

The Economic Impact of Water Transfers on Alfalfa in the West

By

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ABSTRACT

Water markets and transfers will continue the upward pressure on water prices to alfalfa growers. However, the effect on alfalfa will be cushioned by the rotational benefits from alfalfa and the regional dairy demand. Cuts alfalfa acres will be less than other crops that have to face world commodity markets. The paper looks at one past example of a water market and two economic models. I conclude that the alfalfa industry will be changed by water scarcity, but that there are avenues for growers to adapt to the higher water prices.

Key Words: alfalfa, economics, water transfers.

INTRODUCTION

Water transfers are increasing throughout the west and, over the past fifteen years, have become an integral part of water allocation, particularly during times of low rainfall and drought. Extreme events such as the current drought in much of the west are so severe that they may inhibit transfers. Despite this, it seems very likely that the current trend will continue. Figure 1 shows the total amount of water transferred in California for the past seventeen years. It is worth noting that California has enjoyed average or above average rainfall for the past seven years. Despite this, water transfers have grown, and in the past two years, total transfers exceeded those made during the last major drought in 1991. Clearly, water transfers are a trend that will influence the face of irrigated agriculture in the west.

In this paper, I will briefly discuss the factors that affect the alfalfa industry, from an economist's perspective, and present some results from two economic models of irrigated crop production in the west.

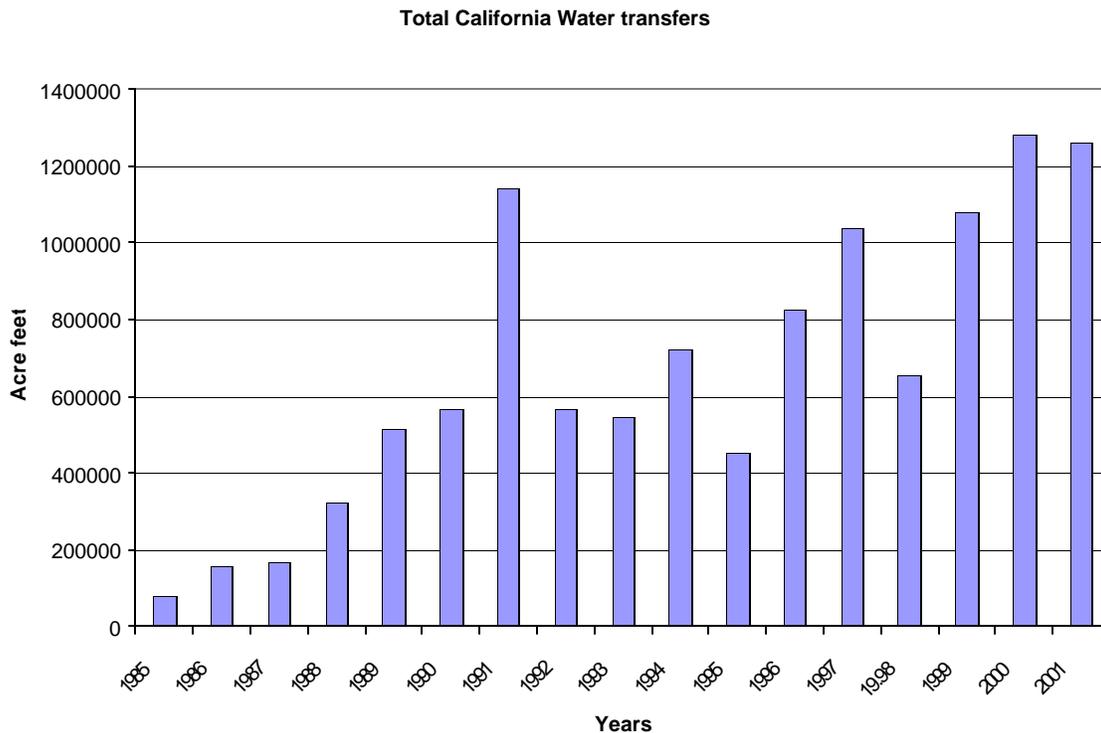
Adjusting to Increased Water Prices

Growing alfalfa is fundamentally driven by crop rotations and economic incentives. Economists assume that farmers are basically maximizing the net returns and the stability of their farm business. While there are exceptions to this rule, it provides a good explanation of farmer actions most of the time. Underlying all crop profits is a set of relationships for each crop that economists term production functions. Essentially, a production function shows the way in which a farmer can turn different quantities of inputs into production. A simplified example may have alfalfa being produced using land,

