COMPARATIVE ASSESSMENT OF RISK MITIGATION OPTIONS FOR IRRIGATED AGRICULTURE

Noel Gollehon
Michael Roberts
Marcel Aillery[1]

ABSTRACT

The impact of reallocating water from historical agricultural uses to expanding non-agricultural uses depends crucially on how reallocation occurs. This paper examines the water reallocation problem from a Federal perspective, focusing on alternative instruments to indemnify or compensate irrigators in the event of reallocation. These include insurance strategies (crop insurance, direct payments, and new financial instruments such as tradable bonds), conservation initiatives, and market-based measures (buyouts, contingent markets, and water banks). Policy mechanisms differ in the level of compensation provided, capacity to address concerns of stakeholders, and reliance on Federal outlays. No clear "winner" emerges among the potential mechanisms to mitigate foregone irrigation returns. The merits of alternative mechanisms depend on the evaluation criteria considered, site-specific conditions, and current water institutions.

INTRODUCTION

Irrigation is a defining feature of crop production in the American West and an increasingly important element of crop production in the eastern U.S. According to the 1997 Census of Agriculture (USDA, 1999), 55.0 million acres (16 percent of cropped acres) of agricultural land were irrigated in the U.S., a 5.6 million acre (11 percent) increase over levels reported in the 1992 Census of Agriculture. The 19 Western states contain 78 percent (43 million acres) of irrigated cropland and pastureland, with the remaining 22 percent (12 million acres) in the Eastern states.

The value of crop sales, which measures the value of commodities leaving the farm gate, indicates the importance of irrigation water to farming and rural areas. Based on calculations from the 1997 Census of Agriculture, an estimated $98 billion of crop sales were produced on 309 million acres of harvested cropland in the U.S. Irrigated crops occupied 16 percent of that area, but accounted for 49 percent of the total value of crop sales from U.S. farms and ranches. Average sales per harvested acre were $950 for irrigated cropland, compared with $200 for non-

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[1] Agricultural Economists, Economic Research Service – USDA, 1800 M St. NW, Washington DC 20036, E-mail Gollehon@ers.usda.gov. The views expressed in this manuscript are the authors' and do not necessarily represent policies or views of the Economic Research Service or USDA.

irrigated cropland. Irrigated crop sales were highest for orchards, vegetables, and nursery crops, while irrigated cropland area was dominated by grain and forage crops, primarily corn for grain and alfalfa hay.

In the 19 Western states, the 1997 Census reported 142 million acres of harvested cropland with total crop sales of $45 billion. Irrigated crops in the West accounted for 27 percent of the area, but produced 72 percent of the total value of crop sales. The sales of Western irrigated crops totaled about $32 billion in 1997, or roughly one-third of all U.S. crop sales. Crop sales per harvested acre in the West averaged $850 for irrigated cropland and $122 for non-irrigated cropland. As was the case at the national level, irrigated crop sales in the West were led by orchards, vegetables, and nursery crops, while irrigated cropland area was dominated by grain and forage crops.

As urban and environmental demands for water grow, there will be increased competition for water historically used by agriculture. This competition may change the economic mix for regions with significant agricultural sectors, especially in the West, where water-supply development opportunities are limited.

The impact of reallocating water from historical agricultural uses to higher-valued agriculture and to expanding non-agricultural demands depends crucially on how this reallocation takes place. In most areas, the water allocation systems are controlled by institutions that currently are not able to respond to market signals. This lack of flexibility makes it difficult for water use to smoothly transition from agriculture to new higher-valued uses and for water-right holders to retain the full value of their rights in the event of a reallocation. Such losses have increased demands to compensate right holders (usually farmers) for lost water supplies. Due to uncertainty regarding water supplies, reallocation quantity and timing is uncertain, and the prospect of reallocation introduces an element of risk that may influence farmers' production decisions. The magnitude of agricultural income losses, of economic losses more broadly, and of costs to Federal and local governments, depends on how water transfer systems evolve and how current users are compensated for the loss of historic water supplies.

