The Effect of Price on Acreage and Yield of Potatoes

By Olman Hee

Farmers' response to price has usually been measured by acreage response. Changes in yield were regarded largely as a consequence of weather. Accordingly, the inclusion of such changes would tend to obscure the underlying production-price responses of farmers. Weather has played a much less important role as a determinant of yields during World War II and the postwar period, and the notion of a yield response to price has become a logical assumption in the statistical measurement of supply response. The effects of weather were not analyzed in this particular study.

In this paper, relationships between supply of potatoes (as measured by acreage and yield response) and expected "normal" price are studied. This price differs from previous year's price. Farmers are believed to gage the prospective price for the current crop from an evaluation of past prices to form some sort of "normal" price. The prospective or expected price is modified each year by the knowledge gained from actual price.

Two objects are sought: (1) To obtain total elasticity of supply measures from elasticity of acreage and elasticity of yield, and (2) to evaluate farmers' response to expected "normal" price as contrasted with previous year's price. The study provides for a single yearly adjustment to price and therefore does not consider projected adjustments that might occur over long periods.

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THIS STUDY shows that high prices of potatoes tend to encourage both the expansion of acreage and higher yields. It shows also that low potato prices discourage the expansion of acreage and tend to hold down the level of yields.

Previous studies include those of Bean (*2*)[1] Walsh (*9*), Pubols and Klaman (*8*), Kohls and Paarlberg (*6*), Bowlen (*3*), and Gray, Sorenson, and Cochrane (*5*). The supply elasticity coefficient obtained in these studies measured acreage response to price. They did not attempt to include other facets of the supply function, such as level of technology (sometimes represented by yield), prices of input factors, farm income, and labor-leisure relationship.

These studies consistently found low supply elasticities of acreage response to price. Some of these elasticities are as follows: Walsh for cotton, 0.20; Kohls and Paarlberg for corn, 0.07, for wheat 0.40, and for potatoes, 0.08; Pubols and Klaman for potatoes, 0.23; and Bowlen for the total United States crop of wheat, a regression coefficient that did not differ enough from zero to justify an elasticity estimate.

Despite these low elasticities, some of the studies indicated that it would be incorrect to say that price was not an important consideration in the decision-making processes of farmers. Rather the conclusions were that the direction and extent of farmers' supply response is influenced by a very diverse set of factors that differ among areas, among farms, and over time.

Response to Expected Price

Prices of potatoes vary considerably from year to year. It has been argued that farmers would receive lower incomes if they revised production plans in relation to these wide swings in prices (*6*). In making decisions with respect to production levels, potato producers are concerned mainly with what the current year's price will be. In other words, potato producers respond, it is argued, not directly to the previous year's price, but to an expected price, though this expected price may be based in part upon the previous year's price.

[1] Italic numbers in parentheses refer to Literature cited, page 140.

Price expectations are shaped by a host of conditions and events. Input-output ratios, cost expectations, past prices, and other influences enter into the formulation of such expectations. Of these, past prices are the most important because each past price is a reflection of the factors that affect a short-run market supply-demand situation.

If we agree that producers do not rely solely on last year's price, we must develop an hypothesis that explains the way price expectations are formed. One such hypothesis has been advanced by Nerlove (*7*) in a study of elasticities of acreages of corn, wheat, and cotton with respect to expected price. He assumes that farmers adjust their expectations of price by the margin of error that they made in predicting the previous year's price. Using this hypothesis, he obtains higher elasticities than those obtained from analyses based on previous year's price. Nerlove's formulation is incorporated in the explanation model discussed in the next section.

The Expectation Model

Total production (supply) of potatoes in any crop year equals the number of acres in potatoes times yield per acre. One could make a study of supply response that ignored these individual components and analyze directly the factors that affect total supply. However, acreage response and yield response are two separate and distinct functions; a considerable quantity of information in regard to farmers' behavior may be lost when only a single supply function is considered.

The formulation presented here considers the elasticity of supply with respect to price to be an additive function of the elasticity of acreage and the elasticity of yield.[2]

Acreage Response Function

The formulation of the expectation model for acreage response follows that of Nerlove (*7*).

Assumption No. 1.—Acreage of potatoes planted depends upon expected price in the year of harvest. We express this as follows:

$$X_t = a_1 + b_1 P_t^* + U_t \qquad (1)$$

where

X_t = planted acreage
P_t^* = expected price
U_t = random residual term

[2] Proof that the relationships are additive are given in Allen (*1*, P. 252).

