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Should Foreign Aid Fund Agricultural Training? Evidence from Armenia

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ABSTRACT

Many foreign aid agencies fund large-scale agricultural training for farmers in developing countries, but little rigorous research has been conducted on whether these programs are effective. We used a clustered randomized controlled trial to estimate the effectiveness of a U.S. government-funded farmer training program that trained more than 50,000 farmers throughout Armenia. Three years after farmers received training, training did not increase household income or consumption. Training also did not affect mediating outcomes, such as adoption of agricultural practices or changes in cultivation of crops, which suggests that longer-term impacts are unlikely to materialize. Many farmers lacked the financial means to invest in the types of practices that were the focus of the curricula, and farmers were also often unwilling to try new crops that have higher up-front costs even if they are much more profitable in the long run. Our findings highlight the challenges that even a well-implemented training program has in spurring behavioral change among farmers and the challenges of providing effective services when foreign aid agencies prioritize having a large programmatic footprint. These challenges were central to the lack of impacts of this particular program but are underplayed when foreign aid agencies decide whether to fund agricultural training programs.

JEL Codes: C93; F35; O12; O13; O19; O33 *Keywords:* Randomized controlled trial; foreign aid; agricultural training

1. INTRODUCTION

Foreign aid agencies have made large investments in improving the agricultural sectors of developing countries with the aim of reducing poverty and hunger. These investments often include farmer training programs that encourage a range of activities, from effective and sustainable use of agricultural inputs (such as irrigation water and fertilizer) to cultivation of different crops (such as higher-profit crops) to more effective marketing and post-harvest practices. The World Bank, for example, has spent more than $400 million to fund agricultural training and education over the past 20 years; the Millennium Challenge Corporation (MCC) has provided agricultural training to about 200,000 farmers in developing countries since its founding as a U.S. agency in 2004. In addition, following historically high and volatile food prices in 2008, President Obama announced the U.S. government's Feed the Future initiative in 2009, a $3.5 billion investment in agricultural development and food security over three years, led by the U.S. Agency for International Development (USAID). U.S.-based nongovernmental organizations pledged an additional $1 billion to the initiative. Under Feed the Future, USAID and partner organizations have implemented large-scale farmer training programs in multiple countries; for example, 70,000 farmers in Senegal received training in agricultural productivity techniques, nearly 50,000 farmers in Rwanda were trained in post-harvest techniques, and more than 300,000 farmers in Kenya were trained in crop management and business skills (USAID 2012).

Despite their prevalence, little rigorous research has been conducted to determine whether these large, foreign aid-funded training programs have been effective at increasing household well-being. The methodologies used to evaluate agricultural training programs funded by foreign aid organizations have focused on monitoring performance metrics or conducting case studies with success stories; rarely has there been even a quasi-experiment that attempts to estimate the counterfactual of how participating farmers would have fared in the absence of the donor-funded training program (Waddington et al. 2010).

Smaller-scale agricultural training programs or agricultural extension services have a somewhat greater but still limited body of research evidence that assesses their effectiveness. A review of studies about agricultural interventions in developing countries covering 2000–2009 found few rigorous evaluations of agricultural training and extension services in developing countries (Independent Evaluation Group 2011). Of the more rigorous evaluations, nearly all were categorized as quasi- or nonexperimental evaluations.[1] Although quasi-experimental analyses can produce unbiased estimates if their underlying assumptions are met, such approaches are less compelling in this setting because the selection mechanism that drives communities or individual farmers to participate in training is often unclear, and the assumption that unobserved factors do not confound estimated treatment effects is hard to justify.

Experimental evaluations based on randomized controlled trials (RCTs) are widely considered to be the gold standard in evaluating the effects of a social program because the randomization process produces intervention and comparison groups that are theoretically equivalent along all dimensions before the intervention. In recent years, there has been a well-known and dramatic increase in the use of RCTs to evaluate interventions in developing countries (Banerjee and Duflo 2009). This set of evaluations has made tremendous strides in

[1] The panel data analysis conducted by Feder et al. (2004) was misclassified as experimental in the Independent Evaluation Group (2011) report.

increasing the level of rigor and, consequently, the body of knowledge about what works for agricultural development more broadly, but has thus far not provided evidence about the efficacy of agricultural training programs specifically.

The present study helps fill an important void in the development economics literature. We estimate three-year impacts of a large agricultural training program implemented across Armenia and funded by MCC, a foreign aid agency that from its inception has placed an institutional emphasis on rigorous assessment. This study is one of the first four evaluations of agricultural training programs funded by MCC and, of the four, we consider the results to be the most instructive for and generalizable to other programs. The other three evaluations in this set were well designed and thoughtfully executed, but they did not end up with large enough sample sizes or sufficiently long follow-up periods, due to delays in implementation (Blair et al. 2012; Institute of Statistical, Social and Economic Research 2012; Carter et al. 2012).

The program that we studied, the Water-to-Market (WtM) training program, trained more than 50,000 individuals in rural Armenia on the efficient use of irrigation water and on making the transition toward the cultivation of high-value crops. We used an RCT and two rounds of data from a longitudinal survey of 3,500 farming households to estimate effects of the program on adoption of new farming practices, cultivation of new crops, agricultural production, and household income and consumption three years after training began. We find no evidence that, three years after it began, the training program had impacts on household income or consumption during the study period, nor do we find evidence that households adopted new farming practices or cultivated new crops that would potentially lead to longer-term impacts on income and consumption.