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labor, water and capital. The concept of tradeoffs between inputs means that there are very many ways to produce the same output with different input quantities. For example, one may be able to get the same effective irrigation on a crop with less water applied, if it is done by a series of smaller irrigation areas, which would require more labor per acre. Alternatively, one could use a combination of increased labor and capital needed for a sideroll or linear move sprinkler system. This trade off substitutes capital or labor for applied water. The best combination of these inputs depends on the relative costs of the inputs and their effectiveness. Note, up to the point that a farmer is making zero profits, the optimal production combination is determined by the relative costs not the absolute cost of an input. In addition to the cash cost of inputs there is an additional value termed the opportunity cost that is present whenever inputs are in scarce supply. One overlying principle is that of diminishing returns to any input as its quantity is increased. This physical reality gives the production surface its curved shape.

Figure 1.



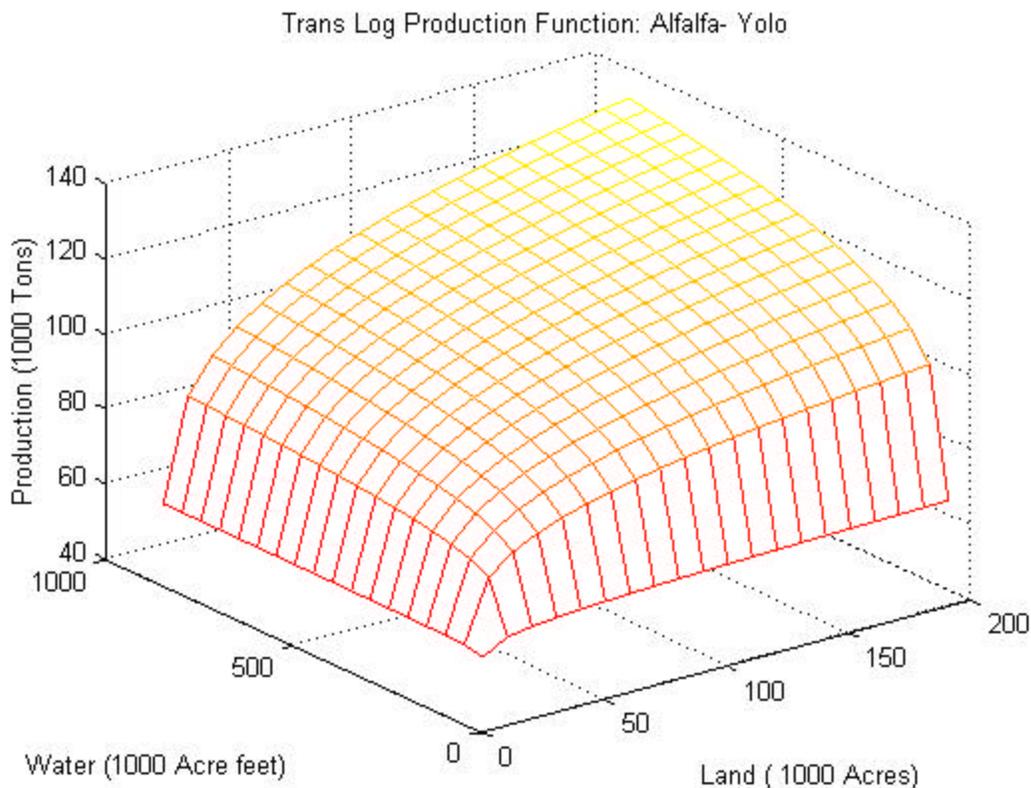
Faced with a competitive market for alfalfa, the grower has three avenues for adjustment when faced with higher water costs or reduced supplies.

1. **Crop Acreage Reduction**, or crop switching. If water become more restricting than land then a farmer will optimize farm profit by maximizing the return per unit of water. This may stimulate a partial switch to a crop such as safflower or barley that has a lower return per acre than alfalfa, but due to a lower water use, it may return and equal or greater value per unit water.