This paper examines the water reallocation problem from a Federal perspective, focusing on alternative ways to indemnify or compensate irrigators in the event of reallocation. The Federal perspective is important because Federally supplied water (Bureau of Reclamation) is often the source of the reallocated supply, Federal agency actions are often the impetus for reallocation, and Federal programs are often called on to provide compensation. The discussion of alternative policy instruments to compensate irrigators addresses 1) potential Federal expenditures, 2) the extent to which each policy can be expected to reduce agricultural water use and augment in-stream flows, and 3) the effectiveness of policies in mitigating financial harm to irrigators.

THE ROLE OF FEDERAL DECISIONS

The Federal role in the development and allocation of irrigation water supplies has evolved over time. Federal authority for water resources was established in early legislation to promote economic development through the Federal reclamation, hydropower and navigation programs. More recently, the focus on large-scale capital construction projects has given way to multi-objective management of river ecosystems, with greater emphasis on trust responsibilities and environmental concerns. The evolving Federal role—and its relation to established water rights under state law—continue to play out in river basins across the West.

Congressional mandates and legal statutes over the past century have substantially redefined the scope and role of Federal agencies in the management of river systems. Increasingly, Federal actions have prompted reallocation of water supplies—primarily from agriculture—to meet Federal responsibilities for endangered species protection and other purposes.

The probability that future Federal actions will restrict irrigation withdrawals depends on many factors, including: weather factors relating to drought; the capacity of the water storage and delivery system; future water demands; the flexibility of legal institutions in accommodating water-supply shortfalls; and the extent and nature of Federal interests in the basin.

The rationale for Federal indemnification of potential producer losses will depend in part on the nature of the Federal action. Federal water decisions associated with endangered species protection are likely to occur unexpectedly. Unanticipated weather, for example, may lead to species threats that must be addressed immediately. However, Endangered Species Act (ESA) restrictions will most likely coincide with natural drought events, making it difficult to distinguish drought impacts from the effect of Federal actions.

Changes in water allocations associated with the settlement of Native American water rights or other Federal Reserved rights may not pose as serious a 'single-year' indemnification issue because water reallocations generally will be known prior to crop planting. However, compensation for foregone returns still may be at issue. In the case of a permanent water loss, the decline in asset values may be a more appropriate measure of compensation than estimates of annual income loss. While water transfer volumes may be fixed and certain, basin reallocations to meet these claims can have broader risk implications for irrigated producers. Measures that reduce the dependability of agricultural water supplies may increase future risk exposure and heighten the likelihood of 'single-year' indemnification.

POLICIES TO MITIGATE WATER INTERRUPTION LOSSES

Various policies have been proposed to mitigate agricultural losses from water-supply reductions. These include insurance strategies (crop insurance, direct payments, and new financial instruments such as tradable bonds), conservation initiatives, and market-based measures (buyouts, contingent markets, and water banks). Policy measures differ in the level of compensation provided, capacity to address concerns of direct and indirect stakeholders, reliance on Federal outlays, required institutional modifications, and impacts on production and water-use efficiency.

Insurance Mechanisms

Both the costs and consequences of providing insurance or direct payments to farmers who face the risk of water supply reductions due to reallocation depend in part on the insurance strategy or payment mechanism employed. Possible insurance mechanisms include subsidized insurance (similar to that already offered by USDA's Risk Management Agency (RMA) for weather-related yield and price risks), direct compensation (similar to disaster assistance), and market-based insurer tools such as tradable contingent bonds.

Subsidized Insurance: RMA currently offers subsidized crop insurance to protect participating farmers against specific weather and market-related shortfalls in crop yields or revenues. A suite of insurance contracts provide indemnity payments in the event of particularly low yields and/or prices. The current provisions, however, do not cover yield losses that stem from the cancellation or reallocation of irrigation water supplies unless it is instigated by a natural event (e.g., drought). Moreover, insurance coverage is available only for certain crops.

One way to insure farmers against water shortage risk would be to alter the current insurance program so as to include coverage of potential losses stemming from Federal actions that restrict water allocations. While superficially straightforward, adjusting the current program could also entail substantial difficulties, unintended consequences, and institutional and administrative costs.

First, unlike weather-related price and yield variation, no historical data exist that could be used to systematically estimate the likelihood of mandatory water reallocation. Under the current agreement between the Federal government and private insurance agencies, insurance companies pay a portion of the indemnities and retain a portion of the premiums. If the probability and potential damages of Federal water reallocations cannot be assessed in a reliable manner it will be difficult, if not infeasible, to calculate new premiums that satisfy both the government and private insurance companies.

