*Short Communication*

# Potato Prices as Affected by Demand and Yearly Production

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## ABSTRACT

**With increased potato production in the past decade, actual price for potatoes given to growers has changed little, which means that inflation-adjusted price has decreased. Since production is the result of acres harvested and yield per acre, these two parameters to price are key to understanding price fluctuation. To quantify the relation between potato price and production, acreage and yield, NASS data from 1980 to 2002 were analyzed using linear regressions. Pricing and production showed an inverse, linear relationship, which is divided into two periods. Between 1980 and 1988, the price of potatoes (US$/cwt[1]) increased by $1.00 with a decrease in production of 15.6 million cwt, and between 1993 and 2002 with a decrease in production of 35.7 million cwt. Prices have become less responsive to changes in production. Harvested acres account for about one-third of the annual variation in prices, while yield per acre accounts for about one-half of the variability in prices. It appears that there was an increase in demand for potatoes from 1989 to 1992 that divides the two periods. There also was an increase in the percentage of the crop being used in the frozen and fry market, and a decrease in the percentage of the crop being used in the table or fresh market during this time period. This market change could explain the difference between 1980-1988 and 1993-2002 relationships.**

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ADDITIONAL KEY WORDS: potato economics, potato acreage, potato yield

[1]cwt = 100 lb = 45.36 kg, million cwt = 45,360 mt, acre = 2.471 ha, cwt/acre = 112 kg/ha = 0.112 mt/ha.

## INTRODUCTION

In many agricultural markets, where prices are not supported through some government program, prices tend to adjust in response to changes in production. For perishable crops, which are not stored from one production season to the next, that price adjustment generally begins around harvest as production becomes a known quantity. The potato market is an example of one such crop. Prices adjust higher to ration a small crop over the marketing year or prices decline to clear the market for a large crop. The price adjustment that is necessary to ration or clear a market is dependent upon the underlying demand relationship. The number of uses for a commodity and the percentage of a crop such as potatoes that is sold in the fresh market vs sold to be further processed will influence demand and may likely change over time.

The objective of this paper is to look at the relationship of potato production and the marketing year price over time. Additionally, potato production varies because of changes in harvested acres and differences in yield. The relative influence of harvested acres and yield on potato price also will be examined.

## MATERIALS AND METHODS

Data on actual prices per hundred-weight of potato tubers (cwt), production in million cwt, harvested acres in thousands, and yield (cwt/a) were obtained from the National Agricultural Statistics Service (NASS). Data are cumulative for all U.S. uses and do not separate out contracted production or markets from fresh markets; all uses for potatoes are combined and averaged. Actual prices were adjusted for inflation using the Gross National Product Implicit Price Deflator into 2002 U.S. dollars. This removes the influence of inflation when comparing price levels and production levels over time.

Potato production was plotted against the inflation-adjusted price of potatoes. Because the quantity produced of potatoes is effectively the quantity consumed, since there is no storage carryover from one production year to the next, the price vs quantity plot can be used to look at the demand relationship for potatoes. The demand relationship is that quantity demanded is a function of price. However, in this case the inverse demand relationship is of greater appeal: price is a function of quantity. Since quantity is effectively set at harvest, price is the variable that must adjust based on demand to clear the market.

TABLE 1—*Results of estimating Equation 1, the influence of production (million cwt) on price (2002 $/cwt).*

| Parameter | 1980-2003 | 1980-1988 | 1993-2002 |
|---|---|---|---|
| Intercept | 17.492** | 31.360** | 19.295** |
| | (1.555) | (3.131) | (1.602) |
| Production | -0.025** | -0.064** | -0.028** |
| | (0.004) | (0.009) | (0.003) |
| $R^2$ | 0.674 | 0.886 | 0.891 |
| F Statistic | 43.319** | 54.245** | 65.367** |

Note: Standard errors are in parentheses and ** denotes significance at the 0.01 level.

