Methods of Forecasting Production of Fruit

By Cary D. Palmer and E. O. Schlotzhauer [1]

Techniques employed in making production forecasts of fruit crops are somewhat different from those used for field crops. Many questions have arisen as to why this is so. This study shows the reliability of past forecasts, indicates the relative accuracy of the procedure now used and of alternative methods, and suggests under what conditions different techniques should improve the accuracy of forecasts.

HOW ACCURATE are the early-season forecasts of fruit production that are made by the Crop Reporting Board? Will methods other than those now in use give better forecasts? Answers to these questions are given by the study here reported.

Table 1 shows, for several crops, the difference between the first forecasts of the season and the final estimate, by States. Generally speaking, the differences are smaller in the Pacific Coast States than in other States. In the Pacific Coast States most of the fruit crops are grown under irrigation and the hazards of drought, spring frosts, and poor pollination weather are less. Forecasts are made on the assumption that growing conditions for the remainder of the season will be similar to the average of previous years that have had a condition similar to those reported currently. But this seldom occurs. Price-cost relationships also materially affect the size of the harvest. When prices are high, growers are likely to give their orchards better care, to harvest most of it, and to sell the fruit regardless of quality. Low prices, on the other hand, usually mean that the orchards are given less care and there is a greater waste of fruit. Furthermore, in making a forecast there is the problem of allowing for season-to-season trend in bearing capacity, for information on change in bearing acres by ages, varieties, and areas is incomplete.

Forecasts of fruit production during the growing season have been made by the Crop Reporting Board since 1914. The principal indication has been the condition of the crop in terms of a 100-percent or a full crop. The method that has been used to derive a quantitative production forecast from the reported condition has been called the par or 100-percent full-crop-condition method. There has been considerable discussion by members of agricultural estimates and others as to whether the "par method" is the most accurate method for making production forecasts.

Forecasts of field crops (corn, wheat, and potatoes, are examples) are prepared from estimates of acreage for harvest multiplied by forecasts of yield per acre. The forecast of yield per acre is obtained by using a correlation chart which relates the reported condition to yield per acre, in past years.

The study described here was made to compare the results of the par method with other possible methods of deriving production forecasts from reported condition.

The three methods described and evaluated are: (1) Par or 100-percent full-crop-condition method, (2) condition correlated with yield per acre, and (3) condition correlated directly with total production. A comparison with the Crop Reporting Board's published current estimate is also shown in each case.

The par is the theoretical 100-percent full crop which the growers have in mind when they report condition in percentage of a full crop. In the par or 100-percent full-crop method, the par production is derived for past seasons by dividing the estimate of the final production by the reported percentage of a full crop. The par for the current season is then estimated by using available indications of any changes in bearing capacity since the previous season. The principal indication is a time chart of historic pars which shows the trend of pars for past years. The par for a current season is indicated by a projection of the par trend of past seasons. Unusual circumstances are given

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[1] Paul F. Kiesler and Anna Mae Caron were responsible for making and checking the many calculations involved in this study.

TABLE 1.—*Variability of first forecast from final estimate for specified fruits, selected States and United States, 1934–47* [1]