2. **Reduced Irrigation on the Existing acres.** The term stress irrigation refers to a departure from the maximum physical productive quantity of water applied per acre. Given the decreasing productivity of water and a high price or extreme shortage of water, it will be profitable to produce at a slightly lower production level and a significantly lower cost. Rather than reduce the applied water for each cut of alfalfa, annual water use is better reduced by shortening the season by one or more cuts. There has been some research that indicated that the following year's yield may not be significantly reduced. Figure 2 shows the land to water production surface trade-offs for a typical California region.

Note first, that the slope of the surface decreases if one input is held constant and the other input is increased. This is the familiar principle of decreasing productivity. The trade off between the intensity of land and water use, while producing the same output can be seen by moving around the curved surface at a constant level on the vertical production axis. The relative prices of water land and alfalfa determine the point on the surface that maximizes profit. A given point uniquely determines the optimal combination of land water and the total yield of the combination.

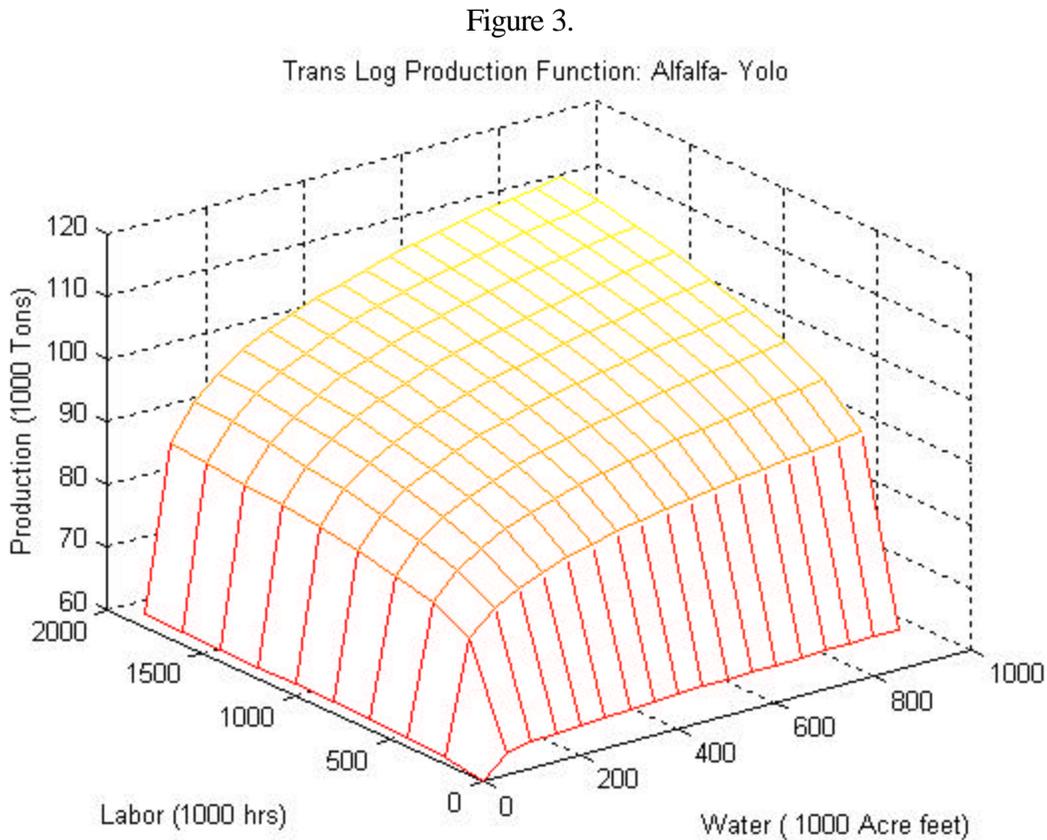
Figure 2.



3. Input Substitution

Figure 3 below plots the ability of an alfalfa grower to substitute labor for applied water. As in the discussion above, a crop can be grown using different combinations of water and irrigation labor to apply it. Yields may be reduced, but, as in the land water trade off, it will probably be optimal to opt for some yield reduction.