Assumption No. 2.—Potato producers adjust their expectations of price in the year of harvest by the margin of error (or proportion of it) that they made in predicting last year's price. This takes the following form:

$$[P_t^* - P_{t-1}^*] = \beta[P_{t-1} - P_{t-1}^*] \qquad (2)$$

where

P_t^* = expected price for current year
P_{t-1}^* = expected price for previous year
P_{t-1} = actual price for the previous year
β = coefficient of expectation (the proportion of the margin of error by which farmers adjust their expectation)

We assume that β will always lie between zero and one.[3] If β equals one, equation (2) becomes $P^*_t = P_{t-1}$. Thus P^*_t in equation (1) can be replaced by P_{t-1}. This is equivalent to saying that farmers rely solely on last year's price in making their decisions. However, we assume that farmers do not respond solely to last year's price but to expected price and that they revise their expectations continually; therefore, the value of β will be less than one.

We cannot observe P^*_t, so that an estimating equation containing P^*_t cannot be fitted from empirical data. However, given relationships (1) and (2), an equation may be derived whose coefficients can be estimated from observed variables. Estimates of these coefficients, in turn, can be used to estimate the parameters in equation (1). From equation (1), we know that expected price, P^*_t, is a linear function of acreage, X_t. Last year's expected price must also be a linear function of last year's acreage; thus,

$$P_{t-1}^* = -\frac{a_1}{b_1} + \frac{1}{b_1} X_{t-1} - \frac{1}{b_1} U_{t-1} \qquad (3)$$

Substituting (3) for P_{t-1}^* in (2), we get

$$P_t^* + \frac{a_1}{b_1} - \frac{1}{b_1} X_{t-1} + \frac{1}{b_1} U_{t-1} = \beta\left[P_{t-1} + \frac{a_1}{b_1} - \frac{1}{b_1} X_{t-1} + \frac{1}{b_1} U_{t-1}\right] \qquad (4)$$

[3] Although it is not a necessary assumption, this mathematical property conveniently places a restriction on the limits of values of β. All known empirical studies indicate that the assumption is a correct one.

Combining like terms and expressing in terms of P_t^* equation (4) becomes

$$P_t^*=\frac{a_1\beta-a_1}{b_1}+\beta P_{t-1}+\left(\frac{1-\beta}{b_1}\right)X_{t-1}-\left(\frac{1-\beta}{b_1}\right)U_{t-1} \tag{5}$$

Substituting equation (5) for P_t^* in (1) results in

$$X_t=a_1+b_1\left[\frac{a_1\beta-a_1}{b_1}+\beta P_{t-1}+\left(\frac{1-\beta}{b_1}\right)X_{t-1}-\left(\frac{1-\beta}{b_1}\right)U_{t-1}\right]+U_t \tag{6}$$

which simplifies to

$$X_t=a_1\beta+b_1\beta P_{t-1}+(1-\beta)X_{t-1}+U_t-(1-\beta)U_{t-1} \tag{7}$$

and can be rewritten as

$$X_t=\pi 0+\pi 1P_{t-1}+\pi 2X_{t-1}+V_t \tag{8}$$

Estimates of the parameters obtained from equation (8) may be used to compute algebraically the coefficient of expectation, β, in equation (2) and to estimate the parameters in the acreage response relation (equation 1). The pertinent algebraic relationships between the relevant parameters are as follows:

$$\beta=1-\pi_2$$
$$a_1=\frac{\pi 0}{\beta} \tag{9}$$
$$b_1=\frac{\pi 1}{\beta}$$

The mathematical formulation may now be stated in more general terms. We assumed that farmers made adjustments in potato acreage on the basis of expected price and that their price expectations were influenced to a considerable degree by the prices they received in previous years. Basic source information on expected price was not available to measure statistically its influence on acreage directly. However, by assuming that acreage in the previous year reflects past price expectations and by including both the price and acreage in the previous year as variables in the regression equation (8), we delineate statistically that part of acreage resulting from last year's price and that portion from previous expectations. Thus, the coefficient of expectation (adjustment) derived from this regression essentially tells us the relative contributions of the price in the previous year and past prices in the other years toward formation of expected price.

Because of this, the coefficient (π_1 in equation (8)) showing the effect of the previous year's price on acreage bears a similar relationship with the coefficient (b_1 in equation (1)) showing the effect of expected price on acreage. Thus, the coefficient associated with last year's price refers to that portion of the total response (b_1) to expected price which is attributable to price in the previous year. Specifically, the coefficient equals the total response, b_1, times some adjustment factor which in this case is the coefficient of expectation, β (see relation 7). Hence, if we know the response of acreage to previous year's price and we know the coefficient of expectation, we can compute the acreage response to expected price, even though we have no data on expected price (see relation 9).

Yield Response Function

The yield response function is similar to the acreage response function. We assume that farmers adjust their production plans to a desired yield level in relation to expected price, complementary to the relation found in equation (1). In addition, it takes into account a cost factor. Thus, the yield function becomes:

$$Y_t=a_1+b_1P_t^*+b_2C_t+U_t \tag{10}$$

where C_t, cost of fertilizer, is the only variable not previously identified.