Second, if farmers are insured against downside losses in the event of water reallocations, they may choose to plant crops that would not normally be as profitable as current crops, but with higher indemnity potential under water supply restrictions. For example, once insured, farmers may elect to plant high-value, high-investment crops, knowing they would be compensated for their lost investment in the event of water-supply restrictions. If farmers do not pay the actuarially fair premium for such potential losses, then altered cropping patterns of this type could be very costly to the government. If the premiums were subsidized, as they are under the current program, the program would instill incentives of this kind. If the premiums were not subsidized, insurance may provide farmers insurance against the risk of single-year reallocation, but would not compensate them for the potential loss of their water rights.

Catastrophic Coverage and Noninsured Crop Disaster Assistance: Under a combination of the Noninsured Crop Disaster Assistance Program (NAP) and the minimal crop insurance program, farmers can obtain "catastrophic coverage" that insures weather-related losses greater than 50 percent of expected yield at 55% of the average market price. Participating farms can obtain this coverage for just $100 per county and crop insured, regardless of how many acres a farmer insures in a given county. Like the "full" crop insurance program, coverage does not currently extend to losses that stem from a reallocation of water. An expansion to cover water shortfalls could entail an ambiguous and potentially large increase in government expenditures while compensating farmers for a relatively small share of the per-acre losses that stem from water reallocations.

Direct Compensation: Congress may choose to compensate farmers in an *ad hoc* fashion in the event of water reallocations, as it occasionally does in response to certain weather-related losses. With direct payments adjusting crops in anticipation of a loss is potentially a concern, except farmers pay no premiums, and have no assurance of compensation in the event of loss.

Tradable Contingent Bonds: Rather than provide individual insurance contracts or direct payments to farmers, the government might insure farmers through an auction of tradable bonds that pay a predetermined value in the event of Federally-imposed, water-supply restrictions. For example, suppose the government wishes to provide a total of $1 million in insurance coverage against a possible reallocation of water in a particular region over the next ten years. To achieve this objective, an Agency could auction one thousand $1000 bonds, each of which pays the face value in the event water is reallocated. The competitive price of the bonds, determined via auction, is the conceptual equivalent of the premium paid in insurance contracts. The number of bonds a farmer chooses to purchase would determine his or her level of coverage. If a farmer later wishes to change coverage levels due to a change in crops, prices, or growing practices, the farmer can do so by buying (or selling bonds) from (to) other farmers.

Unlike insurance or direct payments, tradable contingent bonds do not give farmers an incentive to alter their production artificially in order to take advantage of the program. Further, the compensation costs of water reallocation would be known in advance—the amount would equal the face value of bonds issued.

The non-distortionary nature of tradable contingent bonds constitutes a potential benefit of this approach. Another benefit is that a bond market would preclude administrative costs associated with determining premiums and selling individualized insurance contracts. Furthermore, farmers indirectly affected by water reallocations could also insure themselves. For example, farmers down-slope from farmers who irrigate with Federal water may benefit indirectly to the extent that up-slope irrigation replenishes down-slope supplies. Down-slope farmers could also purchase bonds to insure themselves against potential losses. Similarly, input suppliers and other local agricultural interests who indirectly hold personal stakes in water allocations could insure themselves.

Government officials may also choose to allocate some or all of the bonds (rather that sell them via auction), perhaps according to farmers' current water rights. Allocated bond distribution would increase the net costs to the government, and require an initial allocation of the bonds according to some criteria.

Agricultural Water Conservation Policies

Production adjustments to conserve water supplies at the farm level may help to mitigate the effect of cutbacks in irrigation water deliveries. The extent to which these measures can offset producer losses will depend on many factors, including the nature and timing of the water-supply restriction, the crops produced on the farm, the farm technology and resource base, hydrologic conditions in the basin, and state regulations governing water conservation.

Agricultural water conservation can be achieved through several means. Within an irrigation season, producers may reduce per-acre water use for a given crop through deficit irrigation. If information on water shortages is available before the crop is planted, more options are available, shifting to alternative crops or lower-yielding varieties of the same crop that use less water, or adopting more efficient irrigation technologies. In some cases, producers may convert from irrigated to dryland farming or retire land from production.