Due to decreasing returns from additional inputs, it can be proved that profit is not maximized at the highest yield, but at a lower input level where the incremental contribution of a unit of input in terms of production is equal to its cost. It follows that when a given input such as water becomes more scarce or costly, the quantity used will decrease, quantities of substitute inputs will increase, and production will probably decrease. All three of these effects will influence the alfalfa industry as the value of water in the west increases.

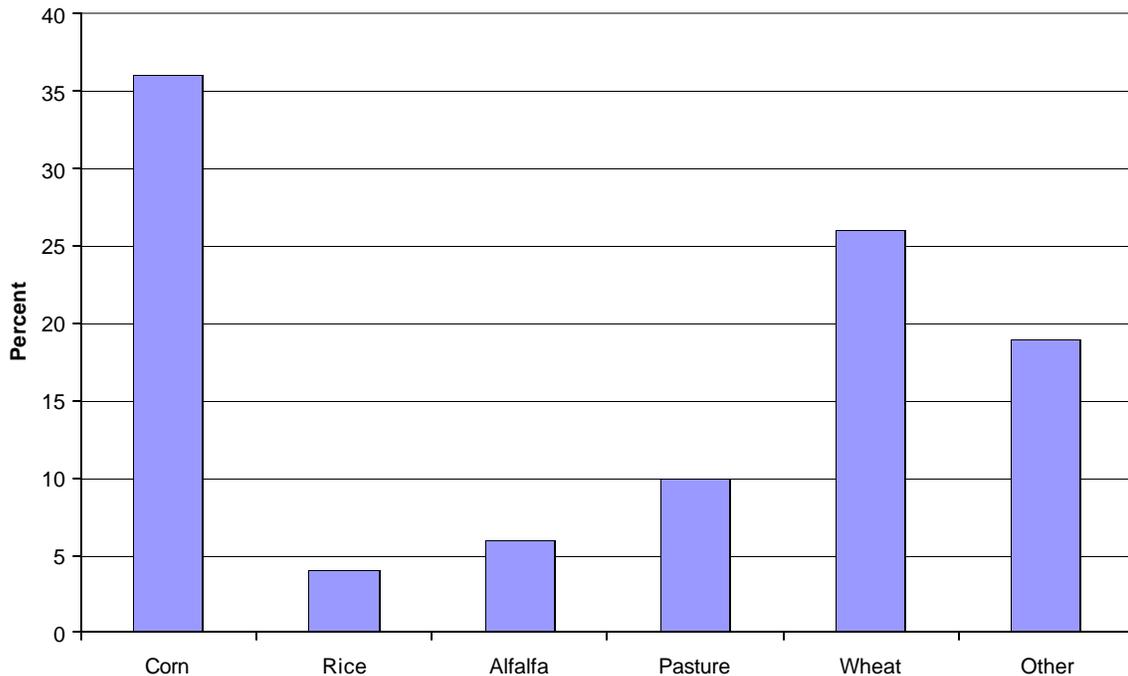


The Impact on Alfalfa of the 1991 California Drought Water Bank

In 1991 California was faced with a very severe drought. As an alternative to the political problems with mandated water transfers, a one year drought water market was organized by the State Department of Water Resources (DWR). DWR offered to buy water from fallowed crops at a price of \$125 per acre foot of consumptive use. The standard consumptive use for alfalfa was set at 4.5 acre feet in most districts, this yielded a total payment of \$450 per acre. The proportion of alfalfa fallowed was less than expected and only comprised 6% of the total acreage fallowed. Figure 4. shows that California growers were much more likely to offer corn, wheat or pasture for fallowing than alfalfa. There are three probable reasons for this reluctance to fallow alfalfa. First, alfalfa is a multiyear crop, so that the fields that can be fallowed at the least cost are those that are past their prime production, restricting the potential to 25% of the planted acres. Second, alfalfa in many parts of California is an integral part of a rotation with more valuable specialty crops. While crop data shows that rotations are not fixed proportions, the effect of a reduced proportion of alfalfa in the rotation will introduce additional costs for other crops. Third, unlike wheat and corn, alfalfa is sold on a regional market driven by a demand from the dairy industry. The “inelasticity” of the demand for dairy alfalfa means that prices usually trend upward in a drought year.

