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Factors Affecting Consumption of Fats and Oils, Other Than Butter, in the United States [1]

By Sidney J. Armore and Edgar L. Burtis

Consumption forecasts for fats and oils are essential in appraising the outlook for oilseeds and guiding farmers' acreage plans. They are also valuable to businessmen who produce, handle, or use fats and oils or who deal in oilseeds. Recognizing the extent of interchangeability among fats and oils, this paper presents an analysis of the factors affecting total consumption of fats and oils, except butter. An equation for forecasting total fat and oil consumption, per person, and techniques which should prove useful as a guide in the analysis of demand for particular groups of fats and oils are likewise presented.

Consumption of fats and oils other than butter in the United States has been closely associated with industrial production and trend. More than 97 percent of the variance in annual consumption, per person, from 1922 to 1940 has been accounted for in a statistical analysis of annual data that represent these factors and fats and oils prices. Prices of fats and oils during that period, however, apparently had little effect on total consumption.

Factors Used in the Analysis

The specific variables used in the statistical analysis were as follows:

Description	*Designation*
Domestic disappearance of all fats and oils, except butter, divided by the population of the United States on July 1 (pounds)	X_1
Bureau of Agricultural Economics index of wholesale prices of 26 major fats and oils (excluding butter) deflated by the Bureau of Labor Statistics wholesale price index for all commodities (1935–39=100)	X_2
Federal Reserve Board index of industrial production divided by the population of the United States on July 1 (1935–39=100)	X_3
Year (1922=1)	X_4

Actual consumption of fats and oils cannot be computed accurately because data on dealers' and consumers' inventories are lacking. In most years, however, a good working approximation to consumption is afforded by the disappearance of fats and oils from factories and warehouses. This disappearance is computed from data on production, factory and warehouse stocks, and foreign trade, including shipments to United States Territories.

[1] This article reports results of the first study undertaken on fats and oils on the project, "Factors Affecting Production, Prices, and Uses of Fats, Oils, and Oilseeds, Including Peanuts," financed by Research and Marketing Act funds. The authors are indebted to Richard O. Been for aid in the development of the mathematical aspects of this paper. Submitted for publication September 1949.

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Wholesale rather than retail prices of fats and oils were necessarily used for the price variable because hardly any of the fats going into nonfood products are priced at retail. Moreover, total demand for fats and oils can best be measured at the wholesale level, where the demands from all fat-using industries converge to "make" the price through competition for available supplies.

The FRB index of industrial production was chosen as a measure of the strength of demand for fats and oils (that is, as the "demand shifter"). Changes in industrial production are closely paralleled in nearly all years by changes in the nonfood uses of fats and oils, which account for far more of the variation in total disappearance than do changes in food uses. An analysis of factors affecting disappearance of food fats might well show that an index of consumer income is the proper demand shifter for food fats. Even if this is true, using industrial production as the demand shifter in the present analysis probably does not introduce serious error, because industrial production is highly correlated with "real" consumer income.

Time was included as an independent variable to measure the effects of factors other than price and industrial activity, to the extent that the combined influence of such other factors may have progressively increased or decreased during the period studied. Factors associated with time might include shifts in consumers' tastes and developments in industrial technology which resulted in new uses for or new products competitive with fats and oils.

The period studied was 1922–40. The beginning year was determined by availability of the fat-and-oil wholesale price index, which begins in 1922. Also, data on disappearance before 1920 are less reliable than those for the years afterward. The year 1941 was not used because of evidences of an abnormal accumulation of inventories by dealers and consumers during that year. This accumulation apparently was at least partly balanced by reductions in inventories in 1942, but none of the years 1942–46 was usable in the analysis owing to price ceilings and rationing. The years 1947 and 1948 were reserved to test the applicability of the analysis to the postwar period.

Results of the Analysis

Analysis of the annual data for 1922–40, by multiple correlation techniques, led to the following equation as the best expression for the relationship between consumption, industrial production, time, and price:

$$(1) \quad X'_1 = -17.036 - 0.014X_2 + 31.713 \log X_3 + 6.691 \log X_4.$$ [2]

[2] Correlation coefficients and other statistical measures for this equation are as follows:

$$R_{1.234}=0.986 \quad r_{12.34}=-0.26$$
$$\bar{R}_{1.234}=0.983 \quad r_{13.24}=0.96$$
$$\bar{S}_{1.234}=0.642 \quad r_{14.23}=0.97$$
$$\beta_{12.34}=-0.06 \quad t_{\beta_{12.34}}=t_{b_{12.34}}\doteq-1.1$$
$$\beta_{13.24}=0.72 \quad t_{\beta_{13.24}}=t_{b_{13.24}}=13.9$$
$$\beta_{14.23}=0.68 \quad t_{\beta_{14.23}}=t_{b_{14.23}}=14.7$$

The price of butter was tested as a fourth independent variable, on the hypothesis that butter is the principal competitor of other fats and oils. However, acceptable results were not obtained from correlations including the price of butter. Either these correlations indicated that the price of butter had no significant effect on total disappearance of other fats and oils or they were rejected because (1) the intercorrelation among independent variables was extremely high or (2) disappearance was explained largely by trend.

The highest multiple correlation in the subset of independent variables was $R_{2.34}$ (=0.586). A relatively low degree of intercorrelation among the independents, as indicated by the value of $R_{2.34}$, gives stability to the statistical constants of the full set, particularly to the standard errors of the regression coefficients, and so enhances confidence in the reliability of the results. Problems introduced by a high intercorrelation among the independent variables have been discussed by Frisch and by Waugh and Been. FRISCH, R. STATISTICAL CONFLUENCE ANALYSIS BY MEANS OF COMPLETE REGRESSION SYSTEMS. Oslo, 1934; WAUGH, F. V., and BEEN, R. O. ON THE VALIDITY OF AN ESTIMATE FROM A MULTIPLE REGRESSION EQUATION, an unpublished paper. A digest of part of this paper, by the same authors, SOME OBSERVATIONS ABOUT THE VALIDITY OF MULTIPLE REGRESSIONS, appears in the Statistical Journal of the College of the City of New York, Vol. 1, No. 1, pp. 6–14 (January 1939).

The semi-logarithmic relationships between X_1 and X_3 and between X_1 and X_4 were used in the equation because residuals from linear regressions suggested a curvilinearity best expressed mathematically by using the logarithms of X_3 and X_4 (fig. 1). When this was done, there was significant improvement in the multiple and partial correlation coefficients and an increase in the t-values of the regression coefficients.

The partial correlation coefficients, the β-values, and the standard errors of the β's indicate that industrial production and trend largely determined disappearance. The effect of price on disappearance is not statistically significant, but the regression coefficient for price is shown as the "most probable" value.

Elasticity of Consumption With Respect to Price ("Elasticity of Demand")

Generally speaking, as the price of a commodity increases the amount consumed tends to decrease. Conversely, as the price decreases, consumption tends to increase. However, the effect on consumption of a given change in price varies widely for different commodities. A convenient measure of the effect of price changes on consumption is the relationship of the percent change in consumption to the percent change in price. This is known as the coefficient of elasticity. In general, a coefficient of elasticity of 1 indicates that consumption and price tend to change in the same proportion (unit elasticity of demand); a coefficient greater than 1 indicates that consumption changes proportionately more than price (elastic demand); and a coefficient less than 1 indicates that consumption changes proportionately less than price (inelastic demand). A coefficient of zero indicates that consumption is not responsive to changes in price (perfectly inelastic demand).

Equation (1) indicates that elasticity of total demand for fats and oils, other than butter, is close to zero. The coefficient of elasticity cannot be determined exactly since statistical tests show that the relation between price and consumption indicated by the equation is subject to a fairly wide range of error. According to the equation, a decrease of 10 points in the deflated price index was accompanied, during the period 1922–40, by an average increase of only 0.14 pound per person in disappearance, after allowance is made for the effects of industrial production and time. With all factors at the 1922–40 average, the elasticity of demand indicated by the equation would be only 0.026.[3]

A consideration of the nature of the demand for fats and oils, other than butter, in each of the major uses tends to support the statistical evidence of a very inelastic total demand. Total demand for food fats other than butter probably is very inelastic, despite the probability of a relatively elastic demand for margarine. Margarine is mainly used as a spread, in competition with butter, and prices of butter and margarine probably have an appreciable effect on the consumption of margarine. Before the war, however, margarine accounted for only about 6 percent of the total consumption of food fats, other than butter.

Lard, shortening, and cooking and salad oils—the remaining major food fats—probably are only little affected by competition of butter, which is mainly used as a spread and usually is priced two to three times as high. Most of the use of these fats, moreover, is either in products having a very inelastic demand or in products to which the fat contributes only a small part of the total cost. Bread is the leading outlet for lard and shortening. As the demand for wheat in food uses is almost completely inelastic,[4] a very inelastic demand for bread may be inferred, and hence a very inelastic demand for the fat used in bread.

Frying is another major food use of fats and oils. Lard, shortening, margarine, and cooking oils are used for this purpose. In most commercial fried products, such as potato chips and salted nuts, the total cost of the product to the consumer probably is several times larger than the cost of the fat used. Therefore, variations in the price of fat probably have relatively little effect on total cost of these products and little effect on the quantity of fat used. A similar relationship exists between the cost of green salads and the salad dressing or salad oil used. Olive oil is an exception but it constitutes only a small fraction of the total quantity of salad oils consumed.

Soap manufacture accounts for about half of the total nonfood use of fats and oils. As substitutes for soap were unimportant during the period studied, demand for soap probably was also very inelastic with respect to price.

Other nonfood utilization of fats and oils comprises use in the manufacture of paints, varnishes, linoleum, lubricants and greases, core oils, synthetic resins, rubber, and many other industrial products. In most of these uses, cost of the fats and oils is only a small fraction of the total cost of the final product. For example, cost of the oils in paints, varnishes, and linoleum, used in building a new house is very small compared with the total cost of the house. Cost of fats used in lubricants for factory machinery is unimportant in relation

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[3] Coefficient of point elasticity of consumption with respect to price $= -b_{12.34}\frac{X_2}{X'_1} = .014\frac{X_2}{X'_1}$; where X'_1 is per person consumption estimated from equation (1).

[4] AN ANALYSIS OF THE EFFECTS OF THE PROCESSING TAXES LEVIED UNDER THE AGRICULTURAL ADJUSTMENT ACT, prepared by the Bureau of Agricultural Economics for the Bureau of Internal Revenue, 1937, p. 25.