Crop and State	Relative error [2]	Years forecast high or low [3]			Ratio of average of first forecast to average of final estimate
		High	Low	Within 1 percent	
	Percent	*Number*	*Number*	*Number*	*Percent*
Apples, Aug. 1:					
Massachusetts	14	2	5	1	94
New York	13	5	3	0	99
New Jersey	23	4	4	0	102
Pennsylvania	16	6	2	0	112
Virginia	7	4	3	1	101
West Virginia	14	2	6	0	95
Ohio	25	7	0	1	120
Illinois	10	3	5	0	101
Michigan	7	5	2	1	101
Idaho	13	4	4	0	100
Colorado	16	3	4	1	103
Washington	6	2	3	3	99
Oregon	7	5	2	1	104
California	9	1	6	1	95
United States	4. 3	6	2	0	101. 1
Peaches, June 1:					
New York	26	7	7	0	94
New Jersey	29	8	6	0	100
Pennsylvania	25	6	8	0	96
Ohio	24	4	8	2	92
Illinois	24	5	8	1	98
Michigan	36	1	13	0	75
Virginia	22	3	10	1	87
North Carolina	16	8	6	0	100
South Carolina	20	5	8	1	90
Georgia	16	7	6	1	98
Arkansas	16	9	5	0	105
Colorado	11	5	9	0	97
Washington	17	1	13	0	87
California, all	9	2	10	2	95
Clingstone	8	4	8	2	97
Freestone	13	2	12	0	92
United States	8. 7	2	10	2	95. 0
Pears, June 1:					
Pennsylvania	4	8	6	0	95
New York	44	9	5	0	114
Michigan	36	10	4	0	103
Washington, all	13	3	9	2	92
Bartlett	14	2	6	3	95
Other	16	6	5	0	100
Oregon, all	10	3	10	1	96
Bartlett	13	3	6	2	97
Other	14	5	5	1	97
California, all	13	2	10	2	91
Bartlett	14	2	9	0	90
Other	19	2	9	0	87
United States	9. 6	4	9	1	94. 9
Apricots, June 1:					
California	11	8	5	0	102
Washington	12	1	5	2	94
Utah	6	2	3	1	110
Walnuts:					
Oregon	26	7	7	0	94
California	10	3	11	0	93
Grapes, July 1:					
New York	16	10	4	0	106
Pennsylvania	22	11	3	0	115
Ohio	43	11	3	0	125
Michigan	30	8	6	0	112
Arkansas	45	9	4	1	122
Washington	19	5	9	0	92
California, all	9	3	10	1	94
Wine varieties	13	5	9	0	96
Table varieties	12	2	12	0	92
Raisin varieties	10	3	8	3	94
United States	8. 1	3	10	1	95. 8
Sour cherries, June 1:					
New York	43	4	4	0	120
Michigan	33	2	6	0	94
Wisconsin	35	3	5	0	96
Pennsylvania	27	6	2	0	110
Washington	17	5	2	1	109
United States	14	4	4	0	100. 2
Sweet cherries, June 1:					
Washington	14	2	4	2	96
Oregon	20	3	5	0	98
California	17	4	4	0	99
United States	15. 0	3	5	0	98. 3
Plums:					
California, June 1	14	5	9	0	96
Michigan, July 1	28	12	2	0	120
Prunes, July 1:					
Idaho	19	2	9	0	89
Washington	12	8	2	1	108
Oregon	16	7	4	0	106
California	10	4	6	1	99
United States	9. 1	3	6	2	100. 1
Oranges:					
Florida, all	16	6	7	1	100
Early and Midseason	14	8	6	0	101
Valencias	21	6	8	0	103
California, all	12	6	8	0	99
Navels and miscellaneous	14	5	9	0	96
Valencias	14	5	9	0	102
United States	6. 7	7	7	0	101. 7
Grapefruit:					
Florida	20	4	9	1	101
Texas	11	6	7	1	97
United States	10	3	10	1	97. 3
Lemons:					
California	16	6	6	2	99

Footnotes to table 1:

[1] For the following crops the period covered differs from that shown in the table heading: apples, cherries, and Washington apricots, 1940–47; prunes, Bartlett pears and other pears, 1937–47; California apricots, 1935–47; Utah apricots, 1942–47.

[2] Relative error (standard error as percentage of mean of final estimate).

[3] High forecast years=number years forecast more than 1 percent above final estimate. Low forecast years=number years forecast more than 1 percent below final estimate.

consideration when pars are projected. Weather damage to trees reduces the bearing capacity of orchards and lowers the par production. New plantings coming into production increase the par unless offset by tree removals or tree damage. Cultural practices and applications of fertilizer vary with changes in the level of prices of fertilizer and prices for fruits, and other economic factors. These may have a material effect on the production that will not be reflected completely in the reported condition.

To arrive at a forecast of production from a currently reported figure representing condition, the practice is to estimate the final percent full crop from a graphic correlation chart on which the currently reported condition is plotted on the X axis and the final percent full crop (reported at the end of the season) on the Y axis. The forecasted production is the product of the estimated percent full crop multiplied by the par.

In evaluating the three methods, all correlations were computed mathematically and all trend lines were projected mathematically. This was done to eliminate personal judgment. The 12 years 1934–45, were used as a basis when forecasts were made of the crops of 1946 and 1947.

