Agricultural Water Management 216 (2019) 1–11

Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

Effects of training duration and the role of gender on farm participation in water user associations in Southern Tajikistan: Implications for irrigation management

Soumya Balasubramanya

International Water Management Institute, 127 Sunil Mawatha, Pelawatte 10120, Sri Lanka

ARTICLE INFO

Keywords:
Participation
Training
Gender
Difference-in-difference
Propensity-scores
Tajikistan

ABSTRACT

This paper examines whether longer training increases farm participation in community-managed water user associations, in a context where assignment to training duration was not randomized and none of these institutions existed before training began. We also examine whether participation is affected when farm managers migrate and leave farm operations to other workers, in a context where only managers have been directly trained, almost all managers are male, and females are increasingly operating farms. We collected microdata from 1855 farms in Southern Tajikistan, where farm managers in 40 subdistricts received longer training, while those in the other 40 received shorter training. These 'treatment' and 'control' subdistricts were selected by constructing propensity scores and matching without replacement to address observable selection effects that may affect assignment to training duration. Farms were then selected from a census using a stratified random sampling process. A difference-in-difference technique with right-hand-side covariates is employed, where both sets of data were collected after training was completed. This choice of econometric methods controls against farm-level selection effects, but introduces a potential bias due to measurement error. Longer training has a causal effect on increasing participation in WUAs. Results also demonstrate that when male workers not directly trained operate farms, participation is not affected; however, participation is negatively affected when female workers operate farms. These results provide evidence for designing irrigation management programs to target female workers directly, in order to strengthen institutions whose success depends on active farm participation.

1. Introduction

In Tajikistan, water user associations (WUAs) are legally mandated to bring publicly provided irrigation water to the farm gate (Republic of Tajikistan, 2006). WUAs in Tajikistan serve *dehkan* (meaning private) farms, and legally, *dehkan* farms (not farmers) are eligible members of a WUA. These WUAs are participatory institutions; this implies that the participation and cooperation of representatives of member-farms is needed for WUAs to perform their mandated duty of water delivery successfully (Beresford, 2010).[1] The *dehkan* farm is headed by a *manager*—a legally recognized position that is listed on the title of the *dehkan* farm. The farm title also lists the workers of the farm; these are individuals with a legal claim to work on the farm, who also have a stake in the outputs of the farm. The farm manager and the listed workers typically belong to the same family, but not necessarily the same household.[2] The manager is the operator of the farm and represents the farm at the WUAs, when physically in residence.[3]

The WUA Law (Republic of Tajikistan, 2006) specifies the roles of the members. *Dehkan* farms are supposed to pay an irrigation service fee (toward the expense of water provision), which is levied seasonally; and a WUA membership fee (toward the expenses of WUA services

E-mail address: s.balasubramanya@cgiar.org.

[1] Most irrigation management is participatory, globally. Authors such as Das (2014) have commented on the neo-liberal policy of the 1990s that encouraged the transfer of irrigation management from state to non-state actors, namely farmer communities, due to issues around improving cost-recovery and performance of systems.) Suhardiman and Giordano (2014) provide a succinct explanation around the beliefs and evidence that led to such devolution of responsibilities from the state to farmer communities. These topics in participatory irrigation are acknowledged, but are beyond the scope of this paper.

[2] A family is defined as a set of individuals related through blood or through marriage. A household is defined as a set of individuals who consume food cooked in the same kitchen.

[3] When the manager is physically present, he is the operator for the farm. When the manager is not physically present, this could be because either they are deceased, or they have migrated to Dushanbe or overseas. In these cases, another member of the farm (listed on the title) became the operator. In cases of migration, the name of the manager is not legally changed on the title of the farm.

https://doi.org/10.1016/j.agwat.2019.01.019
Received 6 March 2018; Received in revised form 14 November 2018; Accepted 19 January 2019

provided), which is levied annually. They are also expected to contribute to (uncompensated) pre-irrigation season repair and maintenance of canals that is coordinated by the WUAs through the provision of labour of the workers of the farm (listed on the title) for the task. *Dehkan* farms are encouraged to sign a contract with the WUA at the start of the year. In the contract, water needs are stated for planning purposes. Representatives of member-farms are encouraged to attend WUA meetings. Participation can be assessed by examining these member-mandated functions in WUAs (Yakubov, 2011).

Some WUAs in Tajikistan were created using longer and more gradual training processes—20–24 months, in contrast to other WUAs that were created with 3–6 months of training. Consequently the managers of the farms served by such WUAs received longer training on how to participate and cooperate with the WUA for more successful irrigation management (only managers of farms were trained, irrespective of the length of training). The institutional literature on farmer participation in community-based participatory management organizations suggests that longer training can increase the likelihood and extent of participation and cooperation, which is needed for such organizations to function successfully (Yap-Salinas, 1994; Kazbekov et al., 2009; Mukhtarov et al., 2015).

Estimating the impact of longer training using quantitative econometric methods can provide important information to target efforts to strengthen participation and functioning of new institutions.[4] However, conducting such evaluations in Tajikistan is challenging for at least two important reasons. First, assignment to longer training was not random, introducing potential selection bias. The second challenge pertains to the establishment of a baseline. *Dehkan* farms were created in the mid 2000s through the de-collectivization of the Soviet-era collectives. The government enacted the WUA Law in 2006 and mandated WUAs to be responsible for delivering water to farms. Even so, there was no participatory management irrigation organization in place until 2012. The process of creating the WUAs only began in 2012 through coordinated international assistance and government policy. At the start of the training, consequently, WUAs were not functioning, and there were no functional WUAs in which farms could participate. WUAs were established (and the managers of the farms were trained) in gravity schemes in Southern Tajikistan, the breadbasket of the country, by USAID and by the government, during 2012 and 2013. Managers of farms in WUAs created by USAID received 20–24 months of training, while those in WUAs created by the government received three to six months of training (Balasubramanya et al., 2018).[5]

Training materials used to establish WUAs were developed by USAID, in consultation with the government, and the same sets of materials were used in all cases. The training covered topics pertaining to: creating irrigation schedules; coordinating routine repair, cleaning and maintenance of canals and water courses; setting, levying and collecting WUA membership fees from *dehkan* farms, which is retained by the WUA towards its operational costs; collecting irrigation fees from *dehkan* farms and transferring them to the district irrigation department; maintaining financial accounts; organizing and scheduling meetings of members. All WUAs were imparted training in these topics using the same set of materials; but the duration of time over which the WUAs were trained in these topics significantly differed between WUAs established by USAID and those established by the government, with USAID WUAs receiving repeated sets of the same training at regular intervals over the 20–24 month period. In all cases, the trainers were male, and the trainees were *dehkan* farm managers (only managers were trained). These trainings were conducted by bringing together managers whose farms were in geographic proximity.

Since 98% of dehkan farm managers are male (Food and Agriculture Organization of the United Nations (FAO, 2018), this implies that training in participatory irrigation was overwhelmingly provided to males. Migration of (mostly) males to either urban areas or overseas is rather common in Tajikistan. A study in 2013 estimated that 28% of households had at least one migrant, with migration greater in locations with rural and poorer households (Danzer et al., 2013). Another study, with a study area matching that in this paper, estimated that in 2015, 48% of rural households in Southern Tajikistan had at least one migrant (Buisson et al., 2016). A consequence of migration is that farm workers who were not directly trained in participatory irrigation are increasingly operating farms, with female farmers[6] constituting an important share of non-trained individuals operating farms. In this study, 21% of farms were operated by women in 2014; which increased to 35% in 2016.

Whether training can increase participation in circumstances when individuals not directly trained are managing the farm would depend on the diffusion of information from those who were directly trained—the farm managers in this case—to those who were not trained but are now taking on the role of operating the farm. The literature on whether (and to whom) information diffuses from farmers directly trained (and produces associated behavior changes), suggests that the evidence is mixed and depends on farmer and farm characteristics of trained and other farmers such as age, education, social status and connections, land size and quality, and endowments (e.g. see Clausen et al., 2017; Feder et al., 2004). [7] The diffusion of information to females to encourage participation is also likely to depend on pre-existing differences in the endowments, capabilities and capacities of males and female (e.g. see Agarwal, 2006); social structures around age, caste and religion (e.g. Guijt and Shah, 1998); local power structures (e.g Cleaver, 1998); and bargaining power within the household (e.g. Meinzen-Dick and Zwarteveen, 1998; Cleaver and Elson, 1995). However, the perceived costs and benefits of participating are also important determinants, and are often not given adequate attention (Van Koppen and Hussein, 2007; Meinzen-Dick and Zwarteveen, 1998).

