposable income per capita. These variables were excluded from the final demand equation because regression analyses indicated *one or more* of the following: the statistical relationship to price which was obtained is inconsistent with economic logic: the factor or variable was not statistically significant; or inclusion of the variable did not materially increase the percentage of the variation in prices which was explained by the equation (the R^2 value).

Economic interpretation of the resulting equation can be summarized as follows:

1. An increase in total farm production of Pacific coast Bartlett pears of 0.1 ton per 1,000 persons of the United States population, considered by itself, resulted in a decrease in annual average grower returns for all sales of Pacific coast Bartlett pears of $4.35 per ton, in real terms. (At 1964 levels of the Consumer Price Index [108.1] this price change would be comparable to a change of $4.70 per ton in current dollars.)

2. An increase in production of all pears in Michigan and New York of 0.1 ton per 1,000 persons of United States population, considered by itself, resulted in a decrease in annual average grower returns for all sales of Pacific coast Bartlett pears of $7.76 per ton, in real terms. (This price change would be comparable to a change of $8.39 per ton in current [1964] dollars.)

3. An increase in annual average grower returns for California cling peaches for canning of one dollar per ton, expressed in real terms, resulted in an increase in annual average grower returns for all sales of Pacific coast Bartlett pears of $.99 per ton, in real terms, if the other variables remained constant. (This price change would be comparable to a change of $1.07 per ton in current [1964] dollars.)

4. An increase in canners' stocks of canned pears at the beginning of the year (June 1) of 100 cases (24 No. 2½ basis) per 1,000 persons of United States population, considered by itself, resulted in a decrease in annual average grower returns for all sales of Pacific coast Bartlett pears of $4.65 per ton, in real terms. (This price change would be comparable to a change of $5.03 per ton in current [1964] dollars.)

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[3] Data employed to measure canners' profits were based upon very approximate estimates, because more reliable data were not readily available.

5. An increase in the two-year average of canned pear exports in the preceding period (t-1) of 1,000 tons, considered by itself, resulted in an increase in annual average grower returns for all sales of Pacific coast Bartlett pears of $1.96 per ton, in real terms. (This price change would be comparable to a change of $2.12 per ton in current [1964] dollars.)

According to the statistical analysis, Pacific coast production of Bartlett pears is the single most important factor in determining farm prices for this fruit. This factor alone explains about 57% of the annual variation in grower prices. This relationship suggests the magnitude of future farm price changes as a result of future production changes.

The fact that the five price-influencing variables in the demand equation (Pacific coast Bartlett pear production, pear production in Michigan and New York, California cling peach price, canner stocks of canned pears, and canned pear exports) explain approximately 95% of the annual variation in farm price of Bartlett pears suggests that this equation may provide a useful tool for predicting future price levels.

An indication of the accuracy of price estimates obtained from this equation can be gained from a comparison of estimated and actual prices in a given past period. Estimated real farm prices of Pacific coast Bartlett pears during the 1947-1962 period are presented graphically in Figure 1 along with actual prices for purposes of comparison. During the 16-year period, the average absolute difference between actual and estimated price was $6.90 per ton, or about 9%.

Price-estimating equation for cannery Bartlett pears

A demand, or price, equation was also estimated for Pacific coast Bartlett pears sold for canning. Because canning sales are a major component of all sales of Bartlett pears, the most satisfactory statistical results included the same price-influencing factors in both analyses. The price equation for cannery Bartlett pears is presented below:[4]

$$\hat{Y}_2 = \underset{}{1.64879} \underset{(-5.373)^*}{-47.44792 X_1} \underset{(-1.724)}{-70.65333 X_2} + \underset{(5.013)^*}{1.10861 X_3}$$

$$\underset{(-4.470)^*}{-47.38091 X_4} + \underset{(1.876)\ddagger}{0.00229 X_5}$$

$R^2 = .931$
Standard error $Y.X = 12.53300$

[4] This equation is based on data for the 1947-1962 period. (* = Significant at the 1% level, and ‡ = significant at the 10% level.)

where: $\hat{Y}_2$ = first difference average annual grower returns per ton of Pacific coast Bartlett pears sold for canning, expressed in real terms (1957-59 dollars),

X_1 = first difference total farm production of Pacific coast Bartlett pears (tons per 1,000 persons),

X_2 = first difference production of all pears in Michigan and New York (tons per 1,000 persons),

X_3 = first difference average annual grower returns from California cling peaches for canning, expressed in real terms (1957-59 dollars),

X_4 = first difference canners' stocks of canned pears at beginning of year (June 1) (1,000 cases—24 No. 2½ basis per 1,000 persons), and

X_5 = first difference two-year average canned pear exports in period t-1 (tons).

As in the case for all sales of Bartlett pears, the use of first differences in the price-estimating equation for cannery Bartlett sales provided the most satisfactory results. In addition to the five variables included in the above equation, several other price-influencing factors

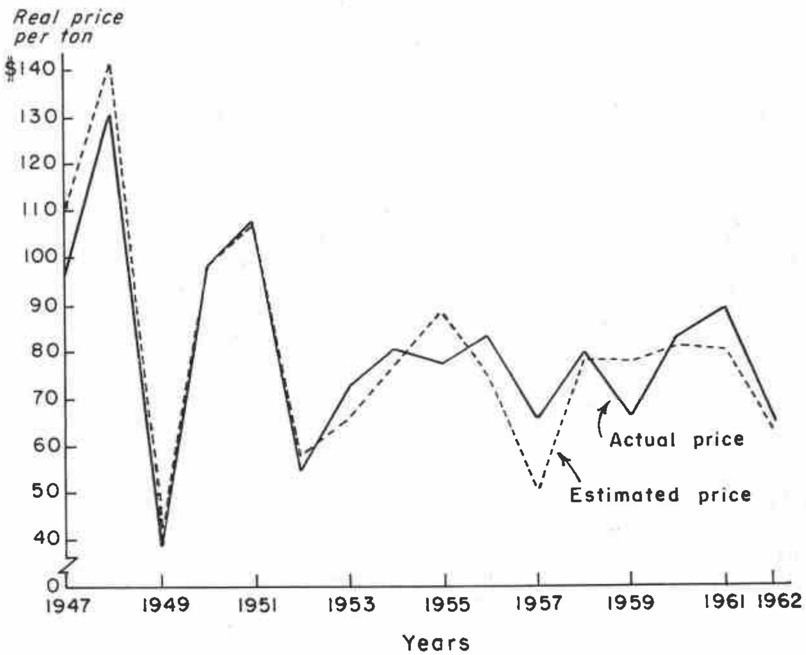

Figure 1. Actual and estimated real farm prices for all sales of Pacific coast Bartlett pears, 1947-1962.

were analyzed but were excluded from the final price equation. Comparison of estimated real farm prices of cannery Bartlett pears to actual farm prices for the 16 years during the period 1947 to 1962 showed an average difference between actual and estimated prices of about 12%.

The Supply Relationship

Production and supplies of a tree-fruit crop such as Bartlett pears are determined primarily by bearing acreage, yields per acre (as influenced by technology and cultural practices), and the weather. Future pear *production* can be estimated on the basis of existing bearing and nonbearing acreage and prospective yields per acre. Future *bearing acreage* can be projected on the basis of existing bearing and nonbearing acreages if future planting and removal rates can be accurately estimated. The amount of new plantings and removals of old orchards is, however, affected by price expectations on the part of orchard owners. Furthermore, although estimates of future yield can be made on the basis of present cultural practices and expected changes in available technology, future yields as affected by the intensity of input use and the adoption of new technology will also be influenced by expected pear prices. An estimate of changes in future production due to growers' reaction to expected prices can be obtained from an analysis of their past reactions to price changes. For this purpose, a long-run supply function for Pacific coast Bartlett pears was developed to facilitate prediction of future production levels.

Annual production levels are characterized by wide fluctuations because of variations in weather conditions, particularly during bloom periods. Average production during a period of several years, however, is more stable and is determined largely by management decisions affecting the amount of bearing acreage and levels of variable inputs used. Supply relationships developed in this study are intended to describe changes in average or "normal" production over a period of several years. For this reason, production levels are expressed as moving averages during a period of four to six years.

