ECONOMIC FACTORS AFFECTING THE CALIFORNIA ALFALFA MARKET

Keith C. Knapp[1]

Abstract: Alfalfa demand elasticity is -.83, implying that a 10 percent decrease in price results in a 8.3 percent increase in quantity demanded. Long-run alfalfa supply elasticity is .61, implying that a 10 percent increase in alfalfa price results in a 6.1 percent increase in quantity supplied. Alfalfa imports/exports to California are a small part of the market, but can influence price due to inelastic California demand. Real alfalfa prices have declined over time, probably in response to yield increases, and also exhibit a 3-4 year cyclical pattern. Moderate responses were found for federal water policies; however, cotton programs and yield increases at historical rates have potentially large impacts on the California alfalfa market.

Keywords alfalfa demand and supply, prices, agricultural commodity and national resource policy

INTRODUCTION

For the last several years, K. Konyar and I have conducted a series of studies on the California alfalfa market. The primary goal is an improved understanding of price and quantity determination in markets for perennial crops. Alfalfa was chosen as an important crop with little previous economic analysis, a relatively short life-span compared to other perennial crops, no government support programs, and a crop with significant water resource implications. This report summarizes some of the major findings of our research. If successful, economic research on this and other markets can lead to improved policy analysis and price-forecasting.

ALFALFA DEMAND

The annual quantities demanded of alfalfa hay and other products in California are a function of the number and composition of the livestock herd, alfalfa price, other feed prices, livestock prices, and the technology of livestock production. We have conducted several statistical analyses of California alfalfa demand using data from 1945 to 1986. For 1982, we estimated the following breakdown of alfalfa consumption by livestock type: milk cows, 42 percent; other dairy cattle, 16 percent; beef cattle, 17 percent; and horses, 24 percent.

The response of alfalfa quantity demanded to changes in various prices can be measured by elasticities, where an elasticity is a percentage change in quantity divided by a percentage change in price. Evaluated at 1986 prices and quantities, elasticities for California alfalfa quantity demanded are: alfalfa price, -.83; other feed prices index, .54; livestock price index, .51. This implies that, holding everything else constant, a 10% increase in the price of alfalfa results in a 8.3% decrease in alfalfa quantities demanded, while a 10% increase in the feed cost index used here results in a 5.4 percent increase in alfalfa quantity demanded. Similarly, a 10 percent increase in the livestock price index increases alfalfa quantity demanded by 5.1 percent. As for technology, livestock productivity has increased over time with consequent changes in alfalfa consumption per cow, holding everything else constant. To date, we have not attempted to quantify these changes.

PRODUCTION

Alfalfa yields in a given year depend on a variety of factors. These include technology, total area and age-composition of the crop, alfalfa price, production/

[1]Associate Professor, University of California, Riverside, CA 92521

harvesting costs, and climatic and environmental conditions. A statistical analysis was conducted for alfalfa yields. The results suggest that technical change has resulted in yield increases of .064 tons/acre per year over the period 1945-1986. Thus, the effects of technological improvements (improved varieties, better pest control, etc.) on alfalfa yields have been quite substantial. The results also indicate that yields decline as total area planted to alfalfa increases. This is perhaps explained by use of lower quality land for alfalfa production, and spreading fixed management and machinery resources over larger areas. Alfalfa yields also increase as real (deflated) alfalfa prices increase and production costs decrease. Alfalfa yields can also be expected to decrease as the average stand life gets older, although we have not attempted to quantify this at the statewide level. Finally, climatic conditions introduce stochastic year-to-year fluctuations in yields.

