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Water Pricing for a Dry Future: Pricing Policies from Abroad and Their Relevance to California

Ariel Dinar and David Zilberman

It is raining again in California. How long will it last and how effective will it be in addressing the long-term water scarcity that the state faces? We live in a water-scarce, drought-prone state and this fact has to be taken into account in shaping water conservation policy. At a recent water-pricing workshop, co-sponsored by the Giannini Foundation, leading scholars from several countries presented case studies. These illustrated how water-pricing mechanisms have been used creatively throughout the world for promotion of water conservation under water-scarce situations.

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Like other regions, California faces endemic water scarcity problems—droughts. California experienced in 2015 perhaps its most serious drought of the past 100 years. California has faced many other serious droughts, such as in 1923–1924, 1976–1977, 1986–1991, and 2013–2014, and may face even more severe droughts in the future. California must evaluate and redesign its water policies and institutions to address growing water scarcity challenges. But California's deteriorating water availability situation is not unique, as can be seen in Figures 1 and 2.

Water scarcity (measured as available renewable water per capita per year) is increasing in many regions and each has developed its own response strategy by implementing water-use quotas, water-rights trading, promotion of water conservation technologies, and water pricing. Available water-pricing mechanisms include a wide range of schemes, ranging from simple cost recovery to sophisticated economic incentives in the form of block rate structures.

As California considers how to design its water policies, the experience of other countries may provide important lessons. Here, we provide a synthesis of insights from the experience of regions around the world based on selected presentations at a recent conference co-sponsored by the Giannini Foundation. For more information readers are referred to Dinar et al. (2015). We emphasize the experience of regions similar to California, such as Australia, Chile, Israel, and Spain.

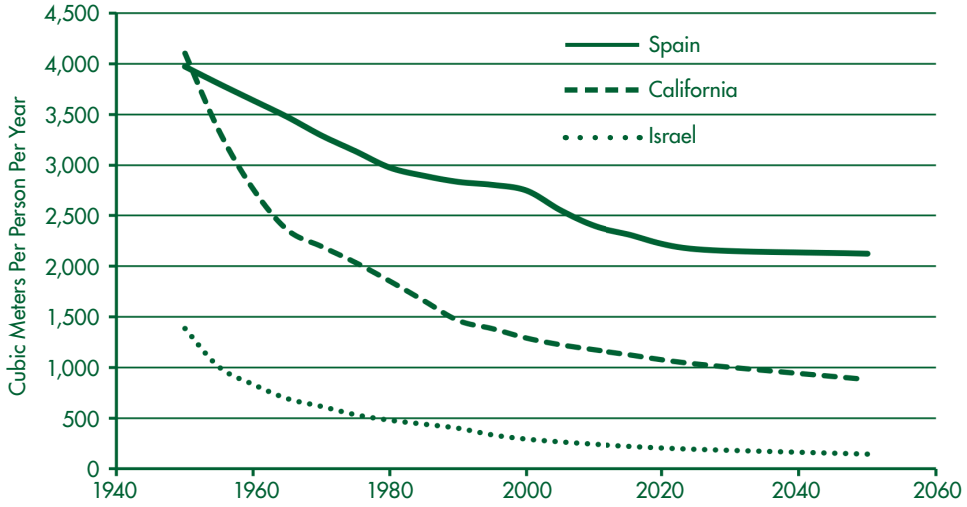
Australia

Australia is the driest continent in the world. Most of the population lives in eastern Australia and relies mostly on the Murray-Darling basin for water. Australia has suffered severe droughts; the most recent, The Millennium Drought, lasted from 2002–2012. Australia is a federation of states; each state controls and prices its own water, but water allocation from the Murray and Darling rivers has been a transboundary challenge, creating disadvantages to downstream states.

Australia reformed its water pricing in 2010, changing its allocation principles across states and sectors (urban, rural, and environmental). Water pricing is based on differentiated prices according to end use. Urban water is provided by public utilities, and irrigation water is managed by irrigation districts. There is a shared commitment to full-cost recovery by states and water sectors, although their political will to maintain it is sometimes weakened, especially during droughts.

One creative principle established in the reform guidelines is that rights to water among the users are allocated proportionally to the available supply. This is in contrast to California's prior appropriation system where users are granted a fixed quantity of water rights, and

Figure 1. Change in Renewable Water Availability Over Time for Spain, California, and Israel (cubic meters per person per year), 1950–2050



Sources: Available water resources in countries except California: CIA Sourcebook 2015. www.cia.gov/library/publications/the-world-factbook/fields/2201.html.

Long-term water resources availability in California: Hanak, E., J. Lund, A. Dinar, B. Gray, R. Howitt, J. Mount, P. Moyle, B. Thompson, "Managing California's Water: From Conflict to Reconciliation." San Francisco: PPIC, 2011.

Population in all countries except California: United States Census Bureau: www.census.gov/population/international/data/idb/worldpopgraph.php.

Population in California: California Department of Finance, Report P-1: Summary Population Projections by Race/Ethnicity and by Major Age Groups.

Note: Population values until 2015 are actual. Population values between 2020 and 2050 are based on medium growth estimates.

vary only in their seniority. The reform also established regulations of groundwater that require licenses for agricultural use. The system allows for water trading between utilities, taking into account third-party impacts, and recognizes the benefits of environmental use.

Water pricing reflects scarcity but emphasizes fairness, and includes a significant fixed cost and variable components with increasing block rates. The financial sustainability of the system is challenged during periods of long droughts where it may encounter revenue shortfalls. The system relies on water metering, education, public participation for demand adjustment during periods of shortages, and investments in recycling water and water conservation. Water management in Australia aims to combine efficiency, fairness, environmental and financial sustainability, and seems to perform well.