Historical production and acreage changes

Total production in the three Pacific coast states (expressed as a six-year moving average) increased at a steady, rapid rate from the early 1920's until shortly after World War II, with a slight pause during the early 1930's (Figure 2). Production increases during this period can be attributed to: (1) an expansion of bearing acreage in each state until the early 1930's; and (2) increases in yields per acre, particularly in California. Pacific coast production levels remained relatively constant from the late 1940's until 1963. During this period,

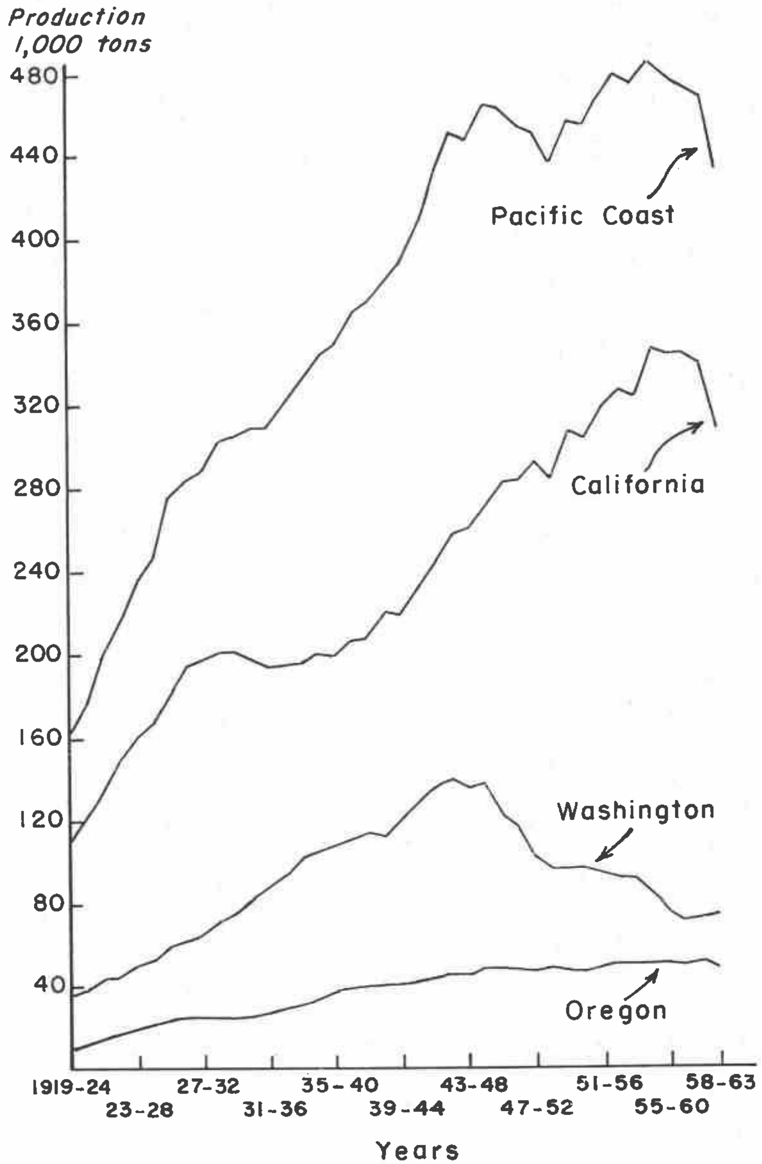

Figure 2. Six-year moving average of Bartlett pear production, Pacific coast states, 1924-1963.

bearing acreage in all three states was relatively stable, while rising yields in California tended to offset yield decreases in Washington.

Production of Bartlett pears in California increased at a relatively rapid rate during the decade from the early 1920's to the early 1930's and during the period between 1940 and 1960. In general, these periods of increasing production have accompanied or immediately followed periods of relatively high price levels. However, during the low price years of the 1930's, production in California leveled off and declined slightly. Production has decreased somewhat during the last several years due to the effects of pear decline. Increases in California production during the 1920's can be ascribed to a steadily expanding bearing acreage during this period. On the other hand, increased production during the war and postwar periods was obtained from a slowly decreasing bearing acreage. Thus, the prolonged rise in production since about 1940 may be attributed to increasing yields per acre.

A steady increase in Washington Bartlett pear production from the early 1920's until just after World War II was due largely to increases in bearing acreage which continued until 1940.[5] Although bearing acreage in this state decreased from 1940 to 1945, average production continued to increase during this period as relatively young trees reached more mature bearing age. Since World War II, however, production in Washington has exhibited a steady, downward trend, while bearing acreage has remained relatively constant. Reduced yields in this period were undoubtedly due, in part, to the inroads of pear decline during the 1950's.

Moderate increases in bearing acreages in Oregon occurred until 1940 and were accompanied by a slow, steady rise in production of Bartlett pears which continued until the late 1940's. Since that time, a relatively stable bearing acreage has been accompanied by similarly stable levels of average production in the state.

Analysis of supply factors

Although uncontrollable weather conditions are a primary determinant of *annual* production and supplies, growers' decisions regarding controllable factors, such as new plantings, removals, amounts of inputs, and types of cultural practices used, are major determinants of *long-run average* levels of production. Growers' decisions regarding these factors are influenced by their expectations of future profit

[5] Accurate estimates of Bartlett pear acreage in Washington and Oregon are hampered by the fact that agricultural census data on pear tree numbers (which is the sole source of information reported on a continuing basis) were not reported by variety before 1940. However, if it is assumed that the variety composition of bearing acreage in these states did not change substantially over time, census figures which indicate changes in acreage of all pears will give an indication of changes in Bartlett acreage as well.

conditions for both Bartlett pears and alternative crops which they may raise. Accurate producer expectations of future profit conditions must take account of expected costs as well as future prices. Expected returns from nonagricultural uses of land and labor also affect growers' decisions regarding long-run production levels.

Although grower decisions regarding future production depend upon their expectations and future profit conditions, these expectations are formed with a lack of complete knowledge regarding the future and are thus of a speculative nature in every instance. For these reasons, growers probably base their future profit expectations to a large extent upon their present or past profit conditions which are known quantities. Therefore, past prices and past costs of Bartlett pears and suitable alternative crops can be expected to be major determinants of growers' decisions regarding new plantings, removals, and inputs used in cultural practices.

Changes in production as a result of new plantings can be expected to be influenced by profit conditions several years previous because a period of several years is required to raise newly planted trees to bearing age. By contrast, removals of bearing acreages have an impact upon production in the immediately following seasons. Thus profits in the more recent past can be expected to influence removals and, hence, changes in production. However, because of the lengthy time period and the large investment required to raise a bearing orchard, pear growers are reluctant to remove bearing acreages in response to relatively small changes in profit expectations. Changes in production and supply which are the result of changes in average yields are also influenced by profit conditions in the immediate past as well as upon technological developments.

An analysis was made of changes in Pacific coast Bartlett pear production in relation to average grower prices for Bartlett pears and production costs (as measured by the index of prices paid by farmers) during the period from 11 to 14 years before the realized production (the period hypothesized to affect plantings). This analysis also included the relationship between production of Bartlett pears and average prices and costs during the immediately preceding two years (the period hypothesized to affect removals). Similarly, the effects upon production of returns from alternative crops during the period from 11 to 14 years before the realized production and the period during the previous two years were also analyzed. Analyses of similar relationships between profit conditions and production of tree-fruit commodities have been made by French for apples (*8*), by Dennis for tart cherries (*5*), and by French and Bressler for California lemons (*9*). However, this approach to the prediction of quantities supplied of Pacific coast Bartlett pears did not prove successful.

An alternative analysis was therefore undertaken to describe the relationship between Bartlett pear production and past profit conditions. In this case, analyses were made of the relationship between average production levels and: (1) prices in the immediately preceding period (t-1) and (2) average production levels in the immediately preceding period. In this analysis it was assumed that quantities produced in the immediately preceding period reflected growers' decisions based upon all past conditions other than price in this period. Growers' decisions and production are, however, modified by price in the immediately preceding period.

The supply-estimating equation obtained from this analysis for the 1919-1962 period can be summarized by the following equation:

$$\hat{Y}_3 = 10.50162 + .16641\, X_6 + .95249\, X_7$$
$$(1.66054) \qquad (45.63785)^{*6}$$

$R^2 = .983$

Standard error $Y.X = 13.38324$

where:

$\hat{Y}_3$ = four-year moving average of all sales of Pacific coast Bartlett pears in period t (1,000 tons),

X_6 = four-year moving average of grower returns in dollars per ton for Pacific coast Bartlett pears—all sales in period t-1; divided by the index of prices paid by farmers for production items, including interest, wages, and taxes, in period t-1, and

X_7 = four-year moving average of all sales of Pacific coast Bartlett pears in period t-1 (1,000 tons).

The variables in this equation were expressed as four-year moving averages in an attempt to minimize fluctuations in production due to annual variations in weather. Economic interpretation of this supply or quantity-estimating equation can be summarized as follows:

1. An increase in the four-year moving average of grower returns from all sales of Pacific coast Bartlett pears, divided by the index of prices paid by farmers for production items, of one dollar per ton in period t-1, taken by itself, is associated with an increase in the four-year moving average of all sales of Pacific coast Bartlett pears in period t of 166.41 tons.

2. An increase of 1,000 tons in the four-year moving average of all sales of Pacific coast Bartlett pears in period t-1, taken by itself, is associated with an increase in the four-year moving average of all sales of Pacific coast Bartlett pears in period t of 952.49 tons.

The R^2 value of .983 indicates that factors of price in the previous period and average production in the previous period account for

[6] Significant at the 1% level.

98% of the changes in production of Pacific coast Bartlett pears during the period of 1919 to 1962. Thus, these two factors explain a large amount of the production changes during this period. Comparison of supplies estimated through the use of the above equation to actual quantities supplied during the 1919-1962 period shows that the average absolute difference between actual and estimated quantities was about 11,000 tons or an average difference of about 3%.

Projections of Future Prices and Production

Future price levels could be projected on the basis of the demand equation alone if future values of all price-determining factors in this equation (production of Pacific coast Bartlett pears per capita, production of pears in Michigan and New York per capita, grower returns for California cling peaches, canners' stocks of canned pears per capita, and export levels of canned pears) were known. Future values of these price-determining factors can be projected on the basis of the current situation and probable future changes. However, the most important factor, Pacific coast production of Bartlett pears, is influenced by pear growers' reactions to prices received for pears. Therefore, both the supply-predicting equation and the demand or price-predicting equation were used to obtain projections of future price and production. These equations and their relationship to one another (the model) can be summarized as follows:

Demand equation — $\hat{Y}_1 = -1.16675 - 43.47234\,X_1 - 77.60454\,X_2 + .98502\,X_3 - 46.52603\,X_4 + .00196\,X_5$.