As in the case of the acreage response function, potato producers revise their expectations of price in the manner indicated by relation (2). Thus, coefficients in equation (10), making use of relation (2), may be computed from coefficients in the following estimating equation:

$$Y_t'=\pi 0+\pi_1P_{t-1}+\pi 2Y_{t-1}+\pi 3C_t+\pi 4C_{t-1}+V_t \tag{11}$$

Coefficients in equation (11) bear a similar relation to equations (10) and (2), as did equation (8) to (1) and (2).

Statistical Analyses

The estimates of supply response for potatoes are based upon two fitted relationships: (1) A regression of acreage on price and other factors, and (2) a regression of yield on price and other factors.

The two periods used in the analyses [1930–41] and [1930–31 and 1951–56] are considered to be as close to free market supply and demand conditions as can be found in the potato industry in the last three decades. The data used (crop-year basis) are those provided by the Crop Reporting Board, Agricultural Marketing Service.

Acreage Response

The acreage estimating equation was fitted by least squares method for two periods—[1930–41] and [1930–41 and 1951–56]. The variables used are as follows:

X_t=Planted acreage of late summer and fall crop potatoes, in millions.

P_{t-1}=Season average price received by farmers for late summer and fall crop potatoes deflated by index of prices received by farmers for all farm products, dollars per hundredweight, lagged one year.

$X_{t-1}=X_t$ lagged one year.

T=Time, 1930=1. Linear trend assumed.

Planted rather than harvested acreage is used as the dependent variable as planted acreage reflects more closely the production plans of farmers. But data for planted acreage of potatoes date only from 1929. This places some limitation on the number of observations available for a free market span of years in the time series.

The use of harvested acreage for which data are available for earlier years as an alternate choice for analysis may not be consistent with assumptions implicit in this study. In years when some of the planted acreage is not harvested because of unfavorable prices, the supply relation with harvested acreage as the dependent variable is affected by current price. But current price is also affected by the demand for potatoes. A complete formulation using harvested acreage would of necessity have included a demand relation.

The following results were obtained from the regression analyses for planted acreage of late summer and fall crop potatoes. As for all analyses in this paper, the numbers in parentheses are the standard errors of the respective coefficients.

1930–41

$$X'_t=0.624+\underset{(.174)}{0.188}P_{t-1}+\underset{(.209)}{0.740}X_{t-1}-\underset{(.019)}{0.031}T \tag{12}$$

1930–41 and 1951–56

$$X'_t=0.466+\underset{(.126)}{0.256}P_{t-1}+\underset{(.157)}{0.740}X_{t-1}-\underset{(.061)}{0.017}T \tag{13}$$

The regression coefficient for acreage on price lagged one year differed significantly from zero at the 5 percent probability level in the analysis for the longer period but not for the 1930–41 period. However, both coefficients were of correct sign and approximately the same magnitude. When these coefficients are expressed as elasticities of acreage with respect to price, they are found to be around 0.1 (see table 1). These values are somewhat lower than the 0.2 obtained by Pubols and Klaman (*6*).

Apparently, the normally wide swings in prices of potatoes from one year to the next make farmers discount some of the most recent price change. This is confirmed by the low coefficients of expectation, B, of 0.260 that were obtained from the regression analyses in both periods. The relatively low values obtained indicate that potato producers, in making acreage adjustments, are influenced more by their ideas of expected "normal" price than by previous year's price. But the low coefficients of expectation also indicate that they make only moderate year-to-year (short-run) adjustments in their price expectations.

Other statistical measures pertaining to the regression analyses such as the coefficients of multiple determination are shown in table 1.

Estimates of coefficients for acreage response to expected price were computed by dividing the regression coefficient of acreage on price lagged one year by the coefficient of expectation (see algebraic relation 9, p. 133). Using the estimates of these coefficients an elasticity of acreage with respect to expected price of 0.3 was obtained from the analysis based on the [1930–41] period and 0.5 for the [1930–41 and 1951–56] period. As expected from the coefficients of expectation of 0.260, elasticities of acreage with respect to expected price are four times as large as the elasticities obtained pertaining to price lagged one year.

Yield Response

The following estimates of the coefficients in the yield-estimating equation for late summer and fall crop potatoes were obtained from regression

analyses based on data for two periods, [1930–41] and [1930–41 and 1951–56]:

1930–41

$$Y_t = 1.889 + 10.579P_{t-1} + 0.723Y_{t-1} - 0.004C_t + 0.007C_{t-1} + 1.188T \quad (14)$$
$$\qquad (1.724) \quad (.135) \qquad (.045) \quad (.046) \quad (.289)$$

1930–41 and 1951–56

$$Y_t = -24.392 + 10.883P_{t-1} + 0.734Y_{t-1} + 0.066C_t + 0.073C_{t-1} + 2.018T \quad (15)$$
$$\qquad (5.154) \quad (.118) \qquad (.165) \quad (.168) \quad (.802)$$

The variables used in the regression analyses, which have not been previously identified are as follows:

Y_t = Yield per acre of late summer and fall crop potatoes, in hundredweight.