The following relationship was estimated using OLS regression:

(1) $\text{Price} = b_0 + b_1\text{Production}$

where price is defined as the real price of potatoes in 2002 dollars per cwt, production is million cwt of potato tubers, and $b_0$ and $b_1$ are the estimated parameters for the intercept and slope. Production can be defined as harvested acres multiplied by yield per acre. Therefore, the inverse demand relationship can be re-estimated as:

(2) $\text{Price} = b_0 + b_1\text{Acres} + b_2\text{Yield}$

where Price is as previously defined in equation 1, acres is in thousand harvested acres, yield is defined as cwt per acre, and $b_0$, $b_1$ and $b_2$ are the estimated parameters. To determine the relative importance of acres and yield on price, the coefficients of separate determination (Burt and Finley 1968) are calculated from the regression results. The sum of the coefficients of separate determination is equal to the $R^2$ value for the regression equation. By accounting for the correlation between variables and the variability of each of the variables, the coefficients of separate determination effectively separate out the variability in price that is explained by acres and by yield. Plots of harvested acres and yield vs the real price of potatoes are also generated.

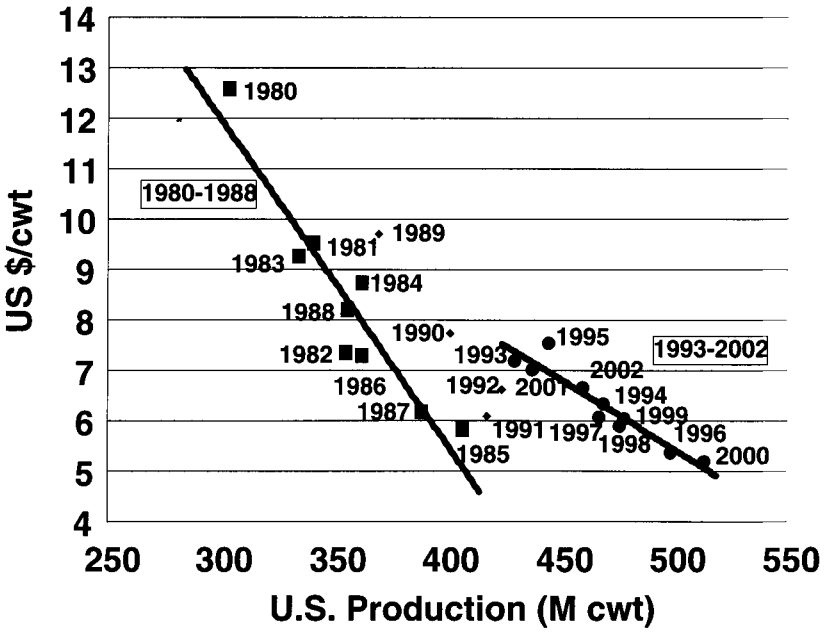


**FIGURE 1.**
**Potato price (2002 $/cwt) vs production (Millions cwt) from 1980 to 2002.**

# RESULTS

## *Production and Price*

Generally, as potato production increased (decreased) each year, potato price decreased (increased) compared to the previous year (Figure 1). In the past 23 years (1980-2002), this occurred in 19 years. The results of estimating the linear relationship between price and production are displayed in Table 1. The parameter estimate of -0.025 on production would indicate that for every 40 million cwt increase in production, there was a loss of U.S. $1 in price. However, in analyzing the plot in Figure 1, it appears there was a shift in the demand relationship during the 1989 through 1992 time period. During this time period, there was an increase in the percentage of potatoes being further processed into fries and frozen products and dehydrated potato products (Table 2).

TABLE 2—*Mean major potato usage for four-year intervals from 1985 to 2000 (source NASS).*

| Market | 1985-1988 | 1989-1992 | 1993-1996 | 1997-2000 |
|---|---|---|---|---|
| | % of total production[1] | | | |
| Table or Fresh | 31.1% | 31.1% | 28.0% | 27.4% |
| Frozen or Fry | 30.3% | 32.3% | 34.8% | 34.7% |
| Dehydration | 7.9% | 9.3% | 9.8% | 10.8% |

[1]Total production also includes potato chip and shoestring, canned, flour, seed, feed, and diversion, and shrinkage, loss, and home use.