Supply equation — $\hat{Y}_3 = 10.50162 + .16641\,X_6 + .95249\,X_7$

where: $\hat{Y}_1$ = first difference grower returns in dollars per ton for Pacific coast Bartlett pears—all sales, expressed in real terms ($\hat{Y}_1$ in period t, adjusted to a four-year moving average of absolute dollars per ton, $= X_6$ in period $t + 1$),

$\hat{Y}_3$ = four-year moving average of all sales of Pacific coast Bartlett pears in period t (1,000 tons) ($\hat{Y}_3$ can be adjusted to the same basis as X_1 in the demand equation),

X_1 = first difference production of Pacific coast Bartlett pears (tons per 1,000 persons),

X_2 = first difference production of all pears in Michigan and New York (tons per 1,000 persons),

X_3 = first difference grower returns for California cling peaches for canning, expressed in real terms,

X_4 = first difference canners' stocks of canned pears at beginning of year (June 1) (1,000 cases per 1,000 persons),

X_5 = first difference two-year average canned pear exports in period t-1 (tons),
X_6 = four-year moving average of grower returns in dollars per ton for Pacific coast Bartlett pears—all sales in period t-1, expressed in real terms, and
X_7 = four-year moving average of all sales of Pacific coast Bartlett pears in period t-1 (1,000 tons).

Separate projections on the basis of the current situation and expected future changes were made of the price-determining variables of: (1) pear production in Michigan and in New York, (2) farm price of California cling peaches, (3) canned-pear exports, and (4) population.[7] These separate projections were used in the demand equation during the appropriate future years to facilitate future predictions of price and production.

Because both of the supply-determining variables in the supply equation (production in the preceding period and price in the preceding period) are known quantities at the beginning of the projection period, production for the first future year (t) can be predicted with known price and production data for the current year (t-1).

At the present time there are abnormally large acreages of nonbearing Bartlett pears in the Pacific coast states. Because these nonbearing acreages have not yet contributed to past production, it was felt that the supply-estimating equation would not adequately reflect future production increases from these abnormally large nonbearing acreages. Therefore, an upward adjustment was made in future production projections derived from the model to allow for this large amount of existing nonbearing acreage.

In 1963 nonbearing acreage amounted to 42% of bearing acreage in California (*1*) and approximately 45% of bearing acreage in Oregon (*12*). Nonbearing acreage in Washington in 1961 was equal to approximately 85% of the state's bearing acreage (*29*). These existing nonbearing percentages were compared to the following estimates of percentages which are needed to maintain a constant bearing acreage in each state: California, 17%; Oregon, 25%; and Washington, 25%.[8]

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[7] The other price-determining variable—average canners' stocks per 1,000 persons—was assumed to remain constant during future periods at a level equal to the average of recent years.

[8] These estimates of required percentages of nonbearing acreage are based upon (1) an examination of past changes in bearing acreage in relation to previous percentages of nonbearing acreage in each production area, and (2) estimates of average years of bearing and nonbearing life obtained from Extension personnel and pear growers in each area.

Comparisons of existing percentages to the required percentages of nonbearing acreage indicate that existing bearing acreage will expand in future years by the following percentages: California, 25%; Oregon, 20%; and Washington, 60%. With average yields comparable to those obtained in recent years, similar percentage increases in production levels can be expected within the next 10 years.[9] These indicated increases in future production were weighted by average Bartlett production levels in each state. The resulting weighted average indicates a 30% increase in future production for the Pacific coast as a whole. It was assumed that the full 30% increase in average production would be obtained by the year 1972 and that production would increase by a constant percentage each year until that time.

Price projections to 1980

Projected price levels will depend upon assumed future values of price-determining variables. These future values cannot be projected with complete accuracy. Therefore, several alternative projections of Bartlett pear prices and production were developed using alternative assumed values of the price-determining variables. Analyses were made of the effects upon future prices of alternative levels of: (1) pear production in Michigan and New York, (2) California cling peach prices, (3) canned pear exports, and (4) population. In this manner, a range of future price and production levels were developed (Figure 3). In the writer's opinion, the probability is greatest that the intermediate series (Alternative 3) will more nearly approximate future conditions than the series at the extremes of the indicated range.

Alternative 3

Alternative 3 involves price projections on the following assumptions: (1) an increase in pear production in Michigan and New York of 20%; (2) a decrease in the California cling peach price of 5%; (3) no change in canned pear exports; and (4) Series B of population projections.[10] With these assumptions the projected series (Alternative 3) indicates increasing farm prices until about 1967. From 1967 until about 1975, a marked, steady decrease in pear prices is indicated—primarily as a result of increased production from existing

[9] These estimates of future production increases lie within the range of projections which were outlined by a recent industry study group (*28*). Estimated production increases in California also are in agreement with projected production levels suggested in a recent analysis by Gingerich of future conditions in California (*10*).

[10] Population projections published by the Bureau of the Census are divided into four alternative series—Series A, B, C, and D. Series A indicates the most rapid rate of population growth, while Series D represents the slowest rate (*24*).

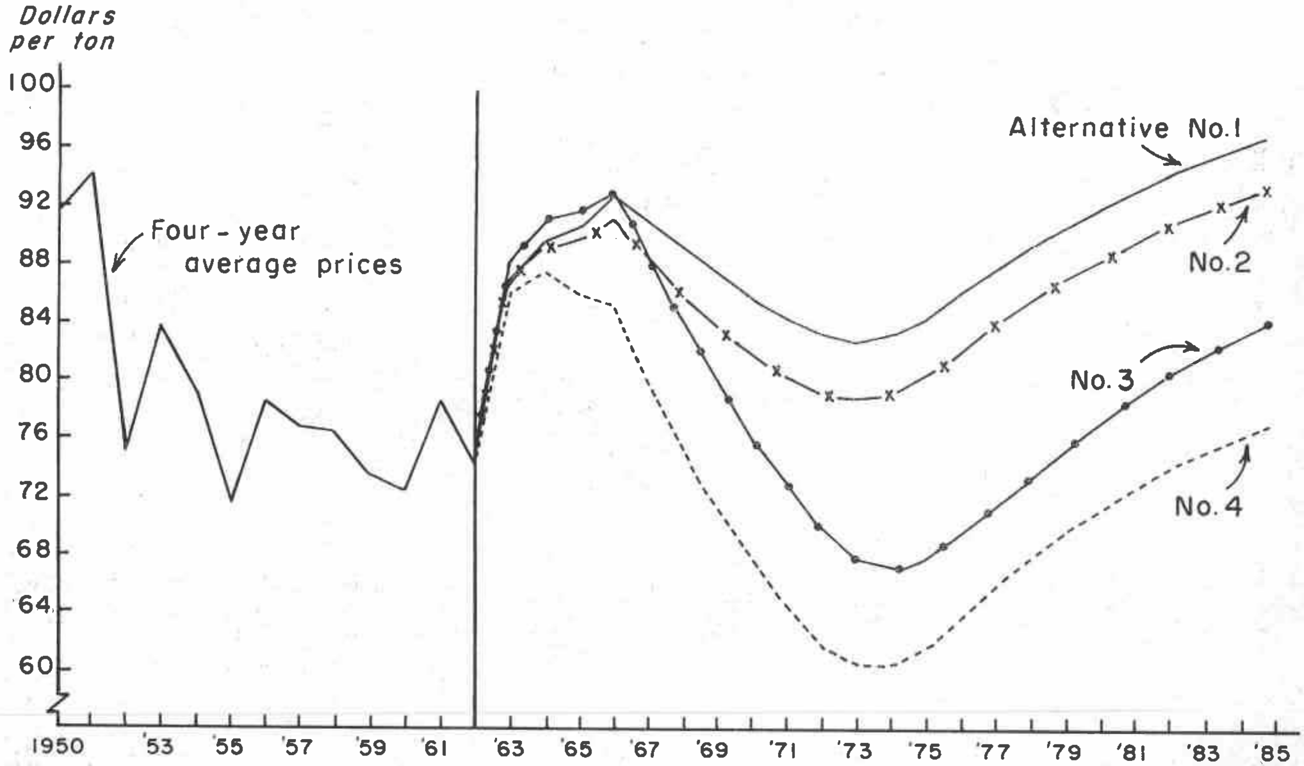

Figure 3. Average real farm prices, Pacific coast Bartlett pears, projected to 1985.

nonbearing acreage. This series indicates that low price levels of approximately $67 per ton (real farm prices) can be expected by the period of 1972 to 1975. After 1975, growers can expect gradually rising prices to about $84 a ton by 1985. The rise in average price levels during this latter period will primarily be a result of curtailed production due to lower prices during the early 1970's.

The assumption of a 20% increase in pear production in Michigan and New York is based upon the following analysis. Agricultural census data on bearing and nonbearing tree numbers were used as a basis for projecting future production trends in these competing states. Data from the most recent census (1959) indicate that nonbearing acreage in the two states was equal to about 37% of bearing acreage at that time. It was assumed that nonbearing acreage equal to about 27% is necessary to maintain a constant bearing acreage in this area.[11] Therefore, the percentage of nonbearing acreage existing in 1959 would allow future increases in bearing acreage of about 10%. Additional new plantings have also been made in these two states since 1959, although present data are not available regarding the exact magnitude of these plantings. However, these recent plantings would suggest a greater increase in future bearing acreage than that indicated by the 1959 acreage data. In addition, production in these states would probably increase more than proportionally with increases in bearing acreage because of improvements in production techniques, management, and other yield-increasing factors. Therefore, an increase in pear production in these states of 20% appears reasonable by the year 1972.