Although an RCT provides internally valid estimates of the effects of a particular program (see Imbens [2010], among others), on its own an RCT cannot say as much about why effects materialized or how well the findings would generalize to other settings. Indeed, this is perhaps the main reason that Deaton (2010) concluded that "RCT-based evaluation of projects, without guidance from an understanding of underlying mechanisms, is unlikely to lead to scientific progress in the understanding of economic development." The particular agricultural training program that is the focus of this paper has similar topical content and delivery methods to many other training programs implemented throughout the world by many different foreign aid agencies. (See, for example, Cocchi and Bravo-Ureta 2007; Dalton et al. 2005; and Dey et al. 2007.) The settings of these programs differ from the WtM program that is the focus of the present study, but they share with the WtM program a focus on cultivation of higher-value crops and adoption of technologies to make production more efficient. The programs also included theoretical in-class lessons and practical lessons provided on demonstration farms. However, neither the program that we studied nor the setting is identical to other cases and there is no guarantee that the program's implementation or its effects would be similar if applied in another setting. Thus, it is crucial for us to understand not only whether this particular training program was successful, but also why it was or was not.

Hence, another important contribution of this paper is that we explore the underlying mechanisms in several simple but illuminating ways. Most importantly, we designed the study to estimate not only program impacts on the ultimate outcome of farm household well-being, but also to examine program impacts on important mediating outcomes such as adoption of specific agricultural technologies targeted in the training, cultivation of new types of crops, and increased land area devoted to higher-value crops. We complement our quantitative analysis with rich qualitative information gleaned from focus groups and in-depth interviews with participating and nonparticipating farmers and program implementers. Although we cannot conclusively say exactly how successful a similar program would be in another country, exploring these mechanisms provides suggestive evidence of why the intended impacts of such programs might deviate from what was expected, providing lessons to inform the design of future donor-funded programs.

The analysis provides a very clear picture of why the expected impacts on household income in this particular context did not materialize; specifically, farmers lacked the financial means to make the intended investments. Farmers' conservative mind-sets might also keep them from changing what crops they choose to cultivate and how, particularly when the up-front costs of these changes are higher for higher-value crops. Also, institutional characteristics specific to Armenia did not incentivize farmers to invest in some of the technologies emphasized in the training curriculum.

The paper proceeds as follows. The context and design of the training program are discussed in Section 2, and our methodology is presented in Section 3. Sections 4 through 6 discuss the effects of the program on agricultural practices, agricultural production, and household well-being, respectively. Finally, key findings and their implications are summarized in Section 7.

2. OVERVIEW OF THE PROGRAM

Armenia was left with the legacy of a centrally planned economy when it declared independence from the Soviet Union in 1991. In 1994, the Armenian government adopted a comprehensive stabilization and reform program that privatized and redistributed collective farm lands as small plots to households. However, many of the beneficiaries of this redistribution had little expertise in farming or had experience working only on collective farms; as a result, they did not have the knowledge required to run profitable farm enterprises. Though many farming households in Armenia cultivate high-value crops such as fruits and vegetables, they grow them only in small amounts (and often only for household consumption). Most farmland is used to cultivate grains and grasses, which require less expertise and up-front cost to grow than high-value crops, but these crops have limited commercial viability in Armenia and are of low value. In 2007, more than 25 percent of people in rural Armenia were estimated to be below the poverty rate (Fortson et al. 2008).

In March 2006, MCC entered into a five-year agreement with Armenia to improve the performance of Armenia's agricultural sector. The agreement included funds for the WtM training program for farmers. WtM training was delivered in two modules: On-Farm Water Management (OFWM) training and High-Value Agriculture (HVA) training. Both OFWM and HVA training used classroom sessions and on-farm demonstrations to promote improved practices. OFWM training aimed to help farmers adopt new and more efficient irrigation techniques, which would lead to increased and more cost-effective agricultural production. HVA training aimed to help farmers adopt new cropping techniques and high-value crops, with the goal of increasing and diversifying agricultural production. HVA trainings also promoted safe and environmentally friendly agricultural behaviors.

The program was designed to have a high degree of interaction between the OFWM and HVA training components, as water management techniques learned in OFWM training could be used to cultivate new high-value crops introduced in HVA training. The increased efficiency in crop production and diversification of crops was expected to lead to increased sales and agricultural profits and correspondingly increased household well-being. Both types of training were offered in most communities, with HVA training usually offered one year after OFWM training.

A typical training sequence was conducted over a three- to five-day period and included 20 to 25 farmers from one or more neighboring communities. An agricultural expert or irrigation engineer from the same region who was knowledgeable about the climatic and agricultural conditions of the region led each sequence. All trainings within a region covered the same set of practices, regardless of the backgrounds of the farmers who attended. Practical lessons at a nearby demonstration farm supplemented the three to four days of theoretical lessons in classrooms. Each of the 230 demonstration farms was selected to serve one to five communities, and farmers who received training were encouraged to revisit the demonstration farms after the official training to see OFWM and HVA practices in use. Trained farmers could also take tours of demonstration farms during key months of the agricultural season.[2]

Training was provided in more than 350 communities. Most of these (277) were randomly assigned and included in our study (as discussed in the next section). A given training module (HVA or OFWM) was often repeated in the same community to enable more farmers to attend. The rest were communities included in the pilot phase or added late after implementers' investigations in later years determined that they could benefit from training. In each community,

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[2] In return for a farmer's willingness to operate a demonstration farm, the implementer provided the farmer with the needed equipment that the farmer could continue to use after the program ended. Selection criteria included the farm's proximity to other farms in the community, topography, and soil characteristics.

implementers focused recruiting efforts on farmers who had access to irrigation water, based on the idea that the greatest benefits from training would accrue to farmers with access to irrigation water. Usually, such farmers were members of water user associations (WUAs), the regional organizations that manage the distribution of and payment for irrigation water in Armenia, but individuals were not required to be WUA members to receive training. Training coordinators also used posters and additional advertisements at village centers to raise awareness of the training. Village mayors further assisted coordinators by encouraging participation and identifying WUA members most likely to participate. These members were targeted for more intensive recruitment efforts.

