The Impact of Surface Water Reallocations on the Eastern San Joaquin Valley

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Abstract

This study considers the impact that surface water reallocations from agriculture could have on the agricultural economy of the eastern San Joaquin Valley of California. Using simulations of ten years of surface water cuts, we report changes in ground water levels, water use, acreage, crop mix, total income, and employment.

Possible Water Reallocations from Agriculture

California agriculture is facing increasing competition for water due to measures to protect and restore natural environments damaged by past water development, as well as growing urban demand for water. The 1992 federal Central Valley Project Improvement Act (CVPIA) is one example of a reallocation of water from agriculture to many of California's rivers in order to improve fish and wildlife habitat in the rivers, in wildlife refuges, and in the San Francisco Bay-Delta Estuary. In addition, the Bay-Delta agreement between federal agencies, state agencies, environmentalists, agricultural water users and urban water interests is likely to require that more water flows into the Sacramento-San Joaquin Delta and San Francisco Bay during certain times in order to reduce salinity and help fish migrations. These developments could mean reallocation of water from agriculture that could pose significant economic impacts for agriculture and local communities.

This study looks at the economic impacts of a hypothetical water reallocation from the east side of the southern San Joaquin Valley served by the Friant-Kern Canal and the Madera Canal (the Friant Unit). The Friant Unit of the Central Valley Project (CVP) delivers water to farm land that extends from approximately Chowchilla on the north to the Tehachapi Mountains on the south, a distance of over 150 miles. We assess the economic impacts on agriculture and the regional economy made up of Merced, Madera, Fresno, Tulare, and Kern counties. In this area there is a high concentration of tree fruit, nut, and vine crops, relatively small farming units, and a significant number of rural communities.

Currently we do not know what amount of water might be reallocated from this area or exactly where the water would come from. We simulate 2 different water reallocation scenarios: water diversions from the Friant Unit of 200 thousand acre-feet (TAF) and 500 TAF annually. This is equivalent to a 9 percent and a 23 percent cut from a full delivery year of CVP water for this region. We use a model of California agricultural production to simulate the conditions of a recent ten year period that includes wet, dry, and average water delivery levels. In addition, we attempt to gauge the impact on ground water levels of surface water reallocations using a simple hydrological model. We do not allow any transfers of water outside of the region in this study. We use regional economic impact multipliers to determine the total economic effects on the region.

Simulation of Water Reallocations

To simulate a water reallocation we use a version of the Central Valley Production Model (CVPM) that was prepared by the Central Valley Project Environmental Team (a group of economic and agricultural consultants) in cooperation with the California Department of Water Resources. In the CVPM, we updated the per-acre-foot price for CVP water and the per-acre assessment charged by a number of irrigation districts to reflect recent increases due to the CVPIA. The CVPM considers 21 regions that span the entire Central Valley. We have aggregated the 21 regions into 10 regions: the 6 regions that contain users of the Friant-Kern and Madera Canals, and four regions outside of the Friant Unit.

In addition to CVP water, several other sources of surface water are available to each region. A surface water delivery system developed by the state of California, the State Water Project, provides water to some areas, mostly in the southern Central Valley. Local sources of surface water have been developed in some regions. One example is in the Fresno area where Pine Flat Dam on the Kings River provides a reliable, locally-operated supply of surface water for the Fresno Irrigation District. In addition, a number of private "ditch companies" supply water to their shareholders.

The major CVP facility that supplies water to the Friant Unit is Millerton Lake behind Friant Dam near Fresno. It holds runoff from the Sierra Nevada mountains and has a capacity of 520,000 acre-feet. This supply, coordinated with other Bureau of Reclamation reservoirs, hydro-electric utility-owned reservoirs, and U.S. Army Corps of Engineers facilities, is sufficient to satisfy only about 60 percent of the needs of all users in the Friant service area. Additional irrigation water needs are met by ground water pumping, making this a conjunctive use area.

The CVPM predicts how things will change with a change in water policy. The model assumes that growers maximize their profits by choosing how much land to allocate to which crops and what type of irrigation technology to adopt (they can lower water use by investing in more efficient irrigation technology). Growers may substitute ground water for surface water, however, they are constrained by land and water availability. The CVPM simulates what would happen with a reduction in surface water availability, and measures changes in crop acreage, gross revenue, and water use by source.