Future cling peach prices were predicted on the basis of projected peach production, disposable income, and an index of prices of competing canned fruit through the use of a price-estimating equation for cling peaches developed by Hoos (*11*, p. 16). This equation takes the following form:

$$\hat{Y} = -12.5090 - \underset{(-5.79)}{.1635}\, X_1 + \underset{(16.57)}{3.7587}\, \log_e X_2 + \underset{(6.77)}{.0229}\, X_3$$

$$R^2 = .96$$

where: $\hat{Y}$ = annual average f.o.b. price (choice, No. $2\frac{1}{2}$) of California canned cling peaches (dollars per case),

X_1 = canners' commercial movement of California canned cling peaches (1,000,000 cases),

X_2 = index of United States disposable personal income (1947-1950 = 100), and

X_3 = adjusted index of prices of competing canned fruits (1947-1950 = 100).

[11] This percentage corresponds to an average tree life of 8 nonbearing years and 30 bearing years.

Production projections for California cling peaches were based upon data regarding existing bearing and nonbearing acreage. Data for 1963 indicate the presence of 60,300 bearing acres and 16,600 nonbearing acres of cling peaches in California (*1*). This nonbearing acreage is equal to approximately 27% of the bearing acreage. Examination of historical acreage data indicates that nonbearing acreage equal to between 17 and 23% of bearing acreage is needed to maintain a constant bearing acreage in California.[12] If the median value of 20% is used, existing nonbearing acreage indicates an increase in future bearing acreage of approximately 7%. This increase in bearing acreage, by itself, can be expected to result in similar increases in production of 7% by about 1967. Future peach production can also be expected to increase as a result of a rising yield trend (approximately 1% per year in the post-World War II period). It was assumed that this trend will continue at the same rate in the future and will, therefore, result in an additional rise in peach production of 5% by about 1967.

In recent years, California cling peach marketings have been limited through operation of a green-drop program which is made possible by a cling peach marketing order in that state. Recent sentiments expressed by industry representatives indicate that the green-drop program has become somewhat unpopular and that this program may be discontinued within the next several years. If this occurs, further increases in marketable cling peach production can be expected. In recent years the tonnage removed through the green-drop program has varied between 6 and 16% of actual production. Therefore, an increase in production of 13% was projected by the year 1967 to account for the possible elimination of the green-drop program.

Expected increases in production of 7% from bearing acreage expansion, 5% from higher yields, and 13% from discontinuation of the green-drop program result in a total increase of 25% in projected cling peach production by 1967.

It was assumed that disposable income in the future will rise at a rate of 2% per year and that the index of prices of competing canned fruits will remain equal to average levels in recent years. By introducing these values for disposable income and competing fruit prices, along with a percentage increase in commercial movement equal to the percentage increase in production, into the Hoos equation, future f.o.b. prices of canned cling peaches about 5% lower than average prices obtained during the 1958 to 1962 period are indicated. It was

[12] These percentages are in agreement with those suggested for medium-yielding trees in a California study of the economics of replacing cling peach trees (*6*).

assumed that this would result in a similar 5% decrease in farm prices of California cling peaches.[13]

Exports of canned pears in recent years have been primarily to Canada and to countries in western Europe. Recent developments within the European Economic Community, such as the planned establishment of a common external tariff, and large new plantings of pears and other deciduous fruits in France and Italy indicate that canned fruit exports to such traditional receiving countries as West Germany, the Netherlands, and Belgium may be considerably reduced in future years. On the other hand, increases in future trade restrictions for such important receiving countries as Canada, Great Britain, and the Scandinavian countries do not appear imminent. Furthermore, rising incomes and growing population in importing countries will tend to raise demand for canned fruits including pears and fruit cocktail. Although it is extremely difficult to predict future conditions regarding the all-important trade restrictions, it seems reasonable to assume that future conditions favorable to increased exports may be balanced by conditions unfavorable to increased exports. Therefore, it was assumed that exports of canned pears will remain equal to the five-year average for the years 1958-1962.

Alternative 4

Projected prices under Alternative 4 are based upon more "pessimistic" assumptions than those made above. The assumed future price-determining conditions can be summarized as follows: (1) an increase in production in Michigan and New York of 30% by the year 1972; (2) a decrease in California cling peach price of 8% by 1967; (3) a decrease in canned pear exports of 20% by 1972; and (4) Series B of population projections. If these future conditions prevail, the industry can expect average price levels of $6 to $9 per ton lower than those predicted with Alternative 3 throughout the future period. Projected prices under Alternative 4 exhibit a similar pattern of change, however. In this case, price increases until about 1966 followed by a steady decline in average prices until about 1974 can be expected, with low price levels of approximately $60 to $61 per ton during the 1972 to 1975 period. Prices will then rise to approximately $76 a ton by 1985.

The rationale of these assumptions is as follows:

Pear production in Michigan and New York. Recent new plantings in these competing states may be sufficient to result in increased

[13] One might ordinarily expect a larger percentage decrease in farm price than that experienced at the f.o.b. processor level from a given change in supplies. However, because no precise estimates of these differences are available, this simplified assumption was made.

production which is greater than the 20% outlined earlier for Alternative 3. An increase of 30% may well be within the realm of possibility, particularly if a practical remedy for fire blight can be developed in these areas (current research indicates some potential success in this endeavor). Therefore, a 30% increase in pear production in Michigan and New York by the year 1972 could be forthcoming.

Farm price of California cling peaches. If yields per acre increase at a more rapid rate in the future than in the recent past, or if a smaller than historic percentage of nonbearing acreage is needed to maintain a future constant bearing acreage, California cling peach production could increase at a faster rate than the 25% increase outlined above. To examine the effects of this possibility, a 30% increase in cling peach production by 1967 was assumed. With this increase in production, the Hoos price-estimating equation indicates a decrease in f.o.b. price of canned cling peaches of about 8%. Therefore, a decrease in farm price of 8% was used for the projections of Alternative 4. A similar decrease may occur in farm price with a smaller than 30% increase in production if the farm price of cling peaches decreases by a greater percentage than the f.o.b. price, as a consequence of an increase in peach production.

Exports of canned pears. Increased trade restrictions in the future, such as those indicated for the European Economic Community, and increased competition for the traditional European export markets may result in substantially reduced canned pear exports. Therefore, a decrease in canned pear exports of 20% by 1972 was assumed for the predictions of Alternative 4.

Alternative 1

A set of relatively "optimistic" future price-determining conditions result in the projections of Alternative 1. The assumptions regarding these conditions can be summarized as follows: an increase in pear production in Michigan and New York of 10%; no change in the California cling peach price; an increase in canned pear exports of 20%; and Series B of the population projections. The lower rate of production increase in competing states may occur if fire blight problems continue to result in relatively low yields per acre or if numbers of new plantings diminish. No change in average California cling peach price levels may occur if the green-drop program under the marketing order is continued and demand-increasing factors such as population growth and rising consumer income offset increases in cling peach supply due to yield increases and to slightly larger bearing acreage. An increase in canned pear exports of 20% is a possibility if a trend toward increased exports continues as a result of rising export demand and stable or decreasing trade restrictions.

Price projections with the assumptions of Alternative 1 are substantially higher than those under the other alternatives. Alternative 1 indicates low levels of approximately $82 to $84 per ton during the 1971-1975 period. Projected price levels then rise to a high of approximately $97 per ton in 1985. Alternative 1 results in a series of projected prices which range between $8 and $15 per ton greater than those of Alternative 3 and $14 to $23 per ton greater than those of Alternative 4 during most of the future period.

Alternative 2

This alternative was included in order to isolate the effects upon projected price and production of a 20% increase in canned pear exports. Alternative 3 includes the same values of all assumed price-determining conditions except exports (Alternative 3 involves no change in export levels from the five-year average between 1958 and 1962). As would be expected, the projections of Alternative 2 are consistently higher than those of Alternative 3. After the full impact of the increase in exports is experienced (after 1972), the price differential remains between $10 and $12 per ton during the remainder of the projection period.

A fifth alternative series of price projections was analyzed to isolate the effect upon future pear prices of the greater (8%) decrease in California cling peach prices in contrast to the lesser (5%) decrease in prices of this competitive fruit. Predicted price levels for Bartlett pears with the 8% decrease in California cling peaches were only slightly lower than with the 5% decrease, with the differences being less than $2 per ton during much of the projection period. Thus, it can be concluded that alternative changes in cling peach prices of this magnitude will have a relatively small effect upon future Bartlett pear prices.

The effect upon future Bartlett pear price levels of an alternative slower rate of population growth (Series D) was also analyzed. Projected prices with the smaller population growth differed by less than one dollar per ton for all but the last few years of the production period. Comparison of these two price series indicates that the alternative low rate of population growth (Series D) would have little effect upon future price levels.

Production projections

Projected levels of future production under alternative conditions are shown in Figure 4. According to these predictions, production can be expected to increase rather sharply until about 1972, after which moderate decreases in production are indicated. It is indicated that future production in each case will be substantially greater throughout the period from 1963 to 1985 than average production in recent years.

