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Impact of Water Users Associations on Water and Land Productivity, Equity and Food Security in Tajikistan

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The International Water Management Institute (IWMI) is a non-profit, scientific research organization focusing on the sustainable use of water and land resources in developing countries. IWMI works in partnership with governments, civil society and the private sector to develop scalable agricultural water management solutions that have a real impact on poverty reduction, food security and ecosystem health. Headquartered in Colombo, Sri Lanka, with regional offices across Asia and Africa, IWMI is a CGIAR Research Center and leads the CGIAR Research Program on Water, Land and Ecosystems (WLE). www.iwmi.org

Front cover photograph: Farmers irrigating their fields in southern Tajikistan (*photo:* Madeline Dahm/IWMI).

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Executive Summary

The United States Agency for International Development (USAID) funded key components of the creation, training of members and support of water users associations (WUAs) in southern Tajikistan over the period from 2004 to 2014. This report provides a summary and synthesis of a series of impact evaluation findings undertaken from 2014 to 2018 by the International Water Management Institute (IWMI). A key focus of this evaluation is to assess the impact that these WUAs have had on the management and productivity of irrigation water and land resources, as well as on equity and food security in Tajikistan.

WUAs represent a form of community-based water management organization whose launch, in many instances, predates a 2006 law in Tajikistan that defines and regulates their role. WUAs have a number of mandated functions related to the allocation and conveyance of irrigation water through canals and other delivery works, including scheduling, maintenance activities, fee collection and dispute resolution. These associations fill a void in water governance which was created when the historical relationship between the government's water agencies and the few, large collective farms was severed by land reform. The water needs of thousands of small, private farms exceeded the existing agencies' capacity to cope.

WUAs are based on members, where the typical member is a private (*dehkan*) farm of 4 ha in size that employs about seven staff, often from the same families or households. *Dehkan* farms produce crops such as cotton and wheat (traditionally), along with (more recently) fruits, vegetables and fodder. Some lands are cropped twice per year. Given the semi-arid climate in this study area, the use of irrigation is nearly universal, drawing from gravity-fed surface water supplies.

Many households rely upon the abstraction of water from canal systems for household garden plots and domestic use. These canals are maintained by WUAs, but the households that abstract water from the canals are denied membership and a voice in WUAs unless the household uses qualify as commercial enterprises. Water scarcity is a growing concern and some canals run dry for some months in some years, creating uncertainty for irrigators, and influencing their cropping and irrigation decisions.

Many of the expected impacts from USAID's intervention, such as broad-based contributions to farm profitability and (local and national) food security will only appear over the longer term. Those impacts are not the focus of the impact evaluation. Instead, the current evaluation examines intermediate and short-term outcomes, such as those related to water management, land use, cropping choices and the allocation of farm labor. This research focused on four principal research questions.

1. What are the impacts of the USAID-supported WUAs on land and water management outcomes?
2. How does the distribution of benefits among members of USAID-funded WUAs differ from that in non-USAID project areas?
3. How sustainable are the impacts and how do beneficiaries perform over time when active donor support is withdrawn?
4. What are the key factors, mechanisms and local specificities that help to understand and explain what did and did not work in the process of bringing about the desired change among the beneficiary groups?

This analysis of WUAs is primarily based on representative panel data. That is, the impact evaluation relies upon the collection and analysis of primary cross-sectional data collected at two intervals from farms and WUAs, first in 2015 and then again in 2017. Other forms of data gathering and investigation, such as the use of cross-sectional data from kitchen gardens and local government officers, focus group discussions and interviews with key informants also play a role. However, a carefully designed sampling program for the implementation of face-to-face interview surveys gathered most of the data to support descriptive analysis and hypothesis testing. A summary of the findings of this evaluation is given below.

With respect to the first research question:

- As measured by changes between the years 2014 and 2016, on a sample of 141 WUAs, relative to other WUAs in the region, USAID WUAs are particularly associated with an increased rate in the collection of membership fees. USAID WUAs increased their collection of fees from existing members by 19% more than non-USAID WUAs; this effect was significant at 1%. As compared to non-USAID WUAs, USAID WUAs also experienced a larger increase in the likelihood of having a seasonal water delivery plan;

holding board meetings to plan water delivery activities; conducting pre-season canal cleaning and maintenance (on the secondary and tertiary canals that fall within their areas of responsibility); and collecting irrigation fees on behalf of the district irrigation departments. These latter effects were modest in size. Therefore, USAID WUAs experienced greater improvements in performance than non-USAID WUAs.

- An analysis of participation in WUAs was conducted on a representative sample of 1,855 *dehkan* farms using panel data collected for the 2014 and 2016 cropping years. These results demonstrate that, as compared to farms served by non-USAID WUAs, farms served by USAID WUAs performed better: there was an 8% higher increase in the likelihood of payment of membership fees; a 20% higher increase in signing a water contract; and a 9% higher increase in sending a farm representative to a WUA meeting. Farms served by USAID WUAs also increased their contributions of labor towards maintaining and cleaning canals by 7 person-days more than the increase in the contribution made by farms served by non-USAID WUAs. These effects were statistically significant, all at 5% and some even at 1%. Therefore, farms served by USAID WUAs experienced greater improvements in participation and fee payment than farms served by non-USAID WUAs.

- A separate examination of the determinants of the cropping choices made by *dehkan* farms shows that farms that received formal training in extension (e.g., those that belong to USAID-funded WUAs) experienced a greater increase in the number of high-value crops cultivated (of the order on 0.28), and this effect was significant at 1%. Translated to the area under high-value crops, farms served by USAID WUAs experienced an increase of 0.14 hectares (ha) than farms served by non-USAID WUAs, which was significant at 5%. There was also a larger increase in an index of crop diversity for *dehkan* farms that received training, significant at 5%. In an environment where cotton produced for export markets is a large incumbent crop choice, a move toward greater diversity almost always implies a move to a larger range of cash crops; in this case, fruits and vegetables. Taken together, these results demonstrate that the diversity of crops cultivated on farms served by USAID WUAs increased more than that on farms served by non-USAID WUAs (though these did not necessarily take place along with a fall in cotton production).

With respect to the second research question, the distribution of benefits from USAID-funded WUAs can be related to how benefits fall across farms of various sizes (a proxy for wealth), and across farms that are relatively advantaged from being situated adjacent to a larger canal.

- Farm operators with less than 3 ha of land in the USAID group perceived the greatest improvements in distribution of water delivery. In 2014, 14% of farm operators with less than 3 ha in the USAID group perceived water delivery to be "rather fair." This increased to 22% in 2016, an increase of 8%. In contrast, 16% of farm operators with less than 3 ha in the non-USAID group perceived water delivery to be "rather fair"; this increased to 21% in 2016, an increase of 5%. The difference-in-difference (between 8% and 5%) was 3%, which was significant at 10%.
- Additionally, more operators of farms on tertiary canals in the USAID group perceived improvements in the distribution of water, as compared to operators of farms on tertiary canals in the non-USAID group. In 2014, 11% of farms in the USAID group perceived water distribution to be "rather fair"; this increased to 16% in 2016, an increase of 5%. In comparison, the perception of water distribution to be "rather fair" increased from 9% in 2014 to 11% in 2016 for the non-USAID group. The difference-in-difference (between 5% and 2%) was 3%, which was significant at 10%.
- Taken together, these results suggest that a higher number of smaller farms and spatially disadvantaged farms experienced improvements in water delivery and distribution when they were served by USAID WUAs. Similar analyses conducted for the distribution of yields of cotton and wheat by farm size and canal type did not suggest any differences between the USAID and non-USAID groups; this is possibly due to the relatively short timeline of this evaluation.

Turning to the third research question, it addresses the performance of USAID-funded WUAs in the interval after active donor support is withdrawn. Although these WUAs will continue to mature with the passage of years, the data and observations taken for this analysis are associated with the post-funding period, and thus shed light on the issue directly.

- Two indicators of sustainability are whether the users felt that the water allocations were timely and fair.[1] For instance, there was an increase from 25% to 39% in the number of farms served by USAID WUAs who perceived the distribution of water to be "rather fair" (third highest of four ratings for fairness). The corresponding increase for the non-USAID group was from 24% in 2014 to 32% in 2016. This difference (between 14% and 8%) were significant at 5%.
- In addition, an analysis of remote sensing data decomposed the irrigated crop areas within the region into those supported by any WUA (not just those funded by USAID) and those without support. Over the 7 years from 2010 to 2017, these data demonstrated a sustained increase in the areas allocated to the production of wheat, the staple crop. In 2010, only 9% of the irrigated crop area with WUAs and 5% of the irrigated crop area without WUAs were under wheat cultivation. By 2017, 21% of the irrigated crop area with WUAs was under wheat cultivation, an increase of 12%. In contrast, the irrigated crop area without WUAs under wheat had only increased to 12%, an increase of 7%. These differences (between 12% and 7%) were significant at 5%.
- Taken together, these results demonstrate that USAID WUAs supported a larger increase in satisfied farmers than non-USAID WUAs. However, equally important, WUAs have had a significant role to play in increasing the area cultivated with wheat (the staple crop in Tajikistan), since irrigated areas without these WUAs have experienced a slower increase in the area cultivated with wheat.

Finally, the fourth research question, which examined factors, mechanisms and local specificities for success (or lack thereof) identified two factors associated with the success of USAID interventions in improving water governance and affecting agricultural outcomes: the duration of training and the 'packaging' of training in water management with that in agricultural extension. Yet, the lack of technical training for female irrigators, feminization of the agricultural workforce and the increasing demands on women's time, especially for labor-intensive agricultural tasks, along with the lack of mechanisms that coordinate water use between farms (which are commercial) and kitchen gardens (where food for household consumption is cultivated) may affect the sustainability of these important medium-term impacts.

[1] These results compare the USAID group with the non-USAID group; the results for the second research question compared these two groups stratified on canal type and farm size.

The findings of this evaluation lend themselves to the following recommendations:

- The changing role of women in agriculture and food production invites a re-examination of training programs that would benefit women specifically, and invites careful consideration of women's time allocation and opportunity costs when evaluating new agricultural practices and technologies.
- The exclusion of numerous household water uses and users from WUAs and from other well-regulated water governance mechanisms appears to invite a broadening of the national approach to water governance for multiple users.
- Finally, with respect to evaluation methodology and best practice, it is a frequent occurrence that large programs of intervention are undertaken without first creating a well-designed knowledge base of baseline conditions to describe both the treatment and control groups. All too often, this has discouraged rigorous, evidence-based impact assessments and evaluations. The modified difference-in-difference methodology developed and implemented during the course of this study may serve as a role or example for other programmers and evaluators. This work can increase opportunities to implement adaptive management at the earliest stages of a program's implementation, and make those mid-course corrections with the highest value.