In total, MCC funding provided training to 45,639 farmers in OFWM practices and to 36,070 farmers in HVA practices. The exact amount of overlap is not known, but we estimate that about 78 percent of farmers trained in HVA also participated in OFWM training, and that about 47,800 households participated in at least one training session. Altogether, the training program cost about $14.3 million, or about $310 per participating household.

3. METHODOLOGY

3.1. Evaluation Design

We randomly assigned 277 communities throughout Armenia to one of three groups: (1) the treatment group, for whom training began in late 2007; (2) the nonresearch group, for whom training could begin in late 2008; or (3) the control group, for whom training could begin in

2011.[3] The 277 selected communities had adequate access to irrigation water as of 2007. Communities instead of individual farmers were assigned to receive trainings because the training sessions are community-level interventions. It would not have been feasible to bar individual farmers assigned to the control group from attending training in their communities; in addition, farmers who received training might share the information with other farmers in the same community. Communities were generally far enough apart that farmers in the control group would be unlikely to participate in trainings or interact frequently with trained farmers.

This phased-in random assignment design was used to estimate the impacts of training by comparing outcomes of communities assigned to the treatment group with those assigned to the control group. By measuring outcomes in 2010, we can compare outcomes for communities that had at least two years, and usually three years, to implement new techniques (the treatment group) with those for communities that would not have benefited from training to that point (the control group).[4]

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[3] Some smaller, neighboring communities were grouped together and randomly assigned as one cluster. Clusters could include as many as five communities, but most communities were assigned individually. For simplicity, we refer to all clusters as communities.

[4] The third, nonresearch group—for whom training was provided in the interval between the treatment and control groups' trainings—was selected to ensure implementers could continue training and meet their contractual requirements for the number of farmers trained. Because there was insufficient time for impacts to materialize for this group, we did not include it in our analysis.

To ensure regional balance, we randomly assigned communities separately within each WUA. Each WUA serves several communities that are in the same region and share water sources, irrigation systems, and climate conditions. On average, our sample contains about four communities from each WUA. The probability that a community was assigned to the treatment group was approximately the same in almost all WUAs. The exceptions were the WUAs in the mountainous zone of Armenia, an area where the farmers focus more on livestock than on crops. They were believed to have smaller potential gains from the agricultural training modules than farmers in other zones, so a smaller proportion of communities and clusters from this area were selected to be in the research sample. This was done so that the evaluation would focus on areas in which impacts were considered likely (Fortson et al. 2008).

Our analysis sample includes 189 communities. Of these, 112 clusters are in the treatment group and 77 are in the control group. The geographic distribution of communities in our research sample was similar to the geographic distribution of all communities that were trained.

3.2. Farm Household Survey

We conducted an in-person survey of farming households to use as the primary data source in our analysis. The key survey domains covered were land cultivated, irrigated, and dedicated to specific crops; crop production, sales, and costs; nonagricultural income, usually from employment earnings; household consumption; specific HVA and OFWM practices used; attendance at training; and basic demographic information. We instructed survey administrators to select as the respondent the person with primary responsibility for household farming decisions whenever feasible. Baseline surveys were completed in late 2007/early 2008 for 4,715 households. Final follow-up surveys were completed in late 2010/early 2011 by 3,547 households (a 75 percent response rate) from the baseline sample.[5,6] Because we wanted to measure the impact of the training program among the population targeted by MCC, we wanted the survey sample to consist of farmers who were likely to participate in training. Although we could ex post identify participating farmers in the treatment villages, it would be impossible to identify a comparable group (during the study period) in the control villages, where training would not be offered for at least three or more years.

To develop a sample frame of likely training participants, we worked with the training implementer to define criteria for identifying farmers who were most likely to benefit from the training program. The criteria aligned with the characteristics of farmers participating in training—most notably, being actively engaged in farming, having a modest farm area, living in the community for several years, and being of working age (ages 25 to 70). The number of farmers included in the sample frame was based on the population of the community and averaged about 60 farmers, from which 25 farmers, on average, were sampled. Survey staff then worked with village mayors to identify sufficient numbers of households that met these criteria.

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[5] The final follow-up survey was fielded at the same time that many control communities first became eligible for training. However, the survey refers to the previous agricultural season, for which outcomes would not yet have been affected.

[6] An interim survey round was conducted in 2008–2009. For the present study, the interim round's main purpose is to provide estimates of training participation rather than relying on recall about participation two to three years earlier.

3.3. Other Data

We supplemented our analysis of the farming household survey data with findings from qualitative-oriented analyses, primarily Socioscope (2010), and our own observations from field visits and interviews. From August to December of 2009, Socioscope conducted about 100 focus groups and interviews of farmers and other stakeholders and observed more than 20 trainings and demonstration farms. Additionally, the training implementer administered a survey among a sample of trained farmers to measure adoption rates of the practices covered in OFWM and HVA training (ACDI 2011). We used these survey data to better understand why trained farmers did not implement some practices and what practices were planned for the next agricultural season.

3.4. Empirical Approach

We used a linear regression adjustment to improve statistical precision, account for the assignment process, and control for chance differences between the treatment and control groups; however, as expected, the estimates were robust (albeit less precisely estimated) when we instead estimate impacts as a simple differences in means. The reported means were regression-adjusted based on the same model structure.[7] All of the models include WUA fixed effects because random assignment was stratified by WUA (Bruhn and McKenzie 2009), and additional covariates were chosen based on their explanatory power for three major, preselected

[7] We did not use regression adjustment for binary outcomes with very low (less than 0.01) or very high (greater than 0.99) prevalence, instead reporting simple means.

outcomes: simple practice adoption, agricultural profits, and consumption.[8] The general regression model we used to estimate impacts took the following form:

(1) $y_{ijk,post} = \delta y_{ijk,pre} + \varphi' X_{ijk} + \lambda_k + \beta T_{jk} + \mu_{jk} + \varepsilon_{ijk}$

where $y_{ijk,post}$ is the outcome of interest (for example, agricultural profits) for farm household i in community j within stratum k at follow-up; $y_{ijk,pre}$ is the outcome for the same household at baseline; X_{ijk} is a vector of characteristics related to the outcome of interest; λ_k is a WUA fixed effect; T_{jk} is a binary variable equal to 1 if the household is in a treatment area and 0 otherwise; μ_{jk} is a community-specific error term; and ε_{ijk} is a household-specific error term. The estimate for the parameter β is the estimated intention-to-treat impact of a program. Because random assignment was conducted at the community level, community-level correlations were accounted

[8] In the absence of a compelling theoretical relationship between baseline covariates and outcomes, we used a modified stepwise process to select covariates. For each of these outcomes, we regressed the outcome on one candidate control variable at a time, using stratum fixed effects and nonresponse weights. We sorted candidate measures by their *p*-values from the *t*-test of their respective coefficients from the first stage. Beginning with the candidate measure that had the smallest *p*-value, we added the remaining candidate measures one at a time to the model. If the newly added candidate measure had a *p*-value of 0.20 or smaller, conditional on the baseline measure of the outcome also being in the model, it was kept as a control variable in the model. If not, it was excluded. After completing this process for each outcome, we combined the sets of covariates to create a list of covariates for the main specification in addition to the treatment indicator, baseline measure of the outcome, and WUA fixed effects.

for using Huber-White standard errors. We used nonresponse weights to correct for possible survey nonresponse bias.

We report estimated effects of the intention to treat rather than the local average treatment effects for two reasons. First, as explained in more detail below, it is likely that training participation is measured with error. Second, farmers who did not participate in training could learn about the OFWM and HVA practices by visiting a demonstration farm or from others in the community who had attended. Although the focus groups revealed little evidence that nonparticipating farmers shared information through either of these channels, both could have happened to a small extent, in which case the local average treatment effect would be invalid.

Nearly 59 percent of treatment group households reported completing training in the first two years of program implementation (2007 and 2008), compared with 10 percent of control households. Control households reporting WtM training participation could have traveled to other locations to attend training. Anecdotal evidence suggests that this occurred occasionally, especially when treatment and control communities were nearby. However, the training rates calculated from the survey might be noisy measures of overall participation for several reasons. First, a few other training programs were in operation at the same time in the same areas. Farmers might have confused participation in one of these programs for participation in MCC-funded training. Second, and more likely based on our conversations with program staff and the survey team, farmers might have incorrectly reported that they attended training. Third, it is possible that more households received training in the third year of the program; unfortunately, we do not have good measures of training participation during the program's third year. However, it is unlikely that farmers would have participated in training in the third year if they had not attended it during the first two years, given the extensive outreach efforts during that period.

Table 1 shows the demographic and basic farm characteristics of the analysis sample. On average, the treatment and control groups had similar characteristics and land holdings at baseline, which is further support that random assignment produced similar groups. Overall, few households reported a female head of household (about 9 percent). Most heads of household had completed secondary school or higher and the average household head was 55 years old.[9]

4. IMPACTS ON AGRICULTURAL PRACTICES

The training program was expected to increase adoption of HVA and OFWM practices covered in training in the medium term. The next subsection summarizes qualitative evidence about changes in farmers' agricultural practices and constraints that farmers faced; Subsection 4.2 discusses the quantitative impacts estimated from our farming household survey data.

4.1. Implementation Findings

Socioscope (2010) reported that training participants valued the trainers' knowledge about agriculture, particularly regional agricultural conditions. Trained farmers recalled key OFWM

[9] At baseline, the treatment and control communities were statistically comparable. Of 60 comparisons of the treatment and control communities (Fortson et al. 2008), there were only 5 statistically significant differences between the research groups at a 0.10 level: treatment communities had a higher percentage of female-headed households, higher revenues from tomatoes, higher total agricultural sales, higher monetary profits, and higher monetary income than control communities.

and HVA concepts. Training was also highly desired in some communities. In these areas, community members organized up to five additional trainings because the initial training did not have space for them (Millennium Challenge Account [MCA]-Armenia 2011).

However, the training program faced implementation challenges in finding farmers able to implement the practices. The repeated theme in interviews, focus groups, and surveys of farmers was a lack of personal finances or affordable credit to implement new practices (Socioscope 2010; ACDI 2011; MCA-Armenia forthcoming). The large scale of the program was also difficult to satisfy while focusing on active farmers interested in training. Some village mayors and implementer field staff attempted to increase the number of people trained by recruiting individuals who were not actively farming or by overemphasizing the importance of training so that they could receive loans from a separate MCC program that provided subsidized credit to qualified borrowers. Consequently, many farmers and nonfarmers who attended training might not have been interested in the substance of the training programs (Socioscope 2010).

Farmers could be predisposed to continue cultivating the same set of crops from one year to the next rather than investing in higher-value crops as well. During the implementation phase, trainers and other program staff noted that Armenian farmers as a whole have a conservative mind-set and are skeptical that new crops will be profitable, especially when those crops have costlier inputs. The training was designed, in part, to overcome this particular concern of the farmers by working through examples of what the changes in revenues and costs would be for specific crops based on the participating farmers' own knowledge about crop sale prices and input prices. These examples demonstrated that profits are substantially higher for crops such as tomatoes compared with wheat. When we observed training sessions, we found the exercise to make a compelling case for investing in higher-value crops, but our findings suggest that it was not compelling enough. Farmers might also have high discount rates that deter them from investing in crops or technologies that generate returns only over a longer time horizon, such as cultivating new fruit trees.

The program logic was also flawed in some respects. Most prominently, OFWM training focused on water conservation, but farmers in Armenia pay for water based on the amount of land and crops they intend to irrigate, no matter how much water they actually use. As a result, there is no private incentive to invest in technologies to conserve water. When this came to light during implementation, water conservation was deemphasized in training.