Chile

Chile is a long and narrow country; most of its water resources are in the South, with most demand in the North. Much of the runoff from the Andes is used for non-consumptive generation of hydroelectric power. Agriculture accounts for 73% of the consumptive water use, with the remaining used for industrial, mining, and urban purposes.

In 1981 Chile introduced a new market-based water code and became a poster child for market-based allocation of water resources. While water is defined as a 'national property for public use,' the new system granted permanent and transferrable water-use rights, with no distinction between sectors and prioritization. This system enabled permanent sales and transfers of water rights across basins, as long as basic sustainability constraints (protection of third parties, protection of ground water storage, etc.) are met. However, water allocation to meet environmental objectives was minimal and the Water Code Reform of 2005 established ecological requirements that are now enforced.

Water prices vary significantly across locations and throughout the year (by orders of magnitude of 100 to 1), not surprising given differences in scarcities, demand, and the cost of water conveyance across regions and seasons. The small fraction of water traded (5–10%) suggests that the initial allocation is reasonable. But still, transfers have facilitated new developments in mining in northern Chile, growth in grape and wine industries, and meeting growing urban demand in central Chile. As water becomes a tradable commodity, it provides incentives for water-use efficiency across sectors.

State-regulated utilities allocate water to urban users. Water prices combine economic efficiency, equity, and affordability objectives subject to full-cost recovery constraints. Water systems are designed to ensure continuity and quality of water provisions and maintenance of sanitation conditions. Water is made affordable for the poor through direct subsidies based on annual surveys. Thus, in the Chilean system, all households are aware of the market price of the water they consume, yet the poor ones are subsidized based on economic criteria.

The Chilean system is challenged by the need to expand ecological flows and to ensure long-term sustainability of rivers and aquifers. In addition, there are concerns with respect to sustainability of groundwater extraction and deterioration of water-dependent ecosystems due to over-allocation of water rights.

Israel

Israel has a high degree of water scarcity (Figure 1), and its population quadrupled over the past 60 years.

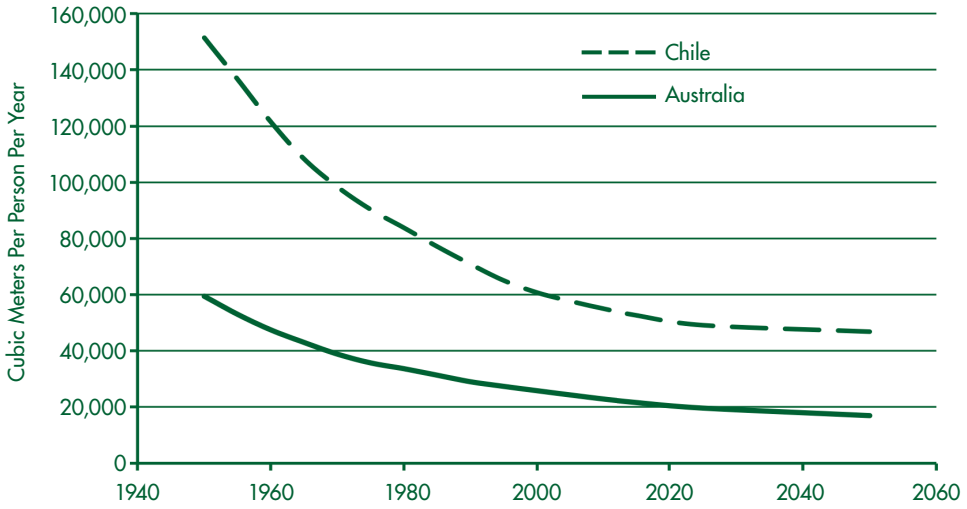
Water is owned and managed by the state, using direct controls and pricing. Currently, water prices reflect the true scarcity of the resource, and are set to about $1,000/acre feet for irrigated agriculture and about three times that for household consumers. Water pricing varies according to source (treated wastewater, desalinated water, groundwater, storm water, surface water, etc.) and use, including non-market nature uses (e.g., in-stream value).

The ever-present extreme water scarcity in Israel has led to the continuous development and adoption of creative technologies and institutions. Between the late 1960s and 1980s, there was widespread adoption of drip irrigation as well as irrigation scheduling; these techniques are now based on monitoring weather and soil conditions. Unlike California, the government monitors all groundwater use and extraction of groundwater is based on a permit system to prevent groundwater depletion and seawater intrusion.

Since the 1980s, the Israeli government encouraged and incentivized the reuse of water for various activities, based on the treatment of wastewater, with differentiated pricing based on water quality. Over the past 20 years, there has been a gradual introduction of desalination plants that today provide roughly 20% of the country's water use. The cost of desalinated water is $600 per acre-foot.

Currently, Israel is using 55% of its freshwater for municipal and industrial use and the rest in agriculture; and the country benefits from an additional source: 85% of wastewater is recycled for agricultural use and aquifer recharge. The introduction of desalination and recycling of water stabilizes the water situation in Israel, with periods of over-supply of recycled water. The water sector in Israel continues to have its own set of challenges, including transboundary water allocation with its neighbors, such as Jordan and the Palestinian Authority.

Figure 2. Change in Renewable Water Availability Over Time for Chile and Australia (cubic meters per person per year), 1950–2050



Source: Population in all countries except California: United States Census Bureau: www.census.gov/population/international/data/idb/worldpopgraph.php.

