

Farm Adaptation to Water Supply Variability: Opportunities in the Colorado River Delta

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Comments and inquiries
welcome.
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- Region and motivation for study

This report focuses on the lower Colorado River in the Mexicali Valley of northern Mexico, located south of Imperial Valley, California and Yuma County, Arizona (refer to map below).

At Morelos Dam, where the Colorado River enters northern Mexico, the river typically runs dry. Water resources in the Colorado River are already fully allocated, meaning that no unclaimed water supplies are available to address increasing demand among urban areas, agriculture and the environment.

The river is funneled into a canal system at Morelos Dam, and water is distributed to a variety of water users across the region. Agriculture depends 100% upon irrigation, as precipitation in the region is negligible. Moreover, international attention is focused on the region due to the high levels of biodiversity and endangered species, and the rapid loss of valuable water-dependent habitat.



Thus, a wide range of stakeholders are interested in water management strategies that can provide water for habitat restoration while maintaining agricultural profitability and economically vibrant communities.

- Research scope
- Research questions covered in this report

The findings highlighted in this report come from two years of research on farm-level adaptations to water supply variability. We investigated: 1) How are farmers responding to water supply variability? 2) How does the type and extent of supply variability influence on-farm water management? 3) Which factors affect farmer decisions to invest in cement lining of conveyance canals and crop diversification? 4) How can collaborative arrangements increase water available for environmental needs while maintaining agricultural livelihoods and a vibrant regional economy?

These questions represent pressing concerns that will only increase in importance with urban growth, increasing bi-national attention to habitat restoration and changing regional climate and water supply patterns.



Photos from the Mexicali Valley Irrigation District. Top: vegetable production (cilantro); **Above middle:** alfalfa production; **Above right:** cement lining of parcel-level irrigation canals; **Bottom right:** parcel level irrigation ditches made of dirt;



- Research methods
- Primary data collection process

Methods: The research began with an exhaustive review of existing literature, followed by expert interviews and farm household surveys. We also use statistics from various Mexican public agencies.

Primary data collection: The farm household surveys were designed in a collaborative process with stakeholders in the Mexicali Valley Irrigation District. As the photos demonstrate, the survey process itself was a relationship-building process. After pre-testing the survey on 20 farmers, suggestions were incorporated, resulting in an improved survey that focused on three categories of questions, as follows:

- 1) What were the biggest impacts on agricultural profitability in the past five years?
- 2) What are the common household-level responses to water supply variability and low profitability?



- 3) Variables describing farm household characteristics. For instance, a farmer owning a large number of hectares may behave differently than a small scale farmer.



Photos taken in the Mexicali Valley Irrigation District during 2012, showing farmers, water managers, and students from the University of Arizona.

- Interview and survey numbers

- Survey statistics

Total survey and interview numbers:



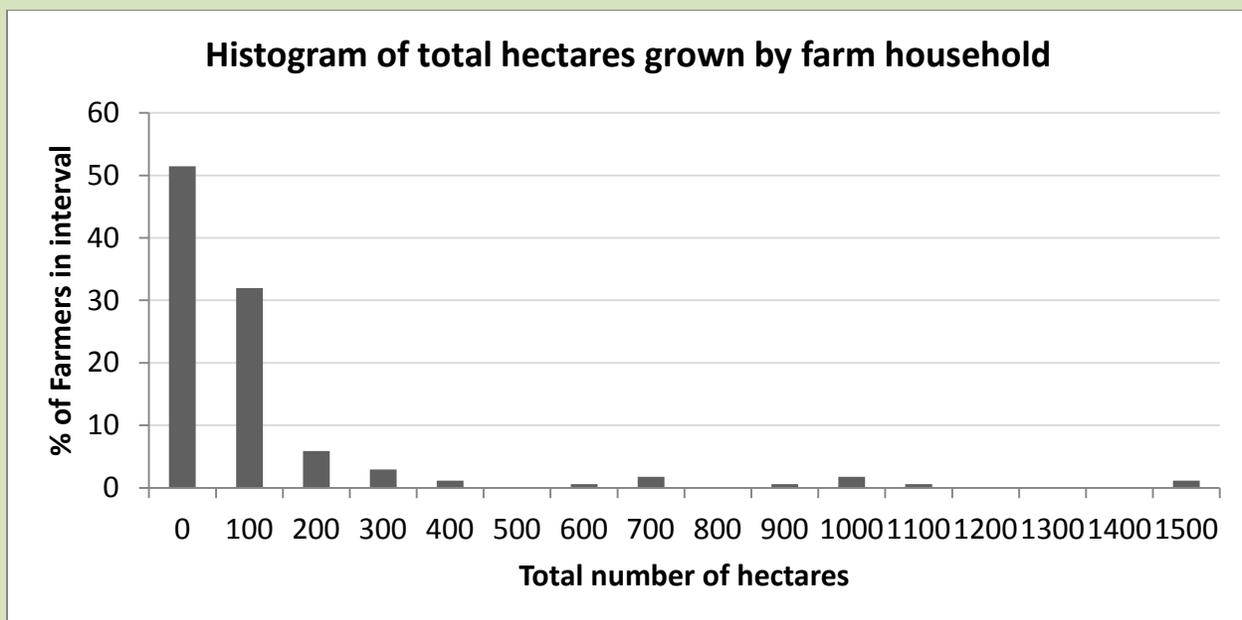
Farmers and water managers from 15 of the 22 irrigation module offices were surveyed in the Mexicali Valley Irrigation District. The total number of hectares (ha) in the survey is 21,751, representing 10.5% of total hectares in the district. Major crops grown on farms in our sample are included in table 1.