Figure 4.

Fallow Acres- California 1991



Trade offs from a California Model

The Statewide Water & Agricultural Production model (SWAP) is used to analyze the impacts of cuts in water supply, rather than changes in its price, on alfalfa production in California. Figure 5 shows the changes in the regional percentage of alfalfa grown as regional water supplies are cut. The three regions are the Sacramento valley, the San Joaquin valley, and the southern Imperial, Coachella and Palo Verde regions. In the Sacramento and San Joaquin valleys alfalfa is a much smaller percentage of the total irrigated area, and would therefore have a larger rotational effect on other crops. In the southern regions, alfalfa is a much larger proportion of the crop area, and cuts would have less effect on other crops. In this region, we see that a 35% cut in water reduces the alfalfa acreage from 28% to 19%. We can draw the conclusion that at this regional scale the effects of cuts in water supply are proportionally higher, where the amount of alfalfa grown is higher.

Figure 5

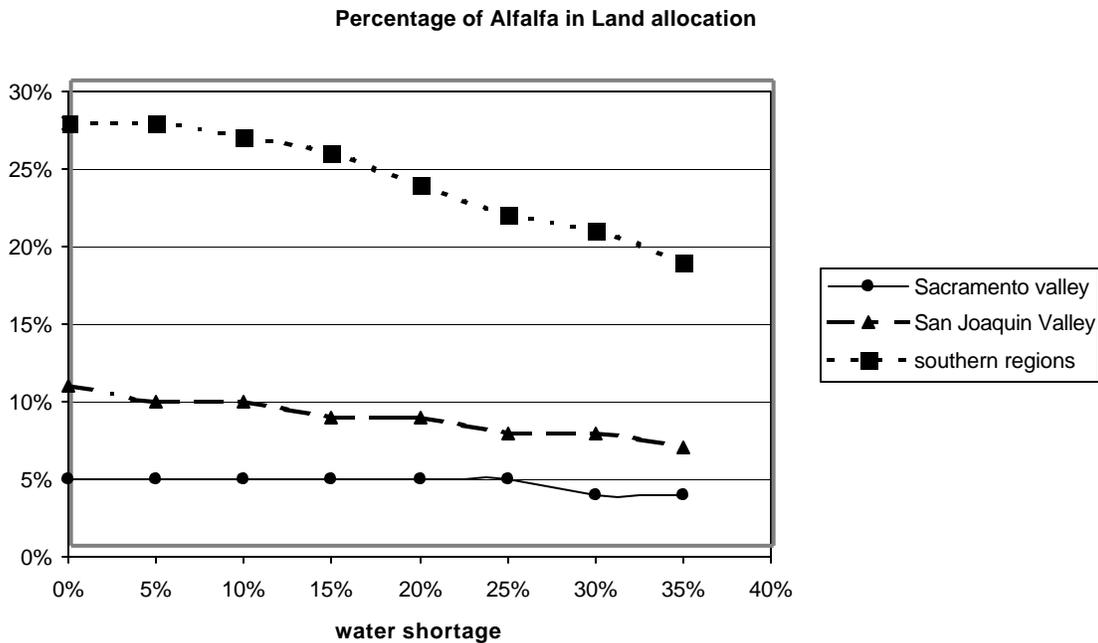


Figure 6.