This paper examines whether longer training has a causal effect on increasing the probability of member-farm participation in WUAs in a context where no participatory organization existed before the training began.[8] The paper considers a sample of 1855 member-farms in 80 subdistricts[9] irrigated by gravity irrigation schemes[10] in Southern Tajikistan, where member-farm managers in 40 subdistricts received longer training (the treatment group) and those in the other 40 subdistricts received shorter training (the control group). These 80 subdistricts were selected from a population of subdistricts by constructing propensity scores and conducting a 1:1 matching without replacement to control against selection of observable confounders at the sub-district level (Rosenbaum and Rubin, 1985). Member-farms in these matched subdistricts were then selected from a census of member-farms through a stratified random sampling process to arrive at a representative

[4] While estimating the impact of longer training on water delivery is a worthy question, the lack of gauges at inlets and outlets to measure water flows in distributary canals and watercourses complicates addressing this question (for examples of such work, see Fernández-Pacheco et al., 2015.

[5] Training was directed only at the managers of the farms, not at the listed members of the farm.

[6] A study by the World Bank in 2016 estimated that 56% of the agricultural work force in Tajikistan is female (Slavchevska et al., 2016).

[7] This literature has focused on pest management, seed choice, and fertilizer application.

[8] A broader and worthy research question is "What are the factors that affect participation in WUAs?" Papers such as Nagrah et al. (2016); Hu et al. (2014) and Aydogdu et al. (2015) address this question. The current paper is not equipped to answer this question. Since the aim of this paper is to identify the effects of training and gender, the study was designed to ensure that subdistricts served by WUAs created with longer and shorter training were selected in pairs, matched on other factors that affect participation (see Section 5.2 for more details). Consequently, the tradeoff is that identifying the effects of other factors that also affect participation is beyond the scope of this paper.

[9] In Tajikistan, a subdistrict is called a *jamoat*.

[10] Tajikistan also has lift irrigation schemes. In these geographies, WUAs have been established by the World Bank. WUAs in lift irrigation schemes are not part of the current study.

sample of farms in Southern Tajikistan. Since there was no organization for member-farms to participate in before the end of the training, controlling against selection effects at the farm level entailed using a difference-in-difference (DID) technique with time-varying and time-invariant right-hand-side covariates, with data collected in two time-periods after the training of managers of member-farms was completed (Balasubramanya et al., 2018).[11] This approach introduces a potential bias in the estimated effects of training due to measurement error, but controls against selection effects (as demonstrated in Balasubramanya et al., 2018, and explained further in the methodology section of this paper).

The paper also considers whether participation is affected when the farm is operated by a person who was not trained, and whether any effect depends on the gender of that (non-trained) individual. This is motivated by the observation that an increasing number of farms (~ 50% in this paper) are being operated by individuals (male and female) who were not directly trained. To keep training costs low, most training programs train lead farmers (managers in this paper) (Anderson and Feder, 2007), who are often male (as is the case in this paper). However, diffusion of information to vulnerable individuals in the community (e.g., see Alesina and La Ferrara, 2000) and to females (e.g., see Kumar and Quisumbing, 2011; Beaman and Dillon, 2018) has often not been observed when lead male farmers are trained, since women's networks are often different than men's (Das, 2014; Mayoux, 1995; Agarwal, 2006, p. 284). In the context of Tajikistan, almost everyone who was trained was male; irrigation was historically regarded as "a man's job" ; the realities of high male outmigration imply that those who were trained are decreasingly managing their farms; and the agricultural workforce is getting 'feminized' (Mukhamedova and Wegerich, 2018). In these circumstances, an understanding of how participation is affected when untrained males and females operate farms can provide information for redesigning training in participatory irrigation to suit the needs of the workforce, and to strengthen functioning of irrigation management.

The context of the participatory irrigation intervention renders the application of other methods of establishing causal effects impossible. Using a method of synthetic controls (Abadie and Gardeazabal, 2003) was not possible due to the non-existence of data on participation from before the starting of the training. Using experimental methods (Tellez Foster et al., 2017) was not possible due to the non-strategic setting. Since data on subdistricts were available, they were used to select matched pairs of treatment and control clusters, in order to control for selection on observable confounders. This modified DID technique with the inclusion of time-varying right-hand-side covariates controls for selection on time-invariant and time-variant unobservable confounders.

This paper contributes to the literature in three ways. First, rather than using cross-sectional data (e.g., Nagrah et al., 2016; Qiao et al., 2009); or conducting qualitative analysis (e.g., Aydogdu et al., 2015) to analyze participation, panel data are used. These data control for several types of selection effects and generate evidence needed for adaptive management and targeted investments in the early years of institutions whose success depends on member participation. The second contribution is to understand how participation, and thus the functioning of these participatory institutions, is likely to be affected as the gender composition of the agricultural workforce changes due to labor market adjustments. The third contribution is to contextualize the results presented in Balasubramanya et al. (2018) that examined the effects of longer training on WUAs' performance of mandated functions. That paper demonstrated that WUAs with longer training were able to recover membership fees from 19% more members, and were 10% more likely to hold meetings with members for planning purposes. The current paper uses a different primary dataset that was collected using a different study design that was specifically tailored for testing the effects of training duration and other determinants of farm participation such as gender.

The results in this paper demonstrate that *dehkan* farms whose managers received longer training are 8% more likely to pay their membership fees; 20% more likely to sign a water contract with the WUA, and 9% more likely to attend the WUA meetings. *Dehkan* farms whose managers received longer training contributed seven more person-days of labor towards routine pre-irrigation repair and maintenance of canals. Participation was not affected when the farm was operated by a male worker who was not directly trained. However, participation was negatively affected when the farm was operated by a female, with such farms 9% less likely to pay their membership fees than farms operated by males, 11% less likely to sign a water contract, and 3% less likely to attend the WUA meetings.

A limitation of the paper is that it is not possible to test formally whether participation outcomes for farms with longer and shorter training would have changed in the absence of the intervention. This is because participatory organizations, with longer and shorter training, came into existence at the same time (2012), which coincides with the commencement of the intervention under consideration in this paper. Before 2012, no participatory water management institutions existed, and consequently, pre-2012 participation data do not exist. The choice of methods in the paper is based on the observation that standard methods to control for selection effects cannot be readily employed on this context.

The remainder of the paper is organized as follows. Section 2 provides a context for how participatory WUAs evolved in Tajikistan. Section 3 presents a conceptual framework and reviews literature concerning length of training and participation in WUAs globally and in Central Asia, along with literature on the diffusion of information from trained to other farmers. Section 4 describes the methodology, while Section 5 presents the study design and Section 6 contains details on data. Summary statistics and results are presented in Section 7. Section 8 aggregates the results and discusses them in relation to the existing literature and the evaluation of participatory institutions.

2. Evolution of participatory water user associations in Tajikistan

Within the former Soviet Union, Tajikistan was designated as Central Asia's main hub of cotton cultivation, which was practiced on collective farms (Food and Agriculture Organization of the United Nations (FAO, 2012). Only 4% of the land in Tajikistan is agricultural, with 95% of crop cultivation on irrigated land (Food and Agriculture Organization of the United Nations (FAO, 2012). Southern Tajikistan is the most populous part of the country, where cotton and wheat production are dominant.

WUAs were created in Tajikistan in response to the de-collectivization of the collective farms into *dehkan* (private) farms, which began in the mid-2000s. With the departure of Russian irrigation specialists and the lack of Soviet subsidies, irrigation departments—called *vodkhozes*—were not able to deal with the challenge of providing water to thousands of private farms (Gunchinmaa and Yakubov, 2009; Shahriari, 2009). The government enacted the WUA Law (Republic of Tajikistan, 2006) and named the WUA as the institution responsible for delivering water to the farms. International assistance for creating these organizations was requested. WUAs were piloted by several international organizations and a countrywide program to create new WUAs gained momentum in 2011. More than 300 WUAs are now functional in Tajikistan, with the service area typically in the range of 1400 ha to 1600 ha (Balasubramanya et al., 2016). All WUAs require their member-farms' participation and cooperation for irrigation service delivery.

Participatory governance and civic engagement are not new to Tajikistan (Cieslewska, 2010). For instance, even though state-directed institutions dominated the agriculture and water sectors during the Soviet era (O'Hara, 2000), traditional neighbourhood (*mahalla)*

[11] This is in contrast to the standard DID approach, where one set of observations would have been collected at the time the training commenced, and the other after the training was completed.

councils, which were elected by the households in the neighbourhood, played an important, though informal, role in addressing local problems (including water-related disputes) in the community. Such neighbourhood councils continue to play an important role today.

3. Conceptual framework

3.1. Participation in community-managed resource systems

Key among Ostrom (1990) eight principles for managing subtractable common pool resources is the concept of participation, and the arrangements that facilitate such participation. Participation is viewed as a way of reconnecting disengaged citizens with the decision-making process in contexts of 'democratic deficit' (Pratchett, 1999: 619), as well as improving the quality of those decisions (Martin, 2009). Beyond mere participation, Gurung (1992: 32) states how it is important that users 'abide by the terms of agreement before, during, and after the implementation process of the participatory management program.' The collective management of common pool resources such as water critically depends on users continuously following the rules (Cleaver, 1999).