The CVPM can analyze short-run or long-run responses to changes in surface water availability. A long-run analysis estimates average conditions after farmers have made permanent adjustments, as compared to a short-run analysis that measures acreage, crop mix, and water use responses to a temporary situation. Only variable costs can be avoided in the short run, but both variable and fixed costs affect long-run decisions. Long-run acreage changes represent permanent changes in crop mix. In the long-run analysis, water use required for non-bearing acreage needs to be included to account for the average replacement rate of perennial crops. Also in the long-run, limitations are put on perennial crop acreage to ensure this acreage does not exceed an amount that could be supported during drought conditions. We use long run responses for our analysis.

The Importance of Ground Water

Ground water is an important source of water for agricultural production in the Friant Unit. Most growers, and a few irrigation districts, maintain ground water pumping facilities. Ground water availability and quality vary throughout the Friant Unit. Plentiful ground water is found on the west side of the Friant Unit where the aquifer provides easily accessed, good quality water with high gallon-per-minute flows. On the east side of the valley a thin aquifer is underlain with granite from the Sierra foothills. This area often has shallow wells with low volume.

Attempts to drill through the granite have not produced economically viable yields.

Before the Friant Dam was built on the San Joaquin River in the 1940s, growers in the eastern San Joaquin Valley depended on small surface water projects and ground water pumping for irrigation. As a consequence, ground water levels had declined. However, they rose after CVP surface water deliveries from Millerton Lake began in 1949.

To account for changes in ground water levels that might occur, we have added a ground water hydrology component to the CVPM. Forty years of U.S. Bureau of Reclamation data on surface water deliveries, changes in ground water volume, and average depth to ground water were used to develop ground water use equations for 17 Friant Unit irrigation districts.[1] Using the estimated parameters, these equations give the change in ground water level as a function of the amount of ground water pumped. Because these equations were estimated at the irrigation district level, they had to be adjusted to correspond with the CVPM Friant Unit regions which cover a much larger geographical area. No ground water equations were developed for irrigation districts outside of the Friant Unit.

A drop in the ground water table results in higher costs for growers due to an increase in power required for the increased lift. In addition, as water is pumped from deeper levels the volume of available water declines. To account for these 2 types of cost increases we developed a ground water cost equation for each region based on its current ground water level and pumping costs, as well as its underlying hydrological conditions. These ground water cost equations reflect pumping costs that increase at an increasing rate.

We use data from 1982 to 1992 to reflect the variety of weather conditions that occurred during that period. Actual surface water deliveries during that time ranged from a high of 100 percent of contracted water to a low of 25 percent. The first 5 years of the simulation reflect the relatively abundant CVP supplies that were available from 1982 to 1986. California suffered from

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1. The hydrology equations were developed by Arvey Swanson (California Department of Water Resources) and Bill Peacock and Tiffanie Simpson (Tulare County Cooperative Extension).

drought for the next 6 years from 1987 to 1992. In order to look at the cumulative effect of surface water reallocations and ground water level changes, without the impact of a drought during the final year under consideration (1992), we also simulate the last year as a 100 percent surface water delivery year for both reallocation scenarios. Consequently, we simulate 10 years of decreased surface water supplies for 4 different reallocation scenarios: a 200 TAF cut with the last year a drought year, a 200 TAF cut with the last year a 100 percent water year, a 500 TAF cut with the last year a drought year, and a 500 TAF cut with the last year a 100 percent water year.

Economic Impacts on the Region

Results from the simulations indicate that ground water will replace much, although not all, of the reallocated surface water used in agricultural production. Total water use declines (Figure 1) for all regions in the last year of the simulation period in both reallocation scenarios when the last year is a drought year. This is the result of cropping pattern changes, as well as adoption of more efficient irrigation systems. In addition, total acreage has declined (Figure 2) for each region, meaning some land has been taken completely out of agricultural production. During a drought, there is very little surface water available throughout the state, and reallocations exacerbate this critical situation. By the time the drought occurs in our simulations, prior increases in ground water pumping, to replace water lost to cuts, have caused significant drops in the ground water table and increases in ground water costs. These conditions mean ground water is now a less desirable alternative. When the last year is a 100 percent water year, total water use in 2 regions does not decline, and in the other regions the water use drop is not as great as when the last year is a drought year. Overall production acreage decreases, with a few exceptions.