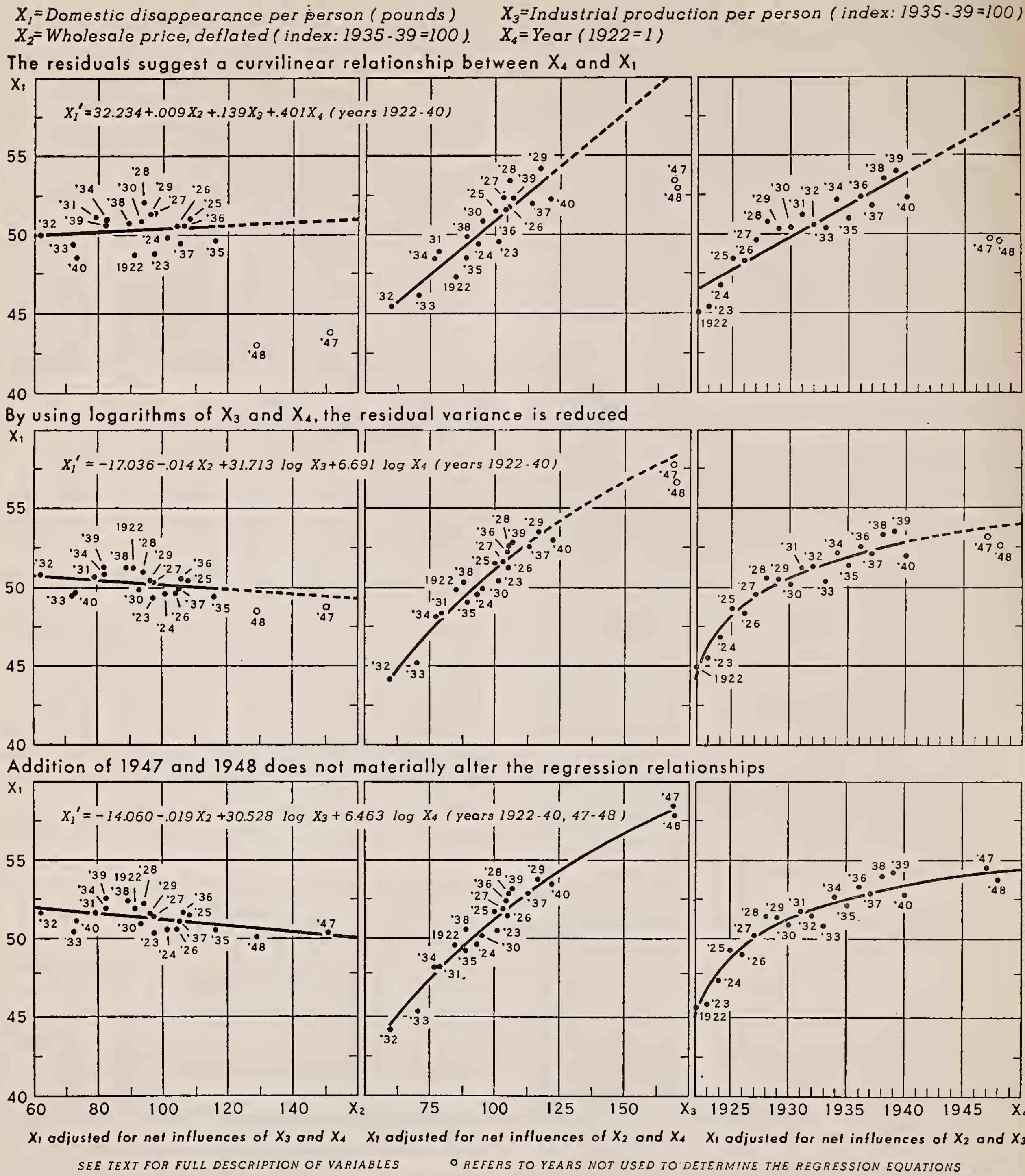

FIGURE 1.—NET INFLUENCE OF PRICE, INDUSTRIAL PRODUCTION, AND TIME ON THE CONSUMPTION OF FATS AND OILS OTHER THAN BUTTER—NET REGRESSIONS AND NET RESIDUALS.

to total cost of the products of the factory. A large percentage change in the price of fats and oils would raise the total cost of the final product by only a very small percentage and probably would have little, if any, effect on the use of fats and oils in manufacturing the product. Hence, elasticity of demand for fats and oils in a wide variety of industrial uses may be expected to be close to zero.

The conclusion that elasticity of total demand for fats other than butter is close to zero does not preclude a higher coefficient of elasticity for particular fats or fat-and-oil products. Also, elasticity for many products, notably foods, is smaller at wholesale than at retail. Therefore, elasticity of demand for some fat-and-oil products, measured at the retail level, may well be materially higher than the elasticity suggested by the present analysis for total demand at the wholesale level.

Elasticity of Consumption With Respect to Industrial Production

The regression equation indicates that consumption increases with industrial production, after allowance is made for the net influence of time and price. However, the higher industrial production, the smaller is the effect on consumption of a given increase in industrial production. With the independent variables at their 1932 level, an increase of 10 percent in industrial production per person would have increased disappearance 3.0 percent; but when the independent variables are held at their 1940 level, the resulting increase in disappearance would have been only 2.4 percent. These percentages indicate income elasticities of 0.30 and 0.24, respectively.[5]

The regression of consumption on industrial production apparently combines a relatively elastic response of utilization in drying-oil and miscellaneous industrial products with a small response in food uses. Decrease in elasticity at higher levels of industrial production probably is due to behavior of the food component in the total.

An unpublished analysis indicates that use of fats and oils in drying-oil products varies closely with the index of industrial production and that elasticity in this use with respect to industrial production is about 0.9. Use of oils and fats in nonfood products other than soap and drying-oil products probably also is roughly proportional to the index of industrial production. This miscellaneous group of products includes lubricants and greases, fatty acids, and many others which are affected by the general level of industrial activity.

A rough approximation to prewar consumption of food fats and oils other than butter, per person, by income groups, has been worked out from consumer purchase studies. This shows that prewar consumption of food fats other than butter rose as income increased, up to the middle-income group, and then declined slowly with rising income. This relation between income and food-fat consumption may be responsible for the curvilinearity in the regression of consumption of all fats and oils, except butter, on industrial production (which is highly correlated with consumer income).

The income elasticity of food fats other than butter at the lower income levels, based on prewar consumer purchase studies, was roughly 0.2. The average income elasticity of consumption for all income groups was approximately zero.

Net Trend in Consumption

The regression equation indicates a net upward trend in consumption during 1922–40, after allowance is made for the effects of price and industrial production. The net trend was rapid in the 1920's but tapered off in the 1930's, and by 1940 it had nearly disappeared. The indicated net increase in disappearance from 1924 to 1925 due to trend was 0.84 pound per person; from 1934 to 1935, 0.22 pound per person; from 1939 to 1940, 0.16 pound per person.

Several developments in the fats and oils field during 1922–40 are probably reflected in the net trend. The ratio of fat to flour in commercial bread baking was increased from about 2 percent in the early twenties to about 3 percent in 1940.[6] As commercial bread baking constitutes a major outlet for lard and shortening, this probably exerted a strong influence toward increasing the level of total demand for these fats. A second

[5] Coefficient of point elasticity of consumption with respect to industrial production$=\frac{0.434}{X'_1}b_{13.24}=\frac{13.763}{X'_1}$; where X'_1=per person consumption estimated from equation (1) and $0.434=\log_{10} e$.

[6] These estimates were derived from Census of Manufactures data by N. Jasny in an unpublished study PRICE AND COST OF BREAD IN THE UNITED STATES AND OTHER COUNTRIES.

development was the expanding use of washing machines during 1922–40, which increased sales of flaked and granulated laundry soaps at the expense of laundry bars. The fat content of the former type of soap is considerably larger and resulted in an increased demand for fats and oils in soap. Another development tending to increase demand for fats and oils, especially during the 1920's, was a rapid increase in consumption of green salads. Consumption of lettuce in the United States rose from less than 11 pounds per person in 1922 to nearly 17 pounds in 1929 and, except for the depression period, continued at about 16 to 17 pounds per person until 1942. This undoubtedly was reflected in a rising level of demand for salad oil.

Projection to the Postwar Period

Projection of a statistical analysis of economic data is particularly hazardous when the change in economic conditions and disruption of consumers' habits are as great as that which took place during and immediately after World War II. Substantial extrapolation of the base-period variables is likely to be necessary. In addition, factors which were not significant in the base period may have become significant in the later period. The probable importance of new factors can be appraised only by judgment based on familiarity with the industry studied. However, the degree of extrapolation of the independent variables beyond the range of the base-period scatter can be determined by a chi-square test proposed by Waugh and Been.[7]

Application of this test shows that a χ^2, as large as the one computed from values of independent variables observed in 1947, could be expected to occur only seven times in a million through random sampling from the universe implied by the 1922–40 data. A χ^2, as large as the one computed for the 1948 combination of observations, could be expected only once in a thousand times.

On the assumption that the relationships determined for the period 1922–40 will hold for 1947 and 1948, despite the extreme extrapolation involved, the standard error of forecast can be computed for each year.[8] Aside from the effects of extrapolation and the influence of new variables, the odds are 2 out of 3 that a forecast of consumption will fall 1 standard error or less from the "true" value; and 99 out of 100 that it will fall 2 standard errors or less from the "true" value. The standard error of forecast for 1947 is 1.0 pound per person. The forecasted disappearance for 1947 from equation (1) was 60.9 pounds per person. The actual disappearance in 1947 was 60.3 pounds per person. In 1948, the forecast was 61.4 pounds per person, the standard error was 0.9 pound per person, and the actual disappearance was 60.3 pounds per person.

The relatively close agreement of the forecasts with actual disappearance in 1947 and 1948 may have occurred despite the operation of factors which are not included in the forecasting equation and which have become important since 1940. These possible factors are the price of butter and the use of synthetic detergents, synthetic resins, and chemical bread softeners.

The price of butter may have had considerable influence on disappearance of other fats and oils in 1947 and 1948. No significant influence could be discovered when the data for 1922–40 were analyzed; but in 1947 and 1948 the price of butter was much higher than in 1922–40. Consumption of butter in 1948, at 10 pounds per person, was more than 6 pounds below the 1935–39 average. Consumption of margarine in 1948, at slightly more than 6 pounds per person, was about 2.5 pounds above the prewar average, in terms of fat; and this increase undoubtedly was related to the high price of butter.

On the other hand, synthetic detergents have become serious competitors of soap since the prewar period. Household use of synthetic detergents became rather general during the war and increased rapidly in 1947 and 1948. By the latter year, the use of synthetic detergents for all purposes amounted to roughly 15 percent of total use of "synthetics" and soap. Some synthetic detergents are partly derived from fats, but others,

[7] WAUGH, F. V., and BEEN, R. O. ON THE VALIDITY OF AN ESTIMATE FROM A MULTIPLE REGRESSION EQUATION, an unpublished paper. A digest of part of this paper, by the same authors, SOME OBSERVATIONS ABOUT THE VALIDITY OF MULTIPLE REGRESSIONS, appears in the Statistical Journal of the College of the City of New York, V. 1, No. 1, pp. 6–14, January 1939. The formula for calculating chi-square in this usage is given in note 2B, at the end of this paper.