Among decentralized participatory institutions such as WUAs, external professionals may deploy an enabling logic, but the users in fact perform the service task for themselves (Bovaird et al., 2015). For example, WUAs coordinate routine cleaning and repair of irrigation canals before the start of the irrigation season, but member-farms must contribute labour (of the workers of the farm) in order to improve irrigation service delivery for all member-farms. Accordingly, users may be viewed as being in partnership with their organizations, as they participate to co-produce services (Beresford, 2010).

3.2. Training members in participatory management

In the literature on institutional reform and service provision, it has become widely accepted that participation of users is required for institutions to be fully effective (Bovaird et al., 2015). However, when newly established, members of participatory institutions, such as managers of member-farms in the case of WUAs, may need training to comprehend how they need to participate and cooperate with the institution (Nagrah et al., 2016).

Since these (new) water users may be constrained in participating and cooperating effectively due to a lack of knowledge (Hu et al., 2014), the length of the training period provided can be an important variable determining user participation (Yap-Salinas, 1994). For example, Nagrah et al. (2016) note that without a sufficiently long period of training, 'farmers in Pakistan may not be ready or even interested in the task' of participating in a WUA and following its rules. In Turkey, Aydogdu et al. (2015) found that 'farmers lacked sufficient knowledge regarding WUAs' and needed more training to perform the WUA functions independently. In contrast, a 'high degree of understanding about water user associations' was found to be an important factor determining respondents' satisfaction based on surveys in Inner Mongolia (Qiao et al., 2009: 822).

Concerning post-Soviet states with a similar recent history to Tajikistan, service user satisfaction and willingness to pay among Armenian WUAs was compromised by insufficient, unreliable and untimely delivery of water, due in part to inadequate training of WUAs and their users (Alaverdyan and Houston, 2004: 11). In Kyrgyzstan, improved water delivery was brought about after a lengthy four-year period of training 'encouraged member participation' (Johnson and Stoutjesdijk, 2008: 311). By contrast, training time was limited or nonspecific in Uzbekistan, leading to poor rates of payment of fees and participation in WUA governance (Wegerich, 2000).

3.3. Gender and irrigation

The inclusion on women in water policy emerged as part of a broader change in neoliberal policy that called for local approach and people's participation in water planning and management, in part to increase cost recovery of projects and improve design and delivery of services (Zwarteveen et al., 2012; Das, 2014; Whittington, 1998).

In the domestic water sector, the rational for females participating was that women stood to gain from reductions in time and effort spent collecting water for domestic purposes (Najlis and Edwards, 1991). The empirical evidence on women's participation in rural water supply schemes has been mixed. For example, Narayan (1995) found that only 17% of 121 such projects in 47 developing countries had achieved a high level of female participation. Reasons for low female participation included pre-existing differences in endowments, social norms, perceptions, local power structures, and division of labor and bargaining power within the household (e.g. see Agarwal, 2006; Guijt and Shah, 1998; Cleaver, 1998; Meinzen-Dick and Zwarteveen, 1998; Singh et al., 2005; Das, 2014).

In the irrigation sector, Meinzen-Dick and Zwarteveen (1998) have noted that women's participation in WUAs in South Asia was rather low, despite being heavily involved in agricultural activities. Reasons for low participation included membership rules (often based on land ownership, which is usually in the man's name) and high opportunity costs of women's time. Van Koppen and Hussein (2007) have pointed that women's involvement in irrigation depends on whether the system is a dual/female farming system, or a male farming system (where men are the breadwinners); and whether irrigation projects incorporate multiple uses of water (to include drinking and domestic water use).

While not the focus of this paper, these factors suggest that women's participation varies across geographies and cases, and is dependent on the perceived costs and benefits from participation,

3.4. Migration, agriculture and gender

Rapid changes in the gender composition of the agricultural work force can change the roles of women in agriculture specifically pertaining to labor allocation and decision-making. These changes occur due to changes in household labor availability and cash income sources (Zimmerer, 1993; Taylor and Dyer, 2006; Gray, 2009). For example, Van Rooij (2000) finds that migration improved the purchasing power of households to hire labor, thus reducing women's effort. In contrast, Sadiqi and Ennaji (2004) found that women in migrant households in Morocco reported an increase in workloads. The same authors found improvements in female autonomy and decision-making by expanding the set of roles; as did Taylor et al. (2007) in Guatemala. However, Paris et al. (2005) found reduced autonomy and decision making among migrant households in India due to increased burden of work. The effects of the roles of women depend on the type of migration, type of household, access to land and livestock holdings, family structures and size of remittances (Maharjan et al., 2012; Paris et al., 2005; Desai and Banerji, 2008; Gray, 2009). For example, Maharjan et al. (2012) note that in households with high remittances, women experienced reductions in physical burden and improvements in decision-making, while those in households with low remittances experienced the opposite effects.

In contexts such as Tajikistan, where cotton/wheat systems were historically "male" systems (van Koppen and Hussein, 2007), a rapid and drastic feminization of the *dehkan* farm production system due to high rates of male outmigration presents an interesting case. Mukhamedova and Wegerich (2018) found that despite *dehkan* farms being "male" systems, gender-based occupational segregation were being challenged in Tajikistan, with women stepping into roles that men traditionally performed, including irrigation, despite the high opportunity costs of women's time and the pre-existing cultural barriers that might hinder such changes.

3.5. Diffusion of information from trained farmers to other men and women

Farmer-training programs are typically designed to improve performance by providing technical information to increase human capital (Anderson and Feder, 2004). Since farmers often rely on other farmers for information about agricultural practices (Rees, 2000); such

programs usually train head farmers or village heads, who in turn share that technical information with other farmers (Anderson and Feder, 2007). This also keep costs of programs low (Feder et al., 2004).

The literature on whether information diffuses from directly trained farmers to other farmers and encourages changes in behaviors usually regards farmers as ungendered[12], and the evidence on diffusion is mixed. For example, Feder et al. (2004) found that while Indonesian farmers directly trained in pest management reduced pesticide use, farmers not directly trained did not experience an improvement in either knowledge or a reduction in pesticide use. In contrast, in Uganda, Clausen et al. (2017) found that farmers directly trained in pest management were also able to reduce the pesticide use of neighboring farmers. These differences in diffusion of information, and associated changes in behaviors, are likely to depend on several factors. The complexity of the knowledge to be shared (e.g., Rola et al., 2002), and the strength of interpersonal networks (e.g., Tripp et al., 2005) are two such factors. Also important are the social status of persons chosen for training (e.g., see Pemsl et al., 2006); and idiosyncratic characteristics of farmers and their farms (e.g., Fuglie and Kascak, 2001).

In addition to the factors discussed in 3.3 and 3,4, diffusion of information to women is likely to depend upon whether those who were trained are part of women's networks, which are often distinct from men's networks (Mayoux, 1995; Das, 2014). Using low cost options to diffuse information, which often involves using pre-existing networks, may have unfortunate distributional consequences for diffusion of information to women. For example, Beaman and Dillon (2018) find that when the information on composting is spread using existing social networks in Mali (where networks are among lead male farmers) less influential farmers and female farmers, in particular, lose out on receiving valuable information. Within a household, the diffusion of information is likely to depend on factors that were discussed in Section 3.3. Male migration could change the information that is shared within the household with women, if the roles of women are likely to change. However, the same factors (such as family structures, relative bargaining power, social norms and power structures) may prevent women from gaining information, even when they need to have it in order to undertake new roles.

3.6. Hypotheses

The paper considers member-mandated functions as specified in the WUA Law (Republic of Tajikistan, 2006), and introduces a number of hypotheses regarding the effects of longer training on these indicators. A list of indicators is provided in Table 1.

a) Irrigation fees: Longer training is expected to increase the probability of a farm paying the seasonal irrigation fees.
b) WUA membership fees: Longer training is expected to increase the probability of a farm paying its annual membership fees
c) Participation in pre-irrigation cleaning of canals: Longer training is expected to increase the number of person-days of labor that the member-farm contributes towards cleaning.
d) Legal relations: Longer training is expected to increase the probability of a farm signing a contract with a WUA; and is expected to increase the probability of the manager or (listed) worker of a farm attending a WUA meeting.

Training in Tajikistan was imparted to managers (lead farmers), almost all of whom are male. Irrigation was historically viewed as a "man's job" especially on cotton/wheat cultivating *dehkan* farms. Since migration has led to the departure of males, and females have expanded their roles, intra-household sharing of information may have changed to equip women to execute the job that men were traditionally undertaking. However, the fact that all those who were trained were male, coupled with pre-existing social norms and women's relative socio-economic status, may hamper the extent to which such information is transferred from men, and received by women. Consequently, participation is not expected to be affected when non-trained males operate the farm. But participation is expected to be lower when females operate the farm.

Table 1
Participation and satisfaction indicators.

