Impact of increasing energy costs on pump-irrigated agriculture

Charles V. Moore

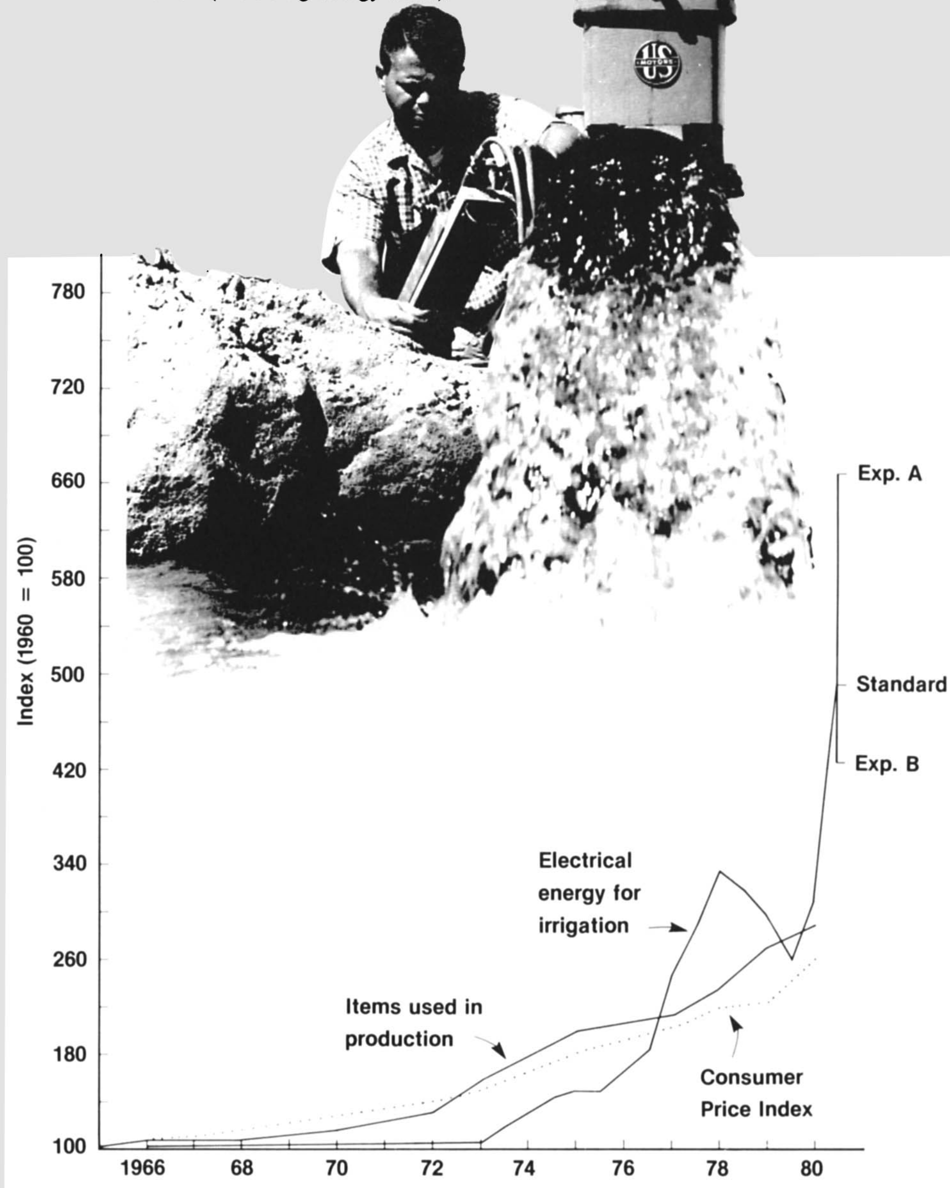
California farmers who pump groundwater for irrigation were shocked when they received their electrical power bills last summer. Rates had reached an all-time high. During the 1960s the cost of electrical energy to pump an acre-foot of water was almost constant. In fact, the real cost, compared to the Consumer Price Index or the USDA Index of Cost of All Items Used in Production, actually was declining until the OPEC oil embargo in 1973.

How will high energy costs affect the 40 percent of California agriculture which relies on groundwater pumping? To find out, we used as an example a large irrigation well and pump—250 horsepower motor with a total lift of 500 feet, pumping 580 acre-feet per year, using 852.5 kilowatt hours per acre-foot. Starting in 1960 with Pacific Gas and Electric Company (PG&E) standard agricultural power rate schedules, we calculated the energy cost of pumping for each year and rate schedule change.

The energy cost of pumping from a constant depth to water remained at $11.62 per acre-foot until 1971. Energy costs began to increase rapidly after the oil embargo in 1973 reaching $19.98 by the end of 1975. A sharp rise and fall in energy costs between 1976 and 1979 was primarily caused by the substitution of oil-fueled power plants for hydroelectric-generated power during the drought. Energy costs then leaped from a mid-1979 low point of $29.77 to a new high of $57.36 per acre-foot in April 1980.

In April of 1980, PG&E offered a new experimental rate schedule, under which rates were highest during the afternoon and lowest at night and on weekends. Using this schedule, if we assume the pump is operated 57 percent of the time during the on-peak hours of 12:30 p.m. to 6:30 p.m. Monday through Friday and 43 percent during the partial peak period of 8:30 a.m. to 12:30 p.m. or 6:30 to 10:30 p.m. Monday through Friday, the average energy cost is $69.67 per acre-foot. If the pump is operated only in off-peak hours, 10:30 p.m. to 8:30 a.m. Monday through Friday, and any time on Saturday and Sunday, the energy cost of pumping the same amount of water drops to $43.99 per acre-foot—15 percent less than the standard rate schedule and 37 percent less than the on-peak cost.