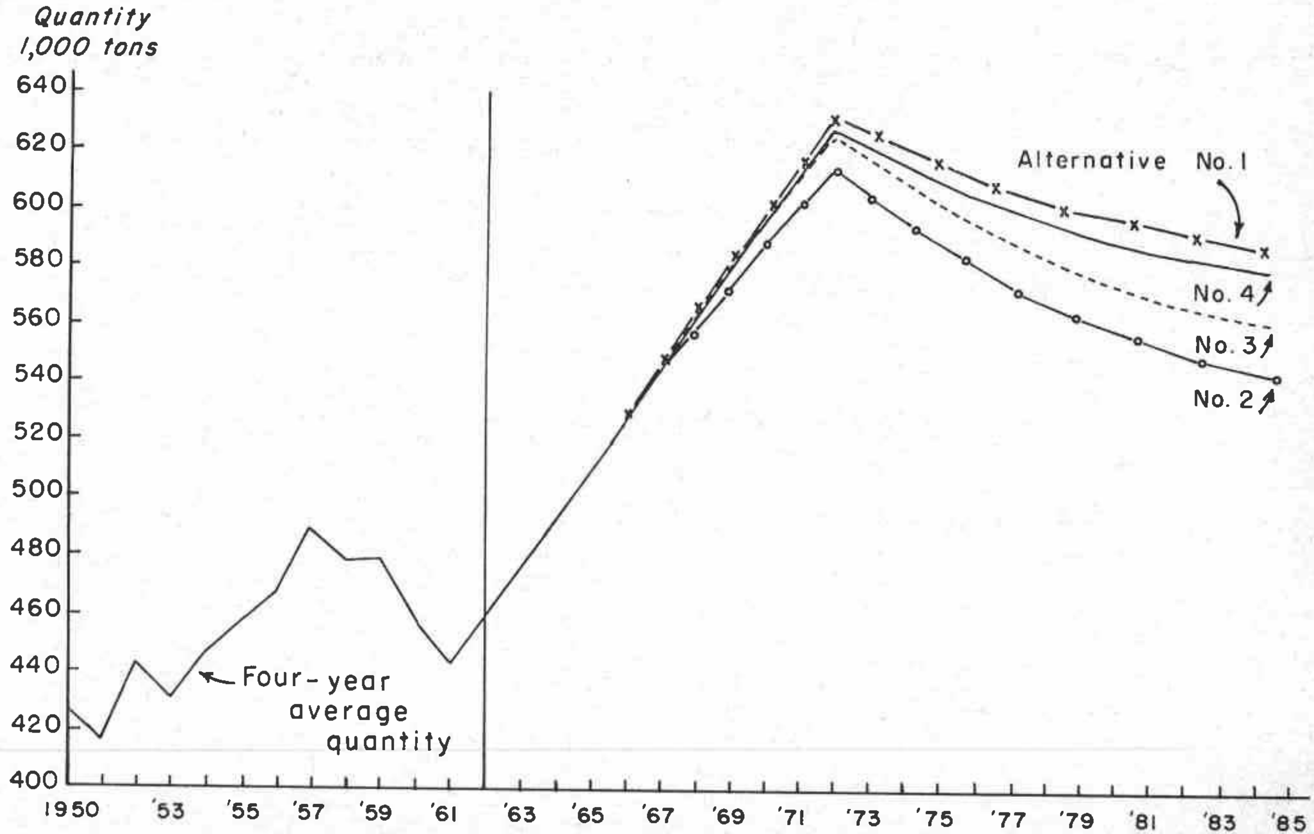

Figure 4. Production projections, Pacific coast Bartlett pears, to 1985.

Production projections from the various alternatives are characterized by their similarity until 1970. During succeeding years, differences in projected levels become increasingly evident. High future prices under Alternative 1 result in projections of relatively high future production as producers respond to relatively favorable price conditions. By contrast, relatively low production levels are projected under Alternative 4 due to lower producer response to unfavorable prices. Differences in projected production for these two "extreme alternatives" (Alternatives 1 and 4) amount to about 18,000 tons by 1972, and gradually widen to approximately 44,000 tons by 1985.

Limitations of the projections

Projections of future price and production such as those presented in the foregoing analysis are, by necessity, subject to several limitations. One of these limitations is that the accuracy of production projections will be affected by the accuracy of the assumptions involved. It is for this reason that alternative assumptions regarding price-determining conditions were made.

Another crucial assumption which affects the accuracy of the projections is that future supply and demand relationships will not differ materially from the historical relationships estimated by the statistical equations. Future changes in demand conditions, such as changes in the market structure or changes in consumer tastes, would violate this assumption and consequently limit the accuracy of the projections. Changes of this kind, however, ordinarily occur relatively slowly over time.

Future changes in the supply relationship may also occur as a result, for example, of technological developments. The supply equation employed in this analysis reflects the impact of historical rates of relevant technological changes. However, if the effect of technological changes upon production is altered in the future by the development of an innovation of *unusual* impact, such as has occurred in the apple industry with the adoption of dwarf and spur-type trees, historical rates of technological change would no longer accurately reflect the existing supply situation. Although major technological developments of an unusual impact do not appear imminent for the pear-producing industry at the present time, future changes of this nature are especially difficult to predict and may well occur. This possibility poses another limitation on the projections.

The further one projects into the future, the greater will be the likelihood of substantial changes in supply and/or demand relationships; hence resulting projections will tend to be less accurate. Although the resulting greater chance for error in the long run must be recognized as an inherent limitation, this does not negate the usefulness of such long-run predictions—particularly for a crop such as pears in which a long-run production and decision-making situation is involved.

Future Changes in Regional Production Patterns

Changing economic and production conditions tend to alter the established pattern of regional production. Thus, in the future, production may become more concentrated in certain areas while other areas decline in relative importance. New or relatively minor areas may also become more prominent in the future. Indications of future production patterns were explored from an analysis of: (1) trends in bearing and nonbearing acreage, and (2) comparative costs of production in relation to expected future prices. For this purpose, the following Pacific coast Bartlett pear production areas were outlined: Central Washington, Hood River, Willamette Valley, Medford, Sierra foothills, Sacramento River, Lake Mendocino, and Santa Clara (Figures 5 and 6).

Acreage trends

Trends of bearing acreage in individual areas are particularly useful as indicators of production shifts in the immediate future. Data on nonbearing acreage (both in total acres and as a percentage of bearing acreage) provide insights into production changes in the more distant future.

Trends in bearing acreage of Bartlett pears in Pacific coast production areas are summarized in Figure 7. Annual data on California bearing acreage are available by counties (*1*). Acreage estimates for Oregon and Washington areas are based on Census of Agriculture data on tree numbers for 1940-1959, and on a 1961 fruit-tree census in Washington (*29*) and a special 1963 tree survey in Oregon (*12*).[14]

Data on bearing and nonbearing acreages were analyzed to project future production changes in each geographical area. The projections by area to 1970 are summarized in Figure 7. To project future bearing acreages, and hence production levels in these areas, existing percentages of nonbearing acreage (Table 1) were compared to estimates of the percentage of nonbearing acreage needed to maintain a constant bearing acreage.[15]

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[14] These data were converted to acreage on the basis of 90 trees per acre in the Medford and Willamette Valley areas and 85 trees in the Hood River and central Washington areas.

[15] Estimates of the needed percentages of nonbearing acreage were made on the basis of: (1) information obtained from growers and Extension personnel regarding the average number of nonbearing years and bearing years of Bart-

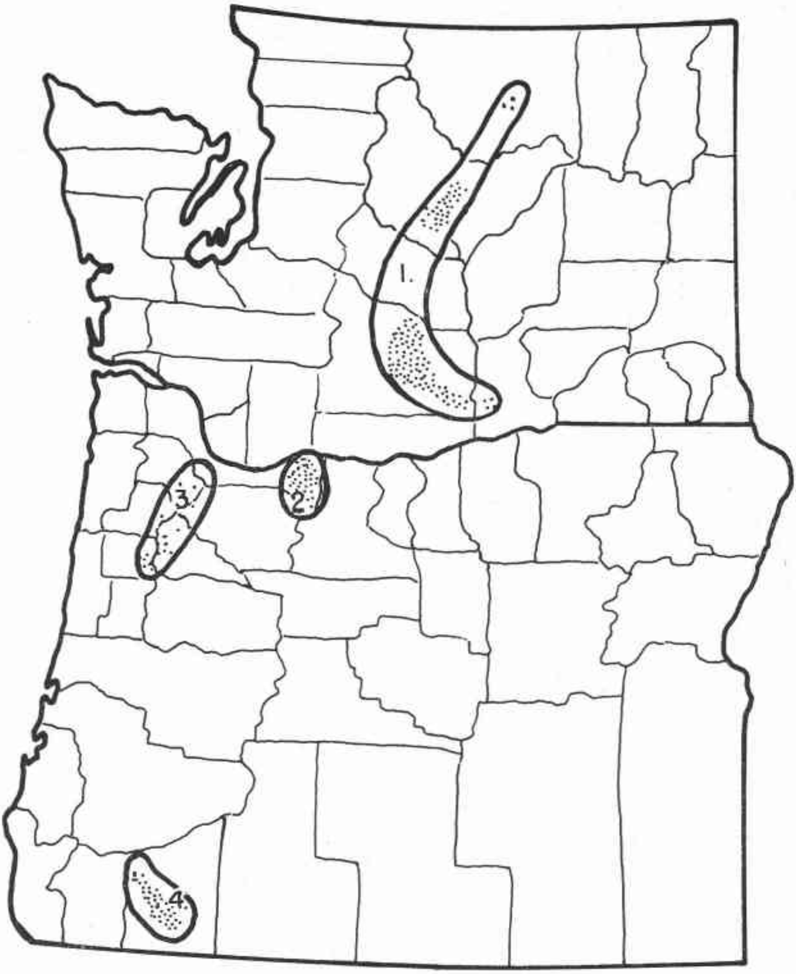

Figure 5. Washington and Oregon Bartlett pear production areas.