Population in California: California Department of Finance, Report P-1: Summary Population Projections by Race/Ethnicity and by Major Age Groups.

Note: Population values until 2015 are actual. Population values between 2020 and 2050 are based on medium growth estimates.

Spain

Spain faces increasing frequency of droughts and severe water pollution. Historically, water allocation was done through water rights, and users of surface water paid river basin authorities. Prices were supposed to cover both water conveyance and wastewater treatment. In most cases, regional water utilities were not able to recover operational costs and were subsidized by the government.

Groundwater users were paying for their own pumping cost with little monitoring of aquifers. Most farmers (80%) were paying for water on a per-acre-basis and urban water consumers were paying low rates compared to other countries in the EU with several increasing price blocks. Given the growing pressure on the water system, it is going through gradual change.

Reforms were introduced first in water-scarce regions. They included an introduction of volumetric pricing in agriculture and supply expansion by desalinization and wastewater recycling. Higher water prices resulted in the adoption of water conservation technologies, especially with high-value crops. Block pricing continues in the urban sector, and the main means to reduce water use are education and incentives for installing water conservation technologies.

Consumer groups opposed the introduction of the EU Water Framework Directive in Spain because of its equity impact. Similarly, agricultural groups opposed the introduction of the 2014 reform of the Common Agricultural Policy (CAP) because of its distributional effect on regions and crops. The Spanish water system is in need of reform, but the challenge is to find the political will to implement it.

Summary and Lessons for California

The case studies presented here illustrate that water markets and pricing approaches evolve over time. Increased resource scarcity, concerns about environmental quality, and

Mini station of the water pipeline in Negev desert in Israel. The ever-present extreme water scarcity in Israel has led to the continuous development and adoption of creative technologies and institutions.

growing demand exacerbate pressure to introduce more efficient water allocation systems. But introducing new institutions, such as pricing and water markets, faces political challenges due to resistance from beneficiaries of the status quo and difficulties in reaching agreement on reforms. Therefore, we find that reforms occur mostly after crises (e.g., a drought or political regime change), and reforms take hold gradually.

The countries and regions that live with the highest levels of water scarcity are the ones more likely to introduce more radical solutions. It is no wonder that Israel has the highest prices of water, monitors all groundwater withdrawals, and relies heavily on intensive water conservation technologies and on desalination and water recycling. The droughts in Australia, and the uneven geographical distribution of water resources in both Australia and Chile, led in both countries to introduce water trading, high water pricing, and increased conservation. In Spain, increased financial pressures led to a transition from reliance on large-scale water projects to the introduction of conservation and recycling.

Settlement in California began during periods of relative water abundance and the establishment of a water-rights system and large water projects in order to accelerate economic activity. But growing demand for water and environmental amenities led to increased scarcity followed by gradual change in water allocation and utilization, mostly during and after periods of drought.

Institutionally, water subsidies have been declining over the past three decades, while water trading has increased. These changes have contributed to increased water-use efficiency in conveyance and irrigation, and more diversion of water for environmental purposes. However, groundwater resources continue to be depleted and recent legislation may lead to increased efficiency in its use. Yet, there remains the potential to increase the level of water trading and increased water supply by desalination and recycling.

A key to sound decision-making is to establish water-pricing mechanisms that reflect the economic value (broadly defined to include environmental objectives) of the water. But such systems must also be designed to take into account equity considerations, which is a major challenge, especially when legal constraints prevent techniques like tiered pricing. There are indications that water pricing can benefit from improved monitoring of water use and adjusting water use in response to weather, climate, and biophysical conditions.

Water systems are a work in progress; their design is an art that is done under uncertainty, draws on economic principles, and must integrate efficiency, equity, and technology considerations. Mutual learning from experience of other regions can only serve to improve California's water system performance.

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For additional information, the authors recommend:

Dinar, A., V. Pochat, and J. Albiac (Eds.), *Water Pricing Experiences and Innovations,* Berlin: Springer Publishing, 2015.

Growers' Assessments of Challenges Facing the California Rice Industry: Past and Present

Zoë T. Plakias and Rachael E. Goodhue

Rice growers in California face many challenges in 2016. In this piece, we consider current challenges cited by growers and their relationship to past challenges in the industry.

In January and February 2016, we administered a survey to California rice growers covering several topics. The survey listed a number of potential challenges facing agriculture and the California rice industry today. Respondents were asked to indicate the top three challenges currently facing their operations. Our survey results represent the opinions of 300 farm operators (about 12% of California rice operations), who accounted for roughly 24% of 2015 California rice production.

Main Challenges

Figure 1 shows the share of growers citing each challenge as among the top three challenges currently facing their operation. Challenges labeled with an asterisk are challenges not listed on the survey that were written into an open "other" category.

Three challenges stand out among the rest: water availability, low or unstable output prices, and environmental regulations. Nearly 99% of growers cited at least one of these as among the top three challenges facing their operation, and 16% of growers cited all three.

Of course, none of these challenges are new. Rice growers in California have been dealing with them for 100 years. While rice had been experimented with previously, the birth of rice production began in earnest with University of California agronomist W.W. Mackie's successful experiments growing Japonica rice in the town of Biggs in 1908, as highlighted in Willson's 1979 book, *Rice in California*. The commercial rice industry in California became established in the following five years.

Water Availability

Water availability is the challenge most commonly cited by growers; this is not surprising in the fifth year of drought in California. What may be more surprising is that nearly 18% of growers *did not* cite water availability (or water cost) among their top three challenges.