Deficit irrigation—knowingly applying less than full crop-consumptive requirements and accepting the corresponding yield loss—may be an option in areas where the loss in irrigated yield is low relative to the value of water saved. Deficit irrigation can be an effective potential producer response where water restrictions are imposed later in the crop season, particularly for drought tolerant crops and other perennial crops and pasture under moderately arid conditions.

The ability to substitute crops is an important response to water shortfalls that are known prior to the planting season. Wide variation in irrigated crop sales values (USDA, 2003) reflects significant flexibility for irrigated agriculture to adjust to changes in water availability through cropping adjustments. Farmers may also adjust to water shortages by growing less water-intensive crops, thus extending limited water supplies over a greater area.

Many irrigators have responded to water scarcity through the use of improved irrigation technologies—often in combination with other water-conserving strategies—and irrigators may look to technology as one of several means of conserving water in the future. Improved water management practices may also be required to achieve the efficiency potential of the physical system. Providing incentives to farmers to adopt more efficient irrigation systems is a common policy proposal for augmenting scarce water supplies in the West.

Improved irrigation and water conveyance technologies that increase onfarm water-use efficiency can have potential benefits for water conservation, water quality and farm returns (Schaible, 2000). However, the extent to which technology adoption can achieve significant water savings for in-stream uses will depend on many factors, including levels of efficiency improvement, the disposition of irrigation losses and return flows, and changes in crop consumptive use, both on-farm and downstream (Aillery and Gollehon, 2000). Improving irrigation technology alone may not achieve the desired reduction in agricultural water use and increase in streamflow, without accompanying reductions in crop consumptive use and irretrievable system losses. The effectiveness of improved on-farm irrigation technology will depend on the objectives of the water-conservation policy. For example, if the goal is to augment flows in a specific stream reach at a specific time of the year, increased on-farm efficiency can be effective provided that diversions are reduced and 'conserved' water is not intercepted before flowing through the critical reach. However, if the goal is to increase total outflow from a watershed, improved irrigation application technologies will often lead to higher consumptive water use, reduced return flows, and a net reduction in basin outflows. Thus, the effectiveness of on-farm water conservation policies to offset reductions in water supplies cannot be easily generalized without considering hydrologic conditions, water diversion rights, and policy objectives for the basin. Conservation programs that target flow augmentation for in-stream environmental uses will often require water-right reforms and regulations to ensure allocation of conserved water for the desired purpose (Schaible and Aillery, 2003; Willis et al., 1998).

Market-based Measures

Differences across crops in per-acre returns to irrigation suggest that market-based policies that facilitate transfer of water from lower- to higher-valued uses will minimize crop revenue losses while meeting other short-term water needs. Market-based policies can involve irrigators as both buyers and sellers of water supplies, as well as Federal/State governments and environmental organizations, depending on the structure of the mechanism.

Buyouts: Rather than compensate farmers for "losses" associated with a reallocation of water, the government might purchase farmers' water rights prior to, or at the time of a water shortfall. Buyouts of farmland and irrigation water rights may be highly effective in redirecting flow to the desired target while compensating farmers for foregone crop returns.

There are problems with using buyouts for reallocations. First, water savings from the buyout must not be intercepted by other users with an unsatisfied water allocation. This can be a significant issue during drought conditions when many irrigators may be experiencing water shortages while streams are flowing with buyout water for instream use. Second, proposed buyout programs generally rely on the Federal government for financing. For example, one recent Congressional proposal [H.R.5698 §3(g)(1)] called for the Federal government to finance up to 75 percent of buyout costs. Third, permanent buyout policies are often infeasible because of concerns expressed by local communities and politicians that the buyouts would have negative impacts on regional agricultural employment, farm-related businesses, and local tax bases (Hymon, 2002). Consequently, although many farmers may be willing sellers, local agribusiness and community interests may oppose buyout policies. For example, a buyout proposal formulated by conservation and agricultural groups was dropped in the Klamath Basin, even though 24 farm families controlling 30,000 acres were offering to sell land and associated water (ONRC, 2001).