Par Method

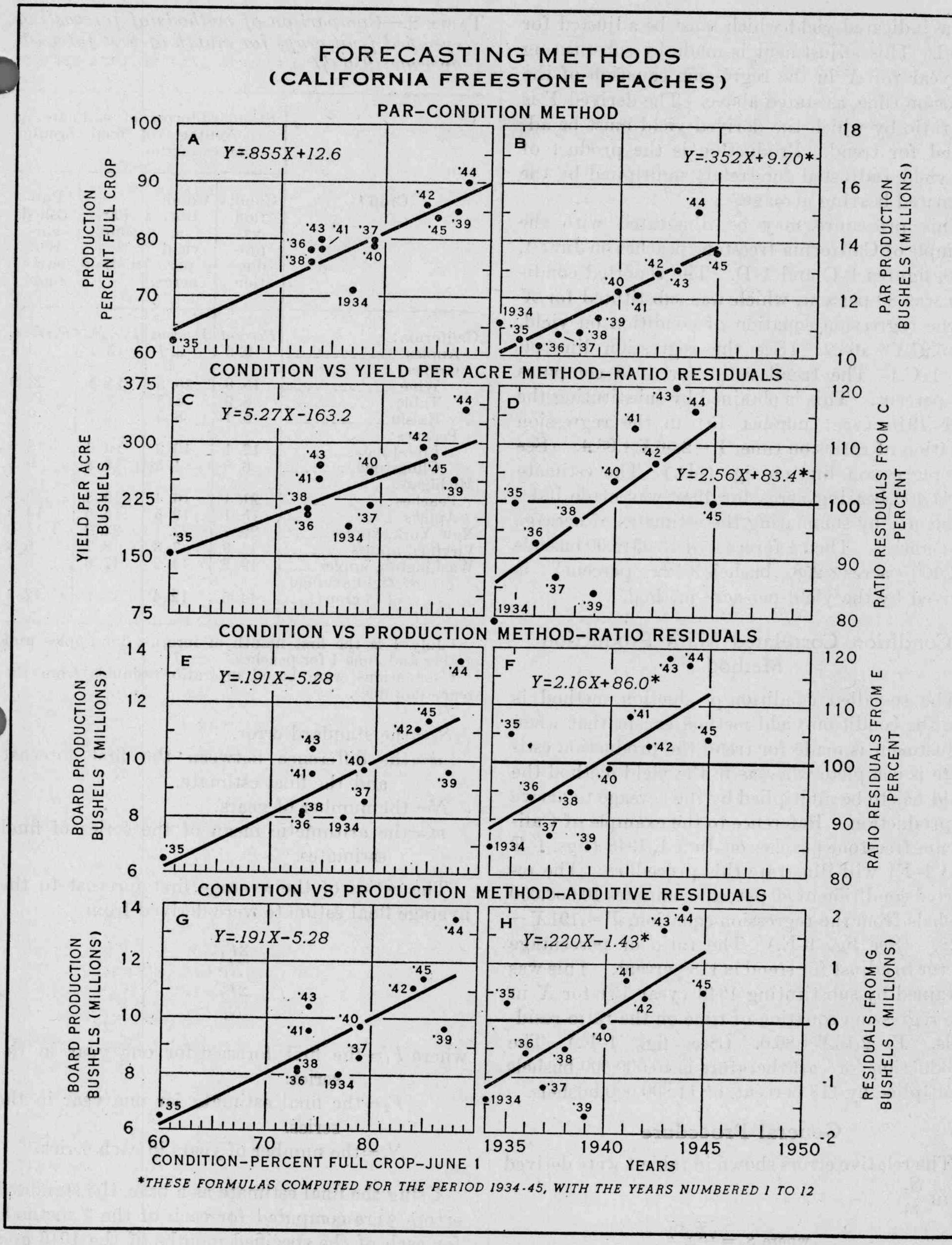
Pars and years for 1934 to 1945 were correlated and a formula was derived for the straight-line trend of pars. Pars for 1946 and 1947 were derived from this formula. Indicated "percent-full-crop" figures for each month, July to October 1946 and 1947, were derived from the formula for the correlation between condition and the final percent full crop for the years 1934–45. Production is the product of the currently derived percent full crop multiplied by par.

Calculation of the forecast for California freestone peaches on June 1, 1948, will demonstrate the procedure. The crop reporters' weighted average condition was 80 percent, which indicates 81 percent of a full crop, based on the correlation of condition and percent-full-crop in the years 1934–45. The percent full crop can be derived by substituting 80 for X in the regression equation $Y=0.855X+12.6$ or by reading 81 percent on the correlation chart in figure 1–A. The estimated par for 1948 was derived by substituting the year 1948 in the regression equation $Y=0.352X+9.70$ in which the pars for 1934–45 were correlated with the years 1934–45 (fig. 1–B). The derived par for 1948 of 14,980,000 times the derived percent-full-crop of 81 percent equals the forecast of production of 12,134,000 bushels.

Condition Correlated With Yield-Per-Acre Method

Estimates have been made recently by the Crop Reporting Board of bearing acres of all tree-fruit crops, for all States, for the years 1919 to 1946. Yields per acre were derived from final estimates of production and estimated bearing acres. The derived yields were correlated with the reported condition for each month and a regression equation was thus derived for each month, based on the period 1934–45. The regression-line yields were then computed for each month of the period 1934–45 by substituting the reported condition figures in the regression formulas. The ratios of the actual yields to the regression yields were then computed. These ratios were correlated with time (years) to obtain the trend in the yields. Thus, if the ratios average about the same for the latter part of the period as for the earlier part, no trend is indicated. But if the ratios are larger for the later years than for the earlier years an upward trend in yields is evident. Conversely, if the ratios are less in later years, a downtrend is evident.