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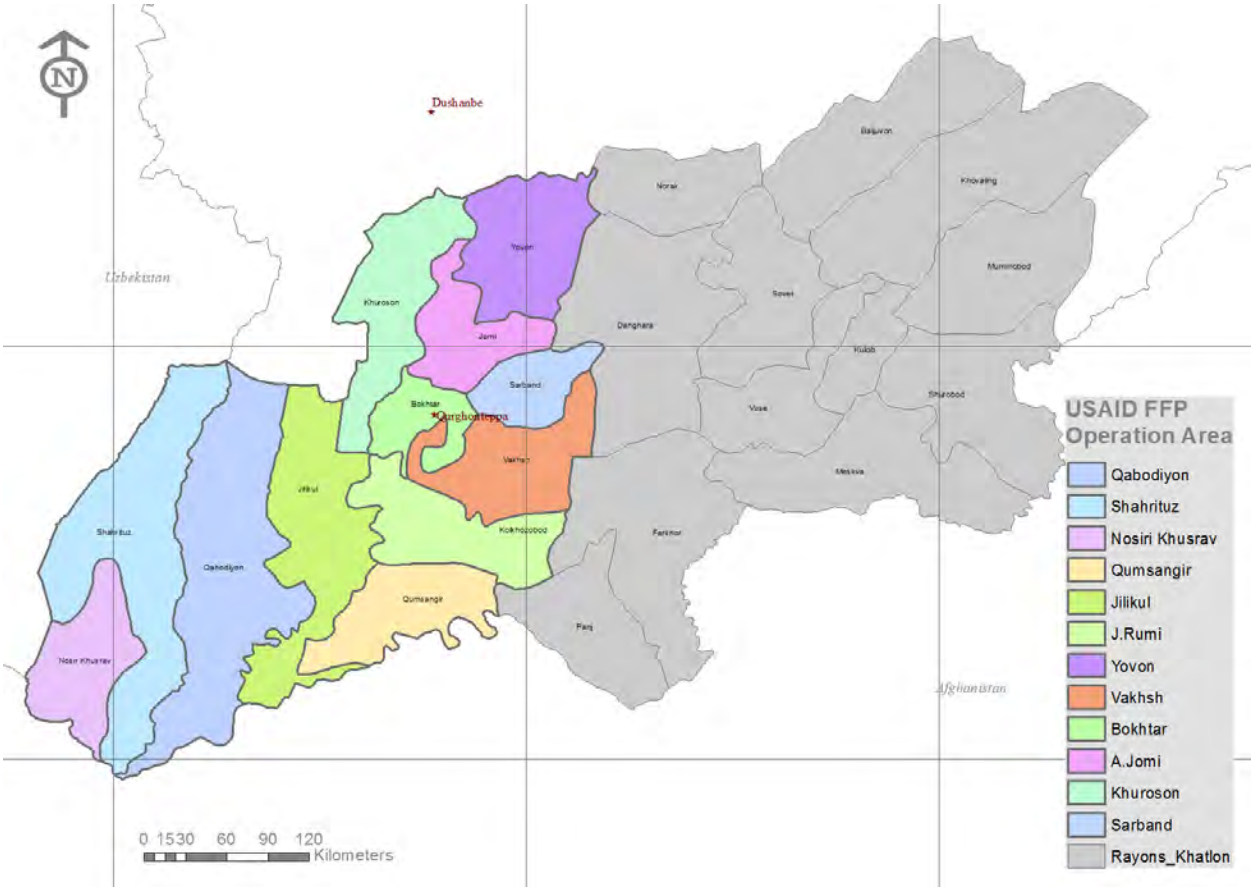
1 Introduction and Overview

In 2014, the United States Agency for International Development (USAID) appointed the International Water Management Institute (IWMI) to design and conduct an impact evaluation of some of the Agency's programmatic work in southern Tajikistan. Specifically, USAID has developed and supported water users associations (WUAs) as a new institution for water governance in the agriculture sector of the country.

The WUAs that are the subject of this evaluation were established and supported by the *Family Farming Program* that had historically been implemented (2010-2014) by USAID in Khatlon Province of Tajikistan. Later, the program expanded to other provinces (Figure 1) and came under the auspices of the *Feed the Future* initiative, the United States government's global hunger and food security initiative. The goal of this programming is to promote equitable and sustainable access to water for irrigation by creating new WUAs and by strengthening existing ones, all with the interest of increasing crop productivity and diversification. USAID had been active in these efforts since 2004, through programs such as the USAID *Water Users Association Support Program* (2004-2011). The experience of a growing number of new WUAs since 2004 provides evidence and insights with which to inform and document the effectiveness of USAID's approaches to increase agricultural productivity and profitability through improved water management.

IWMI's approach to this 49-month impact evaluation project (May 2014-June 2018) is based on a program theory approach. The project has applied quasi-experimental design and mixed methods to generate impact findings that are both robust and contextually rich. The project builds upon sequential phases of survey data collection and analyses. These include: (a) a qualitative exploratory phase at project inception with field visits and documentary review; and (b) a major quasi-experimental quantitative phase through survey research with two main field-data collection programs. IWMI designed a 2015 survey of actions by irrigators in 2014 and a 2017 survey of their actions in 2016. A number of supporting studies draw from additional field interviews and observations to address specific related topics such as the changing role and contribution of women in irrigated agriculture, and the roles of formal and informal water governance approaches to support and enable the work of WUAs (See Appendix 4 and percentages in Volume II; Buisson et al. 2016). In addition, remote-sensing imagery and approaches present comparative information about changes in the use of land and irrigation over the period that USAID has been engaged in this region of Tajikistan.

Figure 1. USAID intervention districts in Khatlon Province under the Feed the Future initiative.

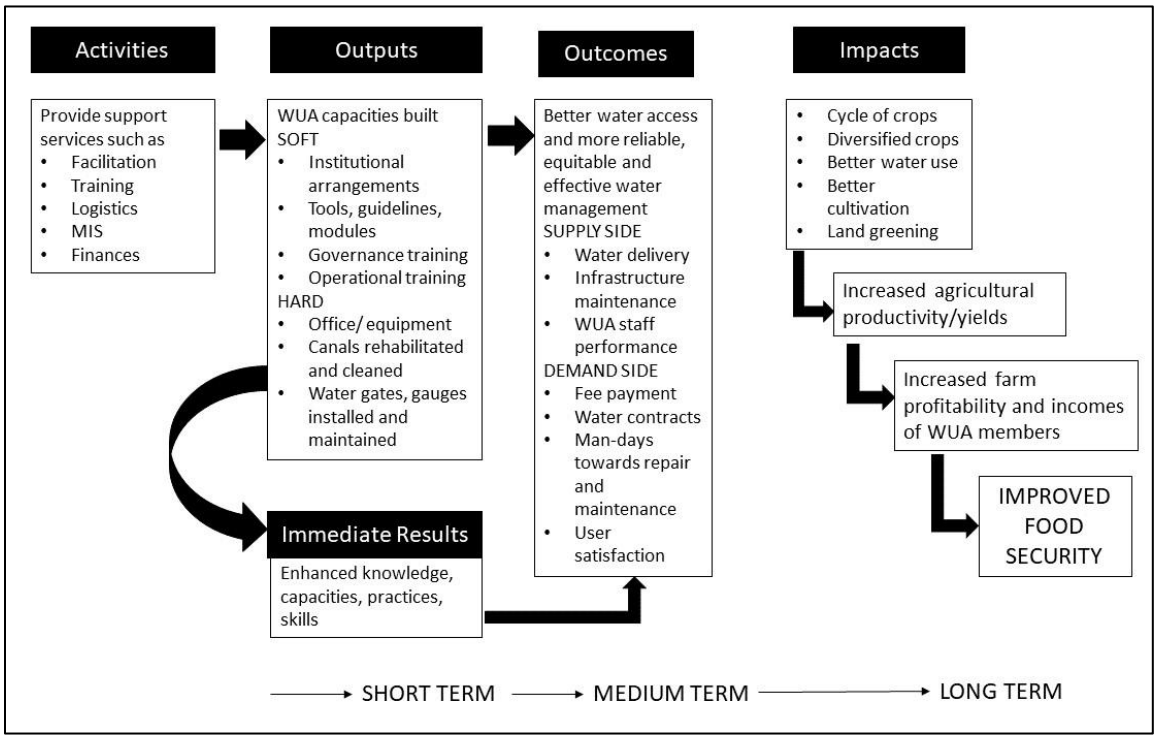


Source: Family Farming Program (FFP) 2013.

The main outputs of this project's program of survey and case study research appear as a substantive portfolio of project reports along with scientific articles that have already been published or are currently under review in peer-reviewed journals. The lessons contained in this body of work are targeted at USAID, the Government of Tajikistan, civil society groups and diverse donors, among others, to assist them in developing and sustaining WUAs with outcomes that are more effective, efficient and equitable. Appendix A lists these project publications.

Figure 2 presents, schematically, a theory of change that illustrates the rationale for providing support to WUAs during this specific era in Tajikistan. When Tajikistan left the Soviet Union in the early 1990s, the country experienced a period of civil war, and then underwent a series of drastic and difficult-to-manage institutional reforms. These included land reform in the agriculture sector, and the termination of established systems and methods of irrigation water governance.

Figure 2. Theory of change for programmatic support to WUAs in Tajikistan.



Note: MIS - Marketing Information Systems.

Large collective farms were subdivided and the rights to operate smaller farms were granted to groups and individuals. Irrigation water management and distribution became more difficult, not only due to the need to coordinate across many more (small farm) irrigators but also due to the loss of Soviet expertise, and changes in the country's fiscal regime. There were critical lapses in investment in and maintenance of irrigation infrastructure and machinery, at the same time when farmers were granted some latitude to produce diverse new crops with unfamiliar irrigation requirements. WUAs offered a promising new vehicle to reverse declines in irrigated production and productivity. As shown in Figure 2, this was an environment where the provision of training and facilitation, coupled with targeted capital and operational assistance, had the potential to restore agricultural productivity and incomes, and thus food security.

1.1 Key Features of the Process and Findings of the Evaluation Exercise

This section introduces three features of the evaluation approach and context that both influence and pervade the subsequent discussions of specific methods and findings from the four-year project as a whole. These are:

(a) the central role of representative panel data;

(b) changing gender roles in light of external labor market changes; and

(c) WUAs' connections to broader water governance.

Consider each in turn.

(a) The central role of representative panel data

This project provides a valuable "real world laboratory" to trace the interrelated effects of a number of specific water governance changes and programming interventions using data and observations from several thousands of farms at two points in time. The project collected these data using a carefully calibrated sample design that allows one to interpret many of the findings as being statistically representative of the larger population base of these irrigated regions.

Other survey studies of this nature often set out to learn about people's perceptions, preferences, intentions and reactions to changes in their economic environment. This study goes further by placing an emphasis on the actual choices and decisions made by the farmers whose farms now belong to WUAs. That is, the study moves past intentions and conjectures in order to observe the actual changes that occur, such as in irrigators' use of labor, land and crops, and changes in the ways that the irrigators support and engage with these new WUAs.

In the absence of these data, theoretical reasoning, such as that based on various microeconomic models, could take one a fair distance by providing a series of testable predictions. In the context of the USAID program to increase access to more reliable water supplies, those predictions might include the expected increase in production of those crops that are more water intensive, and the partial substitution of irrigation water for other inputs that are now relatively more costly. Under a series of standard assumptions, and subject to all else being equal, the expected magnitude of the farmers' adjustments might be estimated based on prior knowledge of key features of the crop production environment, such as crops' yield response to water, and so on. However, in the Tajikistan economy, many of the "standard assumptions" might not hold, since the markets for key agricultural inputs, crops

and produce do not always function smoothly with low transactions costs. There is no expectation of "all else being equal" when a disruptive trend during much of this period has been the out-migration of male farm laborers and managers. Thus, in Tajikistan more than elsewhere, the ability to collect and analyze these representative panel data plays a central role in assessing the entire evaluation exercise.