By the end of ten years of simulations, the ground water table has dropped by several hundred feet in Tulare and Kern counties, even though these areas are able to recharge during abundant water years. Prior to the CVP, ground water was a major source of irrigation water in this area, and ground water levels had dropped by 250 feet. This drop caused land subsidence of 3 to 8 feet in certain areas. Subsidence has caused serious and costly problems in construction and maintenance of highways and water-transport structures. In addition, farmers have had to repeatedly level land and repair or replace deep water wells due to ruptured casings. In the 1980s, subsidence slowed considerably or stopped, but large declines in the ground water level could cause subsidence again in the southern part of the Friant Unit. During the recent drought (1987-1992), these counties experienced ground water level drops, but they have been attempting to recharge the aquifers with the more recent above average precipitation. As these simulations indicate, the cumulative effects of increased pumping could be severe. Some growers would need to install new wells, however, this is only feasible on larger acreages and in areas with a reliable supply of ground water as capital costs of drilling new wells are limiting.

The Fresno county area does not experience a falling ground water table since this area is less dependent on CVP water because of its access to Kings River water. This area also has abundant ground water and is able to recharge the aquifer during wet years. Madera and Merced counties do not see a large drop in the ground water level. This is fortunate as drops of 100 feet or more in this region could lead to serious ground water quality problems.

Falling ground water levels translate into increases in ground water pumping costs for the growers. The regions that would have large drops in the ground water table also must deal with large increases in pumping costs. These results reflect the severe reduction in water volume that could occur with significant drops in the water table. Increased ground water costs, as well as higher surface water prices, feed back into the model and result in predictions that growers switch from low value, high water-use crops, such as alfalfa and irrigated pasture, to higher value, lower water-use crops, such as citrus and vegetables. Because alfalfa and irrigated pasture are important inputs to the dairy industry, this would mean higher costs for California dairy farmers.

When the final simulation year is a drought year, as expected, the regions that suffer large drops in the ground water table take large percentages of lower-value crops out of production. This means less acreage in irrigated pasture, alfalfa, field crops, grain, and cotton. When the final simulation year is a 100 percent water year, although acreages do decline in most of the Friant Unit, the estimates are much smaller.

Revenue for pasture, sugar beets, and rice declines for all regions, and overall revenue from each crop falls when the last year is a drought year. However, there is significant variation among regions. The Fresno area only loses pasture revenue. Overall, cotton revenue falls the most, with a decline of $308 million with a 200 TAF cut, and a decline of $334 million with a 500 TAF cut. This is approximately 35 percent of the $876 million in cotton revenues for Fresno, Kern and Tulare counties in 1993. The Fresno area has an increase in overall revenue in both scenarios, and Merced and Madera counties see increases for the 500 TAF reallocation. When the last year of the simulation is a 100 percent water year the impacts are much smaller, although revenue declines overall for both scenarios. Cotton, again, has the largest overall revenue decline of $23 million and $36 million respectively for the 2 different reallocations.

Changes in gross revenue for the final simulation year are multiplied by employment and total income multipliers derived from the input-output model IMPLAN. The total income multiplier shows us the effect on total personal income (employee compensation, proprietary income, other property type income, and indirect business taxes) that results from a one dollar change in production. The employment multiplier estimates the effect on employment for every one million dollar change in production. We use these multipliers to determine the total economic impacts for the Friant Unit, as seen in Figures 3 and 4.

When the last year of the simulations is a drought year, total personal income in the region for that year declines (Figure 3) by approximately $678 million for the 200 TAF cut and $733 million for the 500 TAF cut. The total loss in regional employment (Figure 4) for that year is 17,925 and 19,430 jobs, respectively. Actual employment in the five county area in 1994 was

800,500 jobs, with 60,323 jobs in the agricultural sectors considered here. Because different regions are impacted disproportionately, the results could be significant in specific areas. Most of the impact of water reallocations will occur in the rural areas of the 5 counties under consideration. When the last year of the simulations is not a drought year, the impacts for that year are smaller. We see a decline in total personal income in the region of $48 and $75 million for the 200 TAF and 500 TAF reallocations. Employment declines by 1,229 and 1,931 jobs, respectively. The cumulative impact of surface water cuts and declining ground water tables reduces crop acreage, revenue, total income, and employment.