The trend in terms of ratios was computed for each month (July-November) for 1946 and 1947 by substituting 1946 and 1947 for X in the trend regression equations, which were derived by correlating ratios with time. To forecast yield per acre for each specified month in 1946 and 1947, the condition was substituted for X in the regression equation of yield on condition. The computed Y



FORECASTING METHODS
(CALIFORNIA FREESTONE PEACHES)
PAR-CONDITION METHOD
A
Y=.855X+12.6
B
Y=.352X+9.70*
PRODUCTION PERCENT FULL CROP
PAR PRODUCTION BUSHELS (MILLIONS)
CONDITION VS YIELD PER ACRE METHOD-RATIO RESIDUALS
C
Y=5.27X-163.2
D
Y=2.56X+83.4*
YIELD PER ACRE BUSHELS
RATIO RESIDUALS FROM C PERCENT
CONDITION VS PRODUCTION METHOD-RATIO RESIDUALS
E
Y=.191X-5.28
F
Y=2.16X+86.0*
BOARD PRODUCTION BUSHELS (MILLIONS)
RATIO RESIDUALS FROM E PERCENT
CONDITION VS PRODUCTION METHOD-ADDITIVE RESIDUALS
G
Y=.191X-5.28
H
Y=.220X-1.43*
BOARD PRODUCTION BUSHELS (MILLIONS)
RESIDUALS FROM G BUSHELS (MILLIONS)
CONDITION-PERCENT FULL CROP-JUNE 1
YEARS
*THESE FORMULAS COMPUTED FOR THE PERIOD 1934-45, WITH THE YEARS NUMBERED 1 TO 12
BAE 47329

FIGURE 1.

is the indicated yield which must be adjusted for trend. This adjustment is made by substituting the year for X in the regression equation of the ratios on time, as stated above. The derived Y is the ratio by which the derived yield must be adjusted for trend. Production is the product of the yield (adjusted for trend) multiplied by the estimated bearing acreage.

This procedure may be illustrated with the example of California freestone peaches on June 1, 1948, figures 1–C and 1–D. The reported condition was 80 percent, which was substituted for X in the regression equation of condition on yield, $Y=5.27X-163.2$. (See the regression line on fig. 1–C.) The trend ratio for 1948 computes 122 percent. This is obtained by substituting the year 1948 (year number 15) in the regression equation of ratios on time, $Y=2.56X+83.4$. (See the regression line on fig. 1–D.) The estimate of 41,400 bearing acres for 1948 was made independently by summating the estimates of acreage by counties. Then a forecast of 13,031,000 bushels (41,400 acres×258 bushels×122 percent) is derived by the yield-per-acre method.

Condition Correlated With Production Method

The so-called condition-production method is like the condition-yield method except that when adjustment is made for trend the production estimate is complete whereas in the yield method the yield has to be multiplied by the acreage to arrive at production. Reference to the example of California freestone peaches on June 1, 1948 (figs. 1–E and 1–F) will illustrate this procedure. The reported condition of 80 percent computes 10,000,000 bushels from the regression equation, $Y=.191X-5.28$. (See fig. 1–E.) The ratio or percentage factor to adjust for trend is 118 percent. This was obtained by substituting 1948 (year 15) for X in the regression equation of time on the ratio residuals, $Y=2.16X+86.0$. (See fig. 1–F.) The production forecast therefore is 10,000,000 bushels multiplied by 118 percent, or 11,800,000 bushels.

General Procedure

The relative errors shown in table 1 were derived from $\frac{S_x}{m}$

$$\text{where } S_x=\frac{\sqrt{\Sigma(d^2)}}{N}$$

TABLE 2.—*Comparison of methods of forecasting specified fruit crops for month of first forecast, average 1946–47*

Crop [1]	Standard error of estimate as percentage of final production estimate: Condition vs. production	Condition vs. yield per acre	Par condition method	Published current estimate
	Percent	*Percent*	*Percent*	*Percent*
California:				
Apples	9.0	3.7	13.1	9.5
Grapes:				
Wine	15.8	15.5	15.1	23.9
Table	8.9	8.5	8.8	11.6
Raisin	8.1	8.5	7.7	9.3
Peaches:				
Freestone	12.1	16.3	10.0	13.8
Clingstone	6.8	4.5	11.3	9.5
Michigan:				
Peaches	21.1	16.4	19.3	16.3
Apples	15.1	19.5	16.6	14.8
New York, apples	29.1	22.1	23.0	15.0
Virginia, apples	14.8	7.3	8.7	6.4
Washington, apples	19.2	14.2	17.8	6.1
Straight average of 11 crops	14.5	12.4	13.8	12.4

[1] July 1 is the first month of forecast for apples and grapes and June 1 for peaches.