(b) Changing gender roles in light of external labor market changes

The promotion and support of WUAs differentially affects and benefits women versus men. Even if one had been examining a slow-changing or static agricultural region that exhibits long-standing traditions and gender roles, which Tajikistan does not exhibit, there would likely have been interest in exploring these differences. However, in the context of southern Tajikistan, these issues become increasingly more interesting and complicated given external labor market forces. These forces have motivated males to migrate—away from rural areas, often to Russia, for months or years at a time—in search of higher-valued work. The current study examines a number of gender roles and adjustments on their own merits, and also acknowledges their pervasive influence on numerous other decisions and outcomes. For instance, although increased access to more reliable water supplies suggests an opportunity to expand crop production, especially of high-value crops, these effects have been held back in some cases by shortages of labor.

The focus of the current evaluation has been on measuring indicators that would be likely to change within the short-term time scale of the current project, such as choices about the crop mix and the use of land, labor and water. In a longer-term study, one would expect to be able to estimate changes in income, well-being or overall food security, as examples. In an economy where migrating males' on-farm workloads are increasingly being borne by the women who stay behind, it would no longer be sufficient to ask if the *monetary* incomes of women or of households have increased because of program efforts. One would also want to assess the way that women's use of labor (and leisure) has changed, where a household's allocation of labor and leisure may be important non-monetary determinants of household well-being. One would want to evaluate and include whatever else has been sacrificed (including non-monetary items) when women's workloads now include larger amounts of agricultural field labor, for example.

In southern Tajikistan, perhaps more than elsewhere, there is additional value in tracking gender-specific effects of the many interactions of WUA training and operations, and of the way that irrigators interact and engage with WUAs.

(c) WUAs' connections to broader water governance

While the focus of this USAID programming in Tajikistan has been on WUAs, it is clear that WUAs are only one key part of a larger hydrological system to be governed and managed. The function and effectiveness of the larger institutional environment also rely upon the effectiveness of the WUAs' interactions with the government's water and extension agencies, farmers, village councils and non-farm water users (garden plots, residential users), among others. This raises issues, explored further below, about identification and resolution of water allocation conflicts, and about planning for the future demands that could be placed on water systems to meet all users' needs. As identified here, there may be further gains to be realized from investing in capacity building and legal and institutional changes across this larger system.

This report proceeds as follows: Section 2 presents the study's purpose and methodology, focusing on four principal research questions. Section 3 provides answers to those research questions and addresses some linkages among them. Section 4 provides brief conclusions. Throughout, these sections provide references to supporting publications that offer additional depth of study and empirical support. These supporting publications are included as Appendices in Volume II of this report (Horbulyk and Balasubramanya 2018).

2 Evaluation Purpose, Questions and Methods

This evaluation of the impact of WUAs has been guided from the outset, in both its design and implementation, by a hypothesis about the expected impact and effect of the programming in Tajikistan.

> The WUAs formed and supported by USAID under its earlier *Water Users Association Support Program (2004-2011)*, and continuing under the *Family Farming Program* and the *Feed the Future* initiative, will lead to significant improvements in water management and in providing adequate, reliable and equitable irrigation water on a sustainable basis. As a result, farmers will be able to adopt improved cultivation practices and realize higher crop yields, leading to improved farm incomes (adapted from Yakubov et al. 2014).

Due recognition was given to the expected timing of many of these effects to be realized. Given that implementation of some of the water management components of the program was still underway, the proposed evaluation approach was to assess intermediate outcomes, such as whether the project improves water management and whether this has triggered further effects along the impact pathway. These could include enhancing water and land productivity, expanding cultivated land area, and giving women more access to resources and enabling them to participate more fully in water and land management. Conversely, participants' realization of higher farm incomes, profitability and diverse components of overall food security are expected to be longer-term outcomes, which are beyond the scope (and time frame) of the current evaluation.

Accordingly, this evaluation poses the following four research questions.

1. What are the impacts of the USAID-supported WUAs on land and water management outcomes?
2. How does the distribution of benefits among members of USAID-funded WUAs differ from that in non-USAID project areas?
3. How sustainable are the impacts and how do beneficiaries perform over time when active donor support is withdrawn?
4. What are the key factors, mechanisms and local specificities that help to understand and explain what did and did not work in the process of bringing about the desired change among the beneficiary groups?

While the main objective of this impact evaluation is to assess whether the creation of these WUAs has been successful in improving water management, it also evaluates a number of other outcomes, such as whether the project has influenced cropping diversity, cropping intensity and crop yields. The evaluation provides the opportunity to observe capacity-building effects in water governance, such as the structure and function of WUAs (e.g., organizational principles, rules and procedures, knowledge, skills, practices, tools and infrastructural improvements) all as influenced by the project.

Perhaps it is essential to mention that the true impact of USAID's WUAs cannot be measured, and that all impacts estimated in this study are likely an underestimate. USAID did not just establish and support WUAs, first under the Water User Association Support Program, and then under the Family Farming Program; it supported the government to draft the Water User Association Law of 2006; and the WUA training materials and blueprints established by USAID have been used by every agency—national or international—to establish and support WUAs. Estimating the true impact of USAID's program would require a counterfactual scenario in which the Agency had never started any WUA programs in Tajikistan. Such a counterfactual cannot be created. This evaluation, therefore, exploits the differences in processes used to create USAID WUAs and other WUAs to examine the impact of USAID WUAs. Though these differences—which relate to the duration of training and packaging training in water management with that in agricultural extension—seem minor, they are associated with superior performance of and participation in WUAs, and with cropping choices.

2.1 Methods

This analysis of WUAs is primarily based on representative panel data. That is, the analysis relies upon the collection and analysis of primary cross-sectional data from farms and WUAs, first in 2015 and then with a follow-up in 2017. Other forms of data gathering and investigation, such as cross-sectional data from kitchen gardens and local government officers, focus group discussions and interviews with key informants also played a role. However, as detailed in the Impact Evaluation Protocol (Yakubov et al. 2014), a carefully designed sampling program for the implementation of face-to-face interview surveys gathered most of the data to support descriptive analysis and hypothesis testing.

Implementation of the farm survey, for example, required a number of steps to ensure that the behavior revealed by the sample would be broadly representative of the population of farms in southern Tajikistan at large. Prior to sampling, and in the absence of current secondary data from published

sources, it was necessary for this project to undertake a census of sub-districts, and later a census of private farms within selected sub-districts, to establish the representativeness of these units of observation in southern Tajikistan. To choose which sub-districts to target, data gathered by this census were used to estimate propensity scores separately for sub-districts where the WUAs had been supported by USAID and for other sub-districts where USAID had not supported the WUAs. These estimates allowed the selection of matched pairs of targeted sub-districts, thereby controlling for other observable factors (reflected in historical agronomic and socioeconomic data) that might be contributing to differences in effects between the USAID-supported WUAs and others. Then, having selected sub-districts of interest, a stratified random sampling process chose a set of almost 2,000 farms within those districts that are broadly representative of similar farms across southern Tajikistan.

The panel data that were collected supported the use of difference-in-difference estimates of behavioral change, thereby controlling statistically for time-invariant unobservable confounders that could be responsible for outcomes of interest on these farms. The difference-in-difference analysis was conducted by including observable covariates on the right-hand side, to control for time-varying confounders. However, even with these statistical controls in place, a limitation of this study is the absence of data on production choices and other population characteristics in the period prior to implementation of the USAID interventions of interest. As explained in Balasubramanya et al. (2018) (included in Appendix 1, Volume II of this report), the use of first measurements taken later, such as for the year 2014 in this case, can still reveal important information but may introduce a bias in estimates of program impact. The results pertaining to impacts of longer training on WUA performance and farmer participation, and those pertaining to impacts of extension training on land use and crop choice, are likely underestimated.

The individual research papers presented in Appendix A of this report provide greater detail on the analytical assumptions, approaches and limitations associated with the specific findings each report presents.

3 Findings for Evaluation Questions

Each of the evaluation questions will be considered in turn here, supported by references to specific reports and studies conducted during the course of this research where relevant. To promote access by readers to these source documents, a number of the individual research papers appear as Volume II of this project report, especially those that are not already published. Other technical reports, such as those prepared for USAID, are accessible on the Internet. Although these reports are not part of Volume II, full bibliographic citations to them appear in the References section of this volume, including their Uniform Resource Locators (URLs).

3.1 Evaluation Question 1: What are the impacts of the USAID-supported WUAs on land and water management outcomes?

There are a number of water management outcomes represented in the data either as observations of behavior and activity or, in some cases, as numerical measures of the participants' perceptions about those aspects of water management that affect them. Answers to Evaluation Question 1 will first draw upon a number of aspects of water management, and then turn to impacts on crop production decisions that are influenced by water management. Comparisons presented here relate to the land and water management practices of two groups of WUAs (and the private farms that belong to those WUAs): (i) WUAs supported by USAID (the "treatment" group in this discussion), and (ii) all other WUAs (the "control" group).

The private farms (so-called *dehkan* farms) that belong to the WUAs are commonly about 4 ha of cultivated area, although the mean area of (the group of) these farms is drawn upward by a relatively small number of larger farms (larger than 100 ha) that persist from the period prior to Tajikistan's land reform programs. A typical *dehkan* farm provides employment to about seven "members" or workers, many, but not all, of whom either live in the same household or are related by blood or marriage. Where historically, employment on commercial farms was more predominantly a male vocation, the participation by females as members of *dehkan* farms increased from 46% to 52% of the *dehkan* farm workforce in the 2014 to 2016 surveys.

Largely related to the recent land reform process, the sites of *dehkan* farmlands are generally not contiguous with the homestead and household lands of their workers. This separation of locations

facilitates a categorical separation of the production activities and water management decisions of the *dehkan* farms from the other production activities of the farm members, such as when householders own and manage kitchen gardens and other small plots that would not qualify as a commercial farm (as *dehkan* farms do). The efforts of WUAs are guided by their members—the *dehkan* farms, represented by a manager or the manager's designate. Through their influence on water allocation, the WUAs influence both their member farms and most other water users who draw canal water for irrigation or domestic purposes.

Turning to impacts and influence, Balasubramanya et al. (2018) (full text in Appendix 1 of Volume II) compared the water management activities of WUAs between the years 2014 and 2016 for 74 WUAs supported by USAID (the treatment group) versus 67 other WUAs (the control group). As measured by difference-in-difference changes between the two groups over time, the results show that USAID WUAs are particularly associated with an increased rate in the collection of membership fees, accomplishing a 19% higher increase in their fee collection from existing members than what non-USAID WUAs were able to accomplish; this effect was significant at 1%. USAID WUAs also experienced a higher increase in the likelihood of having a seasonal water delivery plan; holding board meetings to plan water delivery activities; conducting pre-season canal cleaning and maintenance (on the secondary and tertiary canals that fall within their areas of responsibility); and collecting irrigation fees on behalf of the district irrigation departments. These effects were modest in size and not significant at 5% or 10%, due to the small number of observations (141 WUAs, which is the population of WUAs in 10 districts of Khatlon Province). Therefore, USAID WUAs experienced statistically significant greater improvements in the performance of mandated duties than non-USAID WUAs.

An analysis of participation in WUAs was conducted on a representative sample of 1,855 *dehkan* farms using panel data collected for the 2014 and 2016 cropping years (Balasubramanya 2018; full text in Appendix 2 of Volume II). These results demonstrate that, as compared to farms served by non-USAID WUAs, farms served by USAID WUAs experienced an 8% higher increase in the likelihood of paying their membership fees to their WUA; a 20% higher increase in the likelihood of signing a water contract with the WUA to secure seasonal access to water; and a 9% higher increase in the likelihood of sending a farm representative to a WUA meeting. Farms served by USAID WUAs also increased their contributions of labor towards maintaining and cleaning canals by 7 person-days more than increases in contributions from farms served by non-USAID WUAs. These effects were statistically significant, all at 5% and some

even at 1%. Therefore, farms served by USAID WUAs experienced statistically significant greater improvements in participation and fee payment than farms served by non-USAID WUAs.