$Y_{t-1} = Y_t$ lagged 1 year.

C_t = Cost of fertilizer, April 1st, of each year deflated by wholesale price index 1947–49 = 100.

$C_{t-1} = C_t$ lagged 1 year.

Regression coefficients in both analyses differ significantly from zero at the .05 probability level for all variables except the coefficients associated with fertilizer cost. The negligible effect of cost of fertilizer on yield may be explained in part by the notion that fertilizer applications once initiated are at least maintained at the most recent level even in the face of increased costs.

As expected, the coefficient associated with trend in yield per acre was substantially greater in the analysis including the postwar years. Yield per acre averaged 174 hundredweight during 1954–56 compared with 82 in 1939–41 and 67 in 1930–32. Much of the rise in yield occurred between 1945 and 1950; the increase was from 100 to 167 hundredweight during the period.

The regression coefficients for yield on price lagged one year are almost identical for both periods of analysis. When these coefficients are expressed as elasticities of yield with respect to previous year's price, they were found to be around 0.1, the same as the response of acreage to previous year's price (see table 1).

As in the case of the acreage-estimating equation, relatively low values were obtained for the coefficient of expectation, β, from the yield-estimating equations. The β values of 0.277 and 0.266 for the [1930–41] and [1930–41 and 1951–56] periods, respectively, were approximately of the same magnitude as those obtained from the acreage equations. Again, this would indicate that farmers change their expectations little in the short run and consequently they make moderate adjustments in production plans that affect yield. Potato producers apparently do not make sudden moves in adjusting to new levels of yield.

Other statistical measures pertaining to the regression analyses are shown in table 1.

Based on the above estimates of the price coefficient and the coefficient of expectation, an elasticity of yield with respect to expected price of 0.6 was obtained from the analysis based on the [1930–41] period and 0.4 for the [1930–41 and 1951–56] period. Because of relatively low coefficients of expectations, response of yield to expected price is about four times greater than the response to the most recent price.

Estimates of Planted Acreage and Yield Per Acre

Estimates of planted acreage—based upon acreage estimating relations derived from the model—were made for years included in the analysis and also for other years. Similar estimates were made for yield per acre.

Table 2 compares the estimates for planted acreage obtained from the acreage estimating equation with actual planted acreage published by the Crop Reporting Board, AMS, for the years 1930 to 1956.

Table 3 represents estimates for yield per acre obtained from the yield-estimating equation compared with actual yield per acre as published by the Crop Reporting Board, AMS, for the years 1930 to 1956.

Similar comparisons are shown graphically in figure 1. In addition, the estimates of acreage and yield are combined for comparison with actual production of fall crop potatoes.

For the years in the early 1930's, estimates of acreage obtained from the regression analysis tended to fall below actual acreage. Apparently, farmers were slow to adjust acreage downward during a prolonged period of depression. This behavior would appear to be consistent with the hypothesis suggested by Clodius (*4*, p. 429) that farmers tend to reduce acreage little in bad times

TABLE 1.—*Supply response for late summer and fall crop potatoes; as measured by elasticities of acreage and yield per acre with respect to price lagged 1 year and expected price, and related statistical data* [1]

Item	Acreage response		Yield response	
	1930–41	1930–41 and 1951–56	1930–41	1930–41 and 1951–56
Estimating equation:				
Coefficient of multiple determination	.84	.85	.98	.99
Standard error of estimate	.15	.13	1.29	5.34
Elasticity of dependent variable with respect to price lagged 1 year:				
Actual value	[2] .08	[3] .12	.15	[3] .10
Standard error	.07	.06	.02	.05
Durbin-Watson statistic	[4] 1.34	[4] 1.35	[4] 2.30	[4] 1.42
Coefficient of expectation	.260	.260	.277	.266
Elasticity of dependent variable with respect to expected price:				
Actual value	[2] .31	[2] .48	[2] .56	[2] .38
Standard error	.45	.45	.33	.25

[1] Prices are season average prices received by farmers for late summer and fall crop potatoes deflated by index of prices received by farmers for all farm products, 1910–14=100.

Data used for the dependent variable in the acreage response formulation were planted acreage and for the yield response formulation yield per harvested acre.

[2] Does not differ significantly from zero when tested at the .10 probability level.