4.2. Impacts on OFWM Practices

OFWM training covered a variety of practices to use water more efficiently, ranging from pre-planting practices such as modifying furrow sizes to growing-season actions such as using soil moisture meters and other monitoring tools. Farmers were asked at baseline and follow-up to select all of the OFWM practices they used from a list of training topics. To help interpret the impact estimates, practices were categorized into five groups: simple technological improvements, medium technological improvements, advanced technological improvements, related to irrigation scheduling, and related to organization. We estimated impacts on the adoption of any practices within each category and on the specific practices (Table 2). At baseline, few farmers used any OFWM practices and nearly all of the practices used were simple (Fortson et al. 2008).

We found that little changed three years after training. About 45 percent of the treatment and control groups used at least one simple OFWM practice at final follow-up. Furrow size modification accounts for much of this rate; no other simple OFWM practice was used by more than 4 percent of the treatment or control groups and there are no differences between the two groups (Table 3). Additionally, few farmers in our sample adopted medium improvements (such as gated pipes), advanced improvements (such as drip irrigation), or irrigation scheduling improvements. The impact on advanced improvements approached statistical significance, but the adoption rates for these improvements were less than 0.5 percent even among the treatment group.[10] Most farmers used at least one organizational improvement, such as the preparation of irrigated land or having a copy of the farm's water supply contract from the WUA, but there were no significant impacts on adoption rates. In contrast to advanced improvements, many of the organizational changes are relatively easy to adopt and would not require up-front financial investment.

Although the estimates suggest very limited adoption of advanced OFWM practices, informal evidence indicates that training might have spurred adoption of advanced practices in a handful of communities not included in our analysis. In particular, we visited three communities that were offered training in the pilot phase of the program and were therefore not included in the evaluation. In each community, many farmers had adopted drip irrigation in greenhouses and, based on our conversations, their adoption was plausibly attributable to the program. Each community shared two key features uncommon in most rural Armenian communities: many farmers in these communities had greenhouses already and the farmers were generally better positioned financially to make agricultural investments. Based on these interviews, we speculate

[10] Practice categories are not defined to be mutually exclusive—most farmers included in the count of farmers who adopted advanced practices also are included in the count of farmers who adopted simple practices.

that there might have been impacts in a small number of pilot phase communities, though these represent a small share of all farmers targeted to benefit from the program.

4.3. Impacts on HVA Practices

HVA training covered a wide range of practices intended to increase crop yields, improve soil quality, and increase crop values. The follow-up survey presented farmers with an extensive list of HVA farming practices, organized into two categories: industrial-economical and social-environmental (ACDI 2011). Industrial-economical practices emphasize gains in efficiency or value of production, such as producing more high-value crops. Social-environmental practices focus on environmentally friendly, socially responsible practices that might not translate directly into gains in productivity or profits but could have long-term effects on farmers' health, consumers' health, or the environment. Training emphasized the proper, safe use of pesticides and social-environmental practices were among the HVA practices that trained farmers were most likely to remember (Socioscope 2010).

The estimated impacts on industrial-economical practice adoption are on the margin of statistical significance, but the magnitude of the estimated impacts is small (Table 3). Improved soil preparation activities—such as plowing and soil cultivation—were the most widely used industrial-economical HVA practice. About one-quarter of farmers employed these practices, which could increase crop yields. Farmers in the treatment group were 6 percentage points more likely than farmers in the control group to use soil preparation improvements. Other impacts on industrial-economical practices were neither large nor statistically significant. Though greenhouse farming was one of the most frequently recalled HVA practices from training (Socioscope 2010) and was used by about 10 percent of farmers, impacts on greenhouse farming were small and insignificant. Only two other practices had adoption rates above 7 percent: the improvement of post-planting practices (such as weeding, fertilization, and pest control) and the establishment or renewal of an orchard. There was also no evidence of impacts on the area of land used for orchards or vineyards where HVA crops might be grown (Table 4).

Usage rates of social-environmental HVA practices were generally higher than for industrial-economical HVA practices, particularly those relating to pesticides. As with industrial-economical practices, some of the estimated impacts on social-environmental practice adoption are on the margin of statistical significance, but the magnitudes are small (Table 5). Farmers in the treatment group were 8 percentage points more likely to report purchasing pesticides from licensed stores; this impact estimate is statistically significant at the 0.10 level. No other statistically significant impacts were observed for the use of social-environmental HVA practices. The small but positive impacts on select HVA practices were not accompanied by any statistically significant impacts on the types of crops cultivated (Table 6).

5. IMPACTS ON AGRICULTURAL PRODUCTION AND EXPENDITURES

The long-term objective of training was to increase overall production for farmers and to increase HVA cultivation, both of which should lead to increased farm profits.[11] The estimated

[11] We excluded some less widely grown crops, such as flowers, from our estimate of tons of production because farmers reported their production of flowers in bunches, and there is no straightforward conversion to metric tons. Our estimate of the value of production does, however, include farmers' sales and harvest values for flowers and other crops that were not reported in tons.

impacts of WtM training on production quantities, values, and land under cultivation are shown in Table 7. All estimates are annual values for the 2010 agricultural season.[12]

We found no statistically significant impacts on total agricultural production, production of HVA crops, or production of non-HVA crops (see the top panel of Table 7). Among the subcategories of HVA crops, only the -0.3 ton impact on grape production and 0.1 ton impact on potatoes are statistically significant, and their impacts are in opposite directions. There were also no impacts on land cultivated overall, for HVA crops, or for non-HVA crops.