The surveys of *dehkan* farms gathered farmers' estimates of the farm-level production volumes of major crops and the land areas allocated to each crop (Table 1). From these details, it was possible to estimate the crop yields in each of the 2014 and 2016 cropping years, and the changes in these yields, averaged across a large number of farms. In the case of cotton production, the treatment group had statistically significant higher yields than those of the control group in both cropping years. Farms in the treatment group experienced a cotton yield of 2.82 t/ha in 2014, while farms in the control group had a lower yield of 2.64 t/ha; this difference of 0.19 t/ha was significant at 1%. In 2016, farms in the treatment group experienced a cotton yield of 2.27 t/ha, while farms in the control group experienced a yield of 2.13 t/ha; this difference of 0.14 t/ha was also significant at 1%. The difference-in-difference (0.14-0.19 = -0.05) was not statistically significant at 1%, 5% or 10%. This suggests that, while the treatment group experienced higher yields in both periods than the control group, the yield changes in both groups were likely related to other factors which equally affected yield (such as average temperature and rainfall).

Table 1. Yields of different crops by treatment status.

	2014			2016			DiD	R-squared
	USAID	Non-USAID	Difference (T-C)	USAID	Non-USAID	Difference (T-C)		
Cotton yield (t/ha)	2.826	2.637	0.188*** (0.067)	2.267	2.127	0.140** (0.067)	-0.049 (0.095)	0.06
Wheat yield (t/ha)	2.272	2.246	0.025 (0.065)	2.196	2.212	-0.015 (0.061)	-0.041 (0.089)	0
Onion yield (t/ha)	18.126	17.883	0.243 (1.808)	14.093	12.86	1.233 (1.49)	0.989 (2.343)	0.03
Tomato yield (t/ha)	11.863	12.742	-0.879 (1.503)	7.605	7.614	-0.01 (1.346)	0.869 (2.018)	0.04
Melon yield (t/ha)	11.817	8.498	3.319** (1.514)	12.082	7.447	4.635*** (1.495)	1.316 (2.128)	0.03

Notes: *** $p < 0.01$ and ** $p < 0.05$; standard errors in parentheses. DiD – Difference-in-Difference method; T – Treatment group; C – Control group.

The yields of onion and melon were higher in both the 2014 and 2016 cropping years for farms in the treatment group than those in the control group. For example, farms in the treatment group had an average yield of 11.81 t/ha for melon in 2014, while farms in the control group had only 8.49 t/ha, a difference of 3.32 t/ha, which was statistically significant at 5%. In 2016, farms in the treatment group experienced a melon yield of 12.08 t/ha, while farms in the control group experienced a yield of 7.45 t/ha, a difference of 4.64 t/ha, which was significant at 1%. The difference-in-difference (4.64-3.32=1.32 t/ha) is not statistically significant at 1%, 5% or 10%. As in the case of the cotton yields, these results suggest that the yield changes in the two groups were likely due to other factors (not related to the intervention) that equally affected yield (such as average temperature).

An examination of the determinants of the effect of USAID WUAs on cropping choices made by *dehkan* farms was also conducted (Buisson and Balasubramanya 2018; full text in Appendix 3 of Volume II). This analysis was also based on a sample of 1,730 farms, consisting of farms belonging to USAID WUAs that were matched statistically with similar farms belonging to non-USAID WUAs. Farms in the treatment group (USAID-funded WUAs) experienced an increase in the area cultivated with cotton of 0.54 ha more than the increase in cultivated area experienced by farms served by non-USAID WUAs; this result was significant at 10% (Table 2). Similarly, farms served by USAID WUAs experienced an increase in the area cultivated with wheat of 0.28 ha more than the increase in cultivated area experienced by farms served by non-USAID WUAs; this result was significant at 5% (Table 2).

Table 2. Determinants of cultivated areas, number of crops, cropping intensity and crop diversity.

	Variables	Cotton area	Wheat area
FARM CHARACTERISTICS	Area of the farm (ha)	0.47*** (0.01)	0.14*** (0.01)
	Distance to road (km)	-0.04 (0.05)	0.04 (0.02)
	Age of the farm (#)	0.00 (0.02)	0.031*** (0.01)
	Number of farm members (#)	0.06*** (0.01)	-0.01 (0.01)
	Proportion of women members (%)	1.82*** (0.30)	-0.25 (0.186)
	Age of the head of the farm (#)	-0.01 (0.01	0.00 (0.00)
	Level of education of the head of the farm (categorical)	-0.09 (0.09)	-0.01 (0.04)
	Women head of the farm (dummy)	0.06 (0.15)	0.03 (0.10)
TREATMENT	Farm in a USAID treated location (dummy)	0.54* (0.29)	0.28** (0.14)
	Observations Number of farms	3,476 1,766	3,476 1,766

Note: *** p < 0.01, ** p < 0.05 and * p < 0.1; standard errors in parentheses.

Farms in the treatment (USAID) group received training in agricultural extension, along with training in water management. Farms in the control (non-USAID) group did not receive such focused training, but were exposed to such information through exchange visits. The intervention package was split into its constituent parts (perceived improvements in water delivery, training in agricultural extension, and frequency of interaction with agricultural groups) to examine the effect of these constituents on cultivation choices. Using farm-level data on crop choices, farms served by USAID WUAs (that were provided with training in agricultural extension) experienced a greater increase in the number of high-value crops cultivated (of the order on 0.28), and this effect was significant at 1%. Translated to the area under high-value crops, farms served by USAID WUAs experienced an increase of 0.14 hectares more than the increase experienced by farms served by non-USAID WUAs, which was significant at 5%. Additionally, there was an associated increase in an index of crop diversity (Margalef's Index),

statistically significant at the 1% level, showing that crop diversity on farms served by USAID WUAs increased more than that on farms served by non-USAID WUAs. Taken together, these results suggest that, in an environment where cotton for export is a large incumbent crop choice, an agricultural program that incorporates training in agricultural extension and encourages interactions between farms can support a move toward the cultivation of a larger range of market crops (especially fruits and vegetables), thus improving crop diversity in this region. These results demonstrate that the diversity of crops cultivated on farms served by USAID WUAs increased more than that on farms served by non-USAID WUAs (though these did not necessarily take place along with a fall in cotton production).

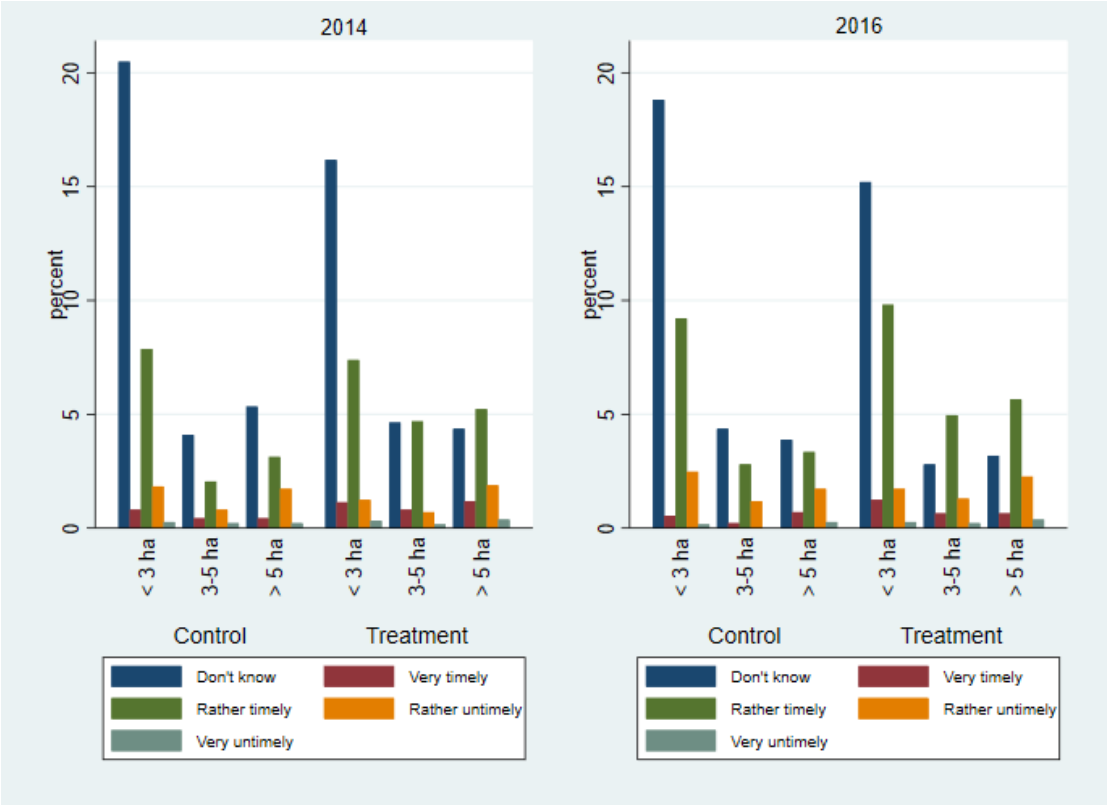
3.2 Evaluation Question 2: How does the distribution of benefits among members of USAID-funded WUAs differ from that in non-USAID project areas?

Two types of benefits were examined: the perceptions of operations of *dehkan* farms on the timeliness of water delivery and the fairness in water distribution; and the yield of a few major crops (cotton, wheat, tomato and onion). These benefits were examined by size of the farm, which is a proxy for wealth, and by canal type, which provides evidence for whether spatially and disadvantageously located farms (those on tertiary canals) are also served well.