Irrigation Fees
Fees were paid for both irrigation seasons in the year
Farm owed arrears in irrigation fees in the calendar year
WUA membership fees
Membership fees were paid for the calendar year
Participation in pre-irrigation cleaning of canals
# of days donated by farm towards cleaning
# of people from the farm who participated
Legal relations
Farm signed a contract with the WUA
Farm member(s) attended WUA meetings

4. Methodology

Consider the following equation:

$$Y_{jt} = \mu + \gamma S_j + \theta t + \omega(S_j \times t) + \beta X_{jt} + \vartheta_{jt} \quad (1)$$

where Y_{jt} refers to a participation indicator for farm j at time t. S_j is a categorical variable that denotes the treatment status of farm j, with $S_j = 1$if the farm manager received longer training, and $S_j = 0$ if the manager received shorter training. The variable ω reports the causal effect of longer training on participation. X_{jt} refers to a set of farm-specific covariates at time t that might also influence Y_{jt}. ϑ_{jt} is the error term.[13]

The difference-in-difference (DID) technique identifies the causal effect of longer training by comparing the average *change* in participation over a time period for the treatment group to that for the control group, while controlling for differences at the starting points and common time trends. Typically, the DID technique would be executed by collecting data on participation and other covariates from farms, first at the start of the training (i.e., when $t = 0$), and again at some time $t > 0$ after training was completed, thus creating a panel dataset. Therefore, the standard DID technique assumes that both treatment and control groups were participating even before the training began (that is $Y_{jt} \neq 0$ when $t \leq 0$), allowing for a pre-training comparison of trends in outcomes between the two groups. Under this condition (called the standard condition), the DID technique eliminates time-invariant unobservable selection effects (μ in Eq. (1))—such as any farm-specific, area-specific, or agency-specific fixed effects that are constant over time but may drive differences in level of participation—and provides an unbiased estimate of ω.

However, if participation indicators take values of zero in the pre-intervention period ($Y_{jt} = 0 \ \forall \ t \leq 0$), then there are no pre-intervention trends to compare. In the case of Tajikistan, there were no participatory institutions for farms to participate in, before training began in the area under study. If the DID technique were implemented by collecting the first set of data on participation and covariates at the start of the training (when $Y_{j0} = 0$ for all farms), and by collecting the next set of data at some time $t > 0$ for all farms (where $Y_{jt} \geq 0$for all farms);

[12] This might be because these farming systems are predominantly single sex; however, gender roles in agiculture are changing across the globe (World Bank, 2016).

[13] The error structure is assumed to follow: $E(\vartheta_{jt} | \ S_j, t) = 0 \ \forall \ S_j \ \forall \ t)$. This is because the identifying assumption is that, by explicitly accounting for, the errors are uncorrelated with S_t and t.

then this would mathematically be equivalent to using cross-sectional data, rather than panel data. Under this condition, the DID-technique would not be able to eliminate the time-invariant unobservable selection effects (μ), and would provide a biased estimate of ω.

Since the case of Tajikistan imposes the condition, where for all farms, $Y_{jt} = 0 \ \forall \ t \leq 0$; the difference-in-difference estimator is used in a modified setting, where *both* the first and the second sets of data are collected in time periods *after* the training was completed. This modification of standard practice eliminates bias in the estimation of ω due to time-invariant unobservable selection effects (μ), but introduces a potential bias due to measurement error. However, the magnitude of any bias due to measurement error is reduced to zero as the first set of data is collected closer to the time when training commenced (i.e. closer to $t = 0$). Therefore, collecting the first set of data as close as possible to $t = 0$ would minimize bias due to this measurement error, while also eliminating bias due to time-invariant unobservable selection effects (μ). A mathematical proof of the elimination of bias due to these unobservable selection effects (μ) and a minimization of the bias due to measurement error as the first set of data is collected closer to the time when training commences can be found in Balasubramanya et al. (2018).

Apart from time-invariant unobservable selection effects, there may be time-varying unobservable selection effects that also bias the estimation of ω. These are controlled for by including a host of farm-specific time-varying covariates (X_{jt}) on the right-hand-side of the modified DID equation, as demonstrated in Balasubramanya et al. (2018).

5. Study design

5.1. Determining sample size, number of clusters and number of observations per cluster

A WUA usually provides water to member-farms in one or two subdistricts[14], enabling each subdistrict to be classified as either a treatment subdistrict (where farm managers received longer training) or a control subdistrict (where farm managers received shorter training). Power calculations were conducted to determine the number of treatment and control subdistricts, the number of observations within a subdistrict, and the sample size. The minimum detectable effect (MDE) size was calculated using the formula:

$$MDE = 2.487\,\sigma_y\sqrt{(1-R^2)\left[(1-\rho)\left(\frac{1}{a_t b_t}+\frac{1}{a_c b_c}\right)+\rho\left(\frac{1}{a_t}+\frac{1}{a_c}\right)\right]} \quad (2)$$

In Eq. (2), a_c and a_t represent the number of control and treatment subdistricts; and b_c and b_t represent the number of member-farms per subdistrict. The variable σ_y is the standard deviation of the outcome variable; and the variable ρ refers to the intra-subdistrict correlation associated with that outcome variable. R^2 is the coefficient of determination. Outcome variables and their means, standard deviations (σ_y), and intra-subdistrict correlations (ρ) were taken from the Tajikistan Living Standards Measurement Survey (T-LSMS) (World Bank, 2003).[15] The coefficient of determination and the level of confidence were set at (conventional) rates of 0.8 and 0.95 respectively. Two outcome variables from the T-LSMS database were used as proxies for the range of indicators to be assessed. These were: proportion of farms that irrigated their agricultural plot; and proportion of farms that believed their plot received adequate water supply.

A sensitivity analysis was subsequently carried out by varying the number of control and treatment subdistricts (respectively a_c and a_t), the number of member-farms per subdistrict (b_c and b_t) and the sample size. Results using the proportion of farms that irrigated their agricultural plot are reported in Figs. 1 and 2. For a given sample size, the MDE is smaller as the number of clusters in the sample increases (Fig. 2), and as the number of observations per cluster in the sample decreases (Fig. 2). A study design of 40 treatment and 40 control subdistricts, with 25 farms per subdistrict, emerged suitable; the MDE for this study design is an increase of 10% in the proportion of households irrigating their plots; and an increase of 6% in the proportion of households that felt that their plots had adequate water. For the design of 40 treatment and 40 control clusters, the MDE falls as the sample size increases (i.e., the number of observations per cluster increases), but the change in the MDE is rather small (Fig. 3).[16]

5.2. Selecting the clusters

Since assignment to longer training was not random, treatment and control subdistricts to be sampled in this assessment were selected by constructing propensity scores, and then using a 1:1 matching process without replacement to select matched pairs of treatment and control subdistricts. A pre-sampling survey of all subdistricts where irrigated cultivation of wheat and cotton was practiced (164 of the 406 subdistricts) was conducted. Of the164 subdistricts, 116 were in Khatlon Province, 21 in Sughd Province and 27 in DRS Province. Information on demographic attributes, agricultural practices, land use and farm attributes, and irrigation infrastructure was collected. Propensity scores were constructed to calculate the probability of each subdistrict being treated (i.e., where farm managers received longer training). A complete list of attributes that were used to construct the propensity scores and the model of treatment can be found in Table 2.[17]

Using the propensity scores, subdistricts with farms whose managers received longer training were matched (using a caliper size of 0.12) to subdistricts with farms whose managers received shorter training, without replacement to their nearest neighbor (1:1 match), to select 40 subdistricts of each type. The differences between the subdistrict attributes for unmatched and matched subdistricts is displayed in Table 3. When unmatched, treatment and control subdistricts displayed significant differences on a number of attributes; these differences did not emerge for the matched pairs.

5.3. Selecting Dehkan farms

Records of the population of *dehkan* farms were not available in any government office at the national level. Therefore, a census of all *dehkan* farms in the 80 selected subdistricts was undertaken by the research team. Information on the name of the farm, and the name of the manager of the farm was collected. In addition, farms were categorized on two key variables: the type of canal from which the farm was irrigated (primary, secondary or tertiary); and the farm's location on that canal (head, middle, or tail). These two variables affect water availability at the farm level and may influence participation. For example, managers of farms located on the tail of a tertiary canal may be more inclined to attend WUA meetings because their access to water is deeply dependent on the actions of farmers at the head. On the other hand, these managers may be less likely to pay the irrigation fees if they

[14] It is unlikely that a dehkan farm is not a member of a WUA. WUAs have been created across all gravity schemes in Southern Tajikistan, and data collected from WUAs in a separate study demonstrate that all farms in the command area are member-farms (Balasubramanya et al., 2016)

[15] The T-LSMS (2003) was preferred to the T-LSMS from 2007 and 2009 due to a larger sample of rural households in the agricultural provinces.

[16] Results from using the proportion of households that believed their plot received adequate water supply are also similar.

[17] The propensity score also takes into account ethnic composition of subdistricts, the number of rural health centers and schools, and the number of agricultural markets in the subdistrict. It also takes into account whether land reforms have been completed, and the number of years of tenure of the current subdistrict leader. These could affect selection into treatment, and hence were accounted for while selecting the treated and control groups.