On the basis of planted acreage, central Washington offers the most notable prospective future production increases. A relatively stable bearing acreage has been accompanied by large increases in nonbearing acreage since 1950 in this area. In the state's last tree cen-

lett pear trees in each area; (2) examination of historical changes in bearing acreage in relation to nonbearing percentages in previous periods; and (3) adjustments to take account of unusual situations, such as pear decline or urbanization in certain areas.

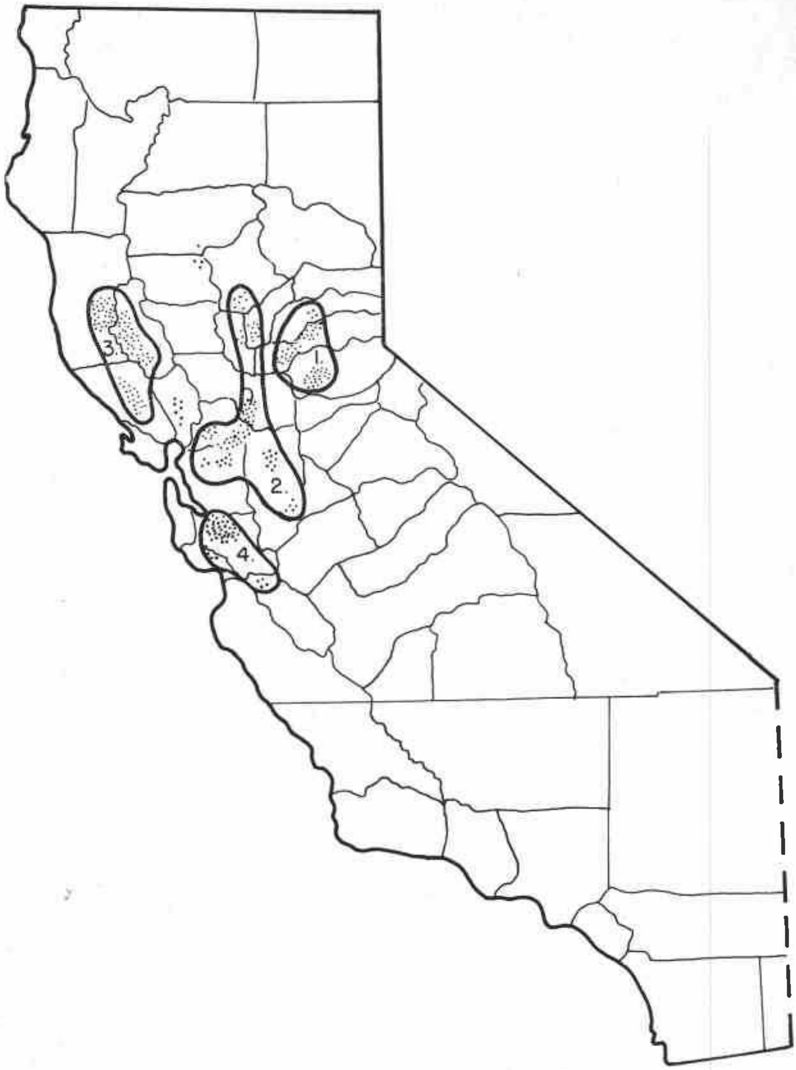

Figure 6. California Bartlett pear production areas.

sus (1961) nonbearing acreage was equal to approximately 86% of bearing acreage. Such a high percentage of nonbearing acreage clearly indicates a substantial increase in future bearing acreage and production in this area. Although some of this exceptionally large nonbearing

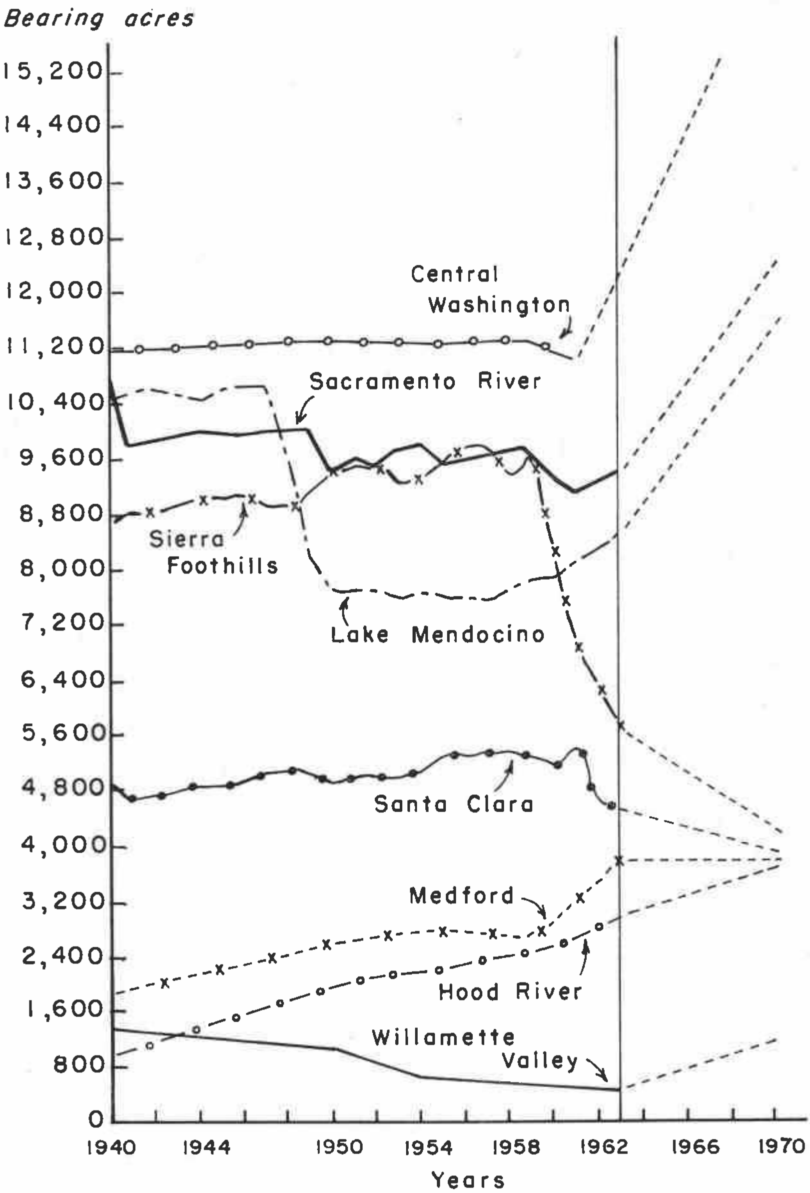

Figure 7. Trends in bearing acreage of Bartlett pears in Pacific coast production areas, 1940-1963 and projected to 1970.

Table 1. NONBEARING ACREAGE OF BARTLETT PEARS AS A PERCENTAGE OF BEARING ACREAGE IN PACIFIC COAST PRODUCTION AREAS, 1940-63[1]

Area	1940	1950	1954	1959	1963
	%	%	%	%	%
Sacramento River	3	7	7	26	49
Lake Mendocino	4	7	10	38	54
Santa Clara	6	11	10	18	23
Sierra foothills	6	10	19	18	15
Medford	18	9	10	25	25
Hood River	53	57	61	60	56
Central Washington	7	21	41	61	86[2]
Willamette Valley	6	18	19	50	136

[1] Computed from data reported in (*1*) and (*26*).
[2] 1961.

acreage will be needed to replace orchards which are removed because of pear decline, the impact of this disease upon future removal is expected to be much less than that experienced during the 1950's. However, even in light of the pear decline situation, the percentages of nonbearing acreage needed to maintain a constant bearing acreage in the central Washington area will probably not exceed 25%. Comparison of the current nonbearing percentage to the estimated percentage required in central Washington indicates an increase of about 60% in future bearing acreage. With average yields which are comparable to those obtained in recent years, future production in this area can be expected to increase by an equal percentage.

Both the Sacramento River and Lake Mendocino areas contained substantial nonbearing acreage in 1963. These acreages amounted to about 50 to 55% of bearing acreage in these areas. During the 1950's, relatively stable bearing acreages were maintained in these areas with nonbearing acreages equal to between 18 and 14%, respectively.[16] Thus, although effects of pear decline will probably raise the needed percentage of nonbearing acres to 15 to 20%, existing nonbearing acreages in these areas indicate an increase of future bearing acreage of about 30 to 35%. Because of high average yields in these two areas, an increase in bearing acreage of this magnitude will result in a substantial rise in the area's future production.