This result could be an indication that some growers are in areas where water availability seems more secure, some are adapting to drought conditions, or simply that other challenges are more significant than the drought. One important observation for either possibility is that growers responded *before* the Bureau of Reclamation announced a 100% allocation of Central Valley Project water to Sacramento Valley growers on April 1, so the responses aren't driven by that 2016 announcement.

Compared to respondents who did not consider water availability as a top three challenge, growers who did consider it among their top three have a significantly higher percentage of output that's organic, significantly fewer years of experience growing rice, and are significantly less likely to cite farming as their sole occupation, as shown in Table 1.

Water is one of the most contentious topics in California at present. And despite increased allocations for some California farmers this spring, water allocation and water policy is a high priority area for many

Figure 1. Top Three Challenges Facing Rice Operations Today (N=279)

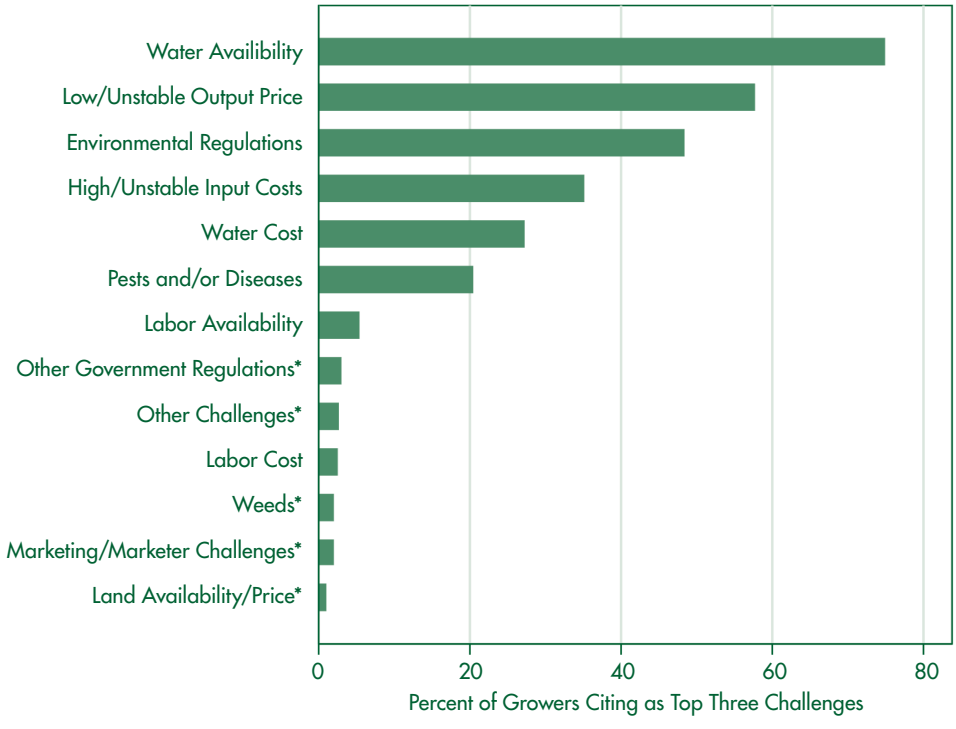


Table 1. Differences in Producer Characteristics by Challenge			
	Top Three Challenge	Not a Top Three Challenge	Difference
Water Availability			
Average percentage of acres rented from another landowner	48.77	49.61	-0.84
Average percentage of production that is organic	5.26	0.92	4.34*
Average percentage of production marketed through a co-op	33.65	40.05	-6.4
Average percentage of production marketed in cash sales	17.37	20.61	-3.24
Average years of experience producing rice	29.46	32.09	-2.64*
Share of respondents with farming as a sole occupation	0.62	0.73	-0.11*
Share of operations with gross farming income over $500K	0.5	0.48	0.02
Share of respondents that are Republican	0.66	0.72	-0.06
Low or Unstable Output Prices			
Average percentage of acres rented from another landowner	52.72	43.93	8.78*
Average percentage of production that is organic	2.45	6.62	-4.17*
Average percentage of production marketed through a co-op	30.03	42.27	-12.24*
Average percentage of production marketed in cash sales	22.69	12.05	10.63*
Average years of experience producing rice	29.37	31.17	-1.8
Share of growers with farming as a sole occupation	0.66	0.63	0.03
Share of operations with gross farming income over $500K	0.53	0.45	0.08*
Share of respondents that are Republican	0.71	0.63	0.08*
Environmental Regulations			
Average percentage of acres rented from another landowner	48.28	49.66	-1.38
Average percentage of production that is organic	2.74	5.54	-2.80
Average percentage of production marketed through a co-op	37.52	32.92	4.6
Average percentage of production marketed in cash sales	16.36	19.99	-3.63
Average years of experience producing rice	31.35	28.93	2.42*
Share of growers with farming as a sole occupation	0.69	0.61	0.07
Share of operations with gross farming income over $500K	0.53	0.46	0.06
Share of respondents that are Republican	0.74	0.61	0.13*

Note: Stars denote statistical significance at the 10% level or below

policymakers, leading to uncertainty about the future of agricultural water supplies in California. Such uncertainty is not unique to present times.

Periodic uncertainty, especially during drought times, is a perennial of California agriculture. Indeed, the early history of water in California agriculture was plagued by supply uncertainty. At first, as water distribution infrastructure was being built, promises made by water companies to rice growers were not met. Some of California's first rice crops failed due to late deliveries of water. And droughts, of course, are also not new to California.