Timeliness of water delivery and fairness in water distribution

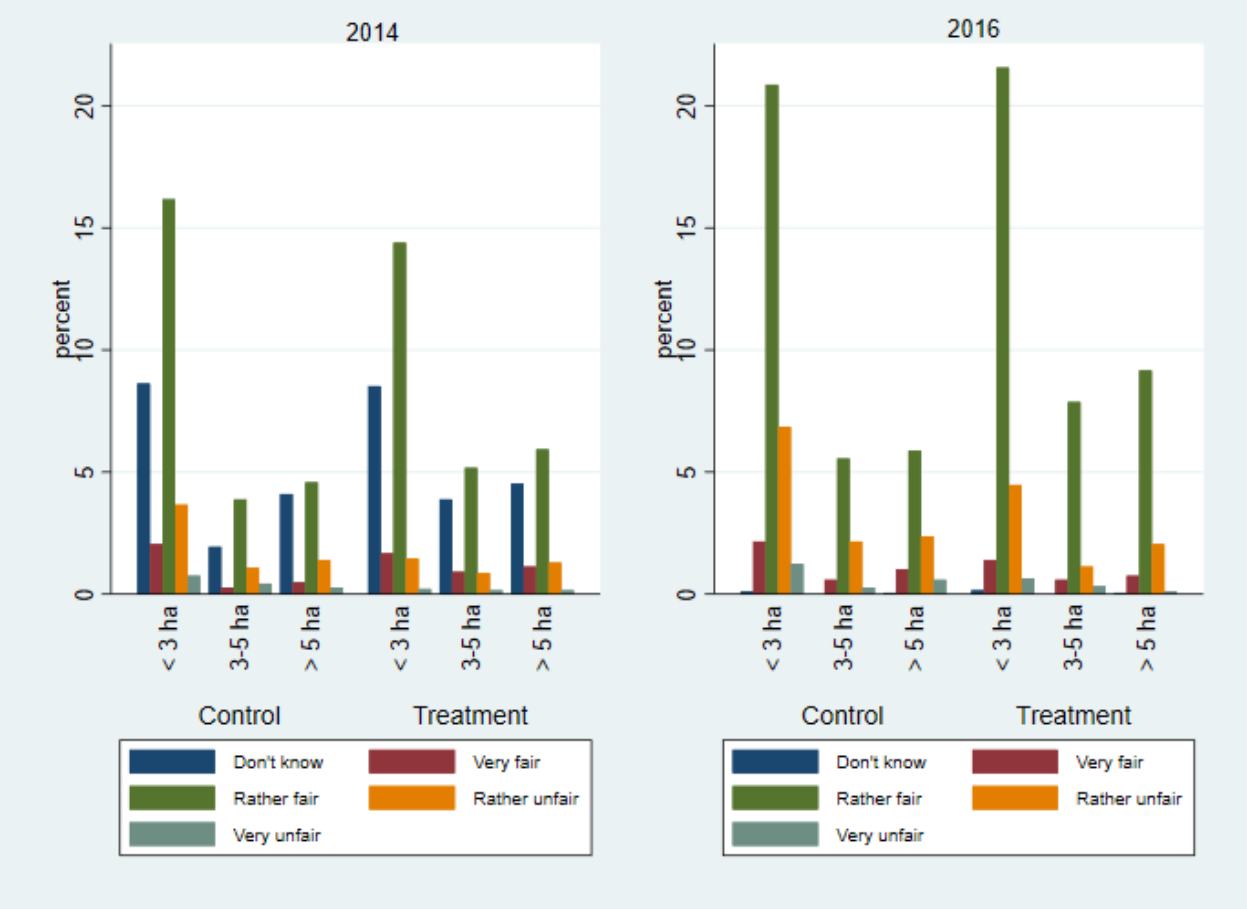
Farm operators in the treatment group perceived improvements in the timeliness of water delivery for all sizes of farms, as did operators in the control group for all farm sizes (Figure 3). More farms experienced an improvement in water delivery in both groups, and there was no statistically significant difference between the number of farms that experienced improvements in the two groups.

Figure 3. Perceptions regarding the timeliness of water delivery by farm size and treatment status.



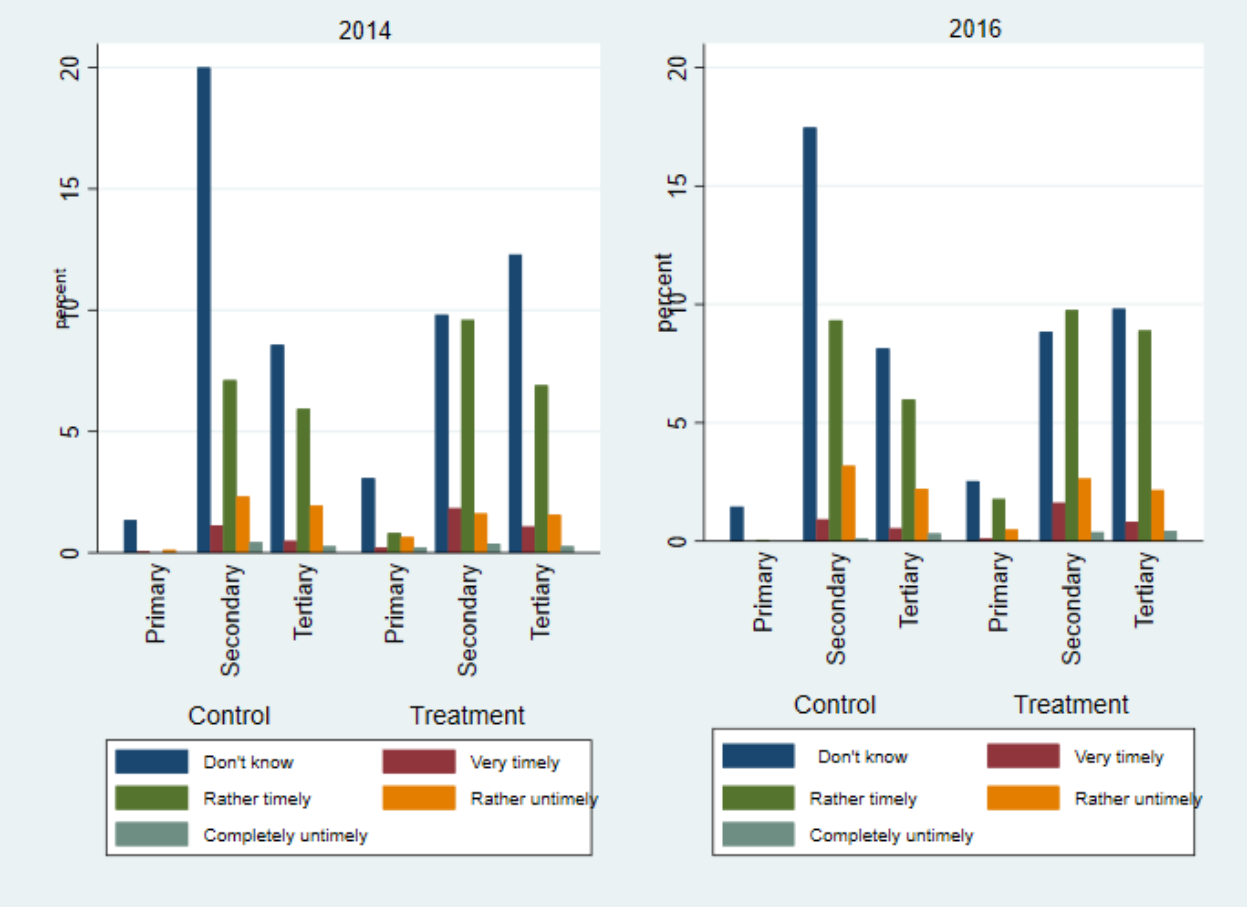
Farm operators with less than 3 ha of land in the treatment group perceived the greatest improvements in the distribution of water (Figure 4). In 2014, 14% of farm operators with less than 3 ha in the treatment group perceived water delivery to be "rather fair." This increased to 22% in 2016, an increase of 8%. In contrast, 16% of farm operators with less that 3 ha in the control group perceived water delivery to be "rather fair" in 2014 and this increased to 21% in 2016, an increase of 5%. The difference-in-difference (8%-5%) was 3%, and was statistically significant at 10%. These results suggest that a greater number of small farms experienced improvements in the timeliness of water delivery when they were served by USAID WUAs than when they were served by non-USAID WUAs.

Figure 4. Perceptions regarding the fairness in water distribution by farm size and treatment status.



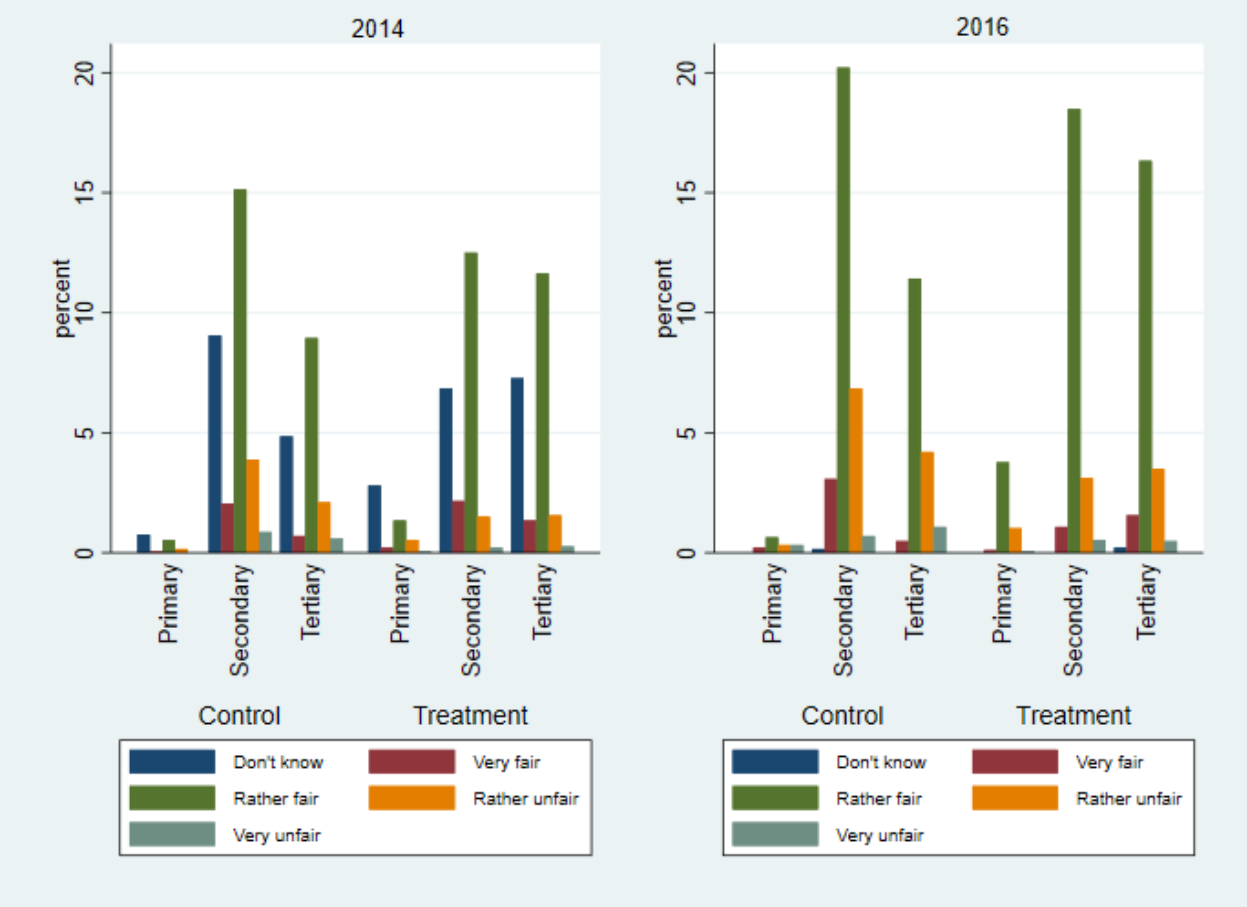
Operators of farms on all types of canals in the treatment group also perceived improvements in the timeliness of water delivery between 2014 and 2016, as was the case with operators of farms in the control group (Figure 5). More farms in both groups perceived improvements in the timeliness of water delivery over the two-year period, but there was no statistically significant difference at the 1%, 5% or 10% levels between the number of farms that perceived improvements, in the treatment and the control groups.

Figure 5. Perceptions regarding the timeliness of water delivery by canal and treatment status.



In contrast, more operators of farms on tertiary canals in the treatment group perceived improvements in the distribution of water, as compared to operators of farms on tertiary canals in the control group (Figure 6). In 2014, 11% of such farms in the treatment group perceived the distribution of water to be "rather fair"; this increased to 16% in 2016—an increase of 5%. In comparison, 9% of operators of farms on tertiary canals in the control group perceived the distribution of water to be "rather fair" in 2014; this increased to 11% in 2016—an increase of 2%. This difference-in-difference (5%-2%) was 3%, which was statistically significant at 10%.

Figure 6. Perceptions regarding the fairness in water distribution by canal and treatment status.