Alfalfa area evolves over time in response to prices and other factors. Our analysis suggests that new plantings increase as existing alfalfa acreage decreases and per-acre profitability increases. We also found that new plantings depend on the age-distribution of the existing stock. In particular, holding everything else constant, an increase in the average age of the stand would tend to increase new plantings. Removals of acreage in a given age category are primarily determined by the existing acreage in that age-category, but tend to decrease as alfalfa prices increase or production costs decrease. Alfalfa area is also influenced by government programs. For example, alfalfa area averaged 1 million acres from 1945-1953, 1.16 million acres from 1954-1977, and 1.03 million acres from 1978-1986. Konyar (1985) attributes the higher 1954-1977 acreage to acreage allotments and marketing quotas for cotton during this period. Finally, we estimate long-run alfalfa acreage elasticities as .61 for alfalfa price, -.29 for production costs, and -.54 for competing crops. Thus, holding everything else constant, a 10% increase in alfalfa prices eventually increases alfalfa area by 6 percent, a 10 percent increase in production costs reduces alfalfa area by 3 percent in the long run, and a 10 percent increase in the price of competing crops reduces alfalfa area by 5 percent in the long run.

EXPORTS AND IMPORTS

Alfalfa products are imported to California from surrounding states and exported to other countries. Data on alfalfa imports/exports are not available before 1962 and Arizona import data are not available from 1973-1981. During the period 1983-1986, howver, alfalfa net imports (imports - exports) averaged 344,000 tons or 5 percent of average California production during that period. While relatively small in percentage terms, an inelastic California alfalfa demand implies that net imports have a potential effect on California alfalfa prices.

Economic theory suggests that net imports of a product to a region will increase as the price differential between regions increases or as transport costs decrease. Our statistical analysis of net imports to California confirms this.

STOCKS

Outside of pipeline stocks, alfalfa may be carried over in some years for use in later years. This occurs when the current period price is less than the expected price in the following year net of storage costs and losses. Thus, holding everything else constant, a decrease in current period price will tend to increase carryover stocks into the next period. Alternately, carryover stocks can be viewed as a function of production and carryin stocks during the year -- an increase in production is likely to increase carryover stocks and likewise for carryin stocks. The statistical results suggest that every 1 ton increase in production results in an additional .07 tons of carryover stocks annually.

PRICES

Economic theory suggests that alfalfa prices are set in every period so that quantity demanded plus the net change in carryover stocks equals production plus net imports to California. In general, alfalfa prices will increase as cattle numbers increase, as competing feed prices and livestock prices increase, and if production in other western states decreases. Given sufficient time for acreage to adjust, alfalfa prices will

decrease as yields increase due to technical change, and wil increase as the price of competing crops and production costs increase.

Price movements over time can be broken down into seasonal, trend, cyclical, and random components. Typical seasonal patterns are high prices at the beginning of the year, falling prices as summer production reaches the market, and then increasing prices in the late fall and early winter. Nominal alfalfa prices have generally been rising over the period 1945-1986, although with declines in some years. More revealing are the long-term trends in real or deflated prices. Using the USDA production cost index as a deflator (1977=100), real alfalfa prices have fallen at an average rate of $.40/year over the period 1945-1986, although the rate of decrease has slowed in recent years. This decline is probably attributed to the substantial yield increases noted earlier. From economic theory, in an industry in long-term equilibrium, total revenues will just cover all economic costs of production. Thus as yields increase, theory would predict a fall in real prices to maintain long-run equilibrium. A spectral analysis of 1945-1986 price data revealed a cycle in alfalfa prices of approximately 3-4 years in length. Finally, random year-to-year fluctuations in aflfalfa prices are attributable to unforeseen changes in a myriad of factors affecting alfalfa supply and demand.

TECHNICAL CHANGE

One of the more striking changes affecting the California alfalfa market has been the large improvement in yields over time. We simulated the effects of continued technological improvement on future alfalfa acreage, production, and prices. If yields continue to increase at the same rate as in the past, then over a 20-year period our results suggest a less than 1 percent decrease in area, a 13 percent increase in production, a 12 percent decrease in alfalfa price paid by alfalfa buyers, and a 15 percent decrease in alfalfa price received by growers. (Both price reductions are measured in constant 1986 dollars.) The production and price effects are substantial and imply that producers need to continually adopt improved varieties and methods to stay profitable.

FEDERAL WATER POLICY

In 1986, some 43 percent of California alfalfa acreage was irrigated with Bureau of Reclamation water. This water is generally provided at below cost to contracting water districts. In 1986, the implied subsidies ranged from $1.31 to $78.54 per acre-foot with an average of $16.70 per acre-foot. Federal water pricing policy has engendered criticism for contributing to the budget deficit and mis-pricing a scarce resource.