Nonbearing acreage in the Hood River area has been consistently equal to a high percentage (50 to 60%) of the area's bearing acreage during the periods since 1940 (Table 1). These high percentages of

[16] These percentages are in agreement with those suggested by estimates of average tree life in these areas.

nonbearing trees have resulted in a steadily increasing bearing acreage. Bearing acreage trends in relation to past percentages of nonbearing acreage indicate that a nonbearing acreage equal to 25 to 30% of bearing acreage is necessary to maintain a stable bearing acreage in this area. Thus, with nonbearing acreage in 1963 equal to about 56% of bearing acreage, future increases in bearing acreage of 25 to 30% can be expected (Figure 7).

Although the Willamette Valley contains only a small acreage of nonbearing trees in relation to other production areas, this small acreage is extremely high relative to the area's bearing acreage. Because the nonbearing acreage is equal to 136% of bearing, an increase in production of over 100% is indicated for the future.

In the Medford area, current nonbearing acreage, equal to approximately 25% of bearing acreage, is estimated to be sufficient to maintain constant bearing tree numbers or, at most, provide a slight future increase if removals due to pear decline are small. Future production in this area can likewise be expected to remain stable or to experience a slight increase.

Bearing acreage in the Santa Clara area has decreased somewhat in recent years, although moderate increases in nonbearing acreage have been experienced. Data for 1963 show nonbearing acreage equal to 23% of bearing acreage. Although the extent of pear decline is less serious in this area than in certain other production regions, a percentage of established orchards will undoubtedly be removed because of its effects. Urbanization pressures also promise to bring about future removals of pear acreage in this area. In light of these conditions, current nonbearing acreage probably is not sufficient to maintain present levels of bearing acreage. Therefore, moderate decreases in bearing acreage and production can be expected in the future. The extent of these decreases is difficult to measure, however, because of the difficulty of accurately predicting rates of urbanization. For the purposes of the analysis, a projection for the Santa Clara area of a decrease of 15% in future bearing acreage was made.

Both bearing and nonbearing acreage in the Sierra foothills have experienced a continuous rapid decrease since 1959. Nonbearing acreage, as a percent of bearing acreage, had also diminished to a level of 15% by 1963. The effects of pear decline will necessitate continued removal of established orchards in this area, although the rate of removal will undoubtedly be slower than that experienced during recent years. In view of the pear decline situation and the fact that pear orchards in this area normally have a relatively short life, current levels of nonbearing acreage are probably insufficient to maintain bearing acreage. It was estimated that, under current conditions, nonbearing acreage equal to about 40% of bearing acreage is necessary to maintain existing bearing acreage. If this is the case, existing nonbearing trees, which are equal to 15% of the bearing tree acreage, will lead to a further decrease of approximately 25% in the area's bearing acreage.

As a result of the indicated acreage projections, Bartlett pear production in the central Washington, Sacramento River, and Lake Mendocino areas can be expected to substantially increase over that of the other Pacific coast areas. Acreage projections indicate that the Willamette Valley will gain in its relative position, although future production in this area will remain comparatively minor in relation to other areas. As indicated, gains in the relative importance of the Hood River area can be expected to be accompanied by a decline in the relative positions of the Sierra foothills, Santa Clara, and Medford areas. As a result, all four of these areas can be expected to contain similar amounts of bearing acreage by approximately 1970 (Figure 7). However, considerable differences in production between these four areas may continue because of differences in average yields.

Thus, acreage projections indicate a dominant future position for the areas of central Washington, Sacramento River, and Lake Mendocino. The projections also suggest that the Sierra foothills, Santa Clara, Medford, and Hood River areas will compose an intermediate group in respect to production, while the Willamette Valley will occupy a relatively minor position.

Comparative costs and expected prices

Expected future prices, which were developed in the supply and demand analysis, were analyzed in combination with estimates of comparative production costs in the various Pacific coast areas to provide indication of future patterns of production. The indicated lower farm prices of Bartlett pears in the future (Figure 3) will reduce profit potentials of growers in all areas. However, the impact upon profit conditions will be particularly great in areas with high production costs, in which cases profits may be reduced to zero or negative levels. Continued losses over a period of years will encourage growers in high-cost areas to reduce their bearing pear acreage, while prospects of continued profits in the low-cost areas will result in a greater incentive for growers in these areas to maintain bearing acreage—provided that alternative uses of their resources remain relatively unchanged. As a result, production in the high-cost areas will become relatively less important, while that in low-cost areas will represent a growing proportion of the total.

Recent production cost estimates by area, summarized in Table 2, indicate that growers in the Sacramento River area have the lowest production costs with an average of approximately $53 per ton. Estimated costs in Hood River and Lake Mendocino areas are also rela-

Table 2. ESTIMATED COSTS OF PRODUCING BARTLETT PEARS IN PACIFIC COAST PRODUCTION AREAS, 1963

Area	Average yield per bearing acre	Estimated costs	
		Per acre	Per ton
	tons		
Sacramento River	20.9	$1,102.50	$52.70
Hood River	11.4	752.10	66.00
Lake Mendocino	14.8	991.20	67.00
Central Washington	12.0	895.75	74.20
Santa Clara	12.6	946.80	75.10
Medford	9.6	736.80	76.70
Willamette Valley (irrigated)	7.0	539.40	77.00
Sierra foothills	9.1	782.90	86.00
Willamette Valley (unirrigated)	5.0	444.60	88.90

Source: *An Appraisal of Future Economic Conditions Affecting the Pacific Coast Bartlett Pear Industry,* unpublished Ph.D. thesis by Donald J. Ricks, Oregon State University, June 1965.

tively low—$66 to $67 per ton. According to the cost estimates, the Sierra foothills area and unirrigated orchards in the Willamette Valley have the highest production costs with a range of $86 to $89 per ton. The areas of central Washington, Santa Clara, Medford, and irrigated orchards in the Willamette Valley form an intermediate group in respect to production cost with estimates of $74 to $77 per ton.

On the basis of high cost estimates for the Sierra foothills area and unirrigated orchards in the Willamette Valley, growers in these areas can expect losses from Bartlett pear production during most of the future period to 1980. (Small profits per ton are indicated during the relatively high average price years until about 1967.) The magnitude of these expected losses is particularly great during the 10-year period from 1970 to 1980 (see Figure 3). Thus, on the basis of cost estimates and future price predictions, it appears evident that the Sierra foothills area will become less important in future production of Bartlett pears. Prospects of future production from unirrigated orchards in the Willamette Valley appear equally dim.

Cost estimates for central Washington, Santa Clara, Medford, and irrigated orchards in the Willamette Valley indicate that projected prices under the two high-price series (Alternatives 1 and 2) will permit growers in these areas to make positive average profits throughout the period from 1963 to 1985. These profits will be relatively low during periods of low prices between 1970 and 1975, and somewhat higher during the years before and after this period. On the other hand, prices which are projected with the low-price series (Alternatives

3 and 4) will result in substantial losses to growers in these areas during the 1970's. Thus, if future price-determining conditions approximate those assumed with the low-price series, the resulting negative profits will provide special incentives for growers in these areas to reduce their bearing acreage and production. On the other hand, if future price-determining conditions are more nearly like those involved with the high-price series, realized profits will encourage growers to maintain production in these areas.

Cost estimates for irrigated orchards in the Willamette Valley are based upon average yields of seven tons per acre. Because of the relatively small number of yield observations obtainable in this area, a rather wide margin of error is possible for this estimate. Effects upon costs per ton of an increase in yield of 25% were therefore examined. Increases in yield of this magnitude (from 7.0 tons to 8.8 tons per acre) result in a reduction in average cost per ton to $63.60. Therefore, if cost-influencing conditions are unchanged in other areas, an increase in average yields of this amount will change the ranking of irrigated Willamette Valley orchards from a relatively high-cost situation to a low-cost one. Similarly, increased yields per acre of 25% for unirrigated Willamette Valley orchards (from 5.0 tons to 6.3 tons) will change its ranking from a high-cost situation to one of intermediate rank (cost per ton—$73.10). With these changes in average yield, comparison of cost estimates to future prices suggests a rise in the relative future position of the Willamette Valley in relation to overall Pacific coast production.

Comparison of cost estimates for the Hood River and Lake Mendocino areas ($66 to $67 per ton) to projected prices from all but the lowest-price series (Alternative 4) indicate positive profits throughout the entire projection period from 1963 to 1985 for these areas. With the low prices of Alternative 4, however, negative profits are indicated during the period from 1970 to 1977. Thus, although profit conditions under Alternative 3 will be minimal (and those under Alternative 4 will be negative) during several years in the 1970's, indicated profits during much of the period will be positive and provide an incentive for growers to maintain bearing acreage and production in these areas. In comparison to the areas of central Washington, Santa Clara, Medford, and irrigated Willamette Valley orchards, low production cost in the Hood River and Lake Mendocino areas will provide less of an incentive to growers to remove pear acreages in face of lower future prices. Because of this apparent advantage in the competitive position of the Hood River and Lake Mendocino areas, gains in their relative positions in regard to overall production seem likely.

Because of low costs in the Sacramento River area, substantial future profits are indicated for this area with each series of predicted prices. Even the low prices predicted with Alternative 4 will permit a moderate profit level per ton in this area. Because of this advantage in comparative production costs, a rise in the relative position of this area is clearly indicated on the basis of costs and future prices.

One must recognize that these conclusions, based on relative costs and expected prices, do not take into account opportunity costs (net returns from alternative uses of the resources) in the various production areas. For the above situation to be true, it would be necessary for the combined production and opportunity costs in the low-cost areas to be less than such costs in the high-cost areas.