[8] Waugh and Been, ibid. The formula for the standard error of forecast is given in note 2C at the end of this paper.

which now probably account for a large part of the total, do not contain any fat derivative.

The increasing use of chemical bread softeners was brought to public attention by hearings on standards for bread, held by the Food and Drug Administration in late 1948 and early 1949. A leading type of bread softener is polyoxyethylene stearate, derived partly from petroleum and partly from fats. It is claimed that this type of softener produces the same shortening effect in baked goods as is produced by several times its weight in fat and also retards drying out thus prolonging the shelf life of bread. It was alleged at the hearing that the softener was being used as a replacement for fat in baked goods rather than merely as a supplement. Testimony indicated that sales of the polyoxyethylene type of softener in early 1949 may have been at a rate as high as 10 million pounds annually. If used to replace fat, this quantity would have a relatively minor effect on the market for lard and shortening; but with a continuing increase in sales there would be a major depressing effect on the demand for lard and shortening.

Synthetic resins are being used in increasing quantities in paints, varnishes, and linoleum. Alkyd resins, the leading type of synthetic used in these products, are composed on an average of about 50 percent oils or fatty acids. Other resins contain no fat or fat derivatives.[9]

[9] Regression equation (1) has been re-computed with 1947 and 1948 included in the base period. The results, which are close to those based on 1922–40 only, are as follows:

$$(2)\ldots\ldots X'_1=-14.060-0.019X_2+30.528\ \log X_3+6.463\ \log X_4$$

$$R_{1.234}=0.990 \qquad r_{12.34}=-0.37$$
$$\bar{R}_{1.234}=0.989 \qquad r_{13.24}=0.96$$
$$\bar{S}_{1.234}=0.662 \qquad r_{14.23}=0.97$$
$$\beta_{12.34}=-0.99 \qquad t_{\beta_{12.34}}=-1.7$$
$$\beta_{13.24}=0.74 \qquad t_{\beta_{13.24}}=13.6$$
$$\beta_{14.23}=0.54 \qquad t_{\beta_{14.23}}=15.1$$
$$R_{2.34}=0.766 \qquad R_{3.24}=0.786 \qquad R_{4.23}=0.337$$

The forecast of total domestic disappearance in 1949 for all fats and oils except butter, based on equation (2), assuming a 10-percent decline in industrial production from 1948, and a 25-percent decline in the deflated index of prices of fats and oils, would be 59.9 pounds per person, with a standard error of forecast of 0.8 pound. The chi-square value for the assumed 1949 set of values of the independent variables indicates that this set lies inside, but near the outer boundary of the scatter of the base-period data and, consequently, that the 1949 forecast should be used cautiously. As a result of the upward trend in sales of synthetic detergents and a larger prospective production and consumption of butter in 1949 than in 1948, disappearance of fats and oils other than butter may fall near the lower end of the range indicated by two standard errors of forecast (that is, 59.9±1.6).

Technical Notes

Note 1: Use of Chi-square to Estimate Degree of Extrapolation in a Multivariate Scatter[10]

Regression analysis is based on observed data. The regression equation describes the relationship between the dependent and independent variables within the limits of the observations. Therefore, in using the regression equation to make a forecast, we need to know whether the new combination of values for the independent variables is inside or outside the range of observations from which the regression was calculated. A forecast beyond the observed range is to be used only with caution, this caution increasing with the degree of extrapolation from the limits of the observations.

When there is only one independent variable, the position of a new value with respect to the original set of values is easily observed. With a pair of independent variables, the position of a pair of new values can be noted when plotted as a point on a scatter diagram and compared with the scatter of the original pairs of values. In this case, the new value for each variable may be within the range of the original set of that variable, but when considered together, this new pair may lie outside of the scatter of the original pairs. In this event, the new pair is an extrapolation from the original scatter just as much as if one of the values lay outside the range of the original set for that variable. Hidden extrapolation of this kind becomes difficult to detect graphically when there are three independent variables and practically impossible to discover with more than three.

The N observations of the n independent variables used in a regression analysis may be represented by N points scattered in n dimensional space. The pattern and degree of concentration of this scatter depend on the structure of intercorrelation among the independent variables as well as the variances of the variables. Waugh and Been have suggested that for any number of independent variables, a chi-square can be calculated for each combination of observations to indicate its position with respect to the grouping tendency

[10] Based on WAUGH, F. V., and BEEN, R. O., ON THE VALIDITY OF * * *, op. cit.

TABLE 1.—*Domestic disappearance of all fats and oils excluding butter, per person, and factors used in multiple correlation analysis to explain disappearance, 1922–48*

Year	Domestic disappearance of all fats and oils excluding butter		Wholesale prices of 26 major fats and oils excluding butter (1935–39=100)		Industrial production (1935–39=100)		Time (X_4)	Wholesale prices of all commodities (1935–39=100)	Estimated domestic disappearance of all fats and oils excluding butter, per person, based on—		
	Total	Per person (X_1)	Undeflated	Deflated [1] (X_2)	Total	Per person (X_3)			Linear regression fitted to 1922–40 data [2]	Curvilinear regression fitted to 1922–40 data [3]	Curvilinear regression fitted to 1922–40, 1947–48 data [4]
	Million pounds	*Pounds*							*Pounds*	*Pounds*	*Pounds*
1922	4, 841	43. 7	109	91	73	85	1	120. 0	45. 2	42. 9	43. 1
1923	5, 229	46. 4	121	97	88	101	2	124. 8	47. 9	47. 2	47. 2
1924	5, 359	46. 6	123	101	82	93	3	121. 7	47. 2	47. 2	47. 2
1925	5, 734	49. 2	138	108	90	100	4	128. 4	48. 6	48. 9	48. 8
1926	5, 876	49. 7	129	104	96	105	5	124. 1	49. 7	50. 3	50. 2
1927	6, 074	50. 7	115	97	95	103	6	118. 4	49. 7	50. 6	50. 6
1928	6, 322	52. 1	113	94	99	106	7	120. 0	50. 5	51. 5	51. 4
1929	6, 544	53. 4	113	96	110	117	8	118. 2	52. 5	53. 2	53. 1
1930	6, 234	50. 4	99	93	91	95	9	107. 2	49. 8	50. 8	50. 7
1931	6, 073	48. 7	72	79	75	78	10	90. 6	47. 7	48. 5	48. 6
1932	5, 719	45. 5	50	62	58	60	11	80. 4	45. 5	45. 4	45. 8
1933	5, 916	46. 8	59	72	69	71	12	81. 8	47. 5	47. 9	48. 0
1934	6, 291	49. 5	76	82	75	77	13	92. 9	48. 8	49. 1	49. 2
1935	6, 421	50. 2	115	116	87	88	14	99. 3	51. 0	50. 7	50. 5
1936	6, 924	53. 7	106	106	103	104	15	100. 2	53. 6	53. 3	53. 1
1937	7, 051	54. 4	112	105	113	113	16	107. 1	55. 2	54. 6	54. 4
1938	6, 847	52. 4	87	89	89	88	17	97. 5	52. 0	51. 6	51. 5
1939	7, 297	55. 4	79	82	109	107	18	95. 7	55. 0	54. 6	54. 4
1940	7, 428	55. 9	72	73	125	122	19	97. 5	57. 4	56. 7	56. 5
1941	8, 643	64. 5	116	107	162	157	20	108. 3	[5] 62. 9	[5] 59. 8	[5] 59. 3
1942	7, 995	59. 0	149	122	199	191	21	122. 6	[5] 68. 2	[5] 62. 4	[5] 61. 8
1943	8, 003	58. 2	154	120	239	226	22	127. 9	[5] 73. 4	[5] 64. 9	[5] 64. 2
1944	8, 236	59. 3	154	119	235	220	23	129. 1	[5] 73. 0	[5] 64. 7	[5] 64. 0
1945	8, 031	57. 2	155	118	203	188	24	131. 3	[5] 68. 9	[5] 62. 7	[5] 62. 0
1946	7, 777	54. 7	197	131	170	155	25	150. 2	[5] 64. 9	[5] 59. 9	[5] 59. 3
1947	8, 741	60. 3	285	151	187	168	26	188. 7	[5] 67. 1	[5] 60. 9	60. 1
1948	[6] 8, 870	[6] 60. 3	264	[6] 129	[6] 192	[6] 169	27	[6] 204. 7	[5] 67. 5	[5] 61. 4	60. 7

[1] Deflated by the BLS index of wholesale prices for all commodities (1935–39=100).
[2] $X'_1=32.234+0.009X_2+0.139X_3+0.401X_4$.
[3] $X'_1=-17.036-0.014X_2+31.713 \log X_3+6.691 \log X_4$.
[4] $X'_1=-14.060-0.019X_2+30.528 \log X_3+6.463 \log X_4$.
[5] These years not used in the regression analysis.
[6] Preliminary.

Compiled as follows: Domestic disappearance of all fats and oils excluding butter from data on production, stocks, exports, imports, and shipments to United States territories and possessions; from reports of Bureau of the Census, Fish and Wildlife Service, and U. S. Department of Agriculture.

Index of wholesale prices of all fats and oils excluding butter (1935–39=100)—computed by the Bureau of Agricultural Economics from prices in the National Provisioner, The Journal of Commerce (New York), Oil, Paint, and Drug Reporter, Chicago Journal of Commerce, and reports of the U. S. Department of Agriculture; for method of computation see USDA Technical Bulletin No. 737 (September 1940).

Wholesale price of butter—from reports of the Bureau of Agricultural Economics.

Index of industrial production—U. S. Federal Reserve Board.

Index of wholesale prices of all commodities—Bureau of Labor Statistics.

of the whole set of observed combinations (as defined by the pattern and degree of concentration of the observed scatter). When the values of all independent variables are at their means, chi-square equals zero. As the values depart from their means, chi-square increases. However, chi-square also depends on the structure of intercorrelation among the independent variables in such a way that it indicates the position of any given combination of values of the independent variables with respect to the grouping tendency of the whole set of observed combinations.

Note 2: Computation of Certain Statistics

A. Intercorrelation among the independent variables

If the multiple regression constants have been computed by the method suggested by Waugh,[11] estimates of intercorrelation among the independent variables can be determined readily from the "P-table" (the reciprocal correlation matrix). After eliminating the dependent variable from the P-table,[12] select the highest new P_{ii} value. Translated into terms of the multiple correlation coefficient, this indicates the maximum degree of intercorrelation among the independent variables.