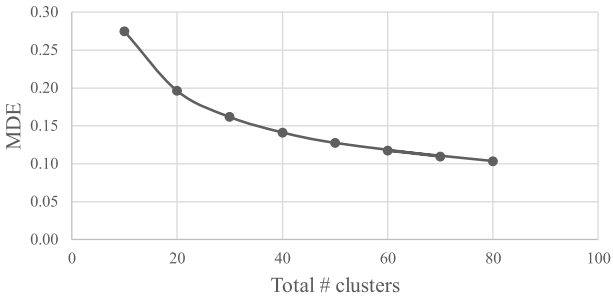

Fig. 1. Relationship between Minimum Detectable Effect and number of clusters for a given sample size.

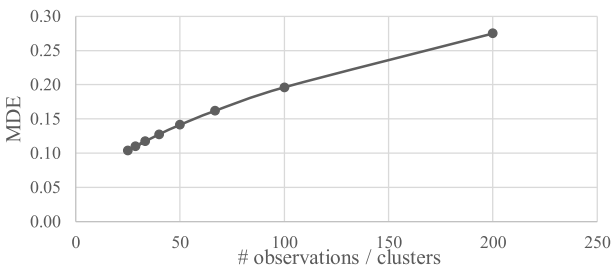

Fig. 2. Relationship between MDE and number of observations per cluster for a given sample size.

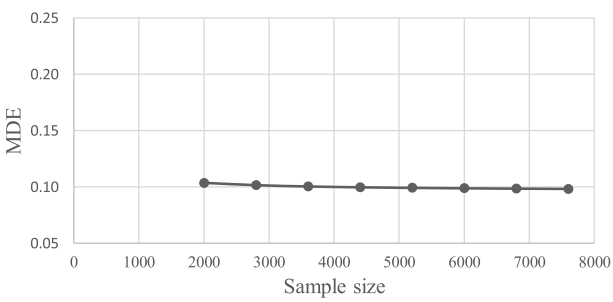

Fig. 3. Relationship between MDE and sample size (n > = 2000).

Table 2
Constructing propensity scores.

	Logit Treatment *Subdistrict*
Population of the subdistrict in 2014	0.00 (0.00)
Number of villages	0.033 (0.05)
Total area of the subdistrict	0.00 (0.00)***
Majority of population Tajik (dummy)	−0.69 (0.54)
Number of secondary schools in subdistrict	0.07 (0.08)
Number of rural health centers in the subdistrict	−0.54 (0.19)***
Number of agricultural markets in the subdistrict	0.40 (0.29)
Chairman born in the subdistrict (dummy)	0.16 (0.64)
Number of years of election of the chairman	−0.07 (0.07)
Elevation of the subdistrict (m ASL)	0.00(0.00)
Sandy soil (dummy)	0.00 (0.55)
Deep groundwater level (dummy)	−0.81 (0.52)
Land reform completed (dummy)	2.54 (0.69)***
Cotton main crop of the subdistrict (dummy)	2.84 (0.66)***
Subdistrict irrigated by gravity system (dummy)	0.61 (0.67)
Constant	−3.89 (1.49)***
Pseudo R^2	0.402
Sample size	164

perceive that they are unlikely to receive water anyway. A stratified random sampling method using these two characteristics was used to select 25 *dehkan* farms from each of the 80 selected subdistricts, totaling 2000 farms. This process randomly selects the nine types of farms in proportion to their numbers in the population, producing a representative sample of farms in each subdistrict.

5.4. Clustering

The sample was selected by first selecting clusters (subdistricts) and then selecting farms within each cluster. Consequently, the econometric analysis of the data in the paper has been conducted by clustering results at the sub-district level, to account for the fact than two farms within the same cluster are likely to be more similar than two farms in different clusters.

6. Data

A panel data set was collected through surveys conducted with the 2000 farms. The first survey was conducted in 2015 to collect information on the 2014 calendar year. The second survey was conducted in 2017 to collect information about the 2016 calendar year.

6.1. Respondent

Both surveys were targeted at the farm-managers, since they are the operators of the farms and had received the training. However, this was often not possible, due to overseas or rural-to-urban male migration. For the first survey, if the manager had not migrated and was in residence during 2014–2015, the manager was interviewed[18] . If the manager was not in residence during 2014–2015, the (listed) worker of the farm who had taken on the operations of the farm was interviewed. For the second survey, if the respondent of the first survey was still in residence, they were interviewed.[19] If the respondent of the first survey had migrated, then the person who had taken on the operations of the farm was interviewed. Interviews were scheduled in advance to check whether the person who had answered the first survey was available, and to coordinate with the new operator when needed. Data were also collected on the gender of the respondent (who was the operator of the farm for that calendar year).

6.2. Attrition between first and second survey

In the first survey, respondents from 1957 of the 2000 member-farms agreed to participate in the study and were consequently interviewed. The second survey was answered by 1855 of the 1957 member-farms. Using data collected from the first survey, no statistically significant differences were observed between farms in the treatment and control group within the subsample of 102 member-farms that did not answer the second survey. The primary reason that these member-farms could not be surveyed again was because production on these dehkan farms had ceased after the first survey and before the implementation of the second survey most often due to male migration.

6.3. Final sample

Data pertaining to 1855 member-farms are used in the analysis, with 933 farms whose managers received longer training (treatment group) and 922 farms whose managers received shorter training (control group).

6.4. Left-hand-side variables

Indicators pertaining to member-farm participation were constructed to reflect the roles as delineated in the WUA Law of 2006. Respondents were asked if the farm has paid its irrigation fees and its WUA membership dues for the calendar year. Respondents were also

[18] We did not find any case where the manager who was trained was in residence but was not the operator of the farm.

[19] We did not find any cases where the respondent of the first survey was still in residence and was not the prime operator of the farm.

Table 3
Differences between treatment and control group for unmatched and matched sample.

	Treatment - Control	
	Unmatched Mean (Std Dev)	Matched Mean (Std Dev)
Population of the subdistrict in 2014	797.18 (1446.5)	−845.48 (2000.07)
Number of villages	−1.34 (1.08)	−0.775 (1.45)
Total area of the subdistrict	2770.21 (2888.16)	1537.04 (3992.63)
Majority of population Tajik (dummy)	−0.13 (0.07)*	−0.1 (0.09)
Number of secondary schools in subdistrict	0.51 (0.69)	−0.125 (0.98)
Number of rural health centers in the subdistrict	−1.03 (0.33)***	−0.125 (0.28)
Number of agricultural markets in the subdistrict	0.09 (0.15)	−0.125 (0.22)
Chairman born in the subdistrict (dummy)	0.05 (0.07)	−0.1 (0.09)
Number of years of election of the chairman	0.12 (0.62)	0.4 (0.81)
Elevation of the subdistrict	−178.22 (56.08)***	−56.48 (70.73)
Sandy soil (dummy)	0.04 (0.07)	−0.025 (0.1)
Deep groundwater level (dummy)	−0.23 (0.08)***	−0.11 (0.11)
Land reform completed (dummy)	0.34 (0.08)***	0.125 (0.09)
Cotton main crop of the subdistrict (dummy)	0.48 (0.08)***	0.17 (0.11)
Subdistrict irrigated by gravity system (dummy)	0.06 (0.07)	−0.025 (0.09)
Number of observations	164	80

Table 4
Summary statistics for first and second survey data.

	First Survey 2014				Second Survey 2016				
	Treatment		Control		Treatment		Control		Difference-in Difference
	N	Mean (Std Err)	N	Mean (Std Err)	N	Mean (Std Err)	N	Mean (Std Err)	Mean (Std Err)
Farm operated by non-trained male	933	0.30 (0.02)	922	0.35 (0.02)	933	0.29 (0.02)	922	0.31 (0.02)	−0.02 (0.02)
Farm operated by female	933	0.10 (0.02)	922	0.11 (0.01)	933	0.16 (0.02)	922	0.19 (0.02)	0.00 (0.02)
Number of members	928	6.71 (0.47)	908	7.84 (0.70)	928	6.07 (0.39)	908	6.96 (0.46)	0.24 (0.60)
Share of members that were female	910	0.46 (0.01)	875	0.48 (0.01)	910	0.53 (0.01)	875	0.51 (0.01)	0.04 (0.01)**
Share of members spend majority of time	911	0.79 (0.02)	833	0.72 (0.02)	911	0.87 (0.01)	883	0.82 (0.02)	−0.03 (0.03)
Number of households	931	3.18 (0.26)	911	3.20 (0.31)	931	3.06 (0.27)	911	3.17 (0.22)	−0.09 (0.29)
Area with official title (ha)	933	5.15 (0.44)	921	5.33 (0.71)	933	4.53 (0.29)	911	5.38 (0.90)	−0.65 (0.54)
Cultivated area (ha)	932	4.19 (0.25)	918	4.43 (0.54)	932	4.01 (0.26)	918	4.48 (0.55)	−0.23 (0.29)
Irrigated area (ha)	933	4.15 (0.24)	917	4.05 (0.51)	933	3.95 (0.25)	917	4.18 (0.47)	−0.32 (0.29)
% farms cultivating cotton	929	0.67 (0.03)	919	0.47 (0.06)	929	0.70 (0.03)	919	0.49 (0.05)	0.01 (0.02)
Area under cotton cultivation (ha)	545	3.27 (0.29)	382	3.95 (0.73)	545	3.18 (0.29)	382	3.81 (0.84)	0.05 (0.27)

asked to report on the number of (listed) workers of the farm who had participated in canal cleaning and the number of days of labor each of those workers had contributed, in order to calculate person-days of labor that the farm had contributed towards repair and maintenance. Finally, respondents were asked if the farm had a signed a contract with the WUA for the calendar year, and if the farm had been represented at the WUA planning meetings in the calendar year. Data on these indicators were collected in both surveys.