Literature Cited

1. California Crop and Livestock Reporting Service. *California fruit and nut acreage.* Sacramento, 1939 to 1964, 26 vols.
2. California Crop and Livestock Reporting Service. *California fruit and nut crops, 1909-1955.* Calif. Dept. of Agri. Spec. Publ. 261. Sacramento, 1956.
3. California Crop and Livestock Reporting Service. *California fruit and nut crops, 1949-1961.* Sacramento, n.d.
4. California Crop and Livestock Reporting Service. *California fruit and nut crop statistics, 1961-1963.* Sacramento, 1964.
5. Dennis, Carleton C. *Long-run equilibrium in tart cherry production.* Mich. Agr. Expt. Sta. Tech. Bull. 291. East Lansing, 1963.
6. Farris, J. Edwin, and A. Doyle Reed. *When to replace cling peach trees.* Calif. Agri. Expt. Sta. Circ. 512. Berkeley, 1962.
7. Foytik, Jerry. *California pear industry, economic situation, 1961.* Calif. Agri. Expt. Sta., Giannini Foundation of Agri. Econ., Giannini Found. Res. Rept. 249. Berkeley, 1962.
8. French, B. C. *The long-term price and production outlook for apples in the United States and Michigan.* Mich. Agr. Expt. Sta. Tech. Bull. 255. East Lansing, 1956.
9. French, Ben C., and Raymond G. Bressler. "The lemon cycle." *Jour. of Farm Econ.,* 44:1021-1036, 1962.
10. Gingerich, Howard F. "California Bartlett pears—a look ahead." In *1964 Pear Annual,* pp. 49-53. Pear Growers' League, Santa Clara, 1964.
11. Hoos, Sidney, and George M. Kuznets. *Pacific coast canned fruit f.o.b. price relationships, 1961-62.* Calif. Agri. Expt. Sta., Giannini Found. of Agri. Econ., Giannini Found. Res. Rept. 566.
12. Oregon State University, Cooperative Extension Service. *Oregon fruit and nut tree survey.* Special Rept. 169. Corvallis, February 1964.
13. Pubols, Ben H. "Factors affecting prices of pears." *Agri. Econ. Res.,* 6:16-22, 1959.
14. Schneider, Vernon Earl. Factors to consider in determining pricing policies of cooperative associations. Ph.D. thesis, Oregon State University, Corvallis, 1962.

15. U. S. Department of Agriculture. *Agricultural Statistics.* Washington, D. C., 1961-1963, 3 vols.

16. U. S. Department of Agriculture, Bureau of Agricultural Economics. *Fruits, noncitrus, production, farm disposition, value, and utilization of sales, 1899-1944.* (CS-27) Washington, D. C., 1948.

17. U. S. Department of Agriculture, Bureau of Agricultural Economics. *Fruits, noncitrus, production, farm disposition, value, and utilization of sales, 1944-49.* Stat. Bull. No. 114, Washington, D. C., 1952.

18. U. S. Department of Agriculture, Statistical Reporting Service. *Fruits, noncitrus by states, 1954-59.* Stat. Bull. No. 292. Washington, D. C., 1961.

19. U. S. Department of Agriculture, Statistical Reporting Service. *Fruits, noncitrus by states, 1960 and 1961.* (Fr Nt 2-1 5-62) Washington, D. C., 1962.

20. U. S. Department of Agriculture, Statistical Reporting Service. *Fruits, noncitrus by states, 1962 and 1963.* (Fr Nt 2-1 5-64) Washington, D. C., 1964.

21. U. S. Department of Agriculture, Statistical Reporting Service. *Noncitrus fruit prices by states, 1959-63.* Agricultural Prices, Supplement No .1, Washington, D. C., 1964.

22. U. S. Department of Agriculture, Agricultural Marketing Service. *Prices received by farmers, apples, 1934-56.* Stat. Bull. No. 253, Washington, D. C., 1959.

23. U. S. Department of Agriculture, Statistical Reporting Service. *Prices received by farmers, citrus fruits, noncitrus fruits, tree nuts, 1944-58.* Stat. Bull. No. 322, Washington, D. C., 1962.

24. U. S. Department of Commerce, Bureau of the Census. *Population estimates.* Series P-25, No. 279, Washington, D. C., 1964.

25. U. S. Department of Commerce, Bureau of the Census. *Statistical Abstract of the United States, 1962,* 83rd ed. Washington, D. C., 1962.

26. U. S. Department of Commerce, Bureau of the Census. *United States Census of Agriculture: 1959.* I: Part 7, pp. 13, 46-48. Washington, D. C., 1961.

27. U. S. President. *Economic Report of the President.* Washington, D. C., 1964.

28. Washington-Oregon-California Pear Bureau. *Trends and projections in Pacific coast Bartlett pear production and utilization.* Report of the Executive Committee. Portland, Oregon, 1963.

29. Washington State Historical Association. *Washington fruit tree census.* Preliminary report. Seattle, 1963.

Appendix Table A. Demand Equation Data

Year	1 Grower returns—All uses—Pacific coast Bartlett pears *(dollars per ton)*	2 Farm production—Pacific coast Bartlett pears *(tons per 1,000 persons)*	3 Pear production—Michigan & New York *(tons per 1,000 persons)*	4 Grower returns—California cling peaches *(dollars per ton)*	5 Canners' stocks—Canned pears (June 1) *(1,000 cases—24 No. 2½ per 1,000 persons)*	6 Canned pear exports *(average of two previous years—tons)*	7 Consumer price index (1957-59=100)
1947	75.50	3.45	.223	49.70	.138	11,291	77.8
1948	110.60	2.49	.092	63.30	.493	11,141	83.8
1949	32.10	3.35	.283	40.00	.508	7,490	83.0
1950	82.90	2.82	.206	60.00	.294	6,837	83.8
1951	98.10	2.89	.224	77.40	.365	8,800	90.5
1952	50.80	3.00	.227	65.00	1.000	9,315	92.5
1953	67.90	2.54	.273	54.70	.850	9,400	93.2
1954	75.60	3.03	.166	54.60	.458	9,909	93.6
1955	72.40	2.95	.249	80.60	.931	13,209	93.3
1956	79.20	3.01	.268	71.00	.953	20,561	94.7
1957	64.40	2.97	.186	64.00	1.504	18,150	98.0
1958	80.60	2.56	.314	65.00	1.379	16,213	100.7
1959	66.70	2.75	.288	58.70	1.086	15,067	101.5
1960	85.60	2.35	.246	55.90	1.117	15,445	103.1
1961	92.50	2.45	.313	67.50	1.271	17,704	104.2
1962	68.80	2.68	.286	64.10	1.662	20,445	105.5

Sources: Column 1—Computed from data reported in *(21)*, *(22)*, and *(23)*.
Columns 2 and 3—Computed from data reported in *(16)*, *(17)*, *(18)*, *(19)*, and *(20)*.
Column 4—*(2)*, *(3)*, and *(4)*.
Column 5—*(7)* and *(11)*.
Column 6—*(15)*.
Column 7—*(27)*.

Appendix Table B. SUPPLY EQUATION DATA

Period	1 All sales—Pacific coast Bartlett pears (*4 yr. annual average tons*)	2 Grower returns—All uses Pacific coast Bartlett pears (*4 yr. annual average dollars per ton*)	3 Index of prices paid by farmers, including interest, taxes, and wage rates (1957-59=100) (*4 yr. annual average*)
1919-22	146,670	63.60	58.3
1920-23	157,850	57.90	55.8
1921-24	167,070	53.80	52.3
1922-25	193,600	52.60	53.5
1923-26	214,820	50.40	54.5
1924-27	221,140	52.30	54.5
1925-28	252,470	45.50	54.8
1926-29	260,060	50.80	54.8
1927-30	270,420	48.00	54.5
1928-31	282,550	41.50	52.3
1929-32	268,670	34.30	48.0
1930-33	268,940	20.60	43.3
1931-34	266,510	22.80	40.3
1932-35	270,140	21.40	39.3
1933-36	295,890	24.90	40.0
1934-37	312,000	26.50	42.0
1935-38	318,760	22.00	42.5
1936-39	337,030	23.00	42.8
1937-40	332,840	23.30	42.8
1938-41	344,640	27.00	42.8
1939-42	354,320	39.90	45.0
1940-43	364,640	53.30	49.0
1941-44	386,850	66.80	54.3
1942-45	410,700	69.60	59.5
1943-46	433,970	71.30	64.5
1944-47	462,850	70.20	70.3
1945-48	448,140	77.80	77.0
1946-49	444,550	66.70	82.0
1947-50	428,770	65.40	86.5
1948-51	417,550	71.10	90.8
1949-52	444,220	56.20	93.3
1950-53	431,190	65.10	95.5
1951-54	447,580	63.30	97.0
1952-55	458,410	56.80	96.0
1953-56	467,810	63.90	94.8
1954-57	490,760	63.10	95.3
1955-58	479,420	64.30	96.8
1956-59	479,960	62.90	98.8
1957-60	459,380	64.50	100.8
1958-61	444,850	71.50	102.5
1959-62	460,090	68.60	104.0

Sources: Column 1—Computed from data reported in (*16*), (*17*), (*18*), (*19*), and (*20*).
Column 2—Computed from data reported in (*21*), (*22*), and (*23*).
Column 3—Computed from data reported in (*27*).