Taken together, these results suggest that a higher number of smaller and spatially disadvantaged farms experienced improvements in the timeliness of water delivery and fairness in water distribution when they were served by USAID WUAs. Similar analyses conducted for the distribution of yields by farm size and canal type did not suggest any differences between the treatment and control groups; this is likely due to the relatively short timeline of this evaluation.

Crop yields

Figure 7 shows that when examined by the type of canal from which the farms receive their irrigation water supply, cotton yields decreased between the two surveys (2014 and 2016) for all three canal types and in both the treatment (USAID) and the control (non-USAID) groups. On secondary canals, the average cotton yield was ~2.8 t/ha in 2014 for the treatment group (farms served by USAID WUAs), and ~2.5 t/ha for the control group (farms served by non-USAID WUAs); in 2016, there was a decrease in cotton yield to 2.4 t/ha for the treatment group and 2.1 t/ha for the control group. The decrease in yield

was 0.4 t/ha for both the treatment and control groups. There were no differences between the two groups with respect to the distribution of cotton yield among beneficiaries by type of canal.

Figure 7. Estimates of cotton yield on *dehkan* farms in 2014 and 2016 according to the type of canal from which the farm received their irrigation water supply and treatment status.

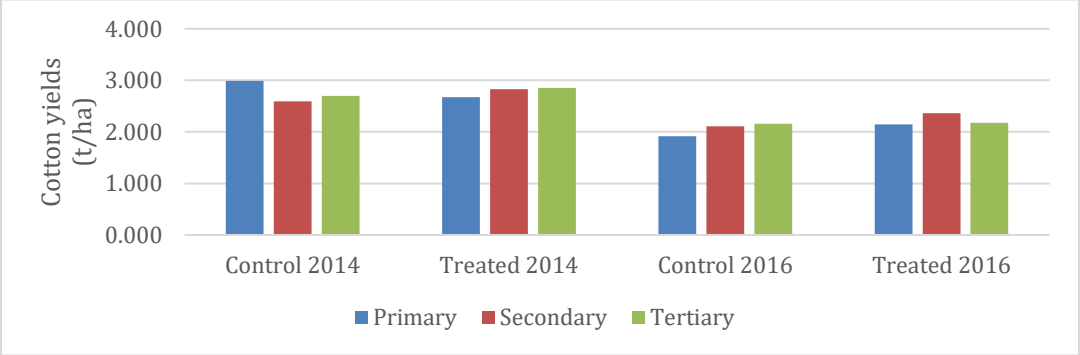


Figure 8 examines the distribution of cotton yield by farm sizes. Farms served by USAID WUAs achieved as high as or better yields than farms served by non-USAID WUAs in both years (2014 and 2016), for farms of all sizes. In the case of small farms (< 2 ha), cotton yield was 2.94 t/ha for farms in the treatment group and 2.66 t/ha for farms in the control group in 2014. These values decreased in 2016 to 2.40 t/ha for the treatment group and 1.89 t/ha for the control group. While yields decreased by 0.54 t/ha for the treatment group, they decreased by 0.77 t/ha for the control group; these changes were not statistically different from one another at 1%, 5% or 10%.

In the case of large farms (more than 4 ha), the average cotton yields in 2014 of farms served by USAID WUAs was significantly better than that of farms served by non-USAID WUAs, a difference of 0.27 t/ha, which is statistically significant at 1%. However, the average cotton yields of large farms in the two groups (treatment and control) were nearly the same in 2016. This generated a difference-in differences estimate of 0.29 t/ha that was negative and significant at the 5% level.

Figure 8. Estimates of cotton yield on *dehkan* farms in 2014 and 2016 according to the magnitude of the area of cotton cultivation on each farm and treatment status.

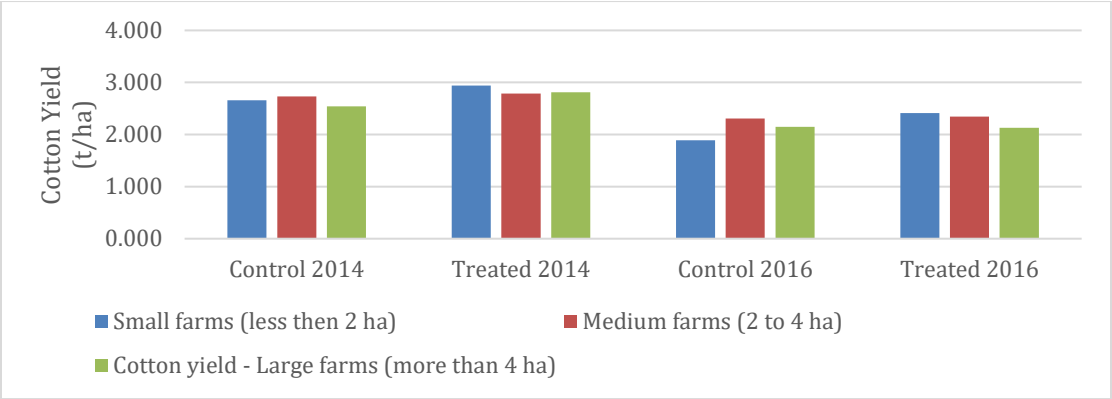


Figure 9 reports the distribution of wheat yields by treatment and canal type. Wheat yields for farms irrigated by tertiary canals were higher for the treatment (USAID) group (2.43 t/ha) than the control (non-USAID) group (2.16 t/ha) in 2014. Yields for the treatment group decreased in 2016 to 2.29 t/ha, but they continued to be higher than that for the control group, which did not change much, at 2.15 t/ha. For farms irrigated by primary canals, yields were higher for the control group in both years. These differences were not significant at 10%, indicating that there were no major differences in the distribution or change in the yields by farm size between the treated and control groups.

Figure 9. Estimates of wheat yield on *dehkan* farms in 2014 and 2016 according to the type of canal from which the farm received their irrigation water supply and treatment status.

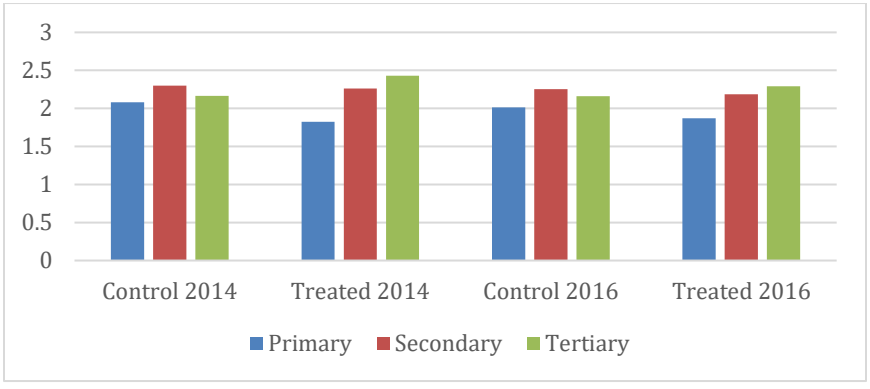
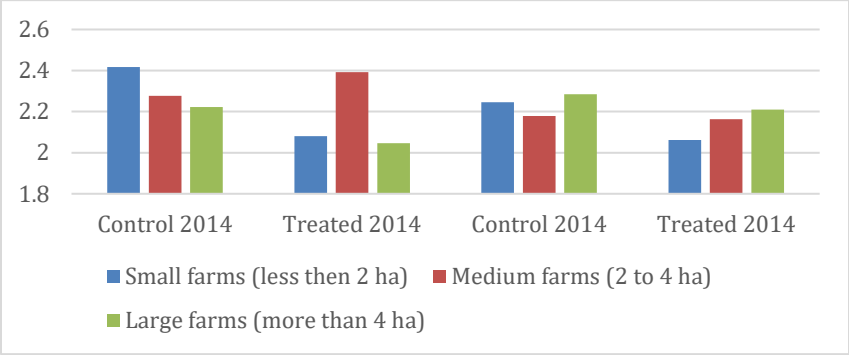


Figure 10 reports the distribution of wheat yields by farm size and treatment. Wheat yields were lower on small farms (less than 2 ha) for the treatment (USAID) group than the control (non-USAID) group in both years (2014 and 2016). The average wheat yield for small farms was 2.07 t/ha for the treatment

group in 2014; this marginally decreased to 2.06 t/ha in 2016, a difference of 0.01 t/ha. For the control group, the average wheat yield for small farms decreased from 2.41 t/ha in 2014 to 2.24 t/ha in 2016, a decrease of 0.17 t/ha. The difference between the changes in yields of the two groups was 0.16 t/ha, which was not statistically significant at 1%, 5% or 10%.

In the case of large farms, the average wheat yields for the treatment group was 2.04 t/ha in 2014, which increased to 2.21 t/ha in 2016, an increase of 0.17 t/ha. For the control group, the average yields increased from 2.22 t/ha in 2014 to 2.28 t/ha in 2016, an increase of 0.06 t/ha. The difference between the changes in yields of the two groups was 0.11 t/ha, which was not statistically significant at 1%, 5% or 10%.

Figure 10. Estimates of wheat yield on *dehkan* farms in 2014 and 2016 according to the magnitude of the area of cotton cultivation on each farm and treatment status.



These estimates of differences across types of WUAs are more readily detectable with cotton and wheat production than with most of the other crops, since the cultivation of cotton and wheat was reported by a large number of farms in the two surveys. Examination of similar data for other major crops, especially wheat, onion, tomato and melon, does not provide any instances where (as judged by the difference-in-difference statistics at significance levels of 1%, 5% and 10%) it is possible to detect important differences between the two types of WUAs. These data are not reported here.

Taken together, these results do not provide much evidence of the impacts of USAID WUAs on the distribution of cotton and wheat yields by farm size or canal type. This is likely due to the relatively short time frame of the evaluation; impacts on yields and their distributions are likely to be observed over longer periods of time.

3.3 Evaluation Question 3: How sustainable are the impacts and how do beneficiaries perform over time when active donor support is withdrawn?

In the absence of water meters, operators of *dehkan* farms were asked about their perceptions on the timeliness of water delivery and fairness in water distribution, in order to gauge whether there were any improvements even after donor support was withdrawn in 2014. Figure 11 reports on perceptions related to the timeliness of water delivery for the treatment (USAID) group and the control (non-USAID) group. Around 17% of farms in the treatment group perceived water delivery to be "rather timely" in 2014; this increased to 21% in 2016, an increase of 4%. A similar increase was also observed for farms in the control group from 13% in 2014 to 17% in 2016, again an increase of 4%.

Figure 11. Perceptions regarding the timeliness of water delivery by treatment status.