We conducted an analysis of the impacts of increasing federal water prices (reducing the subsidy). In the short run, California alfalfa acreage decreases by 6,400 acres and the price paid for alfalfa increases by 67 cents per ton for every $10 increase in the price of USBR water. Comparable figures for the long run are 8,300 acres and 84 cents per ton, respectively. These are statewide averages; individual regions with heavy reliance on federal water and large alfalfa acreages are impacted to a larger degree. Nevertheless, this is only a moderate impact. The explanation appears to be a fairly inelastic supply response preventing large changes in acreage.

FEDERAL DAIRY PROGRAM

The dairy industry is a major alfalfa consumer. Herd sizes and milk prices are affected by government programs. Productivity has also increased over time through technological innovations, one of the more recent being bovine growth hormone. All of these variables have potentially large impacts on the California alfalfa market through the derived demand for alfalfa.

Simulations were conducted by Knapp and Konyar (1990) to determine the potential effects of reduced dairy herd sizes on the California alfalfa market. In the short run, every 10 percent decrease in the dairy herd size reduced alfalfa acreage by 3,800 acres and price paid by $2.16. Comparable results for the long run are 10,200 acres and $1.58, respectively. These results are surprisingly small. The explanation in terms of this model appears to be a fairly inelastic alfalfa supply function resulting in fairly small

acreage reductions, and an alfalfa demand function which is elastic enough to absorb the extra hay with relatively moderate price decreases.

Potential impacts of reduced dairy herd size on long-run equilibrium in the California alfalfa market are also investigated in Knapp (1987). Due to the assumptions in this paper, the long-run equilibrium alfalfa price is determined solely by production costs which presumably do not change as dairy herd size changes. However, the results in this paper suggest that a 10 percent reduction in dairy herd size results in a 7 percent decline in alfalfa acreage, which is substantially greater than the 1 percent decrease predicted by the Knapp and Konyar (1990) analysis.

At this point, model results do not permit firm conclusions to be drawn about the effects of reduced dairy herd sizes on the California alfalfa model. The most that can be said is that a 10 percent reduction in California dairy herd size will decrease alfalfa acreage and prices by somewhere between 1 percent and 7 percent.

FEDERAL COTTON PROGRAMS

Alfalfa competes with cotton for land in many regions of California. During the period 1954-1972, federal cotton programs included acreage allotment and set-aside with the intent of reducing cotton acreage. During this same period, alfalfa area was, on average, 112,000 acres higher and the price $4.60 lower than average levels in other periods.

The effects of re-introducing a cotton program of similar magnitude on the current alfalfa market were simulated. The effects are quite substantial. Alfalfa acreage would increase by 16 percent in the short run and 22 percent in the long run. Prices paid would decline by 15 percent and 20 percent in the short and long run, respectively.

REFERENCES

Knapp, K. C. "Dynamic Equilibrium in Markets for Perennial Crops." American Journal of Agricultural Economics, 69(1): February 1987.

Knapp, K. and K. Konyar. "A Dynamic Spatial Equilibrium Model of the California Alfalfa Market." Giannini Foundation of Agricultural Economics, Research Report #341, University of California, January 1990.

Knapp, K. C. and K. Konyar. "Perennial Crop Supply Response: A Kalman Filter Approach." American Journal of Agricultural Economics (forthcoming).

Konyar, K. "A Dynamic Spatial Equilibrium Model of the California Alfalfa Market." Ph.D. Dissertation, University of California, Riverside, 1985.

Konyar, K. and K. Knapp. "Demand for Alfalfa Hay in California." Giannini Foundation of Agricultural Economics, Research Report #333, University of California, May 1986.

Konyar, K. and K. Knapp. "Market Analysis of Alfalfa Hay: California Case." Agribusiness 4(3): 1988.

Konyar, K. and K. Knapp. "Dynamic Regional Analysis of the California Alfalfa Market with Government Policy Impacts." Western Journal of Agricultural Economics, 15(1): July 1990.