[3] Differs significantly from zero when tested at the .10 probability level but not at the 0.05 level.

[4] Durbin-Watson statistic inconclusive at the .05 level.

because of (1) their desire to maintain total income and (2) the costs of shifting to other limited production alternatives.

As expected, the equation overestimated acreage during price-support years (1943–50). From 1943 to 1946, such wartime (and reconversion) influences on potato acreage as hired labor and equipment shortages and shifts to alternative enterprises combined to decrease acreage appreciably. For 1947–50, potato acreage allotments were in effect and the majority of potato farmers complied with the allotment program. With these limitations but with relatively favorable price relationships and assured markets, farmers increased the yield per acre of potatoes significantly during the years under price support. Yield per acre increased from 92 hundredweight in 1943–44 to 167 hundredweight in 1950, an increase of 82 percent in 6 years; whereas, yield per acre in 1943–44 was only 35 percent greater than in 1930–31. When estimates of acreage and yield are combined for the price-support years, the departures from actual production are relatively less since the overestimation of acreage is offset in part by underestimation of yield.

Estimates of planted acreage for the entire period (1930–56) deviated on the average from the actual acreage by 4.5 percent per year. Estimates of yield per acre for the same period deviated on the average from actual by 3.8 percent per year.

An "error tolerance" equal to twice the standard error of estimate was computed for each estimating equation. The "error tolerance" has the following approximate significance: If the economic structure represented by these regression analyses and the probability distribution of disturbances or residual errors still apply, we might expect actual acreage and yield to be within the range of 2 standard errors of forecast from estimates of acreage and yield, respectively, obtained from the regression equations in 19 out of 20 times, provided the values of the new observations fall within the range of observation included in the analyses. As the standard error of estimate is always smaller than the standard error of forecast, the "error tolerance" cited above is somewhat too small. The standard error of estimate is used in this paper as a measure of the confidence limit as it would be necessary to compute standard errors of forecast for each year.

When an "error tolerance" of twice the standard error of estimate (.26) is applied to estimates of acreage outside the period of fit (1942–50, including World War II and price-support period) one observation falls outside the limits of tolerance.

TABLE 2.—*Potatoes, late summer and fall crops: Estimated and actual planted acreage and related variables, 1930–56*

Crop year	Planted acreage		Price lagged 1 year [2]	Acreage lagged 1 year
	Estimated [1]	Actual		
	Million acres	*Million acres*	*Dollars per cwt.*	*Million acres*
1930	2. 617	2. 457	1. 52	2. 404
1931	2. 585	2. 730	1. 31	2. 457
1932	2. 666	2. 897	. 90	2. 730
1933	2. 765	2. 763	. 87	2. 897
1934	2. 833	2. 997	1. 59	2. 763
1935	2. 754	2. 798	. 67	2. 997
1936	2. 653	2. 421	. 92	2. 798
1937	2. 490	2. 337	1. 44	2. 421
1938	2. 225	2. 212	. 71	2. 337
1939	2. 171	2. 138	. 93	2. 212
1940	2. 156	2. 157	1. 15	2. 138
1941	2. 046	1. 998	. 73	2. 157
1942	1. 962	1. 988	. 93	1. 998
1943	[3] 1. 971	2. 424	1. 06	1. 988
1944	2. 267	2. 061	1. 02	2. 424
1945	2. 022	2. 012	1. 18	2. 061
1946	1. 925	1. 845	1. 01	2. 012
1947	1. 719	1. 461	. 75	1. 845
1948	1. 462	1. 459	. 93	1. 461
1949	1. 441	1. 348	. 92	1. 459
1950	1. 322	1. 278	. 84	1. 348
1951	1. 164	1. 021	. 49	1. 278
1952	1. 077	1. 075	. 96	1. 021
1953	1. 144	1. 160	1. 13	1. 075
1954	1. 021	1. 102	. 47	1. 160
1955	1. 058	1. 106	. 85	1. 102
1956	1. 009	1. 079	. 71	1. 106

[1] Estimated acreage based on following regression:

$$X_t = 0.466 + .256P_{t-1} + .740X_{t-1} - .017\ T$$

Coefficients relating to the analysis in this estimating equation are based on data for the period [1930–41 and 1951–56].

[2] Season average price received by farmers for late summer and fall crop potatoes deflated by index of prices received by farmers for all farm products, 1910–14=100.

[3] Estimate differs from actual by more than twice the standard error of estimate (.26). If the real economic relationships and the factors making for residual errors or disturbances are the same as in the [1930–41 and 1951–56] period in about 1 out of 20 times, actual acreage would be expected to deviate from estimates of acreage by more than 2 standard errors of forecast, provided the values of the independent variables for the new observations fall within the range established by the values for the years included in the analysis. The error tolerance as computed is slightly to considerably smaller than this, and therefore deviations of larger size would be expected somewhat more frequently.