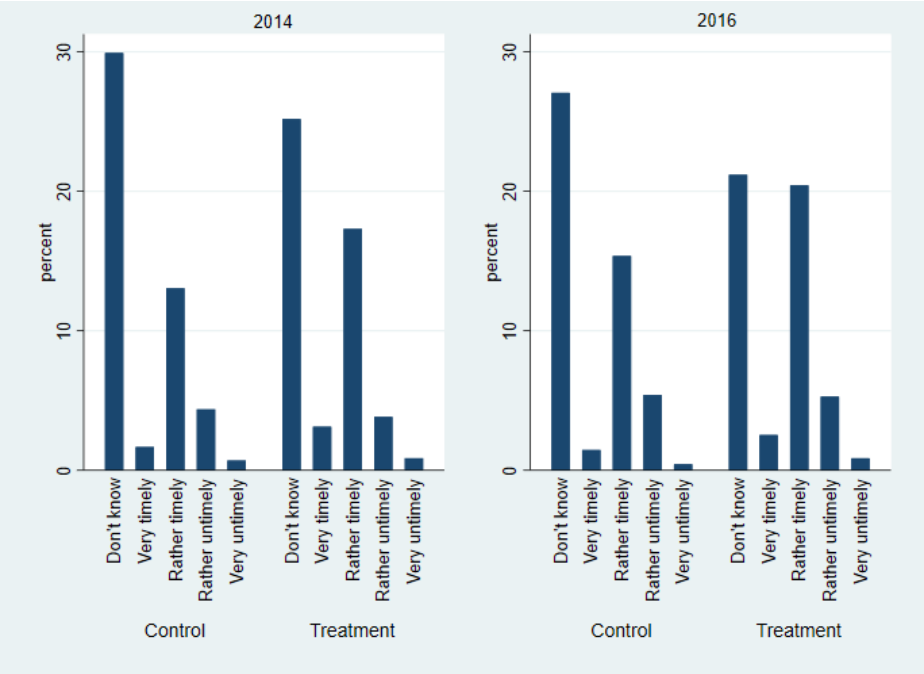
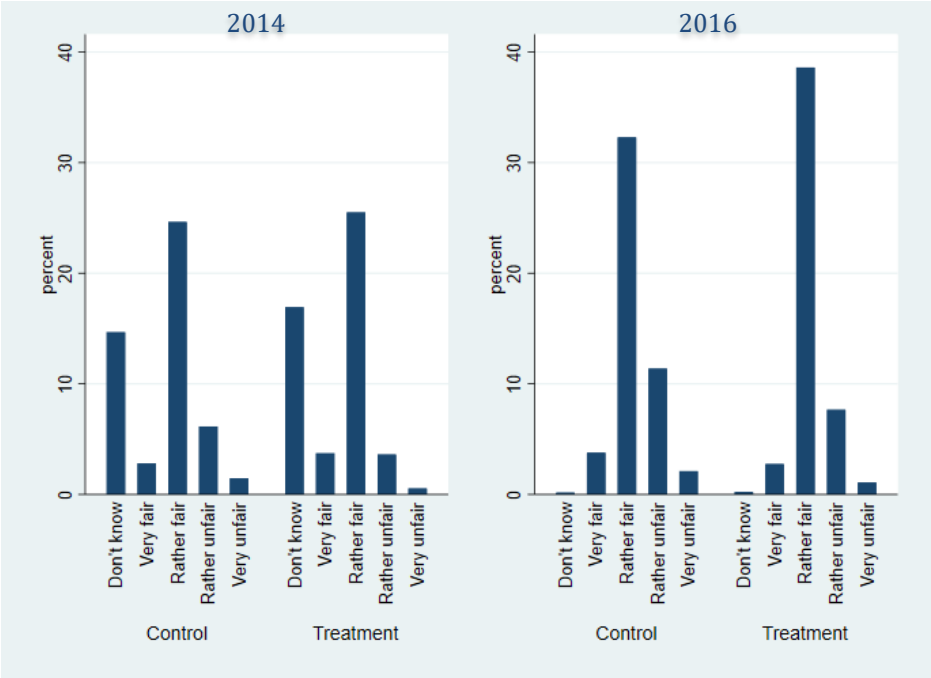


Figure 12 reports on the perceptions related to fairness in water distribution. In 2014, around 25% of farms in the treatment group perceived the distribution of water to be "rather fair"; this increased to 39% in 2016, an increase of 14%. In contrast, 24% of farms in the control group perceived water distribution to be "rather fair" in 2014; this increased to 32% in 2016, an increase of 8%. The difference between these changes in perceptions of the two groups was 6%, which was statistically significant at 5%.

Figure 12. Perceptions regarding the fairness in water distribution by treatment status.



In addition, remote sensing data for the period 2010 through 2017 were analyzed to provide a description of changes in land use and crop selection due to WUA interventions for 12 districts of southwest Khatlon Province, as observed in each of two growing seasons per year (Appendix 6 of Volume II). This analysis was motivated by the observation that USAID supported the government to develop a WUA program and developed blueprints for WUA training that have been used by all agencies. These results make a case for how WUAs have supported the revitalization of agriculture in Tajikistan.

The remote sensing data were subdivided into those describing areas where WUAs have been introduced as a form of participatory water management (combining USAID WUAs with those supported by other funders) versus those describing areas without WUAs. The data have a spatial resolution of 30 meters, and can distinguish among cotton, wheat, rice, vegetables and other crops, fruit trees, fallow land and unimproved pasture. Although the data cannot attribute the cause of the observed differences in land use choices due to the WUAs, the results of the remote sensing analysis offer quantitative evidence of major cropping changes over the period since WUAs were established. The percentage of areas cultivated with cotton and wheat within agricultural lands was higher where WUAs were present compared to other areas where WUAs were not present (Figures 13 and 14).

Figure 13. Comparison of the area cultivated with cotton (percentage) in agriculture lands, in areas where WUAs were present versus the remaining areas.

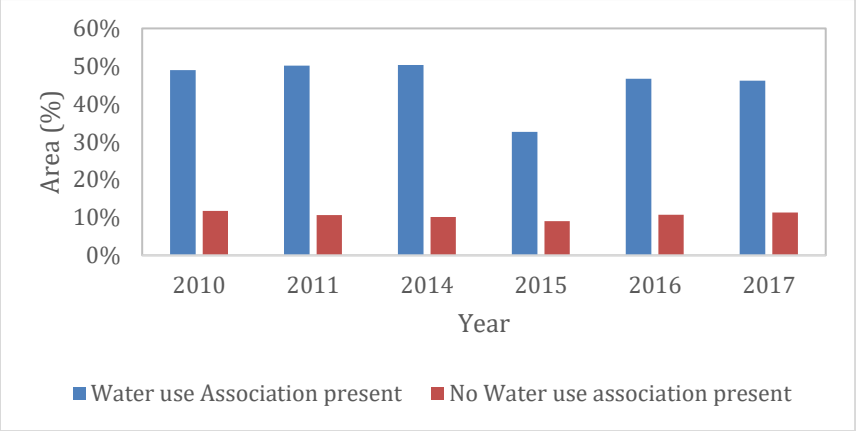
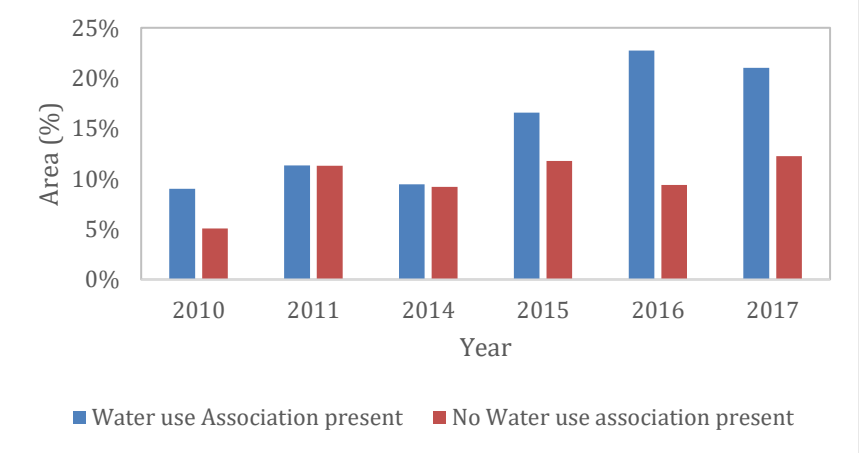


Figure 14. Comparison of the area cultivated with wheat (percentage) in agriculture lands, in areas where WUAs were present versus the remaining areas.



While the extent of cotton cultivation has not changed much over time, the proportion of cotton cultivation in croplands in areas with WUAs is much higher than in the remaining areas (Figure 13). However, the proportion of wheat cultivation in croplands in areas with WUAs is higher compared to the remaining areas, and these areas also show significant increases in wheat cultivation over time (Figure 14). In 2010, only 9% of cropland area with WUAs was under wheat cultivation, while 5% of cropland area without WUAs was under wheat cultivation. By 2017, 21% of cropland area with WUAs was under wheat cultivation, but cropland area under wheat in areas without WUAs had only increased to 12%.

The area cultivated with wheat where WUAs were not present had slightly increased (by 7%), while the area where WUAs were present had increased by 12%.

These results provide an indication of the sustained impacts on cropping areas, especially of wheat, the staple cereal, associated with WUAs in Tajikistan.

Taken together, these results demonstrate that USAID WUAs produced sustained improvements in the distribution of water, and WUAs in Tajikistan had a sustained impact on the cropping areas of the wheat staple crop.

3.4 Evaluation Question 4: What are the key factors, mechanisms and local specificities that help to understand and explain what did and did not work in the process of bringing about the desired change among the beneficiary groups?

Two key factors are associated with the success of the WUA interventions in improving water governance and affecting agricultural outcomes, especially land use and cropping decisions, even after donor support was withdrawn.

First, the duration of training. WUAs established by USAID received 20-24 months of training in water management, where WUA boards and managers of member farms were trained to set membership fees, collect financial dues, design irrigation schedules, coordinate regular repair and maintenance of canals, and arbitrate conflicts. This extended period of training improved the WUAs' performance of mandated functions (Appendix 1 of Volume II); and increased member participation and cooperation (Appendix 2 of Volume II), which are necessary for community-managed systems such as WUAs to function effectively and serve members.

Second, the provision of agricultural extension information, which was a feature of the USAID program. While interventions in water and agriculture are usually provided separately and independently, the Family Farming Program combined training in water management with trainings in the use of better inputs and the cultivation of high-value crops. This 'packaged' training had important effects on agricultural production. Farms served by USAID WUAs experienced an increase in the area cultivated with cotton of 0.54 ha more than the increase in the cultivated area experienced by farms served by non-USAID WUAs; this result was significant at 10%. Similarly, farms served by USAID WUAs also experienced an increase in the cultivated area of wheat of 0.28 ha more than the increase in the

cultivated area experienced by farms served by non-USAID WUAs; this result was significant at 5%. Finally, farms served by USAID WUAs additionally experienced an increase in the cultivated area of high-value crops of 0.14 hectares more than that experienced by farms served by non-USAID WUAs, which was significant at 5%. There was an associated increase in an index of crop diversity (Margalef's Index), statistically significant at the 1% level, showing that crop diversity on farms served by USAID WUAs increased more than that on farms served by non-USAID WUAs (Appendix 3 of Volume II).

Despite these successes, a few important issues may affect the sustainability of the impacts.

- The lack of technical training for female irrigators

Training in water governance and agricultural extension was provided to managers of farms (who are listed as such on the title of the farm), 98% of whom are male (FAO 2018). However, in Tajikistan, 28% of households had a migrant in 2013 (Danzer and Ivanschenko 2013). In 2016, this study estimated that 48% of rural households in Khatlon Province had a migrant (Balasubramanya 2018; details in Appendix 2 of Volume II). Lead farmers (managers) have a higher capacity for absorbing technical information and are also linked well to other farmers in their communities, thus improving the cost-effectiveness of the "train the trainer" model that is used by most agricultural programs. However, there is no guarantee that lead farmers will also train female farmers (Beaman and Dillon 2018). Difference-in-difference estimates that examined the effect of gender of the farm operator on various participation indicators demonstrated that female-headed farms were 9% less likely to pay their membership fees, 11% less likely to sign a water contract and 3% less likely to represent their farm at WUA planning meetings (Appendix 2 of Volume II; reproduced in Table 3 below). These results were significant at 5%, and some also at 1%. In contrast, farms that were operated by males who were not trained managers did not participate any less than farms operated by managers who were trained.