Table 1. Major crops from sample

Crop	Total ha in sample
Wheat	10,720
Alfalfa	4,198
Cotton	3,684
Sorghum	1,293
Sudan	536
Green onion	250
Ryegrass	242

Figure 1 presents the range of farm sizes. The range is 3 to 1,500 ha with a mean farm size of 122 ha and a median of 40 ha.

Figure 1. Farm size - total hectares in production by farmer from survey sample



• Water supply variability

A principal theme of this research is farmer response to water supply variability. We divide water supply variability into two separate components, a timing and volume component. Typically, farmers request a delivery of irrigation water from the irrigation module office and the water arrives within three days.

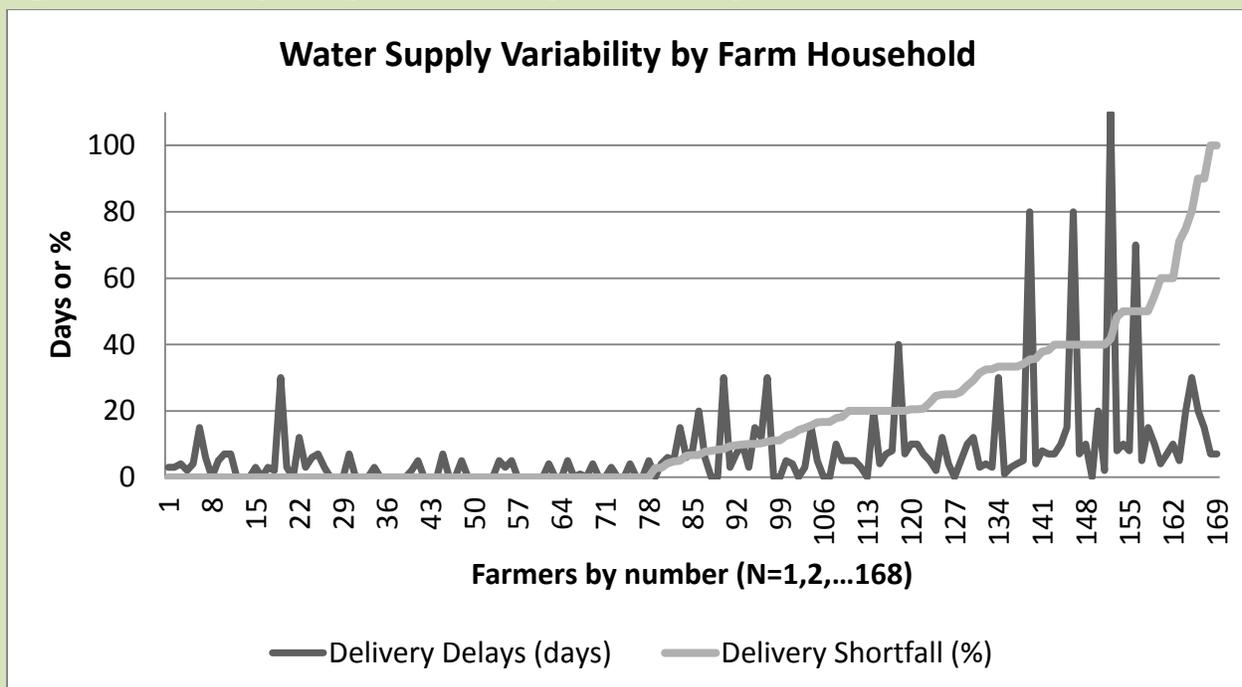
Definition of water supply variability, for the period of Oct. 2010 – Oct. 2011

Delivery delay is our timing variable: farmer perception of the maximum days late, beyond the normal three days delivery time.

