EFFECTS OF TRAINING DURATION AND THE ROLE OF GENDER ON FARM PARTICIPATION IN WATER USER ASSOCIATIONS IN SOUTHERN TAJIKISTAN

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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 1,855 farms in Southern Tajikistan, where farm managers in 40 sub districts received longer training, while those in the other 40 received shorter training. These 'treatment' and 'control' sub districts 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. 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.

Keywords: participation, training, gender, difference-in-difference; propensity-scores; Tajikistan

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. 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]

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[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.

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 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).

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 (FAO, 2018), this implies that training in participatory irrigation was overwhelming 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[4] 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.

[4] A study by the World Bank in 2016 estimated that 56% of the agricultural work force in Tajikistan is female (Slavchevska et al., 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 a number of characteristics such as age, education, social status and connections, land size and quality, and endowments (e.g. see Clausen et al., 2004; Feder et al., 2004; Agarwal 2006Guijt and Shah, 1998; Cleaver, 1998; Meinzen-Dick and Zwarteveen, 1998; Cleaver and Elson, 1995).

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. 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.

2. METHODS

2.1 Estimation Strategy

Consider the following equation:

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

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.[5]

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 Equation 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

[5] 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 .

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); 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). .

2.2 Study Design

A WUA usually provides water to member-farms in one or two sub districts,[6] enabling each sub district to be classified as either a treatment sub district (where farm managers received longer training) or a control sub district (where farm managers received shorter training). Power calculations were conducted to determine the number of treatment and control sub districts, the number of observations within a sub district, and the sample size.

Outcome variables and their means, standard deviations, and intra-sub district correlations were taken from the Tajikistan Living Standards Measurement Survey (T-LSMS) (World Bank, 2003).[7] 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. A sensitivity analysis was subsequently carried out by varying the number of control and treatment sub districts, the number of member-farms per sub district and the sample size. A study design of 40 treatment and 40 control sub districts, with 25 farms per sub district, emerged suitable; the Minimum Detectable Effect (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.

[6] 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)

[7] 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.

Since assignment to longer training was not random, treatment and control sub districts 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 sub districts. A pre-sampling survey of all sub districts where irrigated cultivation of wheat and cotton was practiced (164 of the 406 sub districts) was conducted. Of the164 sub districts, 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 sub district being treated (i.e., where farm managers received longer training).[8]

Using the propensity scores, sub districts with farms whose managers received longer training were matched (using a calliper size of 0.12) to sub districts with farms whose managers received shorter training, without replacement to their nearest neighbour (1:1 match), to select 40 sub districts of each type. When unmatched, treatment and control sub districts displayed significant differences on a number of attributes; these differences did not emerge for the matched pairs.

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 sub districts 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 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 sub districts, totalling 2,000 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 sub district.

The sample was selected by first selecting clusters (sub districts) 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 of the fact that two farms within the same cluster are likely to be more similar that two farms in different clusters.

2.3 Data

A panel data set was collected through surveys conducted with the 2,000 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.

[8] 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.

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.[9] 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.[10] 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).

Attrition between first and second survey: In the first survey, respondents from 1, 957 of the 2,000 member-farms agreed to participate in the study and were consequently interviewed. The second survey was answered by 1,855 of the 1,957 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.

Final sample: Data pertaining to 1,855 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).

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 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.

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.

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

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

[10] 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.

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.

3. RESULTS AND DISCUSSION

3.1 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 1). 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 ($p<0.05$).

3.2 Effect on Participation When Farm Was Operated By Non-Trained Male Workers

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 1). 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 1). 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 3.3 below). [11]

3.3 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 1, 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 ($p<0.1$). [12]

4. CONCLUSIONS

[11] 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 2.

[12] 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 is 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.

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 require 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.

Table 1: 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(20,60)=3.48	F(20,60)=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

The results in this paper 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 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. 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.

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