The energy cost per acre-foot was converted to an index and is plotted in the graph along with the Consumer Price Index (CPI) and the Index of Cost of Items Used in Agricultural Production (including energy costs).



Indexes of farm production costs, consumer prices, and energy for pumping water.

Everyone has felt the pinch of inflation in recent years, but since 1973 the agricultural production index has increased at a faster rate than the CPI—at an annual rate of slightly less than 11 percent, compared with the CPI compound growth rate of slightly over 10 percent. Using the standard rate schedule, the energy cost of pumping irrigation water has increased at an annual rate of about 25 percent over the same period.

Effects

Major impacts of these rapidly escalating energy costs on California agriculture are expected to occur both in the Sacramento Valley, which pumps 12 percent of the 15 million acre-feet of groundwater in the state, and the San Joaquin Valley, which pumps 63 percent. Using an estimated price elasticity of demand for irrigation water of −0.46 (from a study by R.E. Howitt, *et al*) in the long run, the Central Valley can expect a 4.6 percent decrease in water pumped for each 10 percent increase in the real cost of pumping water. A 43 percent decrease in pumping from 1973 levels can be expected once farm operators have had time to adjust crop rotations, use new irrigation technologies, and install other water-conserving practices.

Most of the southern counties, except in localized areas, will not be severely affected, because they rely heavily on surface water. Coastal counties, especially Monterey, will feel the financial effects, but the cropping mix would probably remain unchanged because of the large number of irrigated specialty crops.

Cropping patterns

No detailed data are available on which crops in the state are irrigated from groundwater, which from surface sources, or which from both. From previous studies it is known that forage crops, irrigated pasture, and small grains drop out of the cropping pattern when water costs reach $25 to $35 per acre-foot. Specialty crops like vegetables, fruits, nuts, and vines have a limited market and cannot be expanded to replace acreage left idle by reduced production of forages and small grains, even if the soils were suitable.

Prices for alfalfa hay grown under low cost surface water would rise along with a modest expansion of acreage on surface-irrigated lands as forage acreage declines on pump-irrigated lands. Higher hay prices would adversely affect the dairy and cattle feeding industries. In some areas of the Sacramento Valley, high pumping costs may cause a shift out of rice to row crops and increased acreage of dryland winter wheat and barley.

Groundwater overdraft

Except for the experimental time-varying rate schedule, PG&E has adhered to a decreasing block rate price structure. That is, as more energy is consumed, the incremental and average cost of energy decreases.

Under the 1960 schedule, neglecting the flat service charge, the energy cost of pumping an acre-foot using the rate in the lowest (last) rate block was only 46 percent of the cost of the first acre-foot pumped. This type of rate structure encouraged overdrafting of groundwater basins, because consumption of sufficient energy to place a pumper in the lowest rate block made the private cost of lifting an acre-foot of water an additional foot very small. Under the April 1980 standard schedule, however, the cost of pumping the last acre-foot (marginal cost) is 95.7 percent of the cost of pumping the first acre-foot. Thus, the penalty for overdrafting a groundwater basin was much greater in 1980 than in 1960.

The high average cost of pumping in 1980 relative to prices received by farmers for their crops will have three long-term effects. First, the price elasticity of demand will cause a reduction in the amount of groundwater pumped annually, as marginal lands and crops go out of production. Second, the economic upper limit to overdrafting a particular groundwater basin will be shortened. That is, the economic maximum depth of pumping from a given aquifer will be reduced. Third, the long-term cost of overdrafting a groundwater basin will increase significantly. The increased cost of lifting water an additional foot over the next 20 years due to an overdraft this year will be much higher than in, say, 1970. On the other side of this coin, the money saved over the next 20 years by not lowering the groundwater table this year will be sizable.

The rapid increase in energy costs of irrigation pumping and the projected continued trend in the future create an urgent need for a statewide groundwater management policy.

Mitigating measures

What can be done to lessen the impact of high energy costs on California agriculture? The rapidly increasing disparity between the cost of surface water and groundwater, both within and between hydrographic regions, creates a large incentive for transfers of water.

Suppose there are two farms: Farm P irrigates permanent pasture using canal water at a net return of $2 per acre-foot, and farm O irrigates an orchard from a deep well at a net return of $40 per acre-foot. Then the new high energy costs give farm O an average cost of $50 per acre-foot. Rather than pumping water at a $10 loss or leaving the farm, farmer O can offer farmer P a price for his water right that is greater than farm P's net return but less than $40 per acre-foot, after allowing for transportation. Both farms would be better off, and California would benefit, because it is probably better to abandon the permanent pasture than an equal acreage of orchard in this case.

A number of legal and institutional problems have to be resolved before water transfers between farms and between districts can be easily arranged. These impediments have been specified and legislative options defined in the "Governor's Commission to Review California Water Rights Law."

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Not even in California!

In the November-December 1980 issue of *California Agriculture* (page 18), two specimens of decollate snail were shown "actual size"—a laboratory-reared "giant" measuring almost 4 inches in length and a normal specimen almost 2¾ inches long. The dimensions were actually in centimeters, however, reducing the snails to a more mundane scale, as shown here.