Low or Unstable Output Prices

The second most common challenge cited by respondents was low or unstable output prices. Figure 2 shows both nominal prices received as well as prices deflated by the GDP Implicit Price Deflator, converted to 2015 dollars. While both nominal and deflated prices for rice have been relatively high recently, as compared to the last several decades, deflated prices are not high relative to pre-1981 levels; and the relatively low prices that persisted from 1981 into the early 2000s are fresh in the minds of growers.

Furthermore, since quantities have been reduced during the drought, to maintain farm income farmers must earn a higher price for what rice they do sell. California rice farms are eligible for farm price and income support programs, but they have provided little or no payments in recent years because prices have been relatively high. USDA-subsidized crop insurance is available, but has also provided relatively little benefit.

As shown in Table 1, relative to other respondents, those citing low or unstable output prices among their top three challenges rented a significantly higher percentage of their land in production. They also marketed significantly more of their output

through cash sales and significantly less through co-ops. They were significantly more likely to have gross income from farming (for all crops, not just rice) of greater than $500,000. These growers also had a significantly lower percentage of output that was organic.

Finally, they were significantly more likely to indicate that they were affiliated with the Republican Party. Possible responses to this question in our survey included all registered political parties in California, along with "I do not have a party preference (Independent)" and "I prefer not to answer."

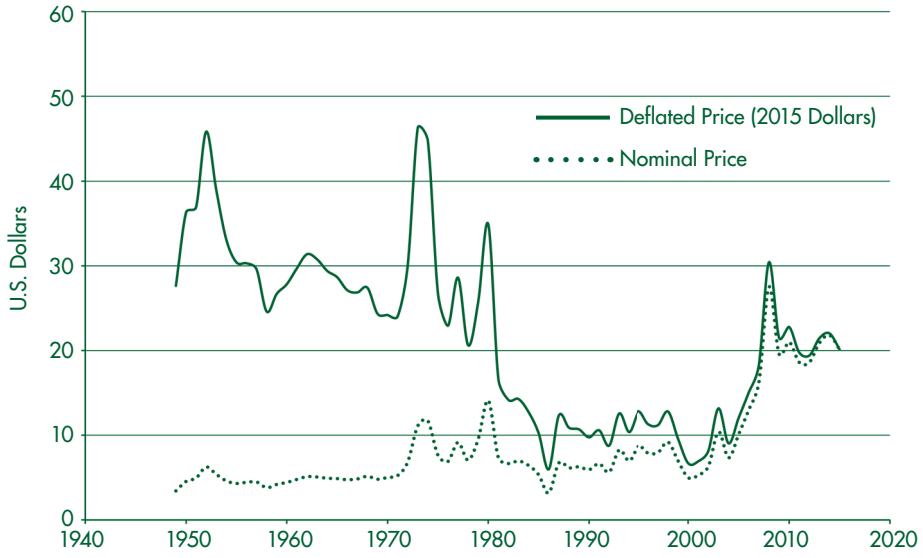
A handful of respondents utilized the option to name another challenge to state that marketers and millers in the rice industry are to blame for low output prices. This point of contention is not new. One of the first main conflicts between millers and growers in the rice industry came very soon after rice was first produced commercially.

In 1920 the Pacific Rice Growers Association (PRGA) contracted with millers to mill their rice, but the price of rice fell well below what the board had agreed would be their minimum acceptable price. Despite the fact that PRGA rice was sold by a control committee with a majority of seats held by PRGA members, growers accused millers of selling rice on the open market behind the backs of the control committee and thus bringing the price down.

Millers, in turn, accused growers of not pricing their rice to compete in a market that was weak due to changing macroeconomic conditions rather than micro-level manipulations. The conflict was one of the contributing factors leading to the reorganization of PRGA into the Rice Growers Association of California a year later, in 1921.

Of course, it is no surprise to see the economic incentives of buyers and sellers at odds. Farmers and buyers, in an effort to do what's best for their businesses, have incentives to keep revenues high and costs low. Resolving this conflict for the long-term health of the industry requires both sides recognizing and acknowledging the others' incentives. No doubt, even with a concerted effort, this will continue to be a point of discussion among industry members, as it was as early as 1920.

Figure 2. Nominal and Deflated Prices Received (dollars per hundredweight)



Sources: United States Department of Agriculture National Agricultural Statistics Service. 2016. "Quick Stats." http://quickstats.nass.usda.gov/.
Federal Reserve Bank of St. Louis. 2016. "Gross Domestic Product: Implicit Price Deflator." https://research.stlouisfed.org/fred2/series/GDPDEF/downloaddata

Environmental Regulations

The third most common challenge cited by growers is environmental regulations. These regulations relate to air and water quality, as well as water quantity. They affect growers' use of machinery, irrigation, disposal of rice straw after harvest, discharge of water, and other activities.

There were two significant differences between those citing environmental regulations as a top-three challenge and other growers: those growers citing environmental regulations challenges had significantly more years of experience growing rice and and were significantly more likely to cite "Republican" as their party preference. Results are reported in Table 1.

Adaptation to environmental regulations has been a major focus of the California rice industry through much of its history. The current work of the California Rice Commission (CRC) and Rice Research Board (RRB) both focus on projects related to meeting environmental regulations. The RRB was established in 1969, the newest iteration of a research organization formed in 1912. At the same time, environmental concerns were emerging nationally and in California; the U.S. Environmental Protection Agency was formed in 1970 and the California Air Resources Board (CARB) was formed in 1968.