B. Chi-square

Chi-square for any combination of independent variables can likewise be calculated from the P-table after the dependent variable has been eliminated. Denote each element of the new P-table (for the independent variables only) as p_{ij}. Form a square matrix, Q_{ij}, with elements q_{ij}, by dividing each element p_{ij} by the standard deviations $\sigma_i\sigma_j$. Compute $x_i = X_i - \overline{X}_i$ (the deviation from the mean), for the observed value of each independent variable. Then, if n equals number of variables used in the regression analysis and X_1 is the dependent variable:

$$\chi^2 = \sum_{i=2}^{n} \sum_{j=2}^{n} q_{ij} x_i x_j.$$ [13]

The theoretical probability of each chi-square can be found in a chi-square table, such as Elderton's[14] or Fisher's.[15] This indicates the probability of occurrence of the given combination, or one farther from the grouping tendency, in sampling from a universe implied by the scatter of the base-period data.

C. Standard error of a forecast

The standard error of forecast, adjusted for degrees of freedom, may be computed from the following equation:

$$\bar{\sigma}_f^2 = \bar{S}^2_{1.2\ldots n}\left(1 + \frac{1+\chi^2}{N}\right).$$

Where: $\bar{S}_{1.2\ldots n}$=standard error of estimate of the regression equation, adjusted for degrees of freedom.

χ^2=chi-square computed for the given combination of values of the independent variables.

n=number of variables used in the regression analysis.

N=number of observed combinations on which the regression equation is based (that is, the number of years used).

The standard error of forecast is a combination of the standard error of estimate and the standard error of the regression function. The $\bar{\sigma}_f$ concept and an alternative method of computation are presented by Ezekiel.[16]

[11] Waugh, F. V. A SIMPLIFIED METHOD OF DETERMINING REGRESSION CONSTANTS. Amer. Statis. Assoc. Jour., December 1935.

[12] Waugh, F. V. THE ANALYSIS OF REGRESSION IN SUBSETS OF VARIABLES. Amer. Statis. Assoc. Jour., December 1936. In this usage, Waugh's equation (2) should be adjusted to read: $P_{ij)k(} = \frac{P_{ij}P_{kk} - P_{ik}P_{jk}}{P_{kk}}$.

[13] An illustration of the above method of computing χ^2 is available on request.

[14] Pearson, K. TABLES FOR STATISTICIANS AND BIOMETRICIANS, Part 1, Ed. 3, 1930, pp. 26–8. In this table, n'= the number of independent variables plus 1.

[15] Fisher, R. A. STATISTICAL METHODS FOR RESEARCH WORKERS, Ed. 8, 1941, pp. 110–11. In this table, n'= number of independent variables.

[16] Ezekiel, M., METHODS OF CORRELATION ANALYSIS, Ed. 2 (1941), pp. 341–7.

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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

[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]: High	Years forecast high or low [3]: Low	Years forecast high or low [3]: Within 1 percent	Ratio of average of first forecast to average of final estimate
	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

Crop and State	Relative error [2]	Years forecast high or low [3]: High	Years forecast high or low [3]: Low	Years forecast high or low [3]: Within 1 percent	Ratio of average of first forecast to average of final estimate
	Percent	*Number*	*Number*	*Number*	*Percent*
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 Mid-season	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

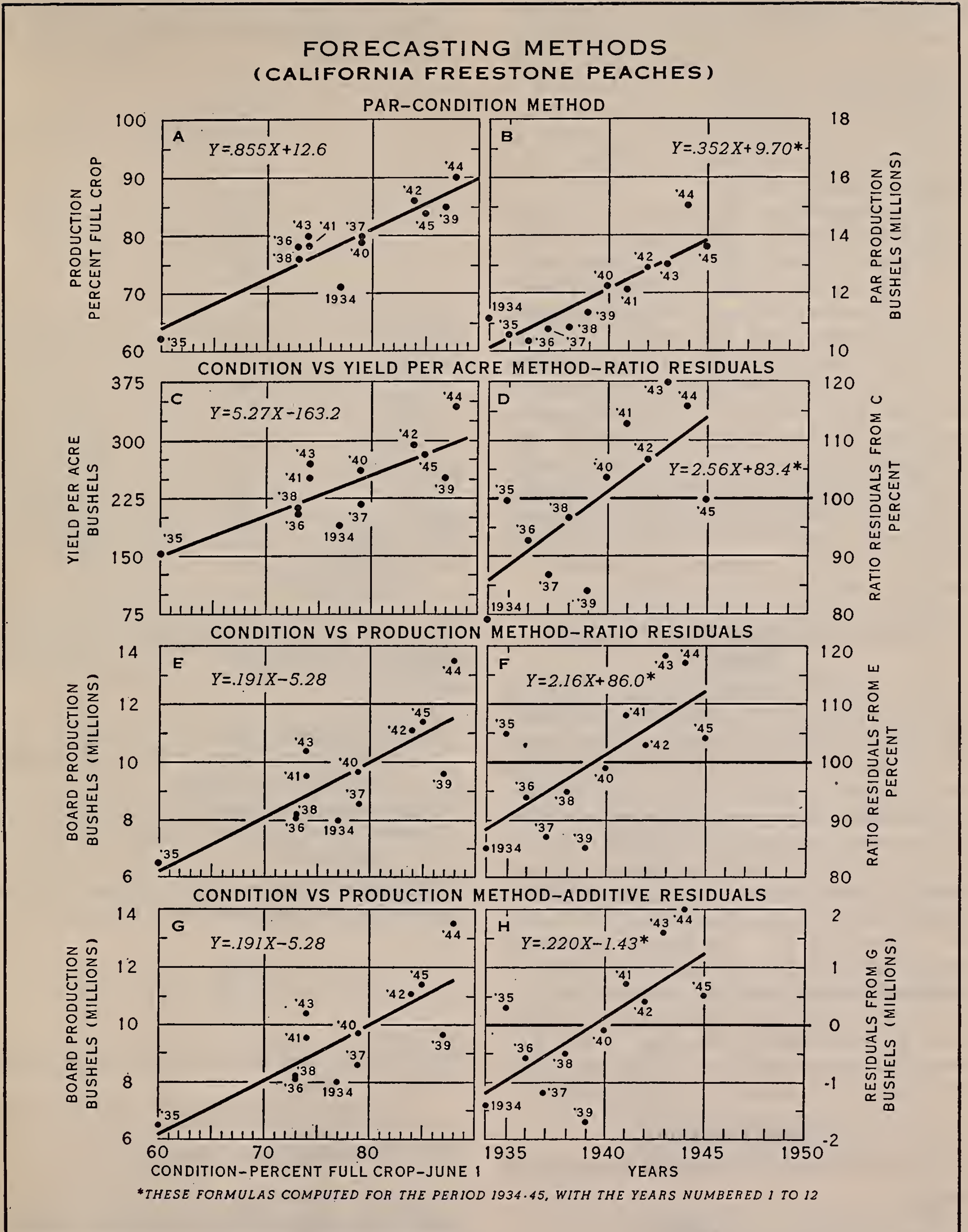
Pars and years for 1934 to 1945 were correlated and a formula was derived for the straight-line trend of pars. Pars for 1946 and 1947 were derived from this formula. Indicated "percent-full-crop" figures for each month, July to October 1946 and 1947, were derived from the formula for the correlation 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 $\frac{S_x}{m}$

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

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 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
California:	Percent	Percent	Percent	Percent
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.

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—

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

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.

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.

N=2.

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

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

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

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).

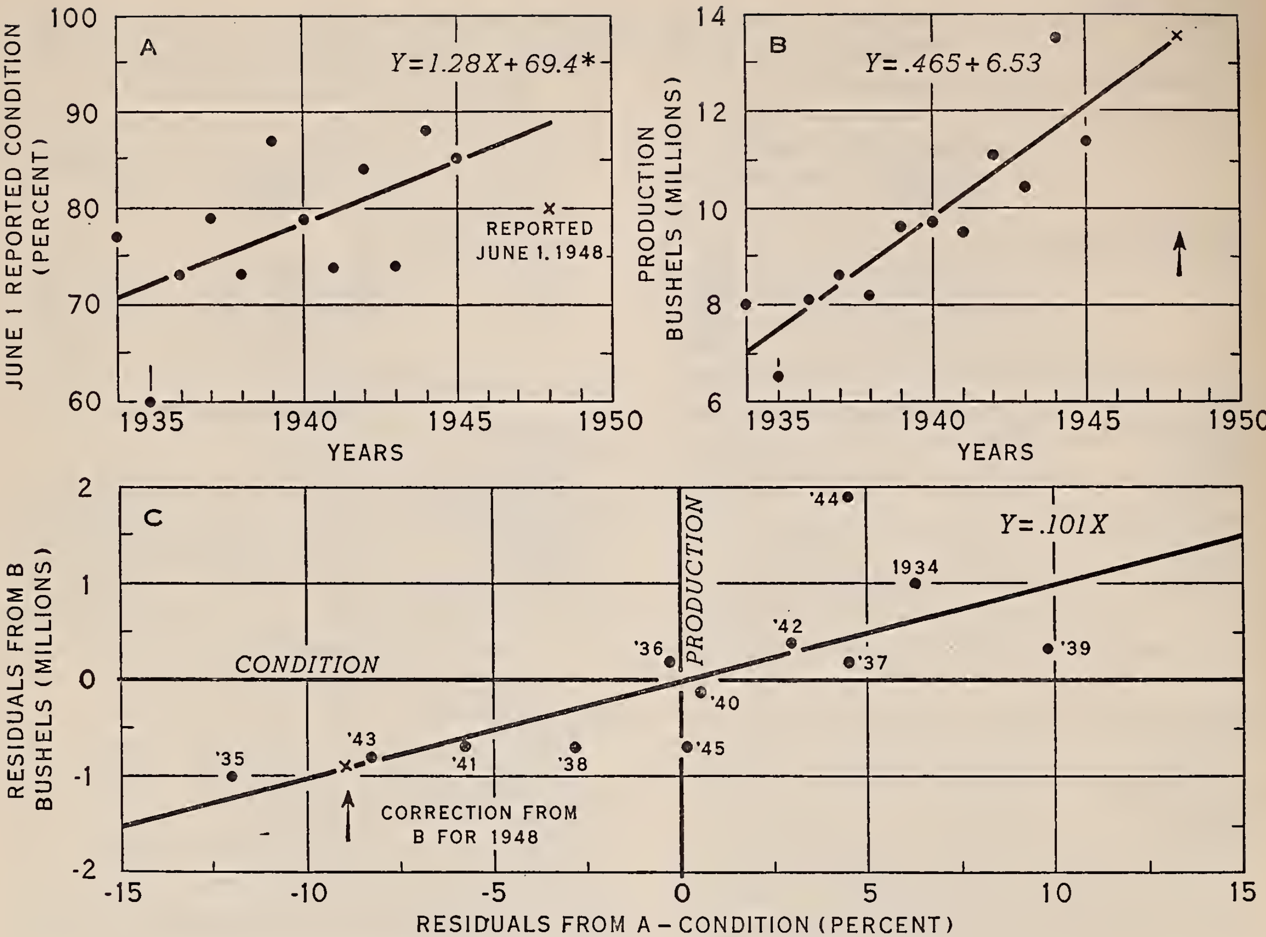
2. Currently published estimates of the Crop Reporting Board agree closely with estimates derived from an objective analysis of the data.