As the availability of surface water decreases, growers increase their use of ground water. This increasing use of ground water cannot continue indefinitely as eventually all of the economically viable ground water will be "mined." How long this takes will be determined by weather conditions. As ground water levels fall, the cost of this resource increases. Ground water cost increases induce a shift to higher value crops as well as some land fallowing. As the aquifer is depleted, growers on the east side of the Friant Unit, where the ground water table is shallow and does not supply abundant flows, will be the first to be affected by surface water cuts. Because of these geographical differences in ground water availability, many eastern Friant Unit towns could be hurt more severely than the western towns.

Ground water is an important resource to have available for use during a drought. To maintain a ground water buffer, we should encourage conservation in non-drought years along with recharge during wet years. Because the Friant Unit is a conjunctive use area in a currently overdrafted ground water basin, consideration needs to be given to the effects that surface water diversions and price increases might have on ground water levels. Optimally both water sources in the Friant Unit would be managed together in order to avoid the environmental degradation and agricultural production problems that could be the result of aquifer depletion.

Figure 1. Change in Total Water Use for the Friant Unit for the Last Year of the Simulations

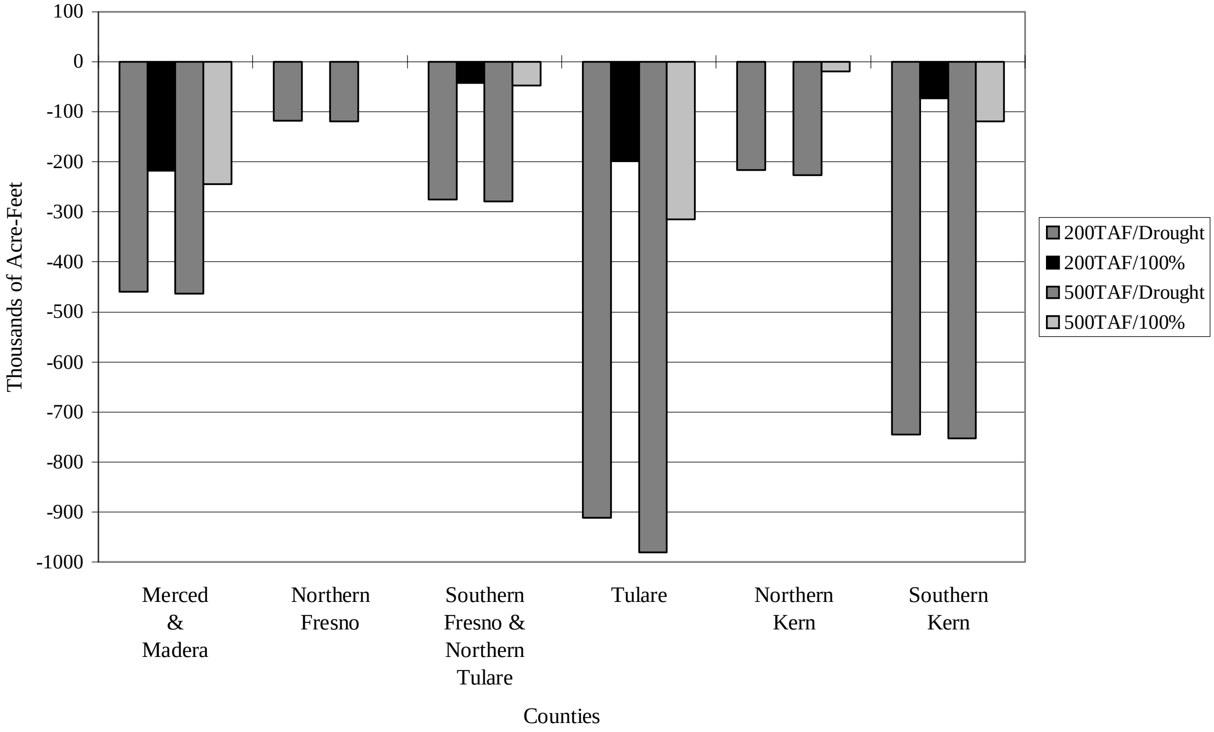


Figure 2. Change in Acreage for the Friant Unit for the Last Year of the Simulations