Taf of water used by 1000 of acre of Alfalfa

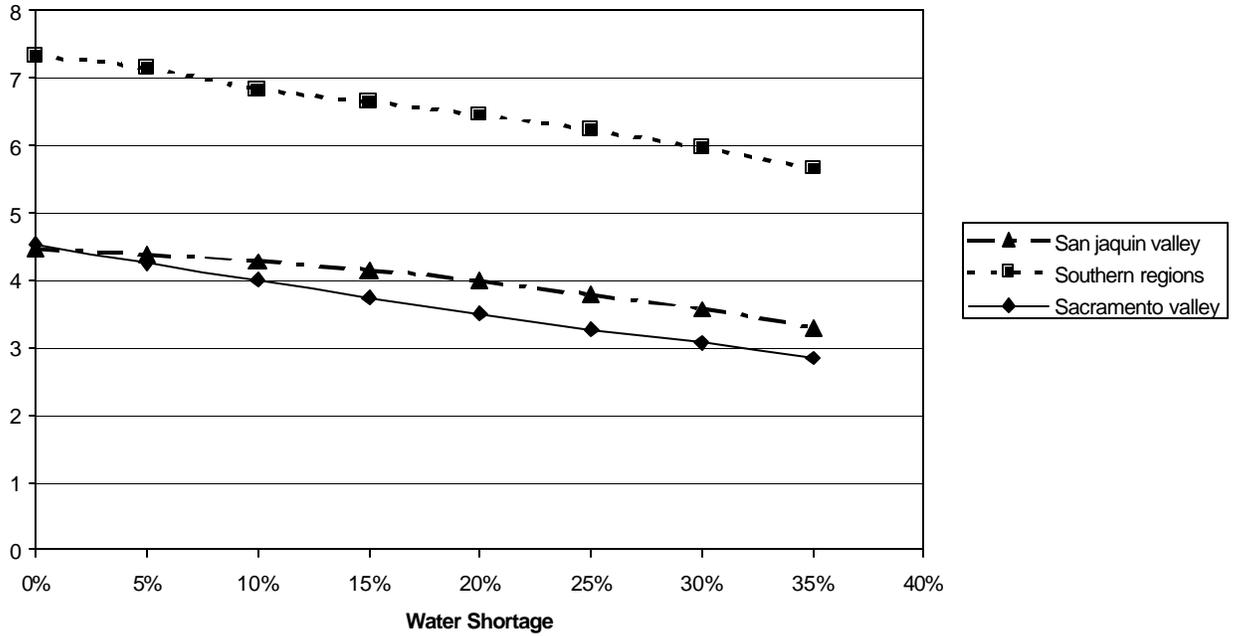


Figure 6 above shows that when water supplies are cut, growers may choose to economize by reducing the annual applied water on alfalfa. There are significant differences in the applied water between the far south and the northern and central regions in California. This is due partially to the less efficient irrigation technologies used and partly to the longer growing season and higher temperatures in the south that enable two additional cuts. However, this higher applied water does lend itself to substantial changes in the way that alfalfa is grown and irrigated in the south under more a more restricted water situation.

Figure 7.