We also estimated impacts on the market value of harvests. We used this measure, rather than agricultural revenue (the value of the part of the harvest that is sold), because agricultural revenue does not reflect any crops consumed or bartered by the household, which can also be

[12] Because of outlying values, throughout this section and the next, we report estimates for outcome measures that have been censored at the 98th percentile. When we examined outliers on a case-by-case basis, we found no evidence that they were accurate data points. For instance, high outliers in crop sales at final follow-up were not accompanied by high values in other, related measures, such as crop production at follow-up or crop revenues at baseline However, their presence severely skews the estimated impacts and inflates standard errors. We chose the 98th percentile because it was the point at which the impact estimates stabilized; further censoring did not change the estimates much. We censored each outcome measure individually, so some reported estimates for totals might not equal the sums of their respective components.

considered income for the farmer. Because many Armenian farmers are subsistence farmers who sell little of their harvest, revenues do not reflect the full value of their production.[13]

The impact of training on the total value of farmers' harvests was large but not statistically significant (the bottom panel of Table 7). The estimated impact of $165 was approximately one-tenth of the control group's (regression-adjusted) mean, but the impact was imprecisely estimated because of the considerable variability in this outcome measure. Consistent with the findings for harvests, we found a significant negative impact on the value of grape harvests that was partially offset by a significant positive impact on the value of potato harvests. We also observed marginally significant impacts on harvest values of tomatoes ($38) and vegetables and herbs ($63).

Although the overall estimated impacts of training on harvest values were not statistically significant, there might still be positive impacts that our sample cannot detect. However,

[13] We calculated market value of harvests in a sequential process. If a farmer reported selling a positive amount of a crop, the price per ton for that farmer's sale was multiplied by the number of tons he or she produced to obtain the market value of the harvest. If a farmer did not report selling any of a particular crop that he or she cultivated, the harvest was multiplied by the median price per ton for that crop in that farmer's WUA. If no median price per ton was available for that crop and WUA, we multiplied the farmer's harvest by the crop's median price per ton in his or her zone. If no median was available for that crop and zone, we used the crop's median price in our sample. If no harvest amount was reported or the calculated harvest value was greater than reported revenues, we set the value of the harvest to the reported sale amount.

considering the pattern of mostly null findings on intermediate measures such as agricultural practices, cropping patterns, and tonnage of production—all of which could be estimated with greater precision than could harvest value—the large but insignificant impact estimate for total market value is more likely due to chance differences in the prices farmers received at market. We would consider this impact estimate more stable if we had observed systematic positive impacts on intermediate measures.

The last component of agricultural income is agricultural expenditures, including expenditures on fertilizers, pesticides, irrigation water, hired labor, rented equipment, and taxes. Because training covered several costly practices, adoption could have also required farmers' investments in new crops and technologies to increase, with corresponding increases in their expenditures. There were no statistically significant impacts on agricultural expenditures, in total (Table 8) or disaggregated by type of cost (not shown).

6. IMPACTS ON INCOME, CONSUMPTION, AND POVERTY

The ultimate goal of WtM training was to increase household income. Our analysis of farmers' well-being examined household income, household consumption, and poverty rates. Although increasing household income was the main goal of WtM training, we also examined the consumption-based measures because they are a lower-variance measure of well-being.

6.1. Household Income

The farming household survey collected rich data on agricultural and nonagricultural income for each member of the household at baseline and final follow-up. Although the program was not expected to directly affect nonagricultural income, it could cause households to reallocate their labor between the agricultural and nonagricultural sectors. For example, farmers might have worked fewer jobs in order to spend more time cultivating HVA crops or they might have received fewer remittances, offsetting gains in agricultural income.

Our measure of nonagricultural income was the previous year's total earnings from employment of the household head, spouse, and any grown children, plus the household's annual income from pensions, remittances, and social programs. Farmers in the treatment and control groups had similar nonagricultural income of approximately $2,300.

Our measure of agricultural profit used the total value of all crops harvested, which included those sold, bartered, or consumed by the household, as described previously.[14] We then calculated agricultural profit as the difference between total value of the harvest minus agricultural costs;[15] we defined total income as the sum of agricultural profit and nonagricultural income. Each of the outcomes examined in this section has been censored individually at the 98th percentile.

At final follow-up, households in the treatment group had an average of $166 more in agricultural profit and $206 more in income than households in the control group, but neither of these differences is statistically significant. This represents a 20 percent increase in agricultural profit and a 6 percent increase in income relative to the control group (Table 8). The differences

[14] We also examined the impacts on monetary agricultural income, which is based on the value of crops sold and excludes the value of crops bartered or consumed by the household. We did not find statistically significant impacts on monetary income from agriculture.

[15] We also did not find statistically significant impacts on agricultural costs.

are almost entirely attributable to the previously reported differences in the average market value of farmers' harvests.

6.2. Poverty Rates

To measure impacts on poverty, we constructed several measures of poverty rates comparing consumption measures in the farming household survey with established poverty lines—thresholds below which households are categorized as impoverished. First, we used the farming household survey to estimate the value of all consumption by the household, including food, health care, other nondurable goods, and durable goods. We adjusted this sum based on the number of adults and children in the household to determine consumption per person. Then, we compared our estimate of total consumption per person with three distinct poverty lines calculated for 2010 by Armenia's National Statistical Service in collaboration with the World Bank: the food poverty line, the lower general poverty line, and the upper general poverty line (National Statistical Service 2010). The food poverty line represents the cost to consume the average caloric requirement for a person in Armenia.[16] The lower and upper general poverty lines add the values of some types of nonfood consumption to the food poverty line. The food poverty line is the lowest and the upper general poverty line is the highest of the poverty lines, so

[16] The average caloric requirement for an Armenian is 2,232 calories per day, as calculated in 2004 by the National Statistical Service and the World Bank. The cost of this caloric amount is based on the specific food items consumed by a reference population, scaled to that number of calories.

poverty rates calculated with the food poverty line will be lowest, followed by the lower general poverty line; rates calculated with the upper general poverty line are highest.[17]