When an "error tolerance" of 10.7 is applied to estimates of yield, 3 observations fall outside the tolerance limit. During the years of price support, some year-to-year changes in yield occurred that were far in excess of yield changes for preceding or later years. Apparently, this was due to such yield-stimulating factors as exodus of low-yielding farms, allotment programs, and greater price certainty present during the period.

Values of twice the standard deviation of year-to-year changes in actual acreage and yield were computed also. They were found to be 0.34 million acres and 13.2 hundredweight per acre, respectively. The "error tolerances" of the estimates of acreage and yield computed from the regression analysis are smaller than the standard deviations obtained for actual changes in acreage and yield.

Durbin-Watson Test

The Durbin-Watson test for serial correlation in the residuals was made for each regression analysis. The statistic for each analysis is given in table 1. The Durbin-Watson statistic in all the analyses was inconclusive at the .05 probability level. The most that can be said of the unex-

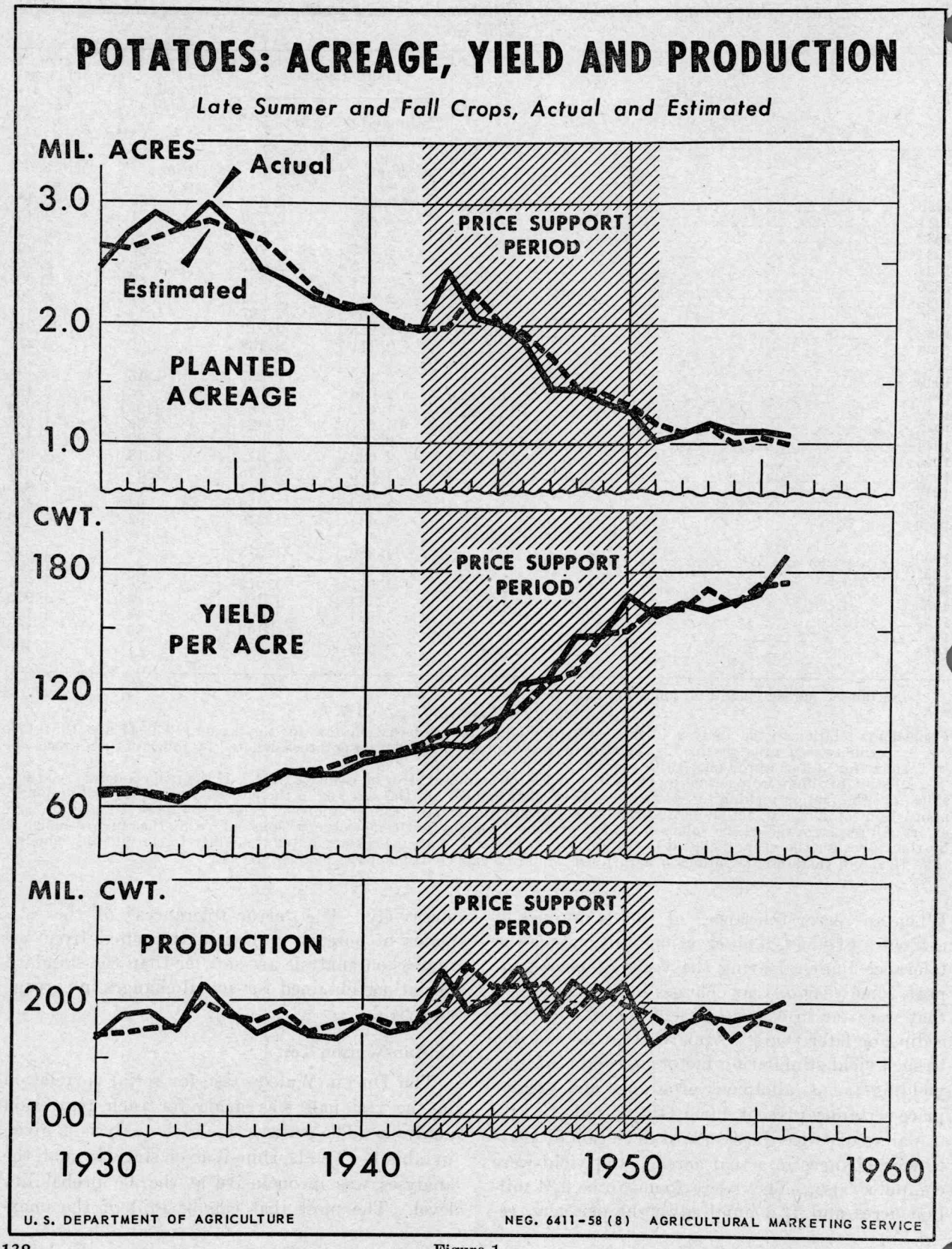
POTATOES: ACREAGE, YIELD AND PRODUCTION
Late Summer and Fall Crops, Actual and Estimated
MIL. ACRES
Actual
Estimated
3.0
2.0
1.0
PLANTED ACREAGE
PRICE SUPPORT PERIOD
CWT.
180
120
60
YIELD PER ACRE
PRICE SUPPORT PERIOD
MIL. CWT.
PRODUCTION
200
100
PRICE SUPPORT PERIOD
1930
1940
1950
1960
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Figure 1.