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.

Using Students in a State University for a Pilot Study When Designing a Sample for a State Survey[1]

By Norman Nybroten

There is a constant need for new techniques of marketing research. In this article the author reports and evaluates the use of a preliminary investigation among the students of a State university to gain knowledge about how to design a State-wide survey.

WHAT can be learned, through surveying students at a college or university, that will help when a sample is to be designed for use in a study of consumer reactions and preferences? That question is bound to occur again and again to researchers who have a body of students constantly at hand.

To test the matter, a survey of 597 persons, mainly university students, was made at West Virginia University. The subject chosen was egg marketing. The principal factors to be considered were related to color, size, freshness, and quality of eggs. It is expected that in some of the future work in egg marketing at West Virginia University, controlled experiments will be carried on in retail stores in order to study consumer behavior under manipulated conditions. These conditions will deal mainly with the factors involved in the questions of this student survey, which was, in effect, a preliminary or exploratory step.

Where to carry on the experiments had been one of the immediate problems in planning that research. It was assumed that if the students from different parts of the State responded differently, these differences would probably serve as a basis for delineating, for sample purposes, areas within the State. The "home county" of the student was used as the designation of his home.

It may be that the students in universities, if proper methods and adjustment can be found, may serve as usable and inexpensive samples of consumers generally. This generalization is subject to considerable discussion and modification as exemplified in the test at West Virginia. These modifying considerations are here reviewed.

[1] Published with the approval of the Director, West Virginia Agricultural Experiment Station, as Scientific Paper No. 413.

As to the Responses

It turned out that in none of the factors studied was there any statistically significant difference between or among different areas. This does not mean that there are not significant differences within the State but it could not be determined by questioning 531 area-designated students.

It has often been said, for instance, that Charleston, W. Va., is a "white-egg" market. The survey did not refute this but it did not show Charleston as favoring white eggs more than did the rest of the State. Preliminary examination of the data seemed to indicate that the northern panhandle might have a decided preference for white eggs over brown eggs but, upon analysis, this difference was not significant. For the State as a whole, the students answered, in round figures, that they thought brown eggs should be worth 76 cents a dozen when white eggs were 80 cents; and 47 cents when white eggs were 50 cents. The two assumptions as to price were used to learn whether their ideas were in terms of an absolute difference or a percentage difference—actually the average result lies between these ideas.

The students were asked to fill in the cells of the following tabulation, assuming Grade A eggs of medium size to be worth 42 cents a dozen. (Incidentally, from the standpoint of obtaining rationalization on the values of "Not sized" and "Not graded for quality" the table was set up incorrectly. Until the line on which "Not sized" appears, the logical values have decreased going downward on the table. This trend served as a "trap" so that many respondents put not-sized eggs at a value lower than Peewee. The same condition pertained to "Not graded for quality"; it would have been better to ask for this information in a separate place in the questionnaire.)

Prices of sizes and qualities of eggs

Sizes	Quality, grades, and prices				DO NOT WRITE
	A	B	C	Not graded for quality	
Jumbo					
Extra large					
Large					
Medium	42				
Small					
Pullet					
Pewee					
Not sized					
DO NOT WRITE.					

Although no significant differences could be found in preferences, between the major geographic areas of the State, there seemed to be a difference on some points between the ideas of respondents from rural areas and those from urban areas; these are indicated later. Of the 531 students included, 140 were farm-reared and 391 were not reared on farms. There was no significant difference between the responses of farm-reared and the other students as to the premium they stated they would pay for Grade A eggs over Grade B eggs.

The survey showed that the awareness of differences in egg-weight classes is not in proportion to differences in weight. When Grade A medium-size eggs were postulated at 42 cents a dozen, it meant that these eggs were, on a weight basis, worth 2 cents an ounce of minimum weight. Table 1 is based on this assumption, but instead of giving the prices for Grade A eggs the figures are the students' estimates of values for eggs having equal numbers of each of Grade A, Grade B, Grade C, and a lesser number of eggs not graded for quality. Note from the first column the values (prices) that should have been placed on a weight basis according to the assumption.

In general, the students do not have enough sensitivity to size differences in classes of eggs. For instance, on the "value, weight basis" there should logically have been a difference of 22 cents a dozen between "Extra Large" and "Pullet." This difference was found for each respondent, and a comparison was made between students reared on farms who expressed an average difference of

TABLE 1.—*Cents per dozen placed on eggs in different size classes*

Sized class	Value, weight basis	Cents per dozen placed by different groups			
		Farm-reared students	Non-farm students	All students	Wholesale market [1]
Jumbo	55. 0	48. 4	52. 4	51. 4	47. 7
Extra Large	49. 5	46. 1	48. 3	47. 7	44. 3
Large	44. 0	43. 0	43. 9	43. 6	42. 7
Medium	38. 5	38. 6	38. 5	38. 5	38. 5
Small	33. 0	35. 0	34. 9	35. 0	------
Pullet	27. 5	32. 2	31. 6	31. 8	30. 7
Peewee	------	27. 2	27. 3	27. 2	------
Not sized [1]	------	35. 4	36. 3	36. 0	------

[1] The figures for "Not sized" should not be accepted without modification. As the text implies, there was a bias because of the set-up of the questionnaire. To offset this, at least in part, all responses placing "not sized" lower than Peewee were rejected. Figures on the wholesale market are from the Connecticut Poultry Producers Association, adjusted by a constant making the prices of "Medium" the same as the other series shown.

13.9 cents per dozen and those not reared on farms who expressed an average difference of 16.7 cents per dozen. The difference between these averages was statistically "highly significant." As a further check the variances around the averages of "Extra Large" in the two groups were analyzed; it was found that the difference between these was significant at the 95-percent level.

There was some evidence that beliefs of students in regard to the points involved in this study were influenced by college instruction to some extent. Respondents were classified by major study into "Agriculture," "Home Economics," "Business Administration," and "Other." Students who were majoring in agriculture mentioned noticeably smaller differences between their ideas of the value of white eggs and brown eggs than did the other groups, but it should be remembered that this did not hold true on the basis of whether or not they were farm-reared. On the basis of sensitivity to size differences those who were majoring in agriculture were definitely further from a rational weight-basis value than were the other groups. Contrary to what might have been expected, there was nothing in their replies to distinguish home economics majors from other majors.

Married and single students did not differ significantly in responses to questions in the survey.

Discussion

If these respondents can be accepted as a representative sample of the State, the responses would seem to mean that *farmers could gain more than they now believe possible by classifying eggs by size.* This assumes, of course, that the farm-reared students represent producer ideas and the others represent consumer ideas. It also assumes that the wholesale market could be changed.

Comparison between the farm-reared students and the others poses an interesting question regarding the wholesale market. Ordinarily an intelligent rational market serves as a moderator between producers and consumers. Ordinarily a market resolves into economic gain both the material and the conceptual differences between buyers and sellers. If this were true in regard to egg sizing, it would be expected that the figures for the wholesale market in table 1 would fall between the other two groups. Nonfarm students placed Extra Large at 48.3 whereas the wholesale market put this class at 44.3. Why did not consumers and then retailers and jobbers bid this class up? How can the wholesale market obtain these eggs at the price indicated when the farm-reared students place them at 46.1 cents?

Answers lie in one of two possible facts—either these data from the survey do not represent producer and consumer groups or the wholesale market for eggs is not necessarily intelligent or rational. Certainly more work needs to be done to learn to a more valid and accurate degree the ideas of producer and consumer groups. But it is also possible, or even probable, that the idea that consumers will react a certain way may be an erroneous one, established by relatively few people in the wholesale trade. For example, the belief that certain cities or areas have color preferences in regard to eggs may be a misconception of a few dominant wholesalers who, by their resulting action, establish what appears to be a preference. If these are misconceptions of the market, then merely to study and simulate the present market will not reveal them. Rather, that would require a more ideal set-up in which consumer behavior is the important entity.

In an effort to get at some of the puzzling points, two correlations were run to find whether there were relationships between types of preferences or sensitivities. One correlation was run on the values placed on brown eggs compared with the values placed on storage eggs—this resulted in a direct correlation of only +0.131, disclosing virtually no relationship. Another was run between sensitivity to quality differences compared with sensitivity to size differences. This also brought a very low direct correlation coefficient of +0.425, indicating an association of about 18 percent.

In Conclusion

From the standpoint of designing experiments to discover consumer preferences, it is important to know whether preferences and sensitivities are interdependent because this should be a determinant in the design. In stratifying consumers in preference studies, it may be important to know that if a respondent seems unusually penurious it is likely that other unusual behavior may be associated. Actually, an exceptionally frugal but logical person would have helped to bring about a lower correlation between sensitivity to quality and sensitivity to size for he would have leaned toward a weight-basis in regard to size and would have suggested little difference in prices for qualities, because present standards for quality do not seem to be related to nutritional value.

Perhaps the most interesting facts evolved were that students not reared on farms expressed a greater response to size in eggs than did the farm-reared students and that both farm-reared and others showed greater sensitivity than is reflected in the wholesale market. As the sensitivity was in no case proportional to the relative weights of eggs, the question arises as to whether the Federal combination of quality grades and sizes may be too complex for the average consumer.

It seems that marketing logically divides into two major categories: (1) Finding out what consumers want and (2) satisfying consumers' wants with a minimum of effort. Studying consumer wants through their behavior is usually an expensive kind of research, yet such research is contemplated and a start has been made in the Northeast in regard to eggs. It is anticipated that under a cooperative project between BAE and West Virginia University, consumer-expressed opinions and consumer behavior in retail stores will be correlated in an effort to seek more efficient methods of sampling. Such groups as students in large institutions will be studied further from the standpoint of sampling efficiency.

Status of Land Classification for Tax Purposes

By Samuel L. Crockett

After a review of recent land-classification activities in several States, the author suggests the need for considering the total farm as an income-producing entity when the tax-paying ability of real estate is discussed.

FOR ALMOST half a century interest in land classification for the purposes of tax assessment has been a subject of recurring importance in many States. As might be expected, the greatest interest and activity in this method of improving property-tax assessments has been centered in areas in which agricultural land accounts for a large part of total real estate values. The degree of interest in the subject at any specific time appears to be closely related to the extent of pressure brought to bear upon local taxing units to obtain adequate revenues.