6.5. Right-hand-side variables

Data on farm membership size and demographics, cotton acreage, and cultivation of other crops were collected. These data were also elicited in both surveys. Table 4 provides summary statistics for these key variables.

In 2014, a male who was not directly trained operated 30% of farms in the treatment group and 35% of farms in the control group. In 2016, males who were not directly trained operated 29% of farms in the treatment group and 31% of farms in the control group. Regarding the gender of the farm operator, females operated 10% of the treatment group farms and 11% of the control group farms in 2014. For 2016, these values changed to 16% and 19% for treatment group and control group respectively. The number of (listed) workers of the farm did not change significantly within and between groups across years; they fell from ˜ 7 workers to ˜6 workers for the treatment group and from ˜8 workers to ˜7 workers for the control group.

The gender composition of the workers of the farm listed on the farm-title changed within and between groups; while 46% and 48% of listed farm-workers in the treatment and control groups during 2014 were female, 53% and 51% of listed farm-workers in the treatment and control groups during 2016 were female. Their difference-in-difference ((53-46) – (51-48)) is 4%, and is significant at 5%. The share of workers of the farm listed on the farm-title spending the majority of their working time on the farm increased within both groups but not between groups. While 79% of listed farm-workers in the treatment group and 72% of listed farm-workers in the control group worked a majority of their time on the farm during 2014, these increased later to 87% and 82% for the treatment and control groups, respectively. The number of households associated with the member-farms did not change, staying at around three households for both groups during both surveys. The area of land covered by the title of the member-farms also did not change much between the two surveys for both groups. This is because rental markets for land are not well-developed in Tajikistan.[20]

The cultivated area of the member-farms did not significantly change within and between the two groups over the two surveys. In 2014, the treatment group cultivated 4.19 ha per member-farm on

[20] In the first survey, the per-farm land rented was 0.14 ha for the treatment group and 0.13 ha for the control group. In the second survey, these numbers were 0.15 ha and 0.09 ha for the treatment and control group respectively.

average, and the control group cultivated 4.43 ha; these changed to 4.01 ha and 4.48 ha in 2016 for the treatment and control group respectively. Irrigated area of the member-farms also did not significantly change within and between the two groups. In 2014, the treated group irrigated 4.15 ha and the control group irrigated 4.05 ha on average; these changed to 3.95 ha and 4.18 ha in 2016. The share of member-farms cultivating cotton remained the same within each group; in 2014, 67% of treatment member-farms and 47% of control member-farms cultivated cotton, and in 2016, these changed to 70% of treatment member-farms and 49% of control member-farms. The area under cotton cultivation also remained the same between both within and between the groups. In 2014 the treatment member-farms cultivated 3.27 ha of cotton on average and the control member-farms cultivated 3.95 ha of cotton on average. In 2016, the treatment member-farms were cultivating 3.18 ha of cotton while the control member-farms were cultivating 3.81 ha of cotton, on average.

The following variables were only measured during the first survey, because they either changed at the same rate over time for both groups, or were time-invariant. Treatment and control member-farms were of the similar age, with treatment member-farms ˜4.83 years old (standard deviation (sd) = 0.32) in 2015 and control member-farms around 5.63 years old in 2015 (sd = 0.47). The average treatment member-farm was ˜1.75 km away from the nearest road (sd = 0.27), while the average control member-farm was 2.03 km away (sd = 0.33). The age of the member-farm manager was similar for both groups, with managers around 48 years of age in 2015 (standard deviation of 0.43 and 0.48 for the treatment and control group respectively). The treatment group had a slightly higher share of member-farm managers who had completed secondary education, with 29% as compared to 24% for the control group. These variables were also included on the right-hand-side of the difference-in-difference estimating equations but the estimated coefficients are not reported in the paper because, being time-invariant, they are eliminated by the difference-in-difference technique during estimation.

7. Results

7.1. Causal effects of longer training on participation and cooperation

Member-farms whose managers were provided with longer training were 8% more likely to pay their membership fees than member-farms whose managers were provided with shorter training ($p < 0.10$) (Table 5). Member-farms receiving longer training contributed seven more person-days of labor per member-farm ($p < 0.01$) towards pre-irrigation season cleaning of canals, were 19% more likely to have signed a contract with their WUAs ($p < 0.01$) and 9% more likely to attend the WUA meetings ($p < 0.05$).

The coefficients of determination (R-squared) in these regressions are low, because these are not ordinary least squares regressions with cross-sectional data. Since these regressions are difference-in-differences (fixed effects) using panel data which is clustered at the sub-district, the F-statistic is a more reliable indicator of explanatory power. These values are below 0.1 for the regressions where the effect of training is positive and significant at the usual levels.

7.2. Effect on participation when farm was operated by non-trained male worker

The likelihood of a farm paying its irrigation fees, WUA membership fees, signing a contract with the WUA and being represented at WUA planning meetings was not affected when the farm was operated by a non-trained male worker (Table 5).

However, when the farm was operated by a male worker who had not been directly trained, that farm contributed two fewer man-days of labor than when the farm was operated by the manager who had been directly trained ($p < 0.1$; Table 5). While shortages of labor may be an explanation, a negative effect is not observed when farms are operated by females (which usually happens when males migrated; see Section 7.3 below).[21]

7.3. Effect on participation when farm was operated by non-trained female worker

The gender of the operator of the farm was significant in determining participation. As seen in Table 5, a farm operated by a female worker (who were not trained, because only managers were trained and almost all managers are male) was 9% less likely to pay its membership fees ($p < 0.01$); 11% less likely to sign a contract ($p < 0.05$); and 3% less likely to attend WUA meetings ($p < 0.1$). [22]

8. Discussion

In countries such as Tajikistan, formal participatory institutions for irrigation are being newly developed after the state-control era of the Soviet Union. Participatory irrigation required members to participate, so that irrigation services can be generated for all; if an important share of members do not participate, that compromises the delivery of irrigation services even for those who do participate, a classic collective-action problem. While training in participation is usually provided to lead farmers who are often male (managers in the case of Tajikistan), larger macroeconomic and labor-market forces are changing gender-based roles in agriculture. Understanding the role of the length of training in enhancing participation in WUAs, and examining whether participation is lower when farms are managed by (non-trained) female workers is important to understand whether program design and policymaking can have a role to play in increasing participation, so that the irrigation system can continue to function and deliver services for all members.

Such evidence is often hard to generate due to methodological challenges. Quantitative assessments of participation in newly created community management institutions is challenging because control groups and baselines are often difficult to identify. Selection into participatory organizations is not random, complicating the isolation of causal effects from observable and unobservable confounders. Further, when participatory institutions are created for the first time, all participation variables take values of zero at baseline because the intervention also created the notion of membership, further complicating the elimination of unobservable confounders.

In this paper, these methodological challenges were addressed using quasi-experimental methods to construct a control group; a modified baseline after the newly created institutions started functioning to control for time-invariant unobservable confounders; and a difference-in-difference approach with a range of right-hand-side indicators to also control for time-varying confounders. Though there is a potential bias in the results due to measurement error, the bias due to selection effects is controlled for, and the results can provide evidence for programming and decision-making.

The results demonstrate that farms that had longer training had a higher probability of paying their membership fees, signing a water contract, and attending WUA meetings. Information on participation diffused from trained male managers to untrained male workers, but

[21] All regressions, including the one pertaining to contribution of man-days of labor include the number of farm members, the share of members that work permanently on the farm, and the share of members that are female, to control for changes in labor and gender composition. None of these is significant in column 3 of Table 5.

[22] The negative effect of female farm management on participation does not depend on the length of training. Interacting the female operator variable with longer training, and including it in all regressions does not appear significant at 10%; and the magnitude and significance on the longer training variable remains the same whether this interaction term is included or not.

Table 5
Effect of longer training on farmer participation.