TABLE 3.—*Potatoes, late summer and fall crops: Estimated and actual yield per acre and related variables, 1930–56*

Crop year	Yield per acre		Price lagged 1 year [2]	Yield lagged 1 year	Cost of fertilizer lagged 1 year [3]
	Estimated [1]	Actual			
	Cwt.	*Cwt.*	*Dollars per cwt.*	*Cwt.*	*Index of dollars per ton*
1930	65. 0	67. 7	1. 52	67. 6	149
1931	66. 1	68. 2	1. 31	67. 7	157
1932	65. 7	65. 5	. 90	68. 2	175
1933	63. 4	63. 2	. 87	65. 5	173
1934	70. 0	71. 1	1. 59	63. 2	145
1935	67. 5	67. 5	. 67	71. 1	152
1936	68. 2	70. 2	. 92	67. 5	140
1937	77. 0	77. 5	1. 44	70. 2	131
1938	77. 0	76. 4	. 71	77. 5	128
1939	81. 7	77. 0	. 93	76. 4	141
1940	86. 0	83. 8	1. 15	77. 0	142
1941	86. 8	86. 0	. 73	83. 8	133
1942	91. 5	89. 3	. 93	86. 0	118
1943	97. 6	92. 3	1. 06	89. 3	118
1944	101. 6	91. 7	1. 02	92. 3	122
1945	104. 9	99. 8	1. 18	91. 7	121
1946	[4] 110. 1	122. 8	1. 01	99. 8	122
1947	124. 4	124. 6	. 75	122. 8	107
1948	[4] 128. 9	147. 4	. 93	124. 6	96
1949	148. 3	147. 6	. 92	147. 4	97
1950	[4] 149. 7	167. 3	. 84	147. 6	107
1951	161. 4	156. 9	. 49	167. 3	98
1952	160. 9	163. 9	. 96	156. 9	93
1953	170. 4	161. 4	1. 13	163. 9	98
1954	163. 4	164. 8	. 47	161. 4	100
1955	171. 9	168. 4	. 85	164. 8	98
1956	174. 6	187. 9	. 71	168. 4	98

[1] Estimated yield based on following regression:

$$Y_t' = -24.392 + 10.883\ P_{t-1} + .734\ Y_{t-1} + .066\ C_t + .073\ C_{t-1} + 2.018\ T$$

Coefficients relating to the analysis in this estimating equation are based upon the period [1930–41 and 1951–56].

[2] Season average price received by farmers for late summer and fall crop potatoes deflated by index of prices received by farmers for all farm products, 1910–14=100.

[3] Index of fertilizer prices paid by farmers deflated by the index of wholesale prices for all commodities, 1947–49=100.

[4] Estimate differs from actual by more than twice the standard error of estimate (10.68). If the real economic relationships and the factors making for residual errors or disturbances are the same as in the [1930–41 and 1951–56] period in about 1 out of 20 times actual yield would be expected to deviate from the estimates of acreage by more than 2 standard errors of forecast, provided the values of the independent variables for the new observations fall within the range established by the values for the years included in the analysis. The error tolerance as computed is slightly to considerably smaller than this, and therefore deviations of larger size would be expected somewhat more frequently.

plained residuals is that there does not appear to be strong evidence of positive or negative serial correlation.

Use of Supply Response Results

Results from the expectation model indicate that production of potatoes is influenced more by farmers' expectations of the long-run "normal" price than by the most recent change in the price of potatoes. Based on analyses for the 1930–41 period, potato farmers were found to increase acreage by about 0.3 percent for each upward revision of 1 percent in their price expectations. During the same period they tended also to increase yield per acre by 0.6 percent following the same 1 percent increase in expected "normal" price. Since, as shown earlier, acreage response and yield response are additive, a supply (production) response of 0.9 percent is indicated following a change of 1 percent in expected "normal" price. A supply elasticity (with respect to expected price) of 0.9 was found to hold also for the analyses based on the [1930–41 and 1951–56] period. However, during this period, the supply

elasticity of 0.9 consisted of 0.5 from acreage response and 0.4 from yield response.