Ideally, we would assess whether households are in poverty by calculating total consumption from detailed, daily consumption diaries of durable and nondurable goods. However, collecting this information would be very expensive, making it infeasible. Instead, each round of the survey gathered households' reports of their expenditures in the past month on purchased food, health care costs, housing products, public utilities, transportation, and other expenses. The final follow-up survey added questions on consumption of education and other annual costs, which we included in our poverty calculations. We also estimated the value of crops that the household consumed from its own production and added this to the sum of

[17] The primary difference between the lower and upper general poverty lines is the reference population used to identify the share of expenditures on nonfood items. The lower poverty line examines the consumption of households whose *total consumption* is near the food poverty line. This is known as the consumption basket method. In Armenia in 2009, about 70 percent of this reference population's total consumption was food. The upper poverty line examines the consumption of households whose *food consumption* is near the food poverty line. This is known as the food expenditures method. In Armenia in 2009, about 57 percent of this reference population's total consumption was food (National Statistical Service 2010).

expenditures. Finally, we applied an adjustment factor to account for durable goods, such as vehicles or appliances.[18]

There were no significant impacts on the poverty rates associated with the three poverty lines (Table 9). The overall poverty rates in our sample using the lower and upper poverty lines were 15 and 28 percent, respectively. Although there were no overall impacts on poverty rates, there could nevertheless be impacts on consumption for households higher in the consumption distribution. To examine this, we characterized household consumption as a proportion of each of the three poverty lines (Table 10). For example, the average household in the control group had consumption equivalent to 259 percent of the food poverty line. The estimated impacts on consumption were negative but not statistically significant.

As described earlier, increasing household income was the goal of the training program. The estimated impacts on income were statistically insignificant, but the magnitude of those estimates would be meaningful if they represented the true program impact. Consumption was measured much more precisely; that the consumption estimates suggested no impact of WtM training bolsters the interpretation that it is unlikely that WtM training affected household income.

[18] The adjustment factor was 9.4 percent, the same factor used in Fortson et al. (2008). It was based on the proportion of total consumption due to durable goods in 2004, as calculated by the National Statistical Service.

7. CONCLUSIONS AND IMPLICATIONS

This study estimated the impacts of the WtM training program implemented in Armenia from 2007 to 2011. In addition to being the largest randomized evaluation of an agricultural training program, we followed farmers for three years after training began—a longer follow-up period than other studies have used—and emphasized understanding the mechanisms that underpin our key findings.

We found few significant differences between farmers in communities where training was offered and farmers in control communities. In particular, there was little evidence that WtM training increased adoption of key agricultural practices or led to cultivation of higher-value crops. Focus groups and interviews revealed that financial limitations were the most common reason given for not implementing new practices. Institutional factors might have also inhibited adoption of OFWM practices, including the lack of monetary incentives to conserve water. Program staff recognized in advance that farmers often have conservative mind-sets about investing in new crops as well, particularly when those crops have costlier inputs; although this challenge was known, it was not surmounted.

We also did not find evidence that training substantially improved long-term measures of farmers' well-being, such as crop cultivation, amount or value of production, revenue, total income, poverty, or consumption. That we found no evidence of impacts on adoption of new OFWM or HVA practices suggests that it is unlikely that longer-term impacts could yet develop for the full beneficiary population. This study also suggests two fundamental considerations for future programs implementing similar training activities:

First, more modest training targets and better selection of training beneficiaries might help spur more farmers to adopt practices. Because the implementer had extremely large targets for the number of farmers to train in a prescribed time frame, the recruitment of farmers for training might not have targeted those most likely to benefit. With smaller training targets, more time could have been spent identifying and selecting farmers and then following up with trained farmers to identify and resolve issues precluding them from adopting new practices. This could have led to a larger net total benefit, even if the footprint of the program was smaller.

Second, training farmers on fewer practices tailored to their circumstances could be more efficient. The implementers tailored training sessions to match the agricultural conditions of the different regions in Armenia. However, the training sessions in each area provided all farmers who attended training with the same type of information regardless of their level of technical sophistication or scale of production. Although these trainings covered some simple practices, they also included many costly practices (which might have better long-term results if adopted). However, it is unlikely that many trained farmers would be able to invest in these more costly practices. An alternate training strategy would be to tailor the content of training more directly to farmers' ability to invest in particular practices. For example, small-scale farmers who lack investment capital could have received training that focused only on simple and inexpensive OFWM practices, or a program to help farmers qualify for affordable agricultural loans could have complemented training. Conditions of the local irrigation infrastructure—for example, whether a given community has an operational and reliable irrigation canal—could also have been considered in the training material. More generally, program designers should consider the contextual factors that might deter practice adoption, such as the lack of incentives to conserve irrigation water in Armenia. Such approaches could have used farmers' and trainers' time more efficiently and placed emphasis on practices that had a higher probability of being adopted.

Though the training program studied here is similar in content and scope to other agricultural training programs implemented around the world (for example, Cocchi and Bravo-Ureta 2007; Dalton et al. 2005; and Dey et al. 2007), we cannot say with certainty whether the impacts of the training program examined in this study would generalize to different training programs implemented in different contexts. Some aspects of the Armenian context are common in many developing economies, such as the prominence of the agriculture sector in the national economy, but other aspects are unique to the region, such as the arid climate and volcanic soil. Armenia's history as a former Soviet republic and the privatization of formerly state-owned collective farmlands are further contextual aspects that make the findings of this particular evaluation more applicable to other former Soviet republics than to training programs implemented elsewhere in the world. Still, this study highlights challenges that were central to the WtM training program's failure to have meaningful impacts in Armenia, challenges that could similarly apply to agricultural training programs implemented elsewhere. Large impacts on farmers' well-being have been assumed (with little hard evidence) as justification for these large investments, and foreign aid agencies should reconsider how well-proposed agricultural training programs can surmount the aforementioned challenges when they decide whether to fund future programs.