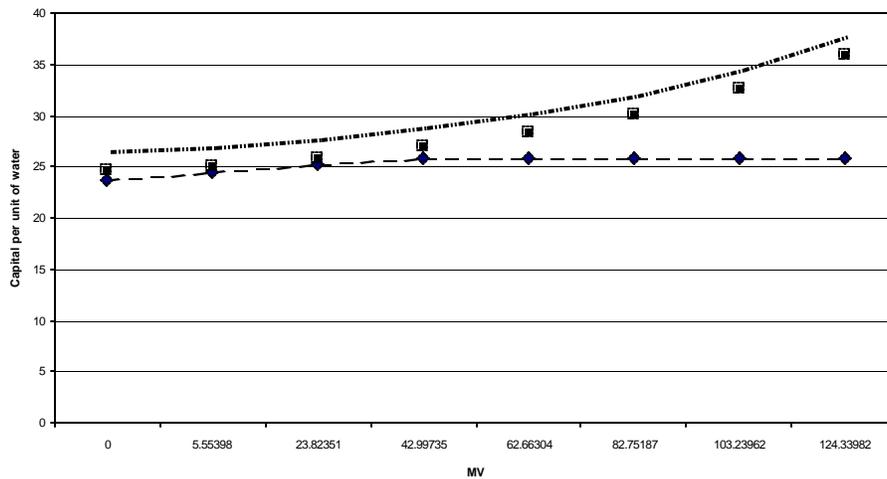
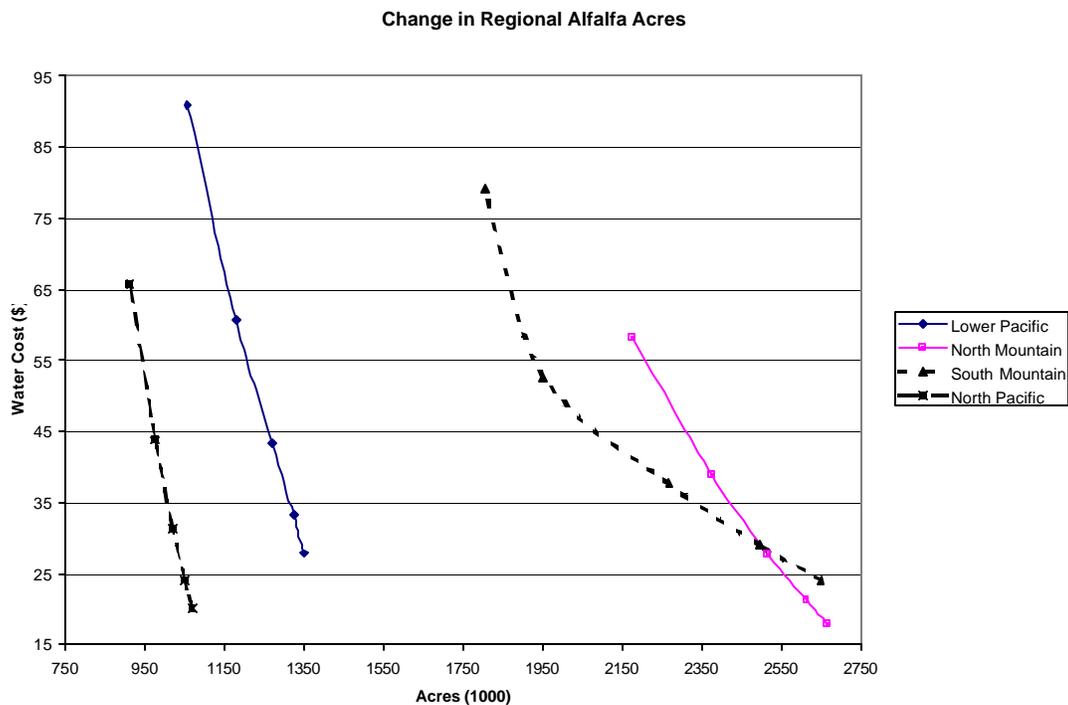


Figure 7. shows that as the value of water increases, the optimal capital investment per unit of water applied also increases. Like the labor expenditures shown in Figure 3, increasing capital investment enables reductions in applied water without a loss in yield.

Western Regional Impacts of Water Prices on Alfalfa Production

The regional effects of an increase in water prices caused by transfers or markets can be estimated using a regional model of national agricultural crop production (ARM). In this model the west is divided into four regions. Northern Mountain (Idaho, Montana, and Wyoming), Southern Mountain (Arizona, Colorado, Nevada, New Mexico, and Nevada), Northern Pacific (Washington, and Oregon) and Southern Pacific (California). Figure 8 shows the effect on the amount of alfalfa acres grown of increasing the average regional water cost in five steps- up to a 200% increase. The slopes of the different response functions show that the pacific regions are relatively unresponsive with a 200% increase in water costs resulting in only a 22% change in acres grown in Lower Pacific and 15% reduction in Northern Pacific. The South Mountain states are most responsive to water cost with a 32% change in acres, while the North Mountain states responded with an 18% change in alfalfa grown. All these results confirm that the elasticity of acreage response to water price is low, with an average value of 0.1. That is, for a 100% water cost increase, alfalfa acres are reduced by 10%. This low response rate is consistent with the results observed in the California water banks.

Figure 8



Conclusions

1. Given the growing urban and environmental demands for water in the west, water prices and values will increase. These increases will change the way that alfalfa is grown, and depending on other relative crop prices, the amount that is grown.
2. The effect of increased water prices and scarcity on alfalfa will be less than on other world commodity annual crops. Rotational benefits from alfalfa and the regional dairy demand will help to cushion the effect.
3. There are avenues of adjustment that farmers can take to partially offset the effects of higher water prices. Increased irrigation efficiency will be achieved with increased expenditures on labor and capital.
4. While on average, a doubling of water price will only induce a 10-15% reduction in alfalfa acreage, the effects will be substantially higher in regions where it is the dominant crop.