TABLE 3—*Results of estimating Equation 2, the influence of acres (thousand) and yield (cwt/acre) on price (2002 $/cwt) and the percentage of price variability explained by acres and yield.*

| Parameter | 1980-2003 | 1980-1988 | 1993-2002 |
|---|---|---|---|
| Intercept | 31.018** | 54.761** | 31.744** |
| | (3.936) | (6.330) | (3.578) |
| Acres | -12.109** | -15.006* | -8.922** |
| | (3.453) | (5.880) | (1.705) |
| | 35% | 35% | 32% |
| Yield | -0.025** | -0.097* | -0.038** |
| | (0.007) | (0.027) | (0.006) |
| | 36% | 55% | 56% |
| $R^2$ | 0.711 | 0.900 | 0.880 |
| F Statistic | 24.592** | 26.998** | 25.830** |

Note: Standard errors are in parentheses and * and ** denote significance at the 0.05 and 0.01 level, respectively

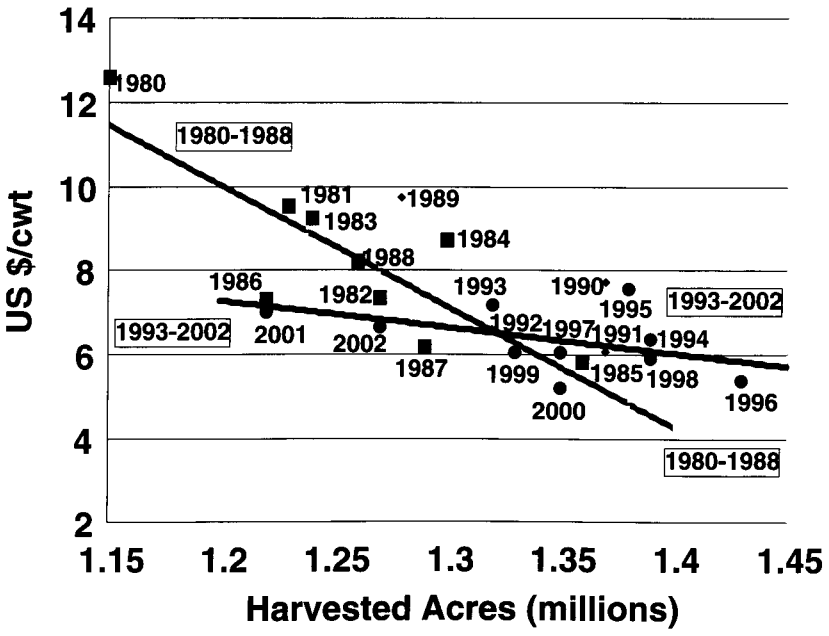


**FIGURE 2.**
**Potato price (2002 $/cwt) vs harvested acres (Millions) from 1980 to 2002.**

Equation 1 was re-estimated for two separate time periods: 1980-1988 and 1993-2002. The results are displayed in Table 3. The parameter estimate for production in the earlier time period of -0.064 indicates that price was lowered by $1 with an increase in production of 15.6 million cwt. For the later time period, 1993-2002, the parameter estimate for production was -0.028, so that an increase in production of 35.7 million cwt would have reduced the price by $1 per cwt. Comparing these two periods, prices during the 1980-1988 period were more responsive to changes in production than were prices in the 1993-2002 period. This is consistent with demand theory, which states that the own price elasticity of demand will be more elastic (less responsive to changes in quantity) if there are more uses for the product. The percentage of potatoes going into further processed products has generally been increasing over time.

## HARVESTED ACRES, YIELD AND PRICE

Plots of harvest acres vs potato price and yield per acre vs potato price are displayed in Figures 2 and 3. As with overall production, there is an inverse relationship of harvested acres and of yield per acre to potato price. Furthermore, as with overall production, these relationships appear to have changed over time. From Figure 2, it is apparent that potato price is less responsive to changes in harvested acres from 1993 to 2002 than in the 1980-1988 period. This is consistent with the previous discussion on price response to changes in production. Figure 3 portrays a somewhat different picture when comparing yield to price. There was an increase in yield potential from 1991 to 1992 that has remained. Prior to 1992 the largest yield was 304 cwt/acre, and since 1992 the smallest yield has been 323 cwt/acre. Improvements in pest control may account for most of this yield gain (Guenthner et al. 1999).

also appears to have been a slight shift in how responsive price is to yield in the more recent time period.