Conditions that appear to give rise to renewed dynamic interest in better assessment techniques vary. In one instance the situation may be brought about by depressed prices and widespread tax delinquency. At the other extreme, in periods of unusually high prices and near 100-percent tax collections, inflated costs of goods and services, coupled with limitations on the tax rate and other rigidities which limit the capacities of local governments to raise revenue may also give impetus to closer study of the problems of assessment. In both instances there seems to be a natural tendency for the individual property owner to become actively interested in the assessment level of his property. It is at this stage that property owners begin to make comparisons between the assessed value of their property and that of similar properties in the surrounding area. If dissatisfaction among property owners is widespread, reassessment or reappraisal projects are often initiated to allay further discontentment.

Near the turn of the twentieth century (1909) a committee was appointed within the International Tax Association (later, the National Tax Association) to study and make recommendations for a method of obtaining, generally, a uniform classification of real property. In the report of this committee, published the following year, it was recommended that classification of rural lands should fall into one of eight basic classes.[1] These classes were apparently established to provide basic descriptive categories for both surface and subsurface properties of land. The first four classes are designed primarily to help in deciding upon the surface values of land. These are (1) cultivated land, (2) arable land (land not under cultivation but suitable for plowing), (3) orchard land, and (4) timbered land. The next three classes are mainly for the purpose of describing certain subsurface properties of land. These classes are (1) mineral land, (2) quarry land, and (3) oil and gas land. To qualify for classification in any one of these three categories land must contain sufficient quantities of ore, stone, oil, or gas, to pay for extracting them. Waste land, the eighth class, is a catch-all into which all land not included in one of the other seven classes is placed.

From the time of the publication of the tax committee's report in 1910 to the early 1930's, land classification for tax-assessment purposes commanded the attention of many students of taxation and local government. It also attracted the attention of numerous State tax administrators. Many State tax organizations adopted some criteria for classifying farm land and other property for the ostensible purpose of improving property assessments. The present use of land and soil types, when known, figured prominently in early methods of classification.

The prevalence of inflated land prices and the extreme postwar pressures on needs for revenue by local governments have once again centered attention upon the perpetual goal in the taxation of property: that is, more equitable assessment of property. As land classification was the fore-

[1] For a more detailed discussion of the committee's report, see INTERNATIONAL TAX ASSOCIATION FOURTH INTERNATIONAL CONFERENCE ON STATE AND LOCAL TAXATION, PROCEEDINGS 1910: 335.

runner of technical methods in assessing farm or rural property it seems appropriate to take inventory of its present status in procedures connected with farm real estate tax assessment.

Situation by States

Because of the wide variation in both the methods and the extent to which land is classified for the purposes of property-tax assessment in the individual States, it is not possible to give detailed information for every State.

Eighteen States use only one descriptive term—farm or rural lands. Eight States use two descriptive categories. Terms used by these eight States are cultivatable and uncultivatable; tillable and untillable; and improved and unimproved. Seventeen States use three or more descriptive categories; six of these States classify land by grades and classes according to use. Of the remaining five States, three do not classify land for tax-assessment purposes. No information was obtained from two States.

Reclassification and reassessment work in progress in several States warrants special attention.

Montana.—Reports on work in land reclassification indicate that previous classifications in Montana are now unsatisfactory for assessment use. Individual counties, in many instances, have taken the initiative to have made a complete reclassification of all real property in the county. A recently published Montana circular says:

> The land classification which is now in effect in most Montana counties was done between 1919 and 1923 under provisions of the 1919 land classification law. This classification has proved to be inequitable because lands of similar producing ability were not placed in the same class. In order to obtain an equitable basis for assessment, it is necessary to reclassify the land in most counties so that pieces of land adapted to the same use and with similar ability to produce will be placed in the same class and grade.[2]

Realizing the inadequacies of the earlier classification, several counties in Montana have reclassified all farm and ranch land within their boundaries within the last few years. During the fiscal year 1948–49 six additional counties provided funds in their annual budgets for work in land reclassification. The Boards of County Commissioners, local assessors, County Planning Committees, the Montana State Board of Equalization, Agricultural Experiment Station, and State Extension Service, have cooperated in developing a schedule to implement more effectively the end results in this work.

As a result of this cooperative effort on the part of State and local groups four major land-use classes have been established for agricultural land in Montana. These classes are:

1. Tillable irrigated land. All land that is tillable under normal conditions and for which irrigation water is reasonably adequate.
2. Nonirrigated farm land. (a) All nonirrigated land that is now under cultivation and (b) all land that is suitable for cultivation under normal conditions but is not now being cultivated.
3. Wild-hay land. All land such as meadow bottoms and cut-over tracts, which is not tillable but is valuable as a source of hay or winter feed.
4. Grazing land. All nontilled land not classed as tillable irrigated land, nonirrigated farm land, wild hay land, or timber land.

When agricultural land has been placed in one of these classes it is then graded according to its productivity. The schedule of grades established for each land-use class is shown below.

Classes and grades for Montana agricultural land classification [1]

Tillable irrigated land

Grade:	*Tons of alfalfa per acre*
1	4.0 and over.
2	3.5–3.9.
3	3.0–3.4.
4	2.5–2.9.
5	2.0–2.4.
6	1.5–1.9.
7	1.0–1.4.
8	Less than 1.0.

Nonirrigated farm land

Grade:	*Bushels of wheat per acre on summer fallow*
1A	24 and over.
1B	22–23.
2A	20–21.
2B	18–19.
2C	16–17.
3A	14–15.
3B	12–13.
4A	10–11.

[1] See text footnote 2.

[2] Stucky, H. R., and Halcrow, Harold G. land reclassification for tax purposes in montana. Mont. Agr. Expt. Sta. Cir. 204, Bozeman. January 1949.

4B	8–9.
5	Under 8.

Wild-hay land

Grade:	*Tons of hay per acre*
1	2.0 and over.
2	1.5–1.9.
3	1.0–1.4.
4	0.5–0.9.
5	Less than 0.5.

Grazing land

Grade:	*Acres for 10 months grazing season per 1,000-lb. steer or equivalent*
1A	10 and under.
1B	11–18
2A	19–21
2B	22–27
3	28–37
4	38–55
5	56–99
6	100 or over.

Colorado.—A State-wide reappraisal project has been in progress in Colorado during the last 2 years. Before the inauguration of the reappraisal work, considerable effort was put into formulating a procedure for appraising farm lands. In the initial stage of the project a system of land classification was agreed upon so that land areas of similar productive character would be placed in the same class. Eight classes of land were agreed upon as being adequate, and local assessors will be required to use the classes that are applicable to land in their respective counties.

The 1949 legislative assembly made additional funds available to the State tax commission for completing the reappraisal. In several instances individual counties have contributed funds to help expedite work in the county.

Utah.—The tax commission has in operation a plan for complete reassessment of land and other real property. The work is being carried on as rapidly as resources permit. One full-time technician is employed to work with county and township assessors in classifying and valuing property. Local committees of taxpayers and agricultural and other technicians are called upon to assist with the classification. All available information, such as soil-survey maps and the soils-capability surveys of the Soil Conservation Service, is used to insure a more uniform and adequate classification of farm lands.

Indiana.—The State Board of Tax Commissioners in Indiana released in 1948 a *Real Estate Appraisal Manual* for use by assessors throughout the State. The publication was to serve as a guide for local assessors when making a general reassessment of real estate ordered by a special act of the 1947 general assembly. This act requires that a general reassessment of all real estate be made as of March 1, 1949.

The manual suggests placing rural or farm lands into four classes with a maximum of five grades of land in each of the classes. Ratings of average per acre productivity and corresponding values are suggested as an aid in placing land in the appropriate grade, and in achieving more uniformity in the assessed values placed upon land that has similar productive capacity.

Nebraska.—Recently two other States have taken steps to permit classification of real property for tax purposes. A 1945 law enacted by the Legislature of Nebraska provides for the classification of all land in the counties lying outside cities and villages. The law is permissive rather than compulsory but a companion bill, by the legislature, requires that the assessment of land be reported as: (1) Farm land under cultivation, (2) irrigated land, (3) pasture land, and (4) waste land. The State Tax Commission has suggested four descriptive grades, ranging from excellent to poor, for use when cultivatable land is being assessed.

Tennessee.—In 1949 the Legislature of Tennessee approved a proposal to permit classification of property for tax purposes.' Additional legislative action will be necessary, however, before the proposal can be put into operation.

Reappraisal and reassessment projects, or both, are under way in other States where classification is an integral part of the assessment procedure but the projects are not of the scope outlined in the foregoing discussion of current or recent classification work in individual States.

Summary and Conclusions

To date no detailed appraisal has been made of the effectiveness of land classification as a means of improving assessments on farm property. A report on a study of assessments on real property in the United States, published in 1936,[3] presents considerable evidence to indicate that early

[3] Silverherz, Joseph D. the assessment of real property in the united states. New York State Tax Com., Spec. Rept. 10. Albany, 1936. p. 290.

attempts at classification netted little in the way of permanent improvement in assessment conditions. In this report it was pointed out that from the beginning one of the basic obstacles to more comparable assessments through the classification method was that local assessors usually classified the land or shifted this responsibility to the individual owner. As long as this condition prevailed any potential improvement that might have accrued from a scientific classification of property was largely voided.

In two States, Montana and Utah, the early classifications were made by special county boards. These boards, composed mostly of local citizens, had no special qualifications for the work. Information on soil types, crop production records, and facts on the carrying capacity of grazing lands, were practically nonexistent. Therefore, the work of these boards, in most instances, left much to be desired.

Real progress has been made in recent years in assembling information on soil capabilities and records of farm production. This material is not always readily available in such form as would be most useful to the local tax assessor or to local equalization boards. But money for a little additional clerical help in the tax assessor's office is all that would be required to assemble the data in a form that the assessor would find useful. Whether classification of land under modern conditions will prove to be more effective than earlier attempts is a question that should be considered carefully.

It must be conceded that attempts to classify land on the basis of its use and annual average productivity should result in some general improvement in farm real estate assessments. Theoretically the concept of "ability to pay" as applied to the taxation of property is based upon "revenue" from property and not upon property *per se*. It is possible that the most elaborate system of classifying farm land would fall short of providing a final solution to the problem of more equitable assessments. The economics of farm operation have become increasingly more complex. For tax-assessment purposes the producing capacity of a specific plot of farm land, over a given period, is significant only to the extent of its effect on the net income of the farm business.

Classification of land, whether based on productivity ratings of soil types or on actual production records, is valid for a limited time only. Unless classifications are frequently reviewed there is a danger of forcing land that may not be devoted to its most advantageous use to remain in the category of lower economic use. Constant use of land to achieve maximum production of specific commodities, as was done during the war years, may have an influential bearing on the long-time productivity of soils. Lands that have recently been classified in the highest producing categories on the basis of wartime records should be frequently reviewed.