Calculations were based on ratio residuals from the regression lines.

S_x= the standard error.

d= the difference between the first forecast and the final estimate.

N= the number of years.

m= the arithmetic mean of the series of final estimates.

The ratios of the average first forecast to the average final estimate were derived from

$$\frac{\frac{\Sigma F_1}{N_1}}{\frac{\Sigma F_2}{N_1}}$$

where F_1= the first forecast for one year in the series.

F_2= the final estimate for one year in the series.

N_1= the number of years in each series.

Using the final estimate as a base, the standard errors were computed for each of the 3 methods for each of the specified months of the 1946 and

TABLE 3.—*Comparison of methods of forecasting specified fruit crops for all months combined, average 1946–47*

Crop [1]	Standard error of estimate as percentage of final production estimate			
	Condition vs. production	Condition vs. yield per acre	Par-condition method	Published current estimate
California:	Percent	Percent	Percent	Percent
Apples	10.3	5.2	12.6	8.0
Grapes:				
Wine	14.6	14.2	13.6	16.9
Table	9.3	9.1	8.8	11.2
Raisin	8.1	8.4	6.5	6.7
Peaches:				
Freestone	9.3	14.4	7.8	11.1
Clingstone	9.0	4.1	11.0	7.1
Michigan:				
Peaches	11.2	8.0	11.0	12.0
Apples	9.1	11.9	11.1	8.3
New York, apples	19.8	15.2	14.6	9.3
Virginia, apples	11.6	5.1	5.3	5.6
Straight average 10 crops	11.2	9.6	10.2	9.6

[1] July 1–Nov. 1, inclusive, for apples and grapes; June 1–Oct. 1, inclusive, for peaches.

Calculations were based on ratio residuals from the regression lines.

1947 seasons. The standard errors for each month were computed by combining 1946 and 1947, by months. Also, the standard errors for each season (1946 and 1947) and for the two seasons combined were computed by using all months of the season.

To compare the accuracy among crops and States the ratios of standard errors to final estimates were computed and expressed as percentages (tables 2, 3, and 4, and figs. 1–A, 1–B, 1–C, 1–D, 1–E, and 1–F).

The statistics for the 1946–47 period reported in tables 2, 3, 4, 5, and 6 were derived from—

$$\text{Standard errors as percentage of final production estimate} = S_v = \frac{\dfrac{\sqrt{\Sigma(d_1^2+d_2^2)}}{N}}{F_1}$$

where d_1=difference between regression line projection and final production estimate for 1946.

d_2=difference between regression line projection and final production estimate for 1947.

N=2.

F_1=arithmetic mean of final production estimates years 1946 and 1947.

TABLE 4.—*Comparison of methods of forecasting production of ten specified fruit crops, by months, average 1946–47* [1]

Date	Standard errors of estimate as percentage of final production estimate			
	Condition vs. production	Condition vs. yield per acre	Par-condition method	Published current estimate
Average 1946–47:	Percent	Percent	Percent	Percent
July 1	12.6	11.0	11.5	12.3
Aug. 1	11.4	9.0	10.3	9.5
Sept. 1	9.9	8.4	9.2	8.2
Oct. 1	8.8	7.0	8.2	7.1
Straight average	10.7	8.8	9.8	9.3

[1] The 10 crops were apples, wine grapes, table grapes, raisin grapes, freestone peaches, clingstone peaches for California; apples and peaches for Michigan; and apples for Virginia and New York.

Calculations were based on ratio residuals from the regression lines.

The statistics for the 1934–45 period reported in tables 5 and 6 were derived from—

$$\text{Standard errors as percentage of final production estimate} = S_v = \frac{\dfrac{\sqrt{\Sigma d_1^2+d_2^2+d_3^2 \ldots d_{12}^2}}{N}}{F_1}$$

where d_1=difference between regression line projection and final production estimate for 1934.

d_2=difference between regression line projection and final production estimate for 1935.

d_3=difference between regression line projection and final production estimate for 1936.

. . .

. . .

d_{12}=difference between regression line projection and final production estimate for 1945.

N=12.

F_1=arithmetic mean of final production estimates years 1934–45 period.

