Policy Directions to Mitigate Water-Supply Risk in Irrigated Agriculture: A Federal Perspective

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Across river basins of the western U.S., emerging water demands for out-of-stream uses and in-stream needs have intensified competition for freshwater resources. Much of this water can only be obtained through conservation and reallocation of existing supplies as opportunities for large-scale water-supply development are increasingly limited. Irrigated agriculture, accounting for over 90 percent of consumptive water use in the West, will likely be the primary source of water targeted for reallocation.

In many cases, new water demands have been driven by Congressional mandates and trust responsibilities of the Federal government. In water-short years, managers of heavily-appropriated water-supply systems have had to reallocate limited supplies to meet required Federal purposes such as endangered species protection. Of concern to water users is the potential reach of Federal actions that restrict access to irrigation water supplies and the accompanying losses to agricultural producers in the absence of compensation.

A recent example of Federal water-supply restrictions to agriculture involved the Klamath River Basin. In 2001, following a prolonged period of drought, the U.S. Fish and Wildlife Service and National Marine Fisheries Service ruled that lake-storage drawdown and low streamflows jeopardized endangered and threatened fish. The joint rulings required the Bureau of Reclamation to restrict irrigation water deliveries on 220,000 acres over much of the growing season, which had a significant impact on agricultural production in the region. Local farmers claimed that the Federal action had resulted in economic damages and an undermining of water

rights. Damages were eventually addressed through *ad hoc* disaster payments of roughly $30 million to affected producers, with an additional $50 million earmarked under the Farm Bill appropriations for agricultural and environmental needs. The Klamath case has raised questions as yet to be resolved regarding Federal water-supply reallocations, the process of compensating irrigators, and the appropriate use of taxpayer resources.

This paper reviews the issue of water reallocation from a Federal perspective. While water allocations are governed primarily by State water law and institutions, the Federal perspective is relevant given that Federally-financed water supplies (Bureau of Reclamation) are often the supplies most likely to be reallocated, Federal agency actions are often the impetus for reallocation, and Federal programs are usually called on to provide compensation. The paper opens with observations on the potential economic loss to agriculture from water-supply reductions and a brief review of Federal water authorities as policy context for Federal actions. The balance of the paper presents a comparative review of alternative policy instruments that have been proposed, and implemented in some cases, to mitigate and/or compensate losses resulting from Federal water-supply restrictions.

Potential Agricultural Losses due to Water-Supply Restrictions

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 of agricultural land were irrigated nationally (about 16 percent of cropped acres). The 19 Western states account for 78 percent (43 million

acres) of total irrigated cropland and pastureland, with the remaining 22 percent (12 million acres) in 31 Eastern states.

The value of crop sales is a measure of the importance of irrigation water to the farm sector and rural areas. In the Western states, the 1997 Census reported 142 million acres of harvested cropland with total crop sales of $45 billion. Irrigated crops accounted for 27 percent of the area, but produced 72 percent of the total value of crop sales in the region. Total sales of irrigated crops in the West—$32 billion in 1997—accounted for roughly one-third of all U.S. crop sales. Crop sales per harvested acre in the West averaged $850 for irrigated cropland, compared with $122 for non-irrigated cropland. Irrigated crop sales were led by high-valued orchards, vegetables, and nursery crops, while irrigated cropland area was dominated by grain and forage crops.

The Federal government, through the U.S. Bureau of Reclamation (Reclamation), serves as a water 'wholesaler' for 9.1 million acres, or more than 20 percent of the West's irrigated acres—collecting, storing, and conveying water to local irrigation districts and incorporated mutual water companies that, in turn, serve about 140,000 irrigators. Roughly 4 million acres are totally dependent on Reclamation for their irrigation water supply. Approximately 4.7 million acres utilize a combination of Reclamation-supplied water and other surface-water sources, while 0.4 million acres utilize Reclamation water in combination with groundwater sources.

The reallocation of regional surface water supplies due to competing water demands may reduce or alter agricultural activity in some regions, particularly in water-short years. This is especially

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the case in areas of the West, where the extent and value of irrigated production is high and secondary water sources may be limited. Reclamation water supplies are potentially the most affected by Federal decisions that limit water withdrawals.