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Table 1. Individual and Household Characteristics (proportions except where indicated)

	N	Control Mean	Treatment-Control Difference	Standard Error
Head of Household's Age (years)	3,546	55.17	-0.058	0.083
Female-Headed Household	3,547	0.081	0.005	0.013
Head of Household's Education				
Less than secondary	3,547	0.125	0.004	0.016
Full secondary	3,547	0.469	-0.015	0.024
Secondary vocational	3,547	0.251	0.018	0.017
More than secondary	3,547	0.155	-0.007	0.015
Total Number of People in Household	3,547	5.134	-0.018	0.086
Number of Children in Household	3,547	1.229	-0.044	0.051
Total Land Owned or Rented (hectares)	3,542	1.686	-0.061	0.172

Note: Estimates use nonresponse weights. All variables are from the follow-up survey because they would not be affected by the training program except for total land owned or operated, which is measured at baseline.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

Table 2. Impacts of WtM Training on OFWM Practices (proportion reporting use of practice)

	N	Control Mean	Estimated Impact	Standard Error
Simple	3,547	0.449	0.004	0.046
Modification of furrow sizes	3,547	0.429	0.013	0.048
Plastic cover for ditch	3,547	0.029	0.004	0.014
Siphons	3,547	0.001	0.003	0.003
Spiles	3,547	0.002	0.003	0.003
Dams (metal or plastic)	3,547	0.001	0.000	0.001
Medium	3,547	0.000	0.002	0.001
Movable gated pipes	3,547	0.000	0.001	0.000
Hydrants	3,547	0.000	0.000	0.000
Advanced	3,547	0.001	0.003*	0.002
Sprinkler irrigation	3,547	0.000	0.001*	0.000
Micro-sprinkler irrigation	3,547	0.000	0.001	0.001
Drip irrigation	3,547	0.001	0.001	0.001
Irrigation Scheduling	3,547	0.001	0.000	0.001
Soil moisture meter	3,547	0.001	0.000	0.001
Evapotranspiration gauge	3,547	0.000	0.000	0.000
Organizational	3,547	0.789	-0.034	0.030
Preparation of irrigated land	3,547	0.611	-0.015	0.045
Water measurement at farm gate	3,547	0.001	0.000	0.001
Have copy of water supply contract from WUA	3,547	0.446	0.006	0.048
Updated the annex to the water supply contract	3,547	0.089	0.008	0.026
Presented water order to the WUA about cultivated crops	3,547	0.160	0.027	0.041
Placed written water order	3,547	0.009	-0.005	0.008

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

OFWM = On-Farm Water Management; WtM = Water-to-Market; WUA = water user association.

Table 3. Impacts of WtM Training on Industrial-Economical HVA Practices (proportion reporting use of practice)

	N	Control Mean	Estimated Impact	Standard Error
Improved Soil Preparation Activities (plowing, cultivation, and so on)	3,547	0.208	0.057	0.035
Improved Post-Planting Practices (weeding, fertilization, pest control, and so on)	3,547	0.115	0.009	0.025
Established or Renewed an Orchard	3,547	0.112	-0.009	0.026
Established or Renewed a Greenhouse	3,547	0.090	0.016	0.021
Used High Quality, Disease-Resistant Seeds or Planting Material	3,547	0.056	0.002	0.022
Changed Crop or Variety Based on Demand	3,547	0.037	0.000	0.016
Mixed Crops	3,547	0.032	-0.001	0.012
Produced High-Value Crops for Budget Reasons	3,547	0.026	0.002	0.014
Produced Multiple Yields	3,547	0.022	0.002	0.010
Shifted Time of Harvest by Using Plastic Tunnels or Planting Seedlings	3,547	0.020	-0.006	0.009
Produced Nontraditional Crops	3,547	0.002	-0.001	0.002

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

HVA = High-Value Agriculture.

Table 4. Impacts of WtM Training on Land Owned or Rented and Irrigated (hectares)

	N	Control Mean	Estimated Impact	Standard Error
Agricultural Land, Total	3,542	1.672	-0.037	0.053
Agricultural Land, Irrigated	3,547	0.769	-0.061	0.042
Arable Land, Total	3,547	1.209	0.005	0.054
Arable Land, Irrigated	3,547	0.405	-0.034	0.034
Orchard Land, Total	3,547	0.107	-0.013	0.013
Orchard Land, Irrigated	3,547	0.099	-0.013	0.012
Vineyard, Total	3,547	0.100	-0.014	0.013
Vineyard, Irrigated	3,547	0.095	-0.013	0.012
Kitchen Plot, Total	3,547	0.167	0.003	0.005
Kitchen Plot, Irrigated	3,547	0.123	0.003	0.007
Other Land, Total	3,547	0.029	-0.009	0.008
Other Land, Irrigated	3,547	0.011	-0.003	0.007

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

WtM = Water-to-Market.

Table 5. Impacts of WtM Training on Social-Environmental HVA Practices (proportions)

	N	Control Mean	Estimated Impact	Standard Error
Used Only Pesticides Permitted in Armenia	3,547	0.562	0.061	0.042
Bought Pesticides for a Specific Problem (pests, diseases, avoiding residuals)	3,547	0.539	0.033	0.044
Purchased Pesticide from Licensed Stores	3,547	0.500	0.078*	0.044
Harvested Crops After the Pesticide's Waiting Period	3,547	0.500	0.050	0.045
Used Safety Equipment When Working with Pesticides	3,547	0.487	0.005	0.042
Did Not Purchase Pesticides in Damaged Packaging	3,547	0.443	0.058	0.047
Did Not Burn or Discard Residual Pesticide into a Ditch or Mudflow Conduit	3,547	0.413	0.041	0.050
Did Not Use Excessive Amounts of Chemical Fertilizer(s)	3,547	0.202	0.025	0.040
Used Organic Fertilizers with Appropriate Methods	3,547	0.120	-0.002	0.029
Used Nonchemical Methods of Pest and Disease