New and unexplored possibilities for improving tax assessments on farm property appear to lie not in the direction of more accurate classification of land but in the application of the concept of an income-producing entity to the farm. As a going concern, the tax-paying ability of the individual farm is not necessarily based upon the productive capacity of separate acreages of land. Rather, it depends upon the net return from the collective output of all of the enterprises entered into for the purpose and in the expectation of making a profit. But detailed land classification, subject to frequent review by qualified technicians, should prove to be a valuable aid in determining resource allocation among various enterprises on the individual farm.

Book Reviews

Freedom From Want. A Survey of the Possibilities of Meeting the World's Food Needs. A Symposium edited by E. E. DeTurk for the American Association for the Advancement of Science, with a foreword by Norris E. Dodd. Chronica Botanica Co., Waltham, Mass. 1948. 72 pages, illus.

SINCE the setting up of Food and Agriculture Organization, the world's food problems, particularly the expansion of food production and the improvement of the diet in underdeveloped countries, has been a popular item of concern. Many leading scientists have devoted considerable time to collecting information to measure the seriousness and extent of the problem and to studying possible solutions. In "Freedom from Want," Dr. DeTurk has presented a series of papers, prepared by some of the leading scientists of the United States, on the possibilities of meeting the world's food needs.

The paper by H. R. Tolley, Director of the Economics and Statistics Division of the FAO, is a concise presentation of the level of food production in the world and the relationship between the trend in food production and population growth, and includes a discussion of the difficulties of expanding food production more rapidly than the population expands in order to improve the level of food consumption. He concludes that although some temporary relief from the food shortage may be gained by the widespread use of current technical knowledge, better tools, improved seeds, and more fertilizers, more concerted action is necessary if permanent improvement is to be attained.

Robert M. Salter gives the results of a survey on the possibilities of expanding food production by better management on the acreage now in cultivation and by bringing new areas into cultivation. He believes that by 1960 food production on the presently cultivated areas could be expanded about 20 percent above prewar, and this would about keep pace with the increase in population. But he points out that there are about 1.3 billion acres of uncultivated land, mostly in the tropics and on the northern limits of crop growth, which could be brought into cultivation, thus making it possible for the people of the world to improve their food supply.

K. S. Quisenberry and M. A. McCall, of the BPISAE, discuss the question of expanding food production through new varieties and improved methods of production. New varieties have made it possible to extend production to less favorable areas and to increase yields in present cultivated areas; but it is much more difficult to get farmers to adopt new methods of cultivation, especially if these require radical changes in farm organization. Even in the more highly developed countries, this has been done successfully only through practical demonstrations.

Problems of expanding the production of livestock products and their place in the world's food supply are well presented by F. B. Morrison, of Cornell University.

One of the most interesting papers is that by John D. Black, of Harvard University, in which he presents some principles of the economics of freedom from want. These principles should be given careful consideration by all who are interested in the development of agricultural technology in underdeveloped areas. He recognizes that the problem of increasing food production is largely one of the natural sciences, but that economic principles must also be considered if we are to obtain the highest level of well-being for all mankind. His general conclusions are that any assistance should be confined to those programs which raise the output per worker, that each country can progress only if it relies on those lines of production for which nature has endowed it most abundantly, and that progress from agricultural technology and industrialization, even under the most favorable conditions, must necessarily be slow.

Although the authors of "Freedom from Want" do not present any rosy picture of the possibilities in the near future, they do indicate that, through hard work, careful planning, and the use of resources that are available to mankind, the general well-being of humanity can be gradually improved.

C. M. Purves

Readings on Agricultural Policy. Assembled and published under the sponsorship of The American Farm Economic Association. Editor, O. B. Jesness. The Blakiston Co., Philadelphia. 1949. 470 pages.

THIS is an extremely interesting collection of papers on agricultural policy. It should be of great value to students specializing in this particular field. In addition, it should be useful to any person who is interested in general economic policy. As shown clearly in Part I, agricultural policy cannot be isolated from economic policies dealing with such matters as money, taxes, public works, social security, wages, and so on. Anyone who is interested in economic policies to promote continuing prosperity (and who is not interested in that?) will profit by a study of these collected writings in the more limited field of agricultural policy.

A book of this kind cannot be appraised without a clear understanding of its purpose. I suggest two standards:

1. The papers should be so selected that all the major fields of policy are covered, and

2. In each of these fields the reader should be given able expositions of differing points of view, rather than an authoritative statement of some one view that is to be considered correct, or final.

How well does this book cover the major fields of agricultural policy? Part I (Background) is especially noteworthy. It includes five papers dealing with the relations between agricultural policy and general economic policy. Agricultural economists are coming to recognize, first, that farm problems cannot be solved by agricultural measures alone; and, second, that appropriate agricultural measures can contribute to the general welfare. Part III (International Trade and Relations) and Part IV (Land and Rural People) also cover the major policies quite adequately.

I feel less satisfied with Part II (Price and Production Adjustment). It is inevitable that most of the space here should be devoted to the urgent and controversial subject of price-support policy. But it does seem that concentration upon price supports as such has led to inadequate treatment of adjustments in production and consumption—and to an almost complete neglect of adjustments in marketing. The index has many references to these topics, but the references are mainly to rather incidental comments in connection with analyses of price-support policy.

The neglect of marketing policy is especially serious when large sums are being spent under the Research and Marketing Act. We need some straight thinking about policy on such matters as transportation rates, cooperative marketing, futures trading, monopolistic practices, trade barriers, grades and inspection, and the improvement of market facilities. I wish some of the space given to price-support policy could have been sacrificed for one good, broad paper on marketing policy. This is not a criticism of the able editor. I cannot suggest a paper that would fill the bill. In our preoccupation with price supports, we agricultural economists have been neglecting the more basic problems of needed adjustments in production, marketing, and consumption. The book simply reflects a lack of balance in our work, thinking, and writing.

My second test is whether the papers ably present different points of view about controversial matters of policy. The book contains 34 contributions. Of these, 24 are individual papers and 10 are excerpts from committee reports. Of the 10 excerpts, 5 are taken from the reports of the Land-Grant College Committee on Postwar Agricultural Policy. My personal preference is for individual papers. At best a committee report is a compromise that covers up real differences in judgment about important issues. This is all right if the reader wants an authoritative statement of areas of agreement among the most competent experts. But the subject of policy really gets interesting when we go beyond these areas of agreement, or when some economist is bold enough to attack principles that have been accepted by most other students. I wish it had been possible for the book to have covered differing views on policies of production, marketing, nutrition, and consumption. The committee reports on these subjects tend to dodge the controversial issues—and it is precisely because they are controversial that these issues are interesting and important.

With this qualification, I think the individual papers have been chosen carefully and well. They certainly include many of the most interesting and stimulating recent papers dealing with American agricultural policy. *Frederick V. Waugh*

History of the White Pine Industry in Minnesota. By Agnes M. Larson. University of Minnesota Press, Minneapolis, 1949. 432 pages.

WITHIN the confines of the political division of the United States known as Minnesota are headwaters leading to the Gulf of St. Lawrence, to Hudson Bay, and to the Gulf of Mexico. With such a continental location, the economy of any commonwealth having even average natural resources is predestined to contribute greatly to the well-being of regions far beyond its borders. Historical and economic analyses of the development of commonwealths thus located have many ramifications and have far more than local significance.

In successive stages, the fur industry, lumbering, wheat and flour, and "contented" cows have been basic to the economy of Minnesota. Each has resulted from the utilization of natural resources, and each has contributed not only to the development of the State but to that of far-away regions as well. Although hitherto little realized, the lumber industry converted vast forest resources to the uses of man; it provided him with the materials for homes and farm buildings, schools and churches, and commercial buildings; it provided the ties for the railroads that linked community with community and region to region and afforded rapid access to national and even world markets. The lumber industry also developed business experience and capital that built other industries of importance in the Upper Mississippi Valley.

A century ago some 38,000,000 acres (70 percent) of the total land area of Minnesota was covered with magnificent forest. By far the most important of the trees in this forest was the white pine, the *Pinus Strobus*. Some specimens stood 200 feet high with a diameter of 5 feet. A more usual height was 160 feet, and many reached only 120 feet. For at least five decades the white pine dominated the lumber industry in Minnesota.

In this study no significant aspect of the economic, technical, and social history of the white pine lumbering industry in Minnesota is slighted or neglected. The subject is introduced with an over-all and interpretative view of the State's "forest treasure." The technical operations of logging, driving, and milling are then delineated in detail and according to stages of development and geographical areas. The functioning of the business operations involved in the lumber industry is analyzed. As the marketing methods were basic to the economic success of the industry, they are considered in detail. The economic importance of the industry is duly interpreted.

The chapter captioned "Life in the Woods" is a noteworthy contribution to American social history. Here the lumberjack's day, dress, food, and recreational activities are described. His tall tales and songs are discussed and examples are given. The famous Paul Bunyan tales are not mentioned and the reason is obvious. The author found no authentic evidence that these tales were told in the camps during the heyday of the industry, and as a historian she ignored the controversy concerning their authenticity as actual tales told in the lumber camps. The discussion of the lumberjack's speech concludes with a glossary. The hazards of the logger's life and the medical care he received are considered. Even the efforts of the "sky pilots" to help the lumberjacks spiritually have a place in the account.

Specialists concerned with land use programs and policies will be especially interested in the chapters on the operation of the national and State land laws in the pineland areas. As early as 1880, General Christopher C. Andrews began to urge the introduction of scientific forestry and forest conservation, and the failure of Minnesota to heed his warnings is a significant and typical episode in the history of the exploitation of the country's natural resources. The retrospective summary and interpretation of the contributions of the white pine industry in the development of Minnesota also serve to underline the importance of constructive and intelligent land use programs.

This study may well be taken as a model in comparable undertakings. The pages show evidence of conscientious and time-consuming research. Every type of pertinent source has been gleaned for data. Interviews with old timers of the industry and trips to see its remnants in operation have contributed to the reality of the account. Analyses of the economic processes involved and interpretations of findings are outstanding. The writing is objective, dispassionate, and crystal clear. The illustrations are excellent.

Everett E. Edwards

1948 Yearbook of Food and Agricultural Statistics. Volume I, Production. Food and Agriculture Organization of the United Nations. Washington, D. C., 1949. 283 pages.