	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 members	−0.00 (0.00)	−0.00 (0.00)	−0.09 (0.11)	0.00 (0.00)**	0.00 (0.00)
Share of members that were female	−0.05 (0.05)	−0.01 (0.03)	2.88 (2.29)	−0.00 (0.05)	0.01 (0.03)
Share of members that work permanently	−0.03 (0.03)	−0.00 (0.03)	−2.96 (2.47)	0.01 (0.05)	−0.03 (0.03)
Number of households	0.01 (0.00)*	0.00 (0.000	0.03 (0.28)	−0.00 (0.00)	−0.00 (0.00)
Area with official title	0.00 (0.00)	0.00 (0.00)*	0.03 (0.08)	0.00 (0.00)	−0.00 (0.00)
Cultivated area	0.01(0.01)	0.00 (0.00)	0.52 (1.03)	0.01 (0.01)*	0.01 (0.01)
Irrigated area	−0.02(0.01)**	−0.00 (0.00)	−0.39 (0.92)	0.01 (0.01)*	−0.01 (0.00)*
Area under cotton cultivation	−0.00 (0.01)	−0.00 (0.00)	−0.20 (0.37)	−0.00 (0.00)	0.00 (0.00)
Number of observations	1753	1753	1561	1753	1753
F-statistic	F (20, 60) = 1.21	F(20, 60) = 0.98	F(20, 60) = 2.34	F(2060) = 3.48	F(2060) = 1.51
Prob > F	0.28	0.57	0.01	0.00	0.09
R-squared	0.02	0.04	0.02	0.09	0.03

not from trained male managers to female workers. This is demonstrated by the absence of a significant effect on participation when farms were operated by male workers who were not directly trained, and by the presence of a significantly lower effect on participation when farms were operated by female workers.

Such evidence is useful for programming purposes. Since longer training produces greater participation, supplemental or refresher-training modules can be designed to provide targeted training in areas where shorter training was provided. If more female workers are likely to operate farms, then investing in the human capital of female workers by directly training them in participatory management may be needed, rather than relying on traditional methods of training (male) lead farmers and expecting diffusion to other farmers across gender lines. In addition, in the current context where most migrants are males, the functioning of young participatory organizations such as WUAs may be enhanced if knowledge is housed with female workers. These new trainees are economically less mobile, and have to continue farming to feed their families even while males are absent.

Training female farmers directly will require changing the design of training programs. Trainings may need to be conducted by bringing together a male and female representative from each farm, and bringing together members of geographically proximate farms, so that both sexes receive the same information. In the event that only women are trained, breaking the training into smaller modules, grouping women who belong to the same social network (e.g. extended family, neighborhood), and ensuring a mixed age of women are present in the group may help increase the probability of attendance from a cultural perspective. Female trainers will be required if women are to be trained, but also if male-female pairs from the farms are to be trained (trainers would also be in male-female pairs). Since the opportunity cost of women's time is high, childcare services may need to be provided at the training location during training hours, in order to encourage attendance. Keeping the training location at the village may also reduce barriers to female mobility. These changes in the design of training programs are necessary, but not sufficient, conditions for building capacity of female farmers, who now form 55% of the agricultural workforce.

Acknowledgments

This research is funded through a project titled 'Impact of Water Users Associations on Water and Land Productivity, Equity and Food Security in Tajikistan' funded by the United States Agency for International Development (USAID) under USAID Grant Number AID-BFS-G-11-00002. The opinions expressed herein are those of the author and do not necessarily reflect the views ofUSAID. I would like to thank Ted Horbulyk for comments and suggestions; Joseph P.G. Price for research assistance; and Sohrob Aslamy and Katherine MacDonald for supervising data collection. This study was co-designed with Marie-Charlotte Buisson. I would also like to thank participants at a World Bank Brown Bag Seminar organized by the Inclusion in Water Program of the Water Global Practice, for comments on this work. All errors are mine.

References

Abadie, A., Gardeazabal, J., 2003. The economic costs of conflict: a case study of the Basque country. Am. Econ. Rev. 93, 113–132.
Agarwal, B., 2006. Gender inequality, cooperation, and environmental sustainability. In: Baland, J., Bardhan, P., Bowles, S. (Eds.), Inequality, Cooperation, and Environmental Sustainability. Princeton University Press, New Jersey, pp. 274–313.
Alaverdyan, A., Houston, J.E., 2004. Water user association in Armenia: current situation and future trends. Selected Paper prepared for presentation at the Western Agricultural Economics Association Annual Meeting 1–32.
Alesina Alberto, Eliana La Ferrara, 2000. Participation in Heterogeneous Communities. Q. J. Econ. 115, 847–904.
Anderson, J.R., Feder, G., 2004. Agricultural Extension: good intentions and hard realities. The World Bank Research Observer 19 (1), 41–60.
Anderson, J.R., Feder, G., 2007. Agricultural extension. Handbook of agricultural economics. Agricultural development: Farmers, farm production and farm markets Vol. 3. Elsevier, pp. 2343–2378.
Aydogdu, M.H., Yenigun, K., Aydogdu, M., 2015. Factors affecting farmers' satisfaction from Water Users Association in the Harran Plain-GAP region, Turkey. J. Agric. Sci. Technol. 17, 1669–1684.
Balasubramanya, S., Buisson, M.-C., Saikia, P., MacDonald, K., Aslamy, S., Horbulyk, T., Hannah, C., Yakubov, M., Platonov, A., 2016. Impact of Water User Associations on Water and Land Productivity, Equity and Food Security in Tajikistan. Baseline Report, Prepared for the United States Agency for International Development (USAID). International Water Management Institute, Colombo, pp. 1–127. (Accessed 15 June 2017). https://agrilinks.org/sites/default/files/resource/files/Feed%20the%20Future%20Tajikistan%20Water%20User%20Associations%20Impact%20Evaluation%20-%20B.pdf.
Balasubramanya, S., Price, J.P., Horbulyk, T., 2018. Impacts assessments without true baselines: assessing the relative effects of training on the performance of water user associations in Southern Tajikistan. Water Econ. Policy 4 (3). https://doi.org/10.1142/S2382624X18500078.
Beaman, L., Dillon, A., 2018. Diffusion of agricultural information within social networks: evidence on gender inequalities from Mali. J. Dev. Econ. https://doi.org/10.1016/j.jdeveco.2018.01.009. online ready.
Beresford, P., 2010. Public partnerships, governance and user involvement: a service user perspective. Int. J. Consum. Stud. 34 (issue 5), 495–502.
Bovaird, T., Van Ryzin, G.G., Loeffler, E., Parrado, S., 2015. Activating citizens to participate in collective co-production of public services. J. Soc. Policy 44 (issue 1), 1–23.
Cieslewska, A., 2010. Tradition and poverty reduction – mahalla and its significance in development process in Tajikistan. International Conference on Eurasian Economies 2010 258–263.
Clausen, A.S., Jors, E., Athuhaire, A., Thomsen, J.F., 2017. Effect of integrated pest management training on Ugandan small-scale farmers. Environ. Health Insights 11, 1–10.
Cleaver, F., 1998. Incentives and informal institutions: gender and the management of water. Agric. Human Values 15, 347–360.
Cleaver, F., 1999. Paradoxes of participation: questioning participatory approaches to development. J. Int. Dev. 11 (4), 597–612.
Cleaver, F., Elson, D., 1995. Women and water resources: continued marginalization and new policies. Gatekeeper Ser. 49, 3–15.
Danzer A. M., Dietz B., Gatskova K., 2013. Migration and remittances in Tajikistan:

Survey technical report, IOS Working Papers, No. 327, Institut für Ost- und Südosteuropaforschung (IOS), Regensburg,http://nbn-resolving.de/urn:nbn:de:101:1–201303128505.
Das, P., 2014. Women's participation in community-level water governance in urban India: the gap between motivation and ability. World Dev. 64, 206–218.
Desai, S., Banerji, M., 2008. Negotiated Identities: male migration and left behind wives in India. J. Popul. Res. 25, 337–355.
Feder, G., Murgai, R., Quizon, J.B., 2004. The acquisition and diffusion of knowledge: the case of pest management training in farmer field schools, Indonesia. J. Agric. Econ. 55 (2), 221–243.
Fernández-Pacheco, D.G., Ferrández-Villena, M., Molina-Martínez, V., Ruiz-Canales, A., 2015. Performance indicators to assess the implementation of automation in water user associations: a case study in southeast Spain. Agric. Water Manag. 151, 87–92.
Food and Agriculture Organization of the United Nations (FAO), 2012. 'AQUASTAT: Tajikistan'. (Accessed 9 January 2017). http://www.fao.org/nr/water/aquastat/countries_regions/TJK/.
Food and Agriculture Organization of the United Nations (FAO), 2018. Gender and Land Rights Data Base: Tajikistan. (Accessed 23 January 2018). http://www.fao.org/gender-landrights-database/country-profiles/countries-list/land-tenure-and-related-institutions/en/?country_iso3=TJK.
Fuglie, O., Kascak, C.A., 2001. Adoption and diffusion of natural-resource conserving agricultural technology. Rev. Agric. Econ. 23 (2), 386–403.
Gray, C.L., 2009. Rural out-migration and smallholder agriculture in the southern Ecuadorian Andes. Popul. Environ. 30, 193–217.
Guijt, I., Shah, M.K., 1998. The Myth of Community: Gender Issues in Participatory Development. Sage Publications, New Delhi.
Gunchinmaa, T., Yakubov, M., 2009. Institutions and transition: does a better institutional environment make water users associations more effective in Central Asia? Water Policy 12 (2), 165–185.
Gurung, M.B., 1992. Concept, procedure and strategy of participatory management program for large irrigation projects under ILC financing, Western regional irrigation directorate. Raj Pant, S., Valera, A., Pradham, U. (Eds.), Proceedings of the National Workshop on Participatory Management in Agency-Managed Irrigation Systems in Nepal 27–34.
Hu, X.-J., Xiong, Y.-C., Li, Y.-J., Wang, J.-X., Li, F.-M., Wang, H.-Y., Li, L.-L., 2014. Integrated water resources management and water users' associations in the arid region of northwest China: a case study of farmers' perceptions. J. Environ. Manage. 145, 162–169.
Johnson, S.H., Stoutjesdijk, J., 2008. WUA training and support in the Kyrgyz Republic. Irrig. Drain. 57, 311–321.
Kazbekov, J., Abdullaev, I., Manthrithilake, H., Qureshi, A., Jumaboev, K., 2009. Evaluating planning and delivery performance of Water User Associations (WUAs) in Osh Province, Kyrgyzstan. Agric. Water Manag. 96 (8), 1259–1267.
Kumar, N., Quisumbing, A., 2011. Understanding the long-term impacts of improved vegetable and fish technologies in Bangladesh. IFPRI Discussion Paper 995. International Food Policy Research Institute, Washington DC.
Maharjan, A., Bauer, S., Knerr, B., 2012. Do rural women who stay behind benefit from male out-migration? A case study in the hills if Nepal. Gend. Technol. Dev. 16, 95–123.
Buisson, Marie-Charlotte, MacDonald, Katherine, Saikia, Panchali, Balasubramanya, Soumya, Aslamy, Sohrob, 2016. Impact of Water Users Associations on Water and Land Productivity, Equity and Food Security in Tajikistan. Mid-term Technical Report. Sri Lanka International Water Management Institute, Colombo.
Martin, G.P., 2009. Public and user participation in public service delivery: tensions in policy and practice. Sociol. Compass 3, 310–326 number s.
Mayoux, L., 1995. Beyond naivety: women, gender inequality and participatory development. Dev. Change 26, 235–258.
Meinzen-Dick, R., Zwarteveen, M., 1998. Gendered participation in water management: issues and illustrations from water users' associations in South Asia. Agric. Human Values 15, 337–345.
Mukhamedova, N., Wegerich, K., 2018. The feminization of agriculture in post-Soviet Tajikistan. J. Rural Stud. 57, 128–139.
Mukhtarov, F., Fox, S., Mukhamedova, N., Wegerich, K., 2015. Interactive institutional design and contextual relevance: water user groups in Turkey, Azerbaijan and Uzbekistan. Environ. Sci. Policy 53, 206–214.
Nagrah, A., Chaudhry, A.M., Giordano, M., 2016. Collective action in decentralized irrigation systems: evidence from Pakistan. World Dev. 84, 282–298.
Najlis, P., Edwards, A., 1991. The international drinking water supply and sanitation decade in retrospect and implications for the future. Nat. Resour. Forum 15, 110–117.
Narayan, D., 1995. The Contribution of People's Participation: Evidence from 121 Rural Water Supply Projects. The World Bank, Washington, DC.
O'Hara, S.L., 2000. Lessons from the past: water management in Central Asia. Water Policy 2, 365–384.
Ostrom, E., 1990. Governing the Commons: the Evolution of Institutions for Collective Action. Cambridge University Press, Cambridge, United Kingdom, pp. 1–294.
Paris, T., Singh, A., Luis, J., 2005. Impact of male out-migration on rice household economy and gender roles: a case in eastern Uttar Pradesh, India. Econ. Polit. XL (25), 2005 New Delhi, India.
Pemsl, D.E., Waibel, H., Witt, R., 2006. Diffusion of information among small-scale farmers in Senegal: the concept of Farmer Field Schools. Proceedings of the German Development Economics Conference, Berlin 2006 / Verein fürSocialpolitik 30. Available at: http://hdl.handle.net/10419/19855.
Pratchett, L., 1999. New fashions in public participation: towards greater democracy? Parliam. Aff. 52 (4), 616–633.
Qiao, G., Zhao, L., Klein, K.K., 2009. Water user associations in Inner Mongolia: factors that influence farmers to join. Agric. Water Manag. 96 (5), 822–830.
Rees, D., 2000. Agricultural Knowledge and Information Systems in Kenya: implications for technology dissemination and development. Agricultural Research and Extension Network Paper 107. DFID, London.
Republic of Tajikistan, 2006. Water user association law. Law of the Republic of Tajikistan 1–12.
Rola, A.C., Jamias, S.J., Quizon, J.B., 2002. Do farmer field school graduates retain and share what they learn? An investigation in Iloilo, Philippines. J. Int. Agric. Ext. Educ. 9 (1), 65–76.
Rosenbaum, P.R., Rubin, D.J., 1985. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. The American Statistician 39, 33–38.
Sadiqi, F., Ennaji, M., 2004. The impact of male migration from Morocco to Europe on women: a gender approach. Finisterra 77, 59–76 XXXIX volume.
Shahriari, H., 2009. Activities, Water and Gender in Tajikistan's Rural Sector: a Social Assessment of Konibodom, Bobojon Ghafurov, and Yovon. Social Development Department, Europe and Central Asia Series. Available at:. World Bank, Washington, DC (Accessed 15 June 2017). http://documents.worldbank.org/curated/en/364511468117242593/pdf/514450WP0TJ0So10Box342028B01PUBLIC1.pdf.
Singh, N., Jacks, G., Bhattacharya, P., 2005. Women and community water supply programs: an analysis from a socio-cultural perspective. Nat. Resour. Forum 29, 213–223.
Slavchevska, V., Kaaria, S., Taivalmaa, S.L., 2016. Feminization of Agriculture in the Context of Rural Transformations: What Is the Evidence? World Bank, Washington, DC Available at https://openknowledge.worldbank.org/handle/10986/25099.
Suhardiman, D., Giordano, M., 2014. Is there an alternative for irrigation reform? World Dev. 54, 91–100.
Taylor, J., Dyer, G., 2006. Migration and the Sending Economy: A Disaggregated Rural Economy Wide Analysis. Working Paper 06-002, Department of Agricultural and Resource Economics. University of California, Davis.
Taylor, M.J., Moran-Taylor, M.J., Ruiz, D.R., 2007. Land, ethnic and gender change: transnational migration and its effects on Guatemalan lives and landscapes. Geoforum 37, 41–61.
Tellez Foster, E., Rapoport, A., Dinar, A., 2017. Groundwater and electricity consumption under alternative subsidies: evidence from laboratory experiments. J. Behav. Exp. Econ. 68, 41–52.
T-LSMS, 2003. Tajikistan Living Standards Survey. Available at:. http://microdata.worldbank.org/index.php/catalog/278.
Tripp, R., Wijeratne, M., Piyadasa, V.H., 2005. What should we expect from farmer field schools? A Sri Lanka case study. World Dev. 33 (10), 1705–1720.
Van Koppen, B., Hussein, I., 2007. Gender and irrigation: overview of issues and options. Irrig. Drain. 56, 289–298.
Van Rooij, A., 2000. Women of Taghzoute: the Effects of Migration on Women Left Behind in Morocco (IMAROM Working Paper Series No. 12). University of Amsterdam, Amsterdam.
Wegerich, K., 2000. Water User Associations in Uzbekistan and Kyrgyzstan: Study on Conditions for Sustainable Development. Occasional Paper – Water Issues Study Group 32. School of Oriental and African Studies, University of London, London, pp. 1–23.
Whittington, D., 1998. Guidelines for Contracting Contingent Valuation Studies in the Water and Sanitation Sector. Report to the Department for International Development, United Kingdom. London.
Yakubov, M., 2011. Assessing irrigation performance from the farmers' perspective: a qualitative study. Irrig. Drain. 61 (3), 316–329.
Yap-Salinas, L.H., 1994. Converging factors in the successful transfer of irrigation management responsibilities to water users' associations in the Dominican Republic. Paper Presented at the International Conference on Irrigation Management Transfer 117–127.
Zimmerer, K., 1993. Soil erosion and labor shortages in the Andes with special reference to Bolivia, 1953–1991: implications for 'conservation-with-development'. World Dev. 21, 1659–1675.
Zwarteveen, M., Ahmed, S., 2012. Gender and water in South Asia: revisiting perspectives, policies and practice. In: Zwarteveen, M., Ahmed, S., Gautam, S.R. (Eds.), Diverting the Flow: Gender Equity and Water in South Asia. Zubaan, New Delhi, pp. 3–30.