Delivery shortfall is farmer perception of the number of irrigations in which less water was delivered than requested (as a percent of total irrigations).

Figure 2 displays the **delivery delay** and **delivery shortfall** variables. Separating out the two components and disaggregating to the household scale reveals significant variation across the sample. Farmer perception of delivery delays ranged from zero to 110 days across the farmers surveyed.

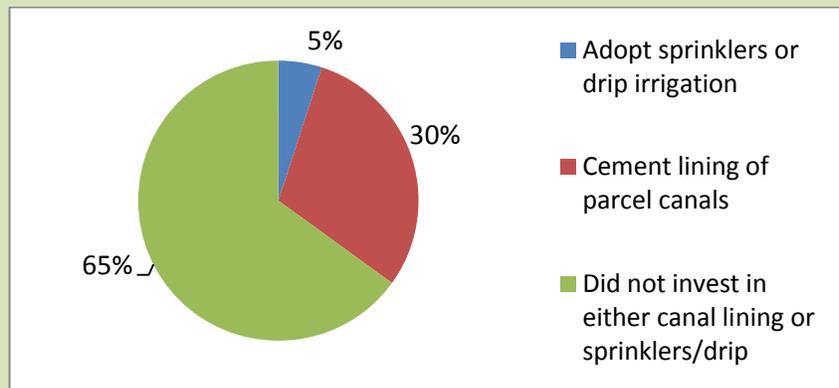
Figure 2. Delivery delay and delivery shortfall by farm household



- Farmer responses to water supply variability with the potential to decrease consumptive use, or water diverted, to grow crops

The surveys assessed recent farmer responses to water supply variability. Laser leveling of parcels ranked as the most common response. Cement lining of parcel-level canals is also common, as shown in figure 3.

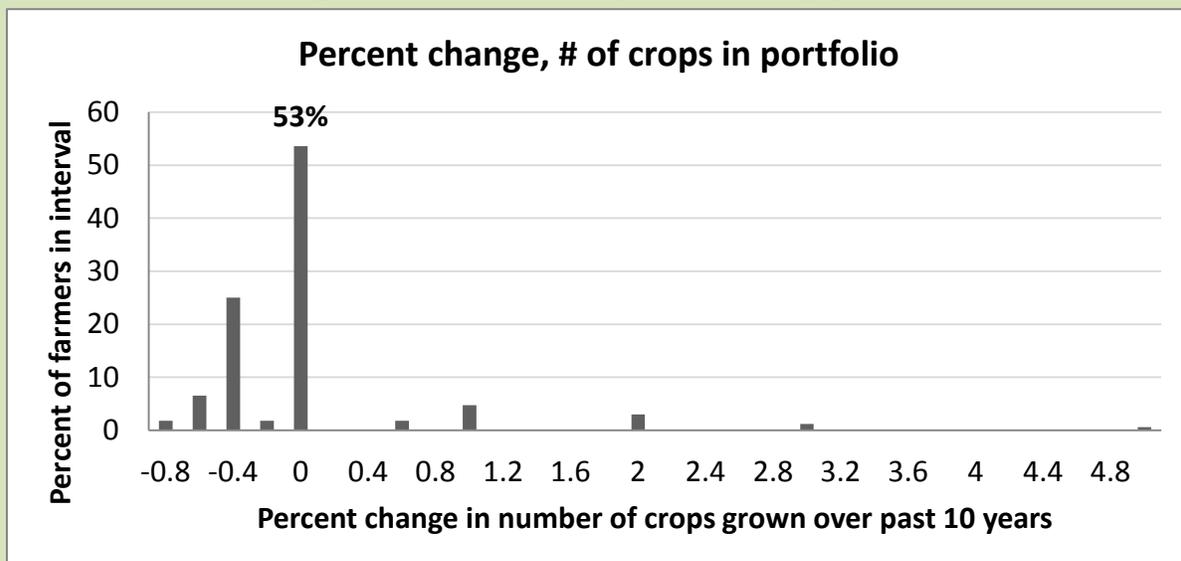
Figure 3. Survey responses for adoption of water conserving irrigation and conveyance technology



Surveys assessed whether crop diversification is occurring, or if the trend is towards crop specialization. Are farmers increasing or decreasing the number of crops in their crop portfolio over time? As figure 4 shows, 53% of farmers in the sample did

not change the number of crops grown in the past 10 years and 12% (those to the right of 0) increased the number of crops.