THOSE INTERESTED in international information on agricultural production will find this yearbook an extremely useful volume. It is the second in the series issued by the Food and Agriculture Organization. As its name implies, it is largely a statistical compilation and, like the 1947 volume, it contains statistical series on crops and livestock numbers formerly published by the International Institute of Agriculture at Rome. Figures included in the tables are described as having been supplied by the governments of the various countries through special questionnaire, or as taken from official government publications. Where official figures were not available, reliable unofficial sources were used and these unofficial figures have been marked. A close review of the tables discloses a relatively small proportion of the figures so marked but there seems to be rather frequent occurrences of "data not available." It should be pointed out, however, that this volume is more nearly complete in this respect than the 1947 volume. Each year more data are being made available to FAO, partly as a result of the resumption of statistical and publication services in several countries after the disruption by war and other causes and partly because of the adoption by FAO of a regular questionnaire program.

The text is carried in English, French, and Spanish, and the tables in English and French, using metric units. Text has been limited mostly to the explanation of the data contained in the tables giving sources of figures, time reference, notes on individual countries and commodities as well as on the symbols and conversion factors used. The explanatory notes on commodities and countries are complete and helpful.

Some of the tables show area in production data for the principal crops in the prewar period (generally 1934–38), and in 1945, 1946, and 1947. Livestock numbers are given for the latest prewar year (usually 1939) and for 1945, 1946, and 1947. This volume presents one series of tables that gives details by commodities by countries and a second series that shows in detail, for specified countries, the utilization of land in crops and the output therefrom, together with detailed classification of livestock numbers by sex and age groups if these are available. The commodity series covers most of the important crops grown in the United States although such crops as hay, many of the fruit crops, and all of the truck crops, are missing in this section. The series by countries, however, includes a complete summary of commodities estimated in the United States. As food and agricultural statistics have not been available for recent years for the U. S. S. R., no figures for that country are shown for 1945, 1946, and 1947, but prewar averages are given for U. S. S. R. on the basis of present boundaries.

Tables new in this yearbook are those showing estimated total population by countries in 1937 and 1947 and those showing number of persons, by sex, engaged in agricultural occupations and in all occupations. Tables have also been added on the production of condensed, evaporated, and dried milk.

R. K. Smith

Selected Recent Research Publications in Agricultural Economics Issued by the Bureau of Agricultural Economics and Cooperatively by the State Colleges [1]

BERRY, RUSSELL L., HILL, ELTON B., and HENDERSON, SIDNEY. HOW TO KEEP YOUR FARM IN THE FAMILY. Mich. Agr. Expt. Sta. Spec. Bul. 357, 41 pp., illus.

Suggestions include: early consideration of transfer arrangement, develop own ideas as to best method; consult with son who is to operate, the other heirs; and consult an attorney.

BRODELL, ALBERT P., and KENDALL, ALBERT R. FARM CONSUMPTION OF LIQUID PETROLEUM FUELS AND MOTOR OIL. 21 pp. Bur. Agr. Econ. 1949.

Estimates of farm consumption of liquid petroleum fuels (including liquefied petroleum gases) and motor oil, by principal uses for 1947; comparative data for other years.

CROWE, GRADY B., and GAINES, JAMES P. PRELIMINARY ESTIMATES OF SPECIFIED PRODUCTION COSTS FOR COTTON AND ALTERNATIVE CROPS, YAZOO-MISSISSIPPI DELTA. 17 pp. Bur. Agr. Econ. and Miss. Agr. Expt. Sta. State College, Miss. November 1949. (RMA report.)

Part of longer study of mechanization of cotton and its implications in Mississippi conducted cooperatively by the station and BAE.

EARLE, WENDELL. MARKETING PRACTICES AND EGG QUALITY. A PRELIMINARY REPORT THAT DEALS WITH THE SUMMER PHASE OF AN EGG-QUALITY STUDY MADE IN 1948–49. N. Y. (Cornell) Agr. Expt. Sta. A. E. 708, 26 pp. September 1949. (State Agr. Expt. Stas. and Depts. Agr. of Conn., Me., N. Y., and Pa.; Bur. Agr. Econ.; Farm Credit Admin.; and Prod. and Mktg. Admin. cooperating.)

Gives level of quality at farm which varied from Maine, Pennsylvania and New York, as measured by percentage of AA quality eggs. Greatest change in quality occurred during long haul between first and second receiver.

GARLOCK, FRED L. DEPOSITS OF COUNTRY BANKS UP MOST SINCE PREWAR. 4 pp. Bur. Agr. Econ. 1949.

Deposits of country banks have increased much more since 1940 than those of banks in trade and financial centers. At the end of 1948, deposits were about 385 percent of deposits at mid-1940.

GARLOCK, F. L., TOSTLEBE, A. S., BURROUGHS, R. J., LARSEN, H. C., LINGARD, H. T., and JONES, L. A., UNDER THE DIRECTION OF NORMAN J. WALL. THE BALANCE SHEET AND CURRENT FINANCIAL TRENDS OF AGRICULTURE, 1949. U. S. Dept. Agr. Agr. Info. Bul. 1, 51 pp., illus. October 1949. [Printed.]

At the beginning of 1949, the physical assets of agriculture were valued at about 105 billion dollars and the financial assets were almost 22 billion. Total assets of more than 127 billion dollars were 5 percent above those of a year earlier and more than 2⅓ times the figure for 1940. The Balance Sheet of Agriculture for January 1, 1949, probably will mark the high point of farm asset values associated with World War II.

HAGOOD, MARGARET JARMAN. PROSPECTS FOR REGIONAL DISTRIBUTION OF THE POPULATION OF THE UNITED STATES. 8 pp. Bur. Agr. Econ. November 1949.

Recent official projections of future population of United States to 1975 indicate a prospective increase through the next 20 or 25 years. By 1975, the population is expected to be 26 percent above the estimated mid-1949 level of 149,215,000 under high assumptions or 9 percent above under low assumptions.

HUFFMAN, ROY E. PRODUCTION COSTS ON SELECTED DRY-LAND GRAIN FARMS. Mont. Agr. Expt. Sta. Mimeo. Cir. 52, 20 pp. September 1949.

Contains up-to-date information and figures for Montana's dry-land grain farms on which costs have changed during the last decade. Cash costs have increased in importance whereas farm-produced items have become less important.

LINGARD, HAROLD T. FARM-MORTGAGE LOANS AND THEIR DISTRIBUTION BY LENDER GROUPS, 1940–48. U. S. Dept. Agr. Cir. 812, 63 pp., illus. 1949. [Printed.]

Often looked upon as a barometer of the financial condition of farmers, and the decline in such debts during the war reflected their favorable position. In contrast, during and immediately after World War I, the farm-mortgage debt increased substantially. In 1923, it reached an all-time high. Otherwise, until 1946, for nearly a quarter-century, the farm real estate debt had been declining. This publication presents revised data on farm-mortgage loans, outstanding at beginning of each year, 1940–48, to suggest explanations for changes in debt as they relate to other factors and to compare trends in different periods.

ROHRER, WAYNE C. TRENDS IN THE TEXAS FARM POPULATION, 1949. Tex. Agr. Expt. Sta. Prog. Rept. 1184, 5 pp. August, 1949. (BAE cooperating.)

Farm population in Texas declined by 11,000 persons during 1948. Number of persons living on Texas farms and ranches on January 1, 1949, was estimated to be 1,701,000.

RUSH, JOHN D. FATAL ACCIDENTS IN FARM WORK. AN ANALYSIS OF 12,141 FATAL ACCIDENTS 1940–45, IN THE UNITED STATES. 11 pp., illus. Bur. Agr. Econ. September 1949.

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[1] Printed reports are indicated as such. All others are processed. State publications may be obtained from the issuing agencies of the respective States.

This is the second such analysis made from material supplied by the Bureau of Vital Statistics, U. S. Public Health Service, Federal Security Agency. Data presented include only those accident fatalities to farm people which occurred in connection with farming operations.

Scofield, W. H., and Davidson, R. D. THE FARM REAL ESTATE SITUATION, 1947–48 AND 1948–49. U. S. Dept. Agr. Cir. 823, 40 pp., illus. September 1949. [Printed.]

1948 was another good year for farmers. In most States, dollar values of farm land reached new highs. By November 1, average values for the country as a whole were 8 percent higher than a year earlier and 113 percent above the 1935–39 average. Since November, however, farm land values have weakened in the western third of the country.

United States Bureau of Agricultural Economics. CONSUMPTION OF FOOD IN THE UNITED STATES, 1909–48. U. S. Dept. Agr. Misc. Pub. 691, 196 pp., illus. 1949. (RMA.)

Brings together for the first time detailed information as to per capita consumption of all major food commodities in the United States. Describes and evaluates sources and methods and gives supplementary information useful in the statistical analysis of the demand for food.

Ward, Ralph E., and Kelso, M. M. IRRIGATION FARMERS REACH OUT INTO THE DRY LAND. Mont. Agr. Expt. Sta. Bul. 464, 36 pp., illus. September 1949. (BAE and Bur. Reclam. cooperating.)

Intended to ascertain the principal types and degrees of integration that have developed spontaneously between irrigation projects and adjoining dry-land areas in Montana. Gives an appraisal of significance of integration found and a discussion of factors that tend to help or hinder its development, and its advantages and disadvantages as reported by farmers.

Weeks, S. B., and Frick, A. E. FARM PRODUCTION IN THE SHELDON, GLOVER, AND CAVENDISH AREAS OF VERMONT. REPORT NO. 5. POST-WAR ADJUSTMENTS. 15 pp. Bur. Agr. Econ. August 1949.

In these areas, in which the trend in number of farms serves as a rough indicator of the economic condition of agriculture in New England, farms were fewer but the land in farms showed little change. Livestock numbers declined as did the use of fertilizer; mechanization increased. And the labor force was smaller.

Statistical Compilations

Bormuth, W. D., under the direction of B. H. Bennett. PRODUCTION OF MANUFACTURED DAIRY PRODUCTS, 1948. U. S. Dept. Agr. CS–40, 32 pp. November 1949.

Jennings, R. D. ANIMAL UNITS OF LIVESTOCK FED ANNUALLY, 1919–20 TO 1948–49. 35 pp., illus. Bur. Agr. Econ. October 1949. (FM 64, revised.)

United States Bureau of Agricultural Economics. CITRUS FRUITS. ACREAGE, PRODUCTION, FARM DISPOSITION, VALUE AND UTILIZATION OF SALES. CROP SEASONS 1946–47 TO 1948–49. 11 pp. October 1949.

United States Bureau of Agricultural Economics, Production and Marketing Administration and the Office of Foreign Agricultural Relations. DISTRIBUTION OF UNITED STATES FOOD, JULY 1, 1948–JUNE 30, 1949. 12 pp. Washington, D. C., October 1949.

United States Bureau of Agricultural Economics. WOOL STATISTICS, INCLUDING MOHAIR AND OTHER ANIMAL FIBERS. CS–37. 66 pp. Washington, D. C. [Printed.]

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