Table 5.—*Comparison of additive and ratio residual methods of estimating production of specified fruits, average 1934–45 and average 1946–47*

Crop	Standard error of estimate as percentage of final production estimate. Condition vs. production			
	Average 1934–45 residuals		Average 1946–47 residuals	
	Additive	Ratio	Additive	Ratio
	Percent	*Percent*	*Percent*	*Percent*
Peaches, June 1:				
California freestone	8.1	8.5	12.3	12.8
California clingstone	6.4	6.7	7.8	7.1
Apples, commercial, July 1:				
Michigan	7.3	7.2	15.3	16.4
Washington	6.3	6.3	18.4	19.2

Three-Chart Graphic Method

In graphic correlation analysis, consideration is given to the possibility of correlation between time and condition, the independent variables, for the line of relationship between condition and yield or production should represent the *net* regression. This net-regression line may differ considerably from the line of best fit on the condition-production chart when there is significant correlation between time and condition. To learn whether this was an important factor in estimating fruit crops, four crops were selected for analysis in which the correlation between time and condition was relatively high. The correlations between time and condition by crops were: California Clingstone peaches on June 1, +0.42; California Freestone peaches on June 1, +0.59; Washington apples on July 1, +0.32; and Michigan apples on July 1, −0.41. The months used were the first forecasts of the season for the respective crops.

Table 6 and figures 1–G, 1–H, 2–A, 2–B, and 2–C, show comparisons between the 2-chart method (1) condition correlated with production and (2) residuals from that regression line correlated with time, and the 3-chart method (1) time correlated with production; (2) time correlated with condition; and (3) the residuals from the regression lines of 1 and 2 correlated with each other.

The mechanical steps in making a forecast of production using the 3-chart analysis, may be demonstrated from the condition of California Freestone peaches on June 1, 1948. The year 1948 indicates a condition of 89 percent on figure 2–A. The difference between the reading of 89 and the actual reported of 80 is −9 (89−80). This −9 condition on the horizontal scale of figure 2–C reads a correction of −900,000 bushels on the vertical scale. On figure 2–B, the year 1948 reads 13,500,000 bushels. Hence the derived forecast is 12,600,000 bushels (13,500,000–900,000).

An examination of table 6 discloses that the 3-chart system has practically no advantage over the 2-chart system for any of the methods of fruit forecasting examined in this study.

Additive and Ratio Residuals

In using the regression method for estimating crop yield or production from condition, an indication of trend is usually obtained by correlating with time, the differences between actual production and the regression line production. This assumes that the relation between condition and production is additive but actually the relation is multiplicative. Theoretically, therefore, the trend should be obtained by correlating with time the ratios of the actual production to the regression estimates of production. As explained above and as shown in figures 1–E and 1–F, the use of ratio residuals indicated a forecast as of June 1, 1948, of 11,800,000 bushels for California freestone peaches. Additive residuals, as shown in figures 1–G and 1–H, produce a forecast of 11,870,000 bushels (10,000,000+1,870,000=11,870,000). The 80-percent condition reads 10,000,000 bushels on figure 1–G ($Y=0.191X-5.28$) and 1948 (year 15) on figure 1–H reads an additive factor of 1,870,000 bushels ($Y=0.220X-1.43$). Except in extreme cases, there is very little difference in results from the two procedures. The additive residual method is easier to use than the ratio method, which explains why the additive residuals are usually used in practice. Table 5 shows the results of the ratio method and the additive method for four fruit crops, for the period 1934–45, and average forecasts for 1946–47. The data are expressed as the standard deviation in percentage of final estimate. Figures 1–E, 1–F, 1–G, and 1–H are charts in which California freestone peaches are used to illustrate these two methods.

TABLE 6.—*Comparison of gross and net regressions in graphic correlation analysis in estimating production of fruit, average 1934–45 and average 1946–47* [1]

CALIFORNIA, FREESTONE PEACHES, JUNE 1

Period and method	Standard error of estimate as percentage of final production estimate			
	Condition vs. production	Condition vs. yield per acre	Par-condition	Published current estimate
	Percent	*Percent*	*Percent*	*Percent*
Average 1934–45				
Method:				
2-chart	8.1	10.0	5.4	
3-chart	5.8	7.1	5.6	
Average 1946–47				15.9
Method:				
2-chart	12.3	14.2	12.0	
3-chart	11.2	13.6	12.0	

CALIFORNIA, CLINGSTONE PEACHES, JUNE 1

Period and method	Condition vs. production	Condition vs. yield per acre	Par-condition	Published current estimate
Average 1934–45				
Method:				
2-chart	6.9	7.6	5.9	
3-chart	6.1	6.4	5.9	
Average 1946–47				9.3
Method:				
2-chart	7.8	8.1	9.0	
3-chart	9.8	6.5	8.4	

MICHIGAN, COMMERCIAL APPLES, JULY 1

Period and method	Standard error of estimate as percentage of final production estimate			
	Condition vs. production	Condition vs. yield per acre	Par-condition	Published current estimate
	Percent	*Percent*	*Percent*	*Percent*
Average 1934–45				
Method:				
2-chart	7.3	8.9	7.2	
3-chart	6.5	8.5	7.2	
Average 1946–47				14.0
Method:				
2-chart	15.3	16.7	16.4	
3-chart	15.8	17.5	15.4	