This increasing emphasis on environmental quality affected how rice was produced in California. For example, around the same time, restrictions on the aerial application of certain herbicides used for rice production were implemented due to concern about drift onto non-target species. These restrictions prompted research into alternatives by the RRB. Later in the 1970s, water quality and water management research became more significant factors for rice production due to increased regulation, such as passage of the Clean Water Act in 1972.

Air quality regulation has altered how California rice land is managed. CARB became an important stakeholder in rice straw management. By 1971

Water availability is the challenge most commonly cited by growers, which is not surprising in the fifth year of drought in California.

CARB was already indicating specific "burn" and "no-burn" days that were affecting the rice industry. Then, in the early 1990s, the California state legislature passed a bill phasing out the burning of rice straw, a common way of disposing of rice straw after harvest.

An industry association, the California Rice Industry Association, ultimately decided to endorse the ban and began working with environmental groups to develop alternative methods of disposing of rice straw. It also began proactively addressing environmental issues to preempt additional regulation. The CRC, formed in 1999, continues these efforts, working with groups such as the Nature Conservancy, the California Department of Pesticide Regulation, and others to address environmental issues.

Implications for the Future

There are two ways that we can think about the top three challenges identified by rice grower respondents. On the one hand, it could be disheartening to see that after 100 years of innovation in the rice industry, the same problems are still not "solved." However, there's another way to look at this history. Whenever the bar has been raised, whether by consumers or policymakers, or by those within the industry itself, the industry has risen to meet the challenge.

This continues today. New innovations and changes are on the horizon. For example, a pilot project testing drip irrigation technology on rice is in progress in Yolo County. New businesses, such as the Rice Growers Association in West Sacramento, are rising from the ashes of old ones. Rice farmers are now generating carbon credits for taking voluntary measures to reduce their greenhouse gas emissions in their rice operations.

While the industry faces many challenges today, its history tells us that these problems have been faced before, and predicts that the industry will succeed in facing them again.

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Zoë Plakias is a Ph.D. candidate and Rachael Goodhue is a professor, both in the Department of Agricultural and Resource Economics at UC Davis. *This work is part of a larger ongoing project that considers the role of producer organizations in several industries in California, including the rice industry. Funding for this project comes from the Giannini Foundation of Agricultural Economics and the United States Department of Agriculture National Institute of Food and Agriculture (Agriculture and Food Research Initiative Competitive Grant, Award 2014-67023-21880). The authors are grateful to Dan Sumner for his comments.*

For additional information, the authors recommend:

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California Agriculture: Water, Labor, and Immigration

Philip Martin

Farmers fear shortages of water and labor. Both have been in short supply in recent years due to drought and reduced Mexico–U.S. migration. California agriculture may be at a crossroads on both issues, facing higher costs and more uncertainty about the availability of two critical inputs.

California's last "normal" water year was 2011, when farm sales were $43 billion. Table 1 shows that during the 2012–15 drought, farm sales rose to $47 billion in 2012, $51 billion in 2013, and $53 billion in 2014. In some cases, smaller volumes of produce can result in higher prices, but this did not occur during the drought years.

California has nine million irrigated acres of farm land, and agriculture normally uses 33 million acre feet of water. About 500,000 acres were fallowed in 2014 and 2015, resulting in up to 10,000 fewer farm jobs. In normal water years, 60% of agricultural irrigation water is surface water and 40% is ground water.

In dry years, these ratios are reversed, as groundwater pumped from underground aquifers replaces surface water. California in 2014 became the last western state to regulate groundwater pumping, enacting laws that created local groundwater sustainability agencies to register private wells, monitor the water-measuring devices that must be attached to pumps, and regulate groundwater pumping to avoid depleting groundwater.

The 2015–16 water year was normal. The state's 154 major reservoirs on April 1, 2016 held almost 22 million acre-feet of water, 85% of normal, so that federal and state farm-water contractors are likely to get half or more of their contracted water. Each water district contracts for a specific share of the surface water available to the federal Central Valley Project and the State Water Project, and CVP and SWP managers provide a percentage of each district's contracted water based on availability.

Three factors shape the longer term outlook for water and agriculture. First, most climate-change models expect warmer winters that are less suited to California's water storage and transport system. If more precipitation falls as rain rather than snow, the capacity of dams and reservoirs to store water for summer irrigation is reduced. Agriculture could cope by changing seeds and farming practices to use less water, but such changes could lower yields and increase labor costs. Alternatively, lower-value forage crops such as alfalfa for dairy cows could be grown outside California, freeing up water for higher-value crops.

Second, is the hardening of the demand for water, as trees and vines that must be watered for 20 to 30 years replace annual crops on land that can be fallowed in dry years. For example, the acreage of almonds, which normally receive three to four acre-feet of water a year, more than doubled over the past three decades to 900,000 acres, while cotton declined from 1.6 million acres in 1980 to 160,000 acres in 2015.

Third, is water marketing to shift water around the state, so that some of the farmers who grow rice and other water-intensive crops in the Sacramento Valley could fallow their land and sell their water to farmers who grow higher-value crops in the San Joaquin Valley. If farmers were to acquire property rights in ground water, they would have incentives to buy water in wet years and recharge aquifers.

Labor

The average employment of hired workers in California agriculture rose 12% over the past decade, reaching 415,000 in 2014. Average employment is a measure of full-time equivalent jobs, not unique farm workers. Some 829,000 unique workers filled these jobs, a ratio of two workers per FTE job, reflecting seasonality (employment rises 20–30% in the summer months), and turnover, as many workers are employed only a short time on farms.