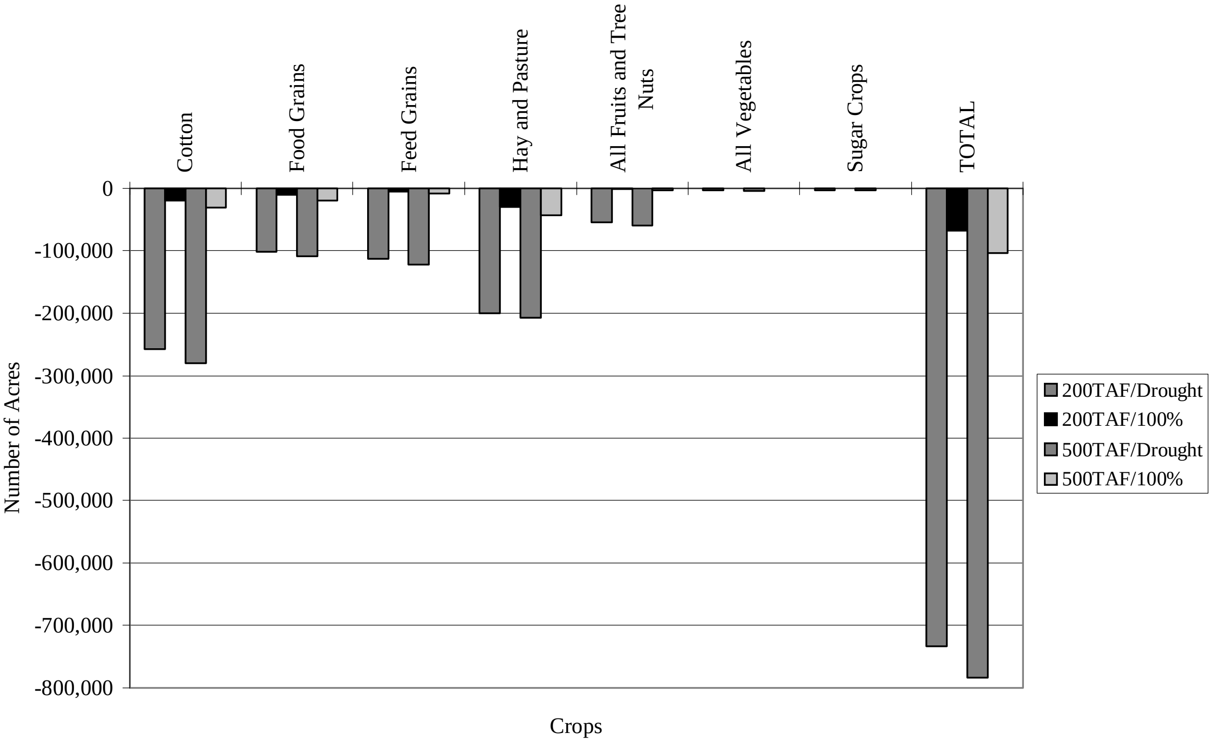


Figure 3. Change in Total Personal Income for the Friant Unit for the Last Year of the Simulations