Equation 2 was estimated to determine the impact that harvested acres and yield have on potato price. As with Equation 1, Equation 2 was estimated for the overall time period and for the sub-time periods of 1980-1988 and 1993-2002. Those results are displayed in Table 3. The R2 value was 0.71 for the overall time period and was 0.90 and 0.88 for the two sub-time periods. In looking at the parameter estimates for both acres and yield, price has become less responsive to changes in these variables in the more recent time period. From 1980 to 1988 a change of harvested acres of 66,640 would change the price of potatoes $1 and an increase in yield of 10.3 cwt/acre would drop the price of potatoes $1. From 1993 to 2002, it required a change of 112,082 harvested acres to affect potato price $1 and a yield increase of 26.3 cwt/acre was required to decrease price $1.

To illustrate the relative importance of harvested acres and yield in explaining variability in price, the coefficients of separate determination were calculated and the percentage of the variability in price explained by each variable is presented in Table 3. For the overall time period, the influence of harvested acres and yield per acre were nearly identical with both variables explaining slightly more than one-third of the variability in potato prices. However, when the two time periods are considered separately, yield per acre became more important in explaining price variability. In both time periods, yield explained over one-half of the variability while harvested acres accounted for about one-third of the variability.

## DISCUSSION

It appears that demand for potatoes increased from 1988 to 1993. Not only did demand increase, but demand became more elastic and prices became less responsive to changes in quantity or production. This is consistent with a larger share of a commodity being used in a greater number of processed foods. From 1985 to 1988, the major potato market was table or fresh market, accounting for over 31% of production (Table 2). But from 1989 to 1992, a transition period occurred and the major market became the frozen and fry market accounting for over 32% of production while the fresh market dropped to nearly 30%. During the following four years, the frozen and fry market increased its share to nearly 35% and stayed at around this level while the fresh market declined to below 28%. These observations strongly correlate to the price data seen in Figures 1, 2, and 3, exhibiting two distinct periods with four transition years in between. The more uses of a commodity, the greater the demand for that commodity and prices tend to be more stable as well.

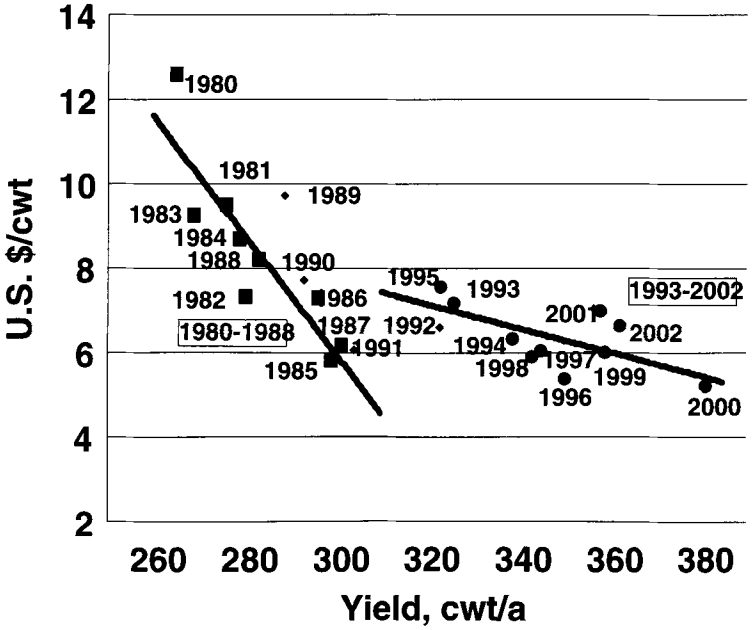


**FIGURE 3.**
**Potato price (2002 $/cwt) vs yield (cwt/acre) from 1980 to 2002.**

Comparing acreage and yield for the two time periods suggests that yield has a greater impact on prices than acreage, although acreage is still a very important component accounting for about one-third of the annual variation in potato prices. Producers likely have more control over harvested acres than they do over yield. Annual yield variations are heavily influenced by environmental conditions. So, while producers can have some influence over the general price level for potatoes by altering planted acres, environmental conditions will also have an impact on the final price level by affecting harvested acres.

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