Figure 4. Percent change in number of crops in the crop portfolio



Connecting farmers, trees, fish, wildlife and habitat

Tree planting examples and opportunities:

One farmer surveyed maintains a tree growing in his alfalfa field despite higher costs, based upon his value for having trees on-farm (see photo below). Some of the farmers surveyed also gain income from serving as guides for hunters and fishermen visiting the region.

Farmers may be more interested in ecological restoration if: a) they have a higher value for fish, wildlife and habitat; b) they live on their land and can benefit from the ecosystem services provided; and c) they see restoration as an opportunity to increase and diversify their household income through earnings from nature-based tourism.

Table 2 shows that 79% of farmers live on the land that they cultivate or in close proximity. These farmers are more likely to benefit from ecosystem services such as temperature regulation (summer cooling) and wind barriers provided by tree planting for ecological restoration in the Colorado River Delta.

Table 2. Survey results: environment

Key variables	% of respondents
Live on land / rural area	79% (133 of the 168 farmers)
Hunt	14% (24 of the 168 farmers)
Fish	11% (18 of the 168 farmers)

After the survey process began, an additional question was added asking farmers if they were willing to contribute to ecological restoration in the Delta. Table 3 shows that an overwhelming majority (94%) are willing to support restoration.

Table 3. Willingness to contribute to ecological restoration

Response	Number of farmers	% of respondents
Contribute water	12	13%
Volunteer to work	53	55%
Donate money	21	22%
Any of these 3 options	4	4%
Not interested	6	6%
TOTAL	96	100%



- **Collaboration among farmers and conservation groups**

Survey results demonstrate that a large percentage of farmers state they have faced delivery shortfalls and delays in recent years. These water challenges for farmers may provide opportunities to connect farmers and conservation groups in partnering to create solutions to improve water supply reliability for farmers and for fish, wildlife and the habitat upon which they depend.

Table 4. Motivations for collaboration

Building relationships among farmers and environmental groups can provide the following benefits:

Improved water management

Increased capacity to influence policy related to regional water resources

Potential for cost sharing for farm inputs

Collaborations are already occurring among farmers and conservation groups. For

example, a pilot restoration project in the southeast portion of the Mexicali Valley Irrigation District involves planting native trees and purchasing irrigation water from the District. Increased organizational capacity from partnering on water issues can help make regional water reliability issues more nationally visible, raising their priority on government agendas.

In the surveys farmers reported that input costs are a substantial impact on farm profitability, with 93% of farmers noting rising input costs as a top impact. Input cost-sharing among farmers and environmental groups could increase profitability for farmers and facilitate new water sharing arrangements. Farmers may be interested in a revolving microcredit fund to support bulk purchases of inputs at the beginning of the season. Water sharing can involve more saline water, which can be suitable for habitat restoration but detrimental to soils and crop yields.

Farmers experiencing higher levels of delivery delays or shortfalls may be good candidates for participation in collaborative arrangements. Farmers with greater delivery delays may be interested in crop diversification, into crops with a higher

tolerance for delays in irrigation deliveries. Farmers who have experienced higher levels of delivery shortfalls may be more interested in programs that support cement lining of parcel-level canals and adoption of drip irrigation, as these farmers demonstrate a higher tendency to invest in such measures.

The surveys found that 86% of farmers have received technical assistance and advice related to agricultural production in the past 5 years, mostly from companies selling them inputs. Additional technical assistance related to economic and agronomic aspects of producing alternative crops would be useful if crop diversification is pursued. Technical assistance and support for farmers to test their soils could decrease input costs for farmers and improve net returns. Conservation organizations could contribute to new forms of technical assistance as an opportunity to build relationships with farmers and create mutually beneficial water management improvements.

Conclusions

Farmers are responding to water supply variability with a variety of strategies, including cement lining of parcel-level canals and crop diversification. Opportunities exist for collaboration among farmers and environmental groups. Better understanding of farmer water management decisions, provided by survey findings, will help create effective policies to encourage adoption of water conserving practices. Changes in on-farm water management and crop mix have the potential to make more water available for restoring the internationally renowned habitat, fisheries and wildlife of the Colorado River Delta.