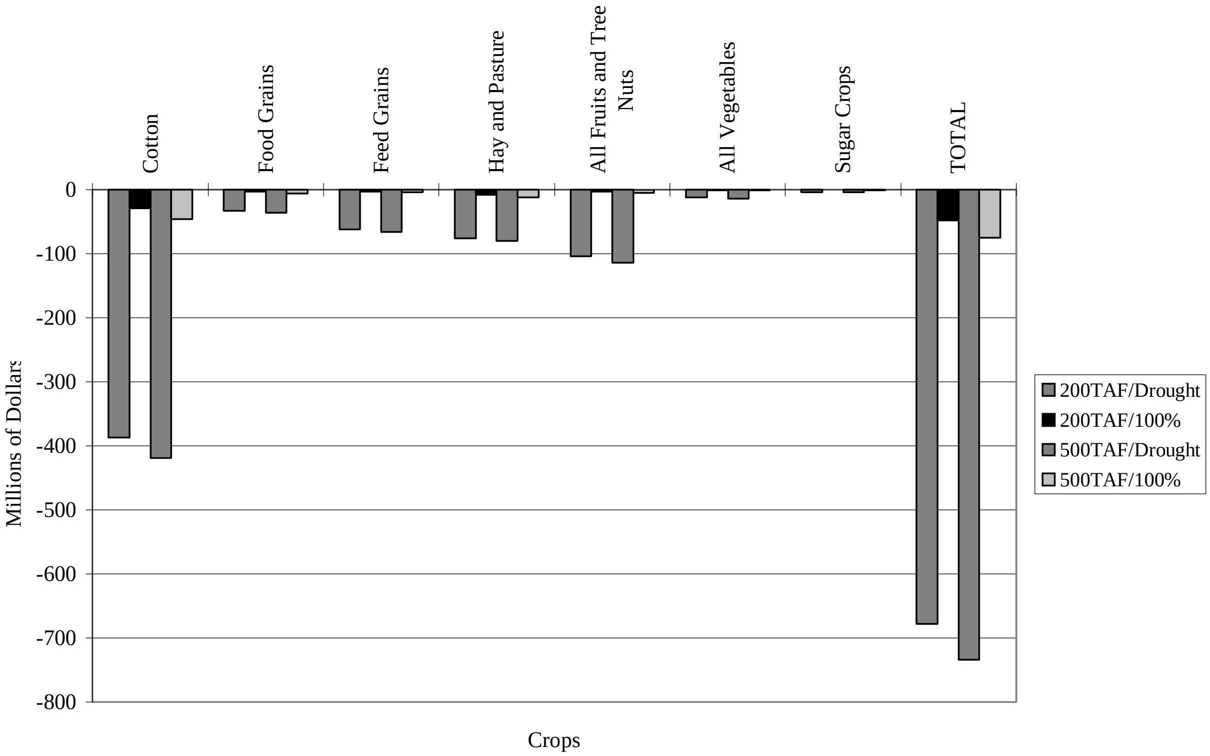
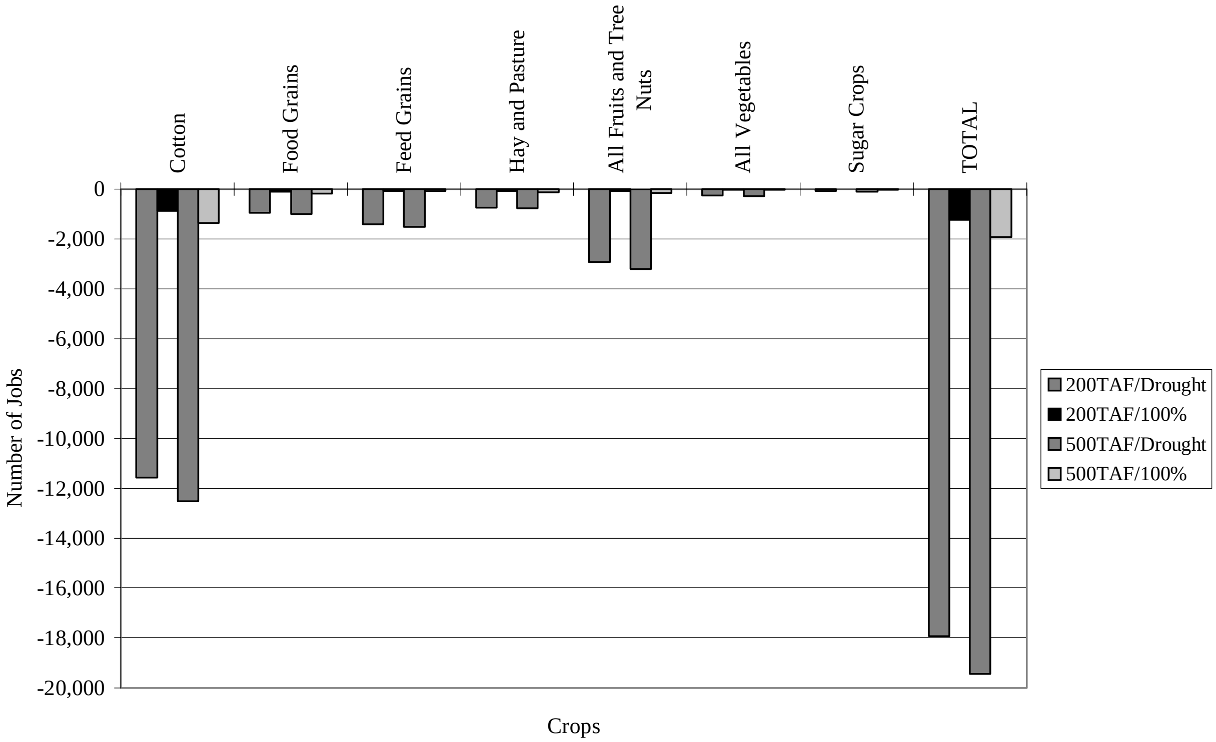


Figure 4. Change in Employment for the Friant Unit for the Last Year of the Simulations



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