Table 3. Effect of gender of the farm operator on various participation indicators.

	Irrigation fees paid	Membership fees paid	# Man-days labor	Farm signed a water contract	Farm attended WUA meetings
Longer training	-0.06 (0.05)	0.08 (0.05)*	7.10 (2.40)***	0.20 (0.05)***	0.09 (0.04)**
Farm operated by non-trained male	-0.02 (0.04)	-0.02 (0.02)	-2.43 (1.85)*	-0.02 (0.03)	-0.01 (0.02)
Farm operated by female	0.03 (0.05)	-0.09 (0.03)***	3.21 (1.94)	-0.11 (0.04)**	-0.03 (0.01)*
Number of observations	1,753	1,753	1,561	1,753	1,753
Prob > F	0.28	0.57	0.01	0.00	0.09
R-squared	0.02	0.04	0.02	0.09	0.03

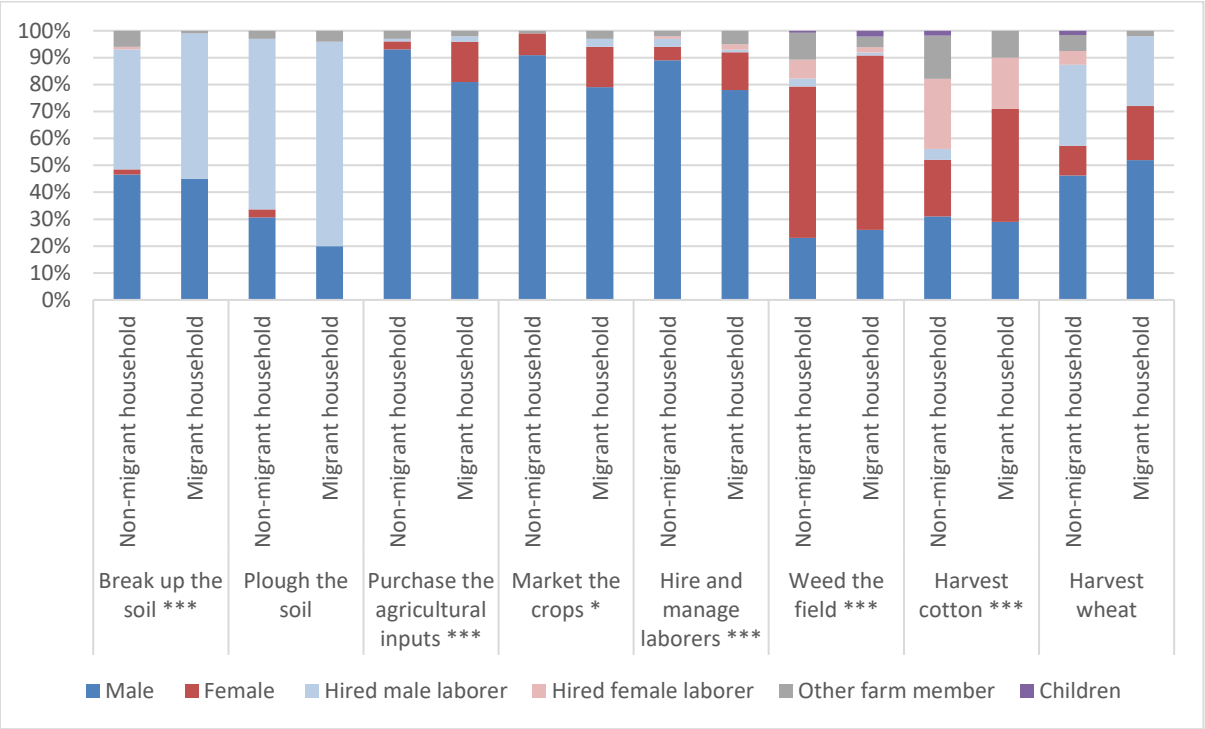
Note: *** p < 0.01, ** p < 0.05 and * p < 0.1; standard errors in parentheses.

The most common reason for lower participation of female-headed farms was a lack of awareness: trained males had not shared information on technical details with women who had taken on the role of running the farm in the absence of the male(s). Since one-third of all farms are now being run by women, lower participation of female-headed farms is likely to compromise the functioning of WUAs for all members, unless steps are taken to increase the technical capacities and capabilities of female irrigators.

- Increasing demands on women's time for labor-intensive tasks

With male migration from rural areas, women are increasingly taking on labor-intensive agricultural tasks on farms (Figure 15). A comparison between households with and without male migrants demonstrates that women weed the farm in 56% of households without migrants and in 65% of households with migrants (Figure 15). Similarly, the harvesting of cotton is performed by women in 21% of households without migrants, but in 42% of households with migrants (Figure 15). When it comes to mechanized tasks such as preparing the farm for cultivation, 76% of households with migrants and 64% of households without migrants hire male laborers, indicating that when males migrate, women hire other males to perform mechanized tasks (Figure 15).

Figure 15. Agricultural tasks by gender and migration for farms.



Focus group discussions with women suggest that they are taking on agricultural tasks in addition to their existing domestic tasks such as cooking, cleaning and providing care, which leaves them with less time to participate in agricultural and water user groups. Unless interventions are designed in a manner that reduces women's efforts in agricultural and irrigation-related tasks, community-managed water programs may suffer from reduced participation.

- Lack of mechanisms that coordinate water use between kitchen gardens and farms

The Water User Association Law of 2006 mandates WUA membership to be restricted to commercial entities (Kabilov 2017; full text in Appendix 5 of Volume II). As a result, farms (which are regarded as commercial entities) are members of WUAs. The operators of kitchen gardens, which are small homestead plots on which vegetables and fruits are cultivated for household consumption, are not members of WUAs because they are not commercial entities. However, the canals that supply water to the farms are the same as those that supply water to kitchen gardens.

Due to this gap in the law, the *mahalla* (village) committee oversees water use for kitchen gardens (Price and Balasubramanya 2018; full text in Appendix 4 of Volume II). The *mahalla* usually negotiates water

use with the WUA using a range of mechanisms that vary locally. In some cases, the *mahalla* signs agreements with the WUA settling upon a mutually acceptable water delivery schedule, while in other cases, the head of the *mahalla* committee is a member of the WUA board. It is not uncommon for disputes to occur among kitchen gardens and between owners of *dehkan* farms and kitchen gardens, especially during the hottest parts of the year.

Almost all households own a kitchen garden, while only 13% of households own a farm (Balasubramanya 2018; full text in Appendix 2 of Volume II). Kitchen gardens and the variety of crops they produce represent an important source of nutrition for the household. In the households studied in this evaluation, only around 5% of the harvest from a kitchen garden was sold for cash, on average. With male migration, kitchen gardens are becoming more important for rural households' food security, as women prefer to allocate their labor to cultivating kitchen gardens which are adjacent to dwellings, rather than cultivating farms that are often away from dwellings. USAID's (and the government's) "water for food" mandate is not likely to be met unless the roles of the *mahalla* and the Water User Association Law are reconsidered in policy.

4 Conclusions

The southern region of Tajikistan supports a prominent agriculture sector that relies on the use of irrigation water to produce one or two crops per year, much of which is cotton destined for export and wheat, a staple of the national diet. Importantly, the systems of irrigation canals and conveyancing works also provide water for multiple uses, including irrigation of a large number of kitchen garden plots and meeting the residential water needs of numerous households. In the presence of intermittent water scarcity, the emphasis on improving water governance is as large as ever.

The advent and development of water users associations (WUAs) have provided the agriculture sector with a means to get past the shortages of expertise, management and coordination that followed the end of the Soviet system. The approaches that the United States Agency for International Development (USAID) has employed in providing this support are distinct from those used for other WUAs, even in the same region. Significant differences include the longer duration of training of farmers and association managers under the USAID approach, and the bundling of training in water governance together with training in agricultural production. These differences in approaches have been identified here with several enhanced outcomes in the short to medium term using statistical and econometric analysis. In some cases, other WUAs have provided the obvious comparison group for a treatment-versus-control approach. For an analysis based on remote-sensing methods, the available comparison was between the cropping behavior of all WUAs versus the behavior of irrigated agriculture that is not (yet) supported by WUAs.

In the series of related analyses and reports prepared over a four-year period as part of this project, the WUAs supported by USAID are associated with improved operational and governance outcomes. These WUAs are also linked to cropping expansion and cropping diversification on the private *dehkan* farms that form their membership. The absence of prior data collection to create a comparable baseline (from the period before the start of USAID support) precludes any unequivocal statistical determination of causation or causality. All the same, the ability to conduct detailed surveys in 2014 and 2016 allows for relatively precise comparisons of outcomes between the USAID-funded WUAs and others.

In some cases, the estimated effects are not statistically significant at the 1% and 5% levels, reflecting perhaps the short period of time elapsed since USAID supported the WUAs or also reflecting the apparent heterogeneity of responses and behaviors both within and across the two groups (treatment

and control). Programs such as these lack a true counterfactual experience against which to compare, because in the absence of the program undertaken by USAID, it is unlikely or uncertain whether any other funders or donors would have chosen to promote WUAs at this scale. There are no data or methods available to characterize such an alternate state of Tajikistan's agricultural development. To address this challenge, this evaluation uses quasi-experimental approaches to select comparable treatment and control groups within Tajikistan, and employs a modified baseline, which likely underestimates the effects of the interventions (Appendix 2 of Volume II).

The implementation of USAID's programming and interventions has also been confounded by the structural adjustments occurring in labor markets in Tajikistan. Specifically, the high rates of seasonal and year-round migration of rural men, especially, to work outside the country have caused a redefinition of women's roles and some shortages of local farm labor.

This examination of so many facets of regional water governance has generated a small list of recommendations for further analysis and research. These may have relevance to USAID, the Government of Tajikistan, civil society groups and diverse donors, among others, to assist them in developing and sustaining WUAs with outcomes that are more effective, efficient and equitable. Without restating the rationales and support for each, some of those recommendations include the following.

The changing role of women in agriculture and food production invites a re-examination of training programs that would benefit women specifically, and invites careful consideration of women's time allocation and opportunity costs when evaluating new agricultural practices and technologies. Also, women's historical lack of comparative advantage in undertaking mechanized and managerial tasks associated with irrigation, and their difficulty in using local labor markets to hire these services invites an examination of labor-market interventions that could forestall shortages of critical skills and services.

The exclusion of numerous household water uses and users from WUAs and from other well-regulated water governance mechanisms appears to invite a broadening of the national approach to water governance for multiple users. The presence of informal and traditional mechanisms for water allocation and dispute resolution, such as village committees, illustrates both a need and a capacity to perform some of these functions. All the same, there seems to be some gaps in both the legislation and current practice that would allow them to rely upon fragmented decision-making structures that may lack consistent accountability or oversight.

Finally, with respect to evaluation methodology and best practice, it is a frequent occurrence that large programs of intervention are undertaken without first creating a well-designed knowledge base of baseline conditions to describe both the treatment and control groups. All too often, this has discouraged rigorous, evidence-based impact assessments and evaluations. The modified difference-in-difference methodology developed and implemented during the course of this study may serve as a role or example for other programmers and evaluators. Relative to the alternative of choosing qualitative methods alone, for example, critical examination using statistical techniques can promote the early assessment of development programs and interventions. This work can increase opportunities to implement adaptive management at the earliest stages of a program's implementation, and make those mid-course corrections with the highest value.

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Appendix A: Project Bibliography

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