Water Banks: Water banks have been established by several states to promote more efficient water distribution during droughts. Water banks are designed to facilitate the temporary reallocation of water among interested parties by lowering the transaction costs of effecting water transfers. The "bank" serves as a broker for water transfers by drafting both purchasing and sales contracts—usually at fixed prices—and coordinating the transfers. This enables both water buyers and sellers who wish to buy (sell) for the fixed price to rapidly complete the sale. For example, the California Department of Water Resources (DWR) operated Drought Water Banks in 1991 and 1992 (Howitt, 1994; Israel and Lund, 1995).

The degree to which State water banks can be used to increase in-stream flows for other uses depends on state institutions. State laws and regulations may create severe impediments and disincentives to sell bank water for nonagricultural purposes (Huffaker, Whittlesey, and Wandschneider, 1993). Associated with all water transfers is the problem that transferred water needs to be protected against further appropriation by downstream irrigators who would otherwise use the flow.

Contingent Water Leases: Contingent water leases have the potential to limit the extent and duration of the negative economic impacts that permanent transfers may have on agricultural uses as well as local communities and water users not party to the trade (Huffaker and Whittlesey, 2000). Contingent water leases, which transfer water when triggered by a predetermined event, secure an option to water supply for environmental and urban uses. Contingent leases operate via a contract, that gives buyers temporary use of the water whenever a given contingency occurs (such as a drought). The seller (e.g., the farmer) retains ownership of the water right and receives his/her normal water supply during years when the option is not exercised. When the option is exercised, the seller leases to the buyer a given portion of water under the right for a specified period of time. Buyers may be other farmers, other users (public water systems or hydroelectric plants) or public agencies seeking instream flows. Both parties benefit: the buyer obtains a secure water supply during the contingency, and the farmer-seller is paid for the option and maintains secure long-term water supplies that allow for continued operation and long-term financing. This also protects the long-term agriculture base of local communities. The water transferred under the lease is temporary and thus potential injuries to local communities are short-lived.

Pioneering work by Hamilton et al. (1989) analyzed contingent water transfers as a means of increasing the production of "firm" power in the Snake River system. Based on their study of the historic hydrograph of the Snake River system, the authors estimated that increasing the assured annual flows by 12 percent over the lowest recorded flow would invoke the contingency (i.e., require interruption in an irrigator's use) to some irrigators in 2 of 10 years and only 1 year in 51 would all the contract water be required. The results indicate that contingent water transfers would be economically feasible in the region because estimated hydropower benefits were estimated to be 10 times greater than lost farm income.

The work by Hamilton et al. (1989) which was extended by Hamilton and Whittlesey (1992), demonstrates another advantage of contingent water markets: they can be financially self sufficient in executing water transfers without requiring Federal loans, grants, and crop insurance or non-insured assistance. The task is to find buyers that can benefit commercially from increased in-stream flows managed for endangered species, such as hydropower producers.

Proposals incorporating short-term leases and contingency aspects are being introduced in the Klamath River Basin. For example, the joint proposal announced by conservation and farm groups in June 2001 has developed into a new initiative in which the Federal government would pay $2,500/acre for permanent "water easements" (Milstein, 2002). Participating farmers would sell their rights to irrigate in dry years, but could continue to irrigate in wet years. In another example, the Bureau of Reclamation is entering the second year of a pilot project in which it leases water from ranchers in Oregon's Wood River Valley to increase inflow to the Upper Klamath Lake (Harper, 2002). In a third example, a private landowner and the Oregon Water Trust formulated a 'split-season' lease of the landowner's water right (Oregon Water Trust, 2002). The lease calls for the landowner to irrigate for a first cutting of hay from April to July, then the landowner foregoes additional cuttings, leaving the remaining water quantity of the right as instream flow for fish passage. So far, no proposal has recognized the potential for contingent water markets to be financially self-sufficient.

Water Markets: A strong argument can be made in favor of market-based mechanisms to reallocate water among current and proposed uses, as demand for these uses adjusts under changing water-supply conditions. Operational water markets would allow farmers and other interests to insure themselves against uncertain deliveries (due to weather or other water restrictions on agricultural and non-agricultural users), providing compensation to those with historical ownership of water rights, while at the same time reducing inefficiencies embedded in the current allocation system. Implementing full-functioning water markets, however, would need to address major physical and institutional hurdles governing water allocation. In most cases, modifications of State water laws and Federal project-level administrative procedures would be required to allow for water market transfers by: (1) allowing private parties or downstream communities to lease water rights for in-stream flow augmentation; (2) relaxing restrictions and disincentives impeding water transfers in general; (3) better protecting in-stream flows from unauthorized diversions, and (4) explicit consideration of the interests of indirect stakeholders in current water allocations. The physical, institutional, and political costs of developing such a system ultimately may be high.