Average employment has been rising because the expansion of some labor-intensive crops, such as berries, more than offsets jobs lost to labor-saving mechanization in others such as raisins. Figure 1 (page 10) shows the shift from crop farmers hiring workers directly, an average 175,000 in 2014, to relying on crop support firms to bring an average 205,000 workers to farms. That is, 54% of those employed on crop farms are there by nonfarm employers rather than being hired directly by the farmer where they work. Almost 70% of crop support employment is with farm labor contractors (FLCs).

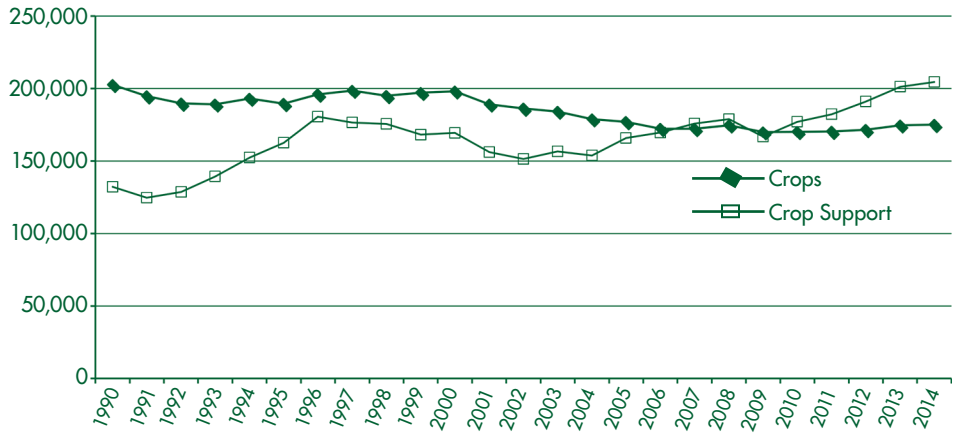
Farm employers face labor challenges, including paying the statewide $15 minimum wage by 2022. The federal minimum wage was $7.25 an hour in 2015, which was 42% of the $17.40 median hourly earnings of all U.S. workers, while the California minimum wage of $9 was 47% of the state's $19.15 median wage. Median wages vary within

Table 1. California Water Availability and Farm Sales, 2011–2016

Year	Acre Feet (millions)	Farm Sales ($billions)
2011	72.7	43.4
2012	41.6	47.0
2013	44.3	50.9
2014	31.3	53.5
2015	37.2	
2016	51.9	
Average 1922-2008	50.2	

Source: Jay Lund, https://californiawaterblog.com

Figure 1. Average Employment, California Crops, and Crop Support, 1990–2014



Source: Quarterly Census of Employment and Wages, Employment Development Department

California. Figure 2 shows that the $15 an hour minimum wage in 2022 is projected to be 70% or more of the median wage in the San Joaquin Valley, which includes half of the state's farm workers.

The real average hourly earnings of California farm workers peaked in the mid-1970s, reached a low in the 1990s, and rose to almost $12 an hour in 2015—below their $14 an hour equivalent of mid-1970s wages. Poverty persists in farming areas, with 20% or more of San Joaquin Valley residents living in families with incomes below the poverty line. Will higher minimum wages reduce poverty and preserve jobs as the expansion of labor-intensive crops continues, or will uncertain water and higher minimum wages curb expansion, spur mechanization, and increase poverty?

The major short-term farm labor challenge is fewer Mexican newcomers, almost all of whom arrive as unauthorized workers. Farm employers are responding with 4-S strategies: **satisfy** current workers to retain them longer in the farm work force, **stretch** the current work force with mechanical aids that increase productivity and make farm work easier, **substitute** machines for workers, and **supplement** the workforce with H-2A guest workers.

About 90% of California farm workers were born in Mexico and 60% are not authorized to work in the United States. Most crop workers are men (75%), settled, and aging, giving California a more unauthorized, less educated (average seven years) and older workforce than the rest of the United States. Farm work is very much like nonfarm work, with workers living off the farm where they work, commuting to work in carpools, and living in families that include U.S.-born children. Many farm worker traits such as years of U.S. farm work experience have a V-shape. For example, California crop workers had an average 11 years of U.S. farm work experience in the early 1990s, nine years in 2000, and 16 years today.

Immigration

The U.S. has 20% of the world's 250 million international migrants—almost 44 million—including a quarter who are not authorized to be in the United States. About eight million of the 11 million unauthorized foreigners are in the U.S. labor force, including at least a million employed in agriculture. The U.S. has been debating what to do about unauthorized foreigners for the past three decades.

California's seasonal farm labor market has been a revolving door for over a century, with newcomers normally staying in the seasonal farm work force a decade or two and their children educated in California shunning farm work. Waves of newcomers—Chinese, Japanese, Filipinos, Dust Bowl farmers, and Mexicans—filled seasonal farm jobs until they returned home or found better nonfarm jobs in the U.S.

In the early 1980s, up to a quarter of California crop workers were unauthorized. The farm labor compromise included in the Immigration Reform and Control Act of 1986 allowed them to legalize and made it easier to hire legal guest workers under the H-2A program. With IRCA introducing sanctions on employers who knowingly hired unauthorized workers, farm labor costs were expected to rise as farmers raised wages to retain newly legalized workers or built housing to hire guest workers.

IRCA backfired, and illegal immigration surged in the 1990s. Farm wages fell and unauthorized workers spread to all commodities and states as H-2A guest worker admissions dropped to less than 20,000 in the mid-1990s. As the unauthorized share of crop workers surpassed 50%, farmers asserted that there was a shortage of legal U.S. workers to harvest their crops, that H-2A program requirements to provide housing were too cumbersome, and that agriculture needed an E-Z guest worker alternative. Congress considered several such programs, but President Clinton threatened a veto and none was enacted in the 1990s.