In on-going research at the Economic Research Service assessing the potential costs of water-supply interruptions, we estimate the impact of a curtailment of Reclamation supplies on producer income and potential compensation costs. Impacts reflect a short-run analysis which assumes that the crop has been planted, that production costs associated with land preparation and planting have been incurred, and that water deliveries are stopped with no opportunity to adjust production decisions. Thus, reported costs and returns reflect maximum potential values for a given reduction in agricultural water supply.[1]

Acreage and cost impacts were estimated under a range of hypothetical reductions in Reclamation water deliveries. A 20-percent reduction in Reclamation deliveries westwide, for example, would affect up to 15.4 percent of total irrigated acres in the 17 Western states, resulting in an estimated decline in farm revenue of up to $1.26 billion, or 2.7 percent of total returns to irrigated crop production. The decline in crop production expenses associated with ceasing irrigation exceeds the rise in production expenses from increased livestock feed purchases, resulting in a net decrease in regional farm production expenses. The combined effect of reduced farm revenue and net reduction in production costs results in a decline in net returns to management, operator labor and invested capital of $1.05 billion.

[1] In this analysis, we did not allow for potential onfarm production adjustments to mitigate producer losses. Net returns are computed based on a fixed-acreage adjustment, with total crop loss assumed over the share of acreage impacted. Thus, maximum revenue losses for water-supply reductions reported here may substantially overstate actual producer losses, especially where supply restrictions are known in advance and are more limited in scale.

Agricultural damages from a given reduction in surface water supply would vary significantly across river basins of the West. Regional variability reflects the nature of irrigated crop production, local reliance on surface water supplies, and the share of surface water supplied by Reclamation. In general, states in the Pacific and Mountain region have the largest share of Reclamation-supplied areas, and are most significantly affected by restrictions on Reclamation water. The Plains states are more dependent upon groundwater, and are likely less affected by Federal restrictions on water withdrawals.

Damages would also depend importantly on the nature of the water-supply restriction, including the severity and duration of the supply interruption, the timing of the interruption within the season, and whether the interruption was anticipated. Producer adaptation may help to mitigate some portion of losses. Prior knowledge of water-supply reductions allows crop choice, cropping practice, and acreage planted decisions to be adjusted to more closely match the projected water supply. Producers can also seek alternative water sources, either surface water from producers not affected by the Federal action or private groundwater supplies. Potential for mitigation is greatest where the water-supply interruption is anticipated, partial and small in scale, and timed to occur prior to crop planting or late in the growing season.

Finally, the extent of damage depends critically on how this reallocation is achieved. The non-market-based institutions that underlie most current water allocation systems may preclude current water users from obtaining the full value of their current water rights in the event that supplies are reallocated. As a result, there is growing pressure to compensate current water right

holders (usually farmers) for water supplies reallocated. The magnitude of agricultural income losses, and costs to Federal and local governments, will depend on how water transfer systems evolve and whether and how current users are compensated for losses.

Federal Role in Water-Supply Reallocation and Compensation

Federal authority for water resources was established in early legislation designed to promote economic development through 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 Federal trust responsibilities and environmental concerns. The evolving Federal role—and the inevitable conflicts with 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 responsibilities of Federal agencies in the management of river systems. Increasingly, Federal actions have prompted reallocation of water supplies—primarily from agriculture—to meet Federal obligations for endangered species protection, water quality, trust responsibilities, and other purposes. Based on an assessment of water conflicts in the West as part of the ongoing ERS research project, it is entirely plausible, if not likely, that reallocation of existing agricultural supplies will continue in response to increasing water demands, due in part to Federal actions designed to meet human health, trust responsibilities and other public-interest goals.

While future Federal reallocations will likely occur, the location, timing, magnitude, and purpose of potential Federal water reallocations are unknown and cannot readily be predicted. The probability that future Federal actions will restrict irrigation withdrawals in any particular basin depends on many factors including: weather factors relating to drought; the capacity of water storage systems, 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 compensation of producer losses due to risk of Federal actions will depend in part on whether the Federal reallocation is unanticipated and non-permanent or longterm and permanent in nature. Federal water decisions associated with endangered species protection, for example, may occur unexpectedly. Unanticipated weather may lead to species threats which must be addressed immediately, increasing the uncertainty of irrigation supplies. 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 in assessing potential compensation costs. In contrast, 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' compensation issue because such water reallocations are generally known prior to crop planting. However, basin reallocations to meet these claims can have broader implications for risk in irrigated production. Affected basins may be more vulnerable to water shortages as competing demands for water expand, reducing the dependability of agricultural water supplies and increasing the likelihood of Federal and State actions in water-short years.[2]

[2] In the case of compensation for foregone returns due to a permanent water loss, the decline in asset values may

While Federal water-resource agencies and authorities have reallocated water supplies to meet changing needs, the Federal role in providing compensation is unclear, with compensation levels undetermined. USDA provides crop insurance and non-insured crop assistance to reduce income losses due to weather-related crop failure and other factors. This coverage, however, has not been extended to losses resulting from restrictions on irrigation water supplies. The potential impact on agriculture has prompted considerable policy interest in both the reach of Federal agencies and the effectiveness of alternative strategies to protect irrigators against financial damage.