WASHINGTON, COMMERCIAL APPLES, JULY 1

Period and method	Condition vs. production	Condition vs. yield per acre	Par-condition	Published current estimate
Average 1934–45				
Method:				
2-chart	6.3	6.3	6.4	
3-chart	6.0	6.1	6.3	
Average 1946–47				6.1
Method:				
2-chart	18.4	11.8	18.0	
3-chart	16.6	11.5	18.0	

[1] Calculations were based on additive residuals. Gross regression refers to the 2-chart method and net regression refers to the 3-chart method of forecasting.

Conclusions

1. This study indicates that there is no great difference in the results obtained from these three methods of using the reported condition to forecast the production of fruit (tables 2, 3, 4, and 5).

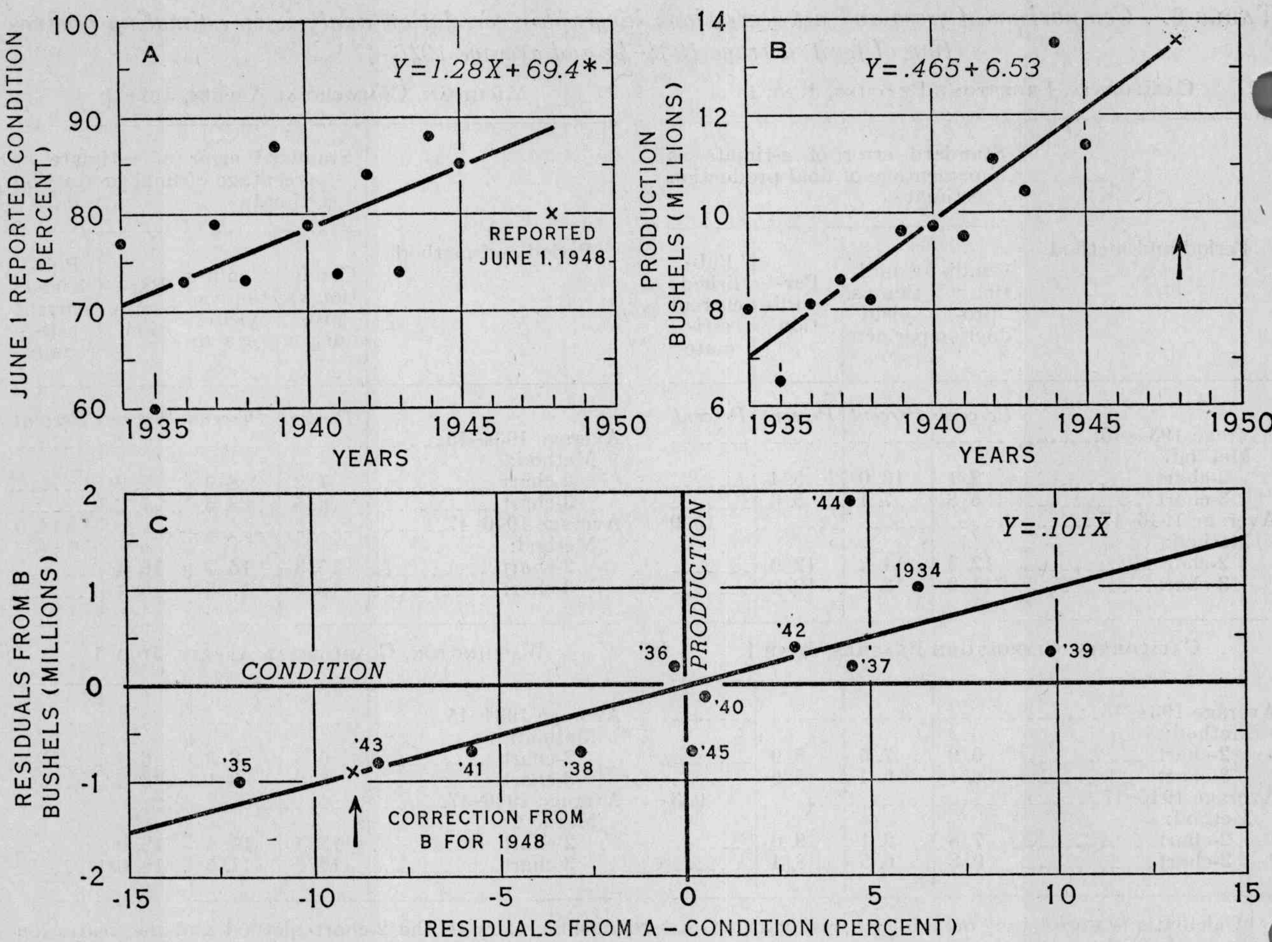
2. Currently published estimates of the Crop Reporting Board agree closely with estimates derived from an objective analysis of the data.