The 2000 election of President Fox in Mexico and President Bush in the U.S. spurred farm employers and worker advocates to negotiate AgJOBS, an IRCA-like effort to legalize unauthorized farm workers and make it easier to hire guest workers. AgJOBS was not enacted, but in November 2014 President Obama issued an executive order to create the Deferred Action for Parents of Americans (DAPA) program. If implemented, DAPA could legalize four million unauthorized parents with legal U.S. children, including up to 500,000 farm workers, giving them three-year work permits.

Texas and 25 other states sued to block DAPA, arguing that it was an unconstitutional overreach of executive power. Meanwhile, the H-2A

program is expanding, quadrupling in California to over 10,000 jobs certified to be filled with guest workers in the past five years, although H-2A workers remain less than 5% of the state's average farm employment. If there is no DAPA or other immigration reforms, the farm labor stage could be set for a return to the 1950s, when some farmers built housing on their farms and others joined labor cooperatives that housed Bracero guest workers and moved them from one farm to another as needed. Instead of coming from Mexico, 21st century guest workers may come from Asia and elsewhere, especially if they are allowed to stay in the U.S. more than the usual maximum of 10 months a year.

ALRB

The Agricultural Labor Relations Board administers the 1975 Agricultural Labor Relations Act, which was enacted "to bring peace and justice to the fields" by giving farm workers the right to organize into unions and bargain over wages and working conditions with their employers. There were an average three elections a day on California farms in 1975, but since then there have been far fewer, and none in the past several years.

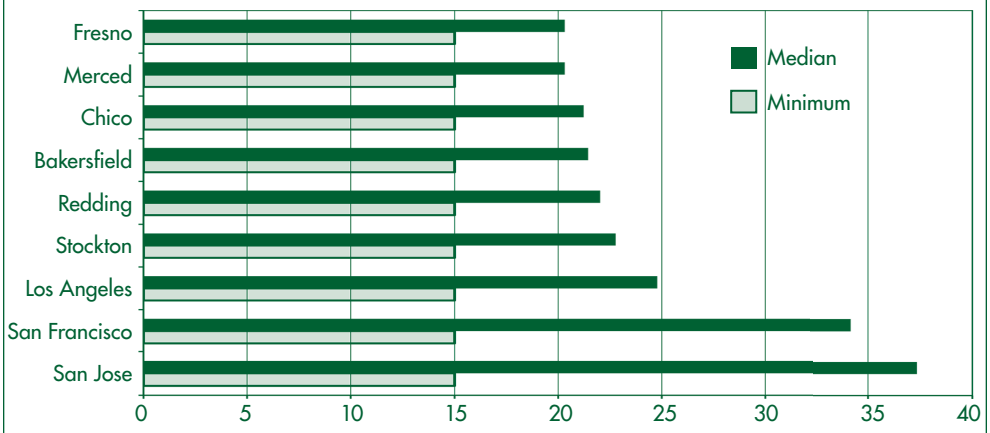
The ALRA had several unique features, including quick elections and a makewhole remedy if employers fail to bargain in good faith with a certified union. That is, employees can receive the additional wages and benefits they could have expected if their employer had bargained in good faith. These provisions, as well as the access regulation that gives union organizers the right to go onto farms and talk to workers, made the ALRA controversial, with farmers complaining that the state was unfairly supporting unions.

Over the past two decades, the dominant United Farm Workers union has switched the focus of its activities from the fields to the Legislature. The UFW, arguing that farm employers delayed bargaining despite the makewhole remedy, got the ALRA amended in 2002 to provide for mandatory mediation that should guarantee workers a first contract within eight months after a union is certified to represent them.

The ALRB has undertaken new initiatives, creating a worker education unit to make non-Spanish speaking and other farm workers aware of their rights under the ALRA. Most ALRA activity today involves protected concerted activities, as when two or more workers complain about wages and working conditions and suffer retaliation as a result.

California was a pioneer when it enacted the ALRA, and may be a pioneer to develop effective remedies for unauthorized farm workers. Under the U.S. Supreme Court's 2002 Hoffman Plastics decision, unauthorized workers who are fired unlawfully do not get back pay because they were not eligible to be employed in the first place. However, the California Supreme Court in 2014 allowed Vincente Salas, who used another person's Social Security number to get hired and was not rehired after filing a worker's compensation claim, to recoup unpaid wages for the period between his first attempt to return to work and the date the employer learned that he was unauthorized. The Salas decision could require farm employers who unlawfully fire workers to pay them for time not worked until the employer learns they are unauthorized.

Figure 2. Minimum and Projected Median Wages, 2022



Source: www.nytimes.com/2016/03/29/business/economy/15-hour-minimum-wage-in-california-plan-has-some-worried.html.

Conclusions

California farm sales have been rising despite more costly water and labor, reaching record levels, and demonstrating the adaptability of California agriculture. Many commodities are labor-intensive, explaining why the employment of farm workers is rising. Over half of the workers employed in FVH commodities are unauthorized. If the DAPA program were implemented, over half of the 400,000 unauthorized farm workers in California could obtain three-year work permits, which may encourage them to stay in agriculture and assert their labor rights or move on to nonfarm jobs, which could further expansion of the H-2A guest worker program.

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The papers and presentations on which this report are based are at: https://gifford.ucdavis.edu/en/events/

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