Potential Policies to Mitigate Water Interruption Losses

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

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be a more appropriate measure of compensation than estimates of annual income loss.

Insurance Mechanisms

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

Crop insurance and non-insured crop assistance are currently the most widely accepted means of mitigating risk of loss in agricultural income. Extension of insurance and crop assistance measures to Federal water-supply restrictions would require clarification of the nature of Federal actions that result in eligible damages and the degree of compensation awarded. Insurance premiums would be difficult to assess, given that the probabilities of water-supply restrictions are not known and not readily quantified. There is a fundamental difference between insuring against natural events and those induced by policy decisions. In addition, Federal outlays may be substantial depending on the nature and extent of the water-supply restriction and the degree of compensation required.

Subsidized Crop Insurance: RMA currently offers a suite of insurance contracts that 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, including Federally-supplied water. Moreover, insurance coverage is available only for certain crops.

One means of insuring farmers against water-shortage risk would be to alter the current insurance program so as to include coverage of potential losses stemming from actions that restrict water allocations. In principle, this approach could only require a slight revision of the current provisions. While superficially appealing, adjusting the current program may also entail substantial difficulties, unintended consequences, and institutional and administrative costs.

First, unlike weather-related price and yield variation, there exist no historical data 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 would 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 profitable but with higher loss potential under water-supply restrictions. If farmers do not pay the actuarially fair premium for such potential losses, then altered cropping patterns of this kind could be very costly to the government.

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 only 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 for NAP or catastrophic crop insurance does not currently extend to losses that stem from a reallocation of water. An expansion of these programs to cover water shortfalls could entail an ambiguous and potentially large growth 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. Direct payments have similar properties of moral hazard as insurance, except farmers pay no premiums, and have no assurance of compensation in the event of loss. The potentially high cost associated with direct compensation/disaster relief has provided the incentive for consideration of alternative compensation schemes.

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 possible losses with a potential reallocation of water in a particular region over the next

ten years. To achieve this objective, an Agency could auction a 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 crop 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 to the government 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, local agricultural interests, and other interested parties who indirectly hold personal stakes in water allocations could also insure themselves.

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

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. Producers may reduce per acre water use for a given crop through deficit irrigation, shifting to alternative crops or lower-yielding varieties of the same crop that use less water, or adopting more efficient irrigation technologies and water-management practices. 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) provides 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 will likely 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. The Federal government supports improved technology adoption through cost-sharing under the Environmental Quality Incentives Program (EQIP) and other initiatives.

Improved irrigation and water conveyance technologies that increase onfarm water-use efficiency can have potential benefits for water conservation, water quality and farm returns. 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 on-farm water conservation policies to offset reductions in water supplies cannot be easily generalized without regard to hydrologic conditions, water diversion rights, and policy objectives in the basin. If the policy goal is to ensure sufficient water for in-stream environmental uses, an effective conservation program will likely 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

Market-based measures have been proposed, and implemented in some areas, to facilitate transfers of water supplies during water-short periods. 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 market mechanism. Currently there is wide variability in water market development, ranging from no market access to advanced, computer managed local markets. Water markets have been limited by state and other institutional requirements, infrastructure needs, and the third party impacts of transfers. Markets may be an attractive option for meeting in-stream flow needs because the infrastructure requirements are often very modest.

As market measures enable irrigators to monetize the value of their water resource, these measures may be an effective means of mitigating the risk of water-supply restrictions to the extent that producers are fully compensated, Federal budget exposure is limited, and resource-

use efficiency is enhanced. Market strategies can help to distribute the potential costs of water reallocations among States and water recipients, while more effectively allocating water to meet in-stream requirements and higher-valued water withdrawals. However, fully operational markets may require legal and institutional reforms and additional storage/conveyance infrastructure to facilitate water transfers.

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 water flow to a desired target, while compensating farmers for foregone crop returns.

Unfortunately, there are associated problems. First, water savings from a buyout program may be intercepted by other users with an unsatisfied water allocation. This can be a significant issue during drought conditions when downstream irrigators facing water shortages are restricted from diverting from water courses flowing with 'buyout water' intended 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 often are politically infeasible because of concerns by local communities and politicians that the buyouts would have disastrous 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 actively work against buyout policies. For example, a 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 severe droughts. Water banks are designed to facilitate the temporary reallocation of water among interested parties by lowering the transaction costs of effecting water transfers. For example, the California Department of Water Resources (DWR) operated Drought Water Banks in 1991 and 1992 (Howitt, 1994; Israel and Lund, 1995). The banks served as a broker for water transfers by drafting both purchasing and sales contracts and coordinating the transfers.