3. The correlation between time and condition is not high enough to make significant the differences in results between the use of net- and gross-regression methods. (Three- and two-chart methods of forecasting. See table 6 and figures 1-G and 1-H, and 2-A, B, C.)

4. An apparent trend in condition usually is not an actual trend but merely a coincidence of small or large crop yields at the beginning or end of the series. California grapes and Michigan apples are representative examples. The upward trend in the July 1 condition of California grapes disappears by the elimination of the short 1936 crop at the beginning and the large 1945 crop at the end of the series. Likewise, the sharp downward trend in the July 1 condition of Michigan apples disappears when the large 1937 crop and the near-failure of the 1945 crop are removed from the series. This study is based on only 12 years, 1934–45.

5. Ordinarily, the saving in work appears to justify the use of additive residuals instead of ratio residuals as in most cases results are about the same. In case of bumper crops or unusually poor crops, however, the ratio residuals should give better estimates because the additive residual chart might give much too large or too small an additive factor.

6. The regression approach—using condition, derived yields, and best estimates of bearing acres—seems to have an advantage over other



*THESE FORMULAS COMPUTED FOR THE PERIOD 1934-45, WITH THE YEARS NUMBERED 1 TO 12

BAE 47330

FIGURE 2.—THREE-CHART METHOD OF FORECASTING (CALIFORNIA FREESTONE PEACHES)

analytical approaches. The use of this general method in graphic form, permitting some flexibility in the projection of regression lines, without the necessity for recomputing them every year, would seem to offer the best method for items on which fairly accurate data are available on bearing acres. When that is not the case, the study affords no grounds for departing from the present par production method.

In the example cited of a forecast of California freestone peach production for June 1, 1948, it may be noted that the par and condition-production methods gave practically the same results, whereas the yield-per-acre method gave a considerably higher estimate; all were larger than the final estimate. For the first part of the period from which the computations were made, the acreage trend was down and the yield trend was up, but toward the end of the period the acreage increased because of young trees coming into bearing, and the yields turned down. The par and condition-production methods showed only a slight trend because of the offsetting effects of smaller yields and larger acreages. However, for the yield-per-acre method, the yield estimated from the regression equation was too high; consequently, production was overstated when the high yield was multiplied by the increased acreage. This seems to indicate that full dependence should not be placed on trends projected by means of regression formulas, but that some judgment should be used in making current forecasts.

7. Estimates of fruit production could be prepared from estimates of bearing acreage and yield

per bearing acre using procedures similar to those used in estimating field crops. Reliable bearing-acreage estimates are made annually for California, where about half of the country's fruit is produced. In the few other States where comprehensive fruit-tree surveys are now in progress, bearing-acreage projections should be rather accurate for the next few years, especially if there is adequate provision for making estimates of annual plantings and removals. In some other States par projections can be made more accurately than bearing acreage estimates, because reliable crop check data are available annually—through records of shipments and of processors—which permit an accurate revision of the estimates. Then the par, derived by dividing the revised production estimate by the grower's final reported percent full crop, gives an accurate par base for the following season. In other States, most of which are unimportant in fruit production, records of crop disposition are not available and par and bearing-acreage projections can be made with about equal accuracy. Of course, forecasting fruit production by the yield-per-acre and bearing-acreage approach involves the projection of the level of per-acre yields. A similar problem is encountered in forecasting yields of field crops. Examples are the higher yields of corn and oats of the last several years which were due to the introduction of hybrids and new varieties, respectively.

8. Whichever method is used—condition correlated with yield per acre, par condition, or condition correlated with total production—clearly more complete information is needed on the "consist" of the fruit production plant. In some areas, particularly California, reasonably accurate estimates of acreage by age groups and varieties are available, but sample surveys of levels of yield at different age groups and in different locations are needed in order to make full use of the available data in acreage by age groups and varieties. In many States comprehensive surveys of the number by age groups and varieties are needed and information on levels of yield are needed in all States.

This report has dealt exclusively with methodology in interpretation of the growers' reported condition in terms of percentage of a full crop. In general, this statistic appears to be the best indication of fruit production during the growing season and has much the lowest cost. Other methods, including individual farm reports of actual production, "cruising" of orchards, and "frame counts" have been used to a limited extent. In cruising, an experienced individual travels through a fruit area and estimates production by visiting representative orchards and inspecting individual trees. The frame count is an objective method of estimating in which sample blocks of fruit are counted and measured. These other methods require larger samples than the condition method for the same degree of statistical accuracy, and are more expensive.