Although prices of potatoes vary considerably from one year to the next and although the estimated response to expected price is large (though still inelastic), potato farmers tend to make small adjustments in acreage and yield following changes in actual prices. This results because farmers tend to revise their long-run expectations of price little from year to year in relation to the wide swings in actual prices. This was indicated by the relatively low coefficients of expectations that were obtained from the analyses.

These values ranged between 0.26 and 0.28 and as expected, approximately the same values were obtained from both the acreage and yield analyses. That is, farmers tend to revise their previous estimates of expected "normal" price by about one-fourth of the amount by which the previous year's actual price differed from previous year's expected price (see relation 2). In relation to observed changes in price and production, a change in supply response of 0.2 percent may be expected following a 1-percent change in the actual price of potatoes.

Conclusions

Potato producers normally plan production under conditions of price uncertainty because of the wide year-to-year swings in prices of potatoes. Further, it is found that producers tend to change their production plans little from one year to the next in relation to the magnitude of changes in actual prices.

Because of price uncertainty, producers tend to make adjustments in acreage and yield based on some notions of expected "normal" price.

Apparently, potato growers not only look back at previous prices; they also look forward, in some sense, to long-run price expectations. But such long-run expectations are modified each year by some ratio of the relation between last year's price expectation and last year's actual price.

This study has found that farmers changed their expectations moderately. Specifically, they tend to change their notion of long-run expected price by about one-fourth of the difference between the price they expected the previous year and the price they actually received.

Given a change in expected price, production response under this formulation was found to be 0.9 percent for a 1-percent change in expected price. However, in relation to the year-to-year change in actual price, this study found the year-to-year production response to be 0.2.

If under conditions of free market and dynamic equilibrium, potato prices fell successively for 3 to 4 years and were expected to fall still further, producers probably would revise their price expectations downward to a greater extent than is suggested by the derived coefficient of expectation of .26–.28. As a result, larger year-to-year adjustments in acreage and yield would be expected to occur in a period of successive price changes (in the same direction) than in a period of fluctuating prices.

Estimates of acreage and yield obtained from the regression analyses indicate that fairly accurate predictions can be made from these estimating equations. When the regression analyses were used for the period outside of fit (1942–50, including World War II and price-support period), the estimate of acreage fell within the expected range of reported acreage. However, the estimates for yield differed from reported yields by more than the expected deviations. The substantial deviations in yield were a result of unusual changes in yield that occurred during the price-support period. These changes in yield were due largely to the sharp decline in number of low-yielding potato farms and to other important shifts that occurred in the potato industry.

Forthcoming studies that take into account (1) productivity change reflecting technological advances and (2) alternate dynamic expectation models, are both important and needed. It is fairly evident that all changes in production are not explainable by price, although many factors may be reflected in price. The supply-response function is so comprehensive that many theoretical and empirical studies are needed to give it full exploration.

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Book Reviews

Farm Prices: Myth and Reality. By Willard W. Cochrane. University of Minnesota Press. 1958. 189 pages. $4.00.

PROFESSOR COCHRANE'S current contribution to the mounting debate on agricultural price and income policy in brief, readable, stimulating, constructive, and controversial. The Cochranian drama unfolds in three parts. Part I recounts the "myth" of farm price-income behaviour, and unveils the "reality." Part II presents a statistical and theoretical analysis to support the theses concerning farm prices and income. Part III contains the policy implications and Cochrane's own prescription.

What is the myth? It is the belief that agriculture tends automatically to adjust to some desirable level of production, prices, and income. The myth has two variants. The first is that the adjustment would soon come about if agriculture "were left alone for a little while," and competitive prices permitted to work their wiles. The second is that agriculture needs a hand from the Government to overcome existing maladjustments, after which the invisible hand that dwells in the marketplace will take over and lead agriculture into the promised land of equilibrium.

If this be myth, what is reality? According to Cochrane, it is chronic instability of farm prices and income. This is compounded of two elements. The first is "wide and irregular swings in the farm price level" that imply chronic income instability for agriculture as a whole. The second is comprised of "irregular year-to-year commodity price variations around the moving farm price level." These gyrations in the price of individual products mean that the farmer faces continuous uncertainty as to what the market really wants, which in turn results in inefficient allocation of farm resources. These instabilities are not transitory; they are the norm for agriculture under free competition.

Though part II accounts for more than a third of the volume, it will be passed over briefly, as it is based to a very considerable extent on Cochrane's own previously published studies that are familiar to agricultural economists. It is enough to say that these three chapters culminate in the theory of the "agricultural treadmill"—a modern version of the farm dilemma, of which Professor Boulding was an early expositor.

Briefly, farmers, like the rest of us, attach a high value to technological advance; in the "sea of competitive behaviour" each farmer has an added incentive to reduce his costs and up his net returns;