Variants of market-based solutions might be used to compensate farmers while simultaneously removing some inefficiencies in resource use. Federal or State government, perhaps in conjunction with third parties (e.g., environmental interests), might accept competitive bids for contingent water leases to meet short-term water needs. Alternatively, water banks can be developed to serve as a market intermediary. Such mechanisms would allow water to move from its lowest-valued use when water is most needed for annual in-stream flows or other uses during periods of restricted water supplies. Farmers would thus be compensated for the water supply diverted while encouraged to account for the risk of water shortfalls in their production decisions. These mechanisms, however, would entail some of the same institutional hurdles as a full-fledged market.

FINAL CONSIDERATIONS

This paper reviews, from a Federal perspective, possible policies to address the risk to irrigators of reduced water availability. Several policy mechanisms are assessed considering: 1) the potential Federal expenditures, 2) the extent to which stream flow augmentation might be achieved, and 3) their effectiveness in mitigating financial harm to irrigators. While Federal water-resource agencies have reallocated water supplies to meet changing needs, the Federal role in providing compensation remains unclear. Many, if not most, of the policy mechanisms would include changes in Federal and State policies, water management institutions and infrastructure, as well as evolving attitudes governing water use.

Potential Federal budgetary outlays will vary by policy mechanism depending on several factors, including: the geographic coverage of water supply restrictions; water demands of competing uses (which influences the magnitude of losses); the share of the irrigation loss that is compensated; the degree to which costs are shifted to other water uses (as with power generation in a contingent market case); and the value of more efficient resource allocations possible in market solutions. For a given quantity of water, Federal costs are likely to be lowest for contingent markets and auctioned tradable bonds, as a portion of the cost is shifted to current water users. Costs are likely to be high for buyouts that acquire irrigated land and appurtenant water rights. Federal costs may range from moderate to high with direct compensation, subsidized insurance, allocated tradable bonds, and agricultural water conservation, where compensation levels are often influenced by non-economic considerations.

The extent to which policy mechanisms could be used to secure water for increased instream flow will depend on legal and institutional adjustments. Mechanisms that engage individual irrigators may be more effective if given the flexibility to geographically target key hydrologic areas. Buyouts, contingent markets, and tradable bonds all are readily targeted to limited areas, and may utilize price incentives to encourage participation. Mechanisms such as state water banks and national water conservation initiatives may not necessarily provide water in the needed areas or in specified amounts, and may be less effective in meeting local reallocation objectives, especially when monitoring of withdrawals is costly or impossible.

Finally, alternative mechanisms differ in their capacity to mitigate financial harm to irrigators. Market mechanisms have a clear advantage when measured according to this criterion, since exchange does not occur if the compensation is inadequate. Allocated tradable bonds may also effectively offset losses if the allocation process is designed to provide full compensation. Since insurance premiums and auctioned tradable bonds are purchased, irrigators incur expenses, with the amount dependent on the level of insurance or auction subsidy. Direct compensation can provide full (or more than full) replacement of lost revenue, depending on the compensation levels established by the political process. Existing catastrophic insurance provides relatively little compensation due to the design of the program which limits payments. Incentives for agricultural water conservation may help prevent the need to transfer water where field-level savings translates to increased streamflow. However, existing conservation programs do not provide compensation when an actual transfer occurs.

Increasing competition for water—resulting in part from Federal actions—will most certainly affect the irrigated agricultural sector. Voluntary, market-based mechanisms have the potential to provide total compensation at the lowest cost. However, no clear "winner" emerges in the examination of potential policy mechanisms to mitigate the effects of foregone irrigation returns. The extent, value and local characteristics of irrigated production have important implications for framing policy that would compensate producer losses from water supply restrictions. The merits of alternative mechanisms depend on the evaluation criteria considered, site-specific conditions, and current water institutions.

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