Water banks facilitate compensated, voluntary water transfers by providing a legal system of trading at a fixed rate, thus lowering information costs and other transaction costs for the contracting parties. The degree to which State water banks can be used to increase in-stream flows for other uses depends on State water law. Unfortunately, existing State laws and regulations may create severe impediments and disincentives to sell banked water for nonagricultural purposes (Huffaker, Whittlesey, and Wandschneider, 1993). Fixed payments per unit-water may inhibit participation from some buyers and sellers, and water banks alone may not be able to target flow augmentation to problem stream reaches. An additional problem attending all water transfers: the transferred water would need to be protected against further appropriation by downstream irrigators who would otherwise use the increased flows.

Contingent Water Leases: Contingent water leases belong to a group of specialized water transfers recommended by some economists to limit the extent and duration of the negative economic impacts that permanent transfers may have on local communities and water users not party to the trade (Huffaker and Whittlesey, 2000). Of this group, contingent water leases (transfers that occur intermittently and are triggered only by some predetermined contingency) offer the most secure water supply to environmental and urban uses because they can be triggered automatically by critically low-water years.

Specifically, contingent leases operate via an "option contract," that gives the buyer 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 (e.g., another farmer, municipality, hydroelectric utility, environmental organization) a given portion of water under their water right for a specified period of time. Both parties benefit: the buyer obtains a more 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 market-based option also protects the long-term agricultural base of local communities. The water transferred under the lease is temporary and thus potential injuries to local communities are short-lived.

A strong argument can be made in favor of contingency contracts and other 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 improving resource use efficiency. Implementing full-functioning water markets, however, would need to address major physical and institutional hurdles in many areas. State water laws and Federal project-level administrative procedures would need to adapt 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 may ultimately be high.

Variants of a market-based solution might be used to compensate farmers and perhaps remove 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. These 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

Expanding water demands for out-of-stream uses, in combination with enforcement of Federal in-stream requirements and other reserved rights, will continue to increase pressures on available water resources to meet the demands of all users, particularly during periods of extended or severe drought. Federal water-resource agencies and authorities have, at times, reallocated agricultural water supplies to meet Federal water mandates, although the Federal role in compensation is unclear.

This paper reports a 'maximum' income loss for a hypothetical 20-percent reduction in Reclamation water-supply deliveries. However, in assessing potential losses that might conceivably be addressed under a compensation program, two qualifiers must be emphasized. First, water-supply restrictions, while potentially severe in a given locality, are likely to constitute a small share of total water supplies at the State or region level for any given year. Thus, reductions in aggregate water supply at a State-level are likely to fall within the 0-20% range under most conditions. While Federal actions during water-short years could result in severe restrictions in irrigation withdrawals in some cases, actual water-supply reductions are apt to be localized in nature and would likely constitute a small share of total water supplies across the region. Second, estimated values by water-reduction scenario are likely to substantially overstate the actual costs due to production input and output adjustments and other institutional measures that could potentially mitigate producer losses. The degree of producer response will depend on a range of factors, including the scale and timing of the water-supply interruption, with substantial variability in potential impacts across areas of the West. The actual level of

producer losses is ultimately an empirical issue, and the subject of further investigation under an ERS research program with cooperating universities.

This paper reviews a number of policy strategies advanced to mitigate the risk to irrigators of reduced water-supply availability. The discussion considers potential Federal expenditures, the extent to which stream flow augmentation might be achieved, and their effectiveness in mitigating financial harm to irrigators, among other factors. Many, if not most, of the policy mechanisms would include changes in Federal and State policies, water management institutions and infrastructure, as well as attitudes governing water use.

Potential Federal budgetary outlays would vary by policy mechanism depending on the geographic coverage of water supply restrictions; water demands by competing uses, which translates into the severity and timing of cutbacks; share of the irrigation loss that is compensated; 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 use 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 sometimes 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 rely on individual irrigators may be more effective 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 agricultural water conservation initiatives that may not necessarily provide water in the needed areas or in specified amounts, may be less effective in meeting local reallocation objectives.

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, if the field-level savings translate to increased streamflow. However, existing conservation programs do not provide compensation when transfers do occur.

The extent, value, and local characteristics of irrigated production have important implications for framing policy that would compensate losses to producers from restricting access to water supplies. Increasing competition for water—resulting in part from Federal agency actions—will most certainly affect the agricultural sector. Voluntary, market-based mechanisms have the potential to provide total compensation at the lowest cost. However, no clear "winner" emerges in an examination of potential policy mechanisms to mitigate the effects of foregone irrigation returns. The preferred suite of mechanisms depends on the evaluation criteria considered, the nature of competing water demands, hydrologic conditions that are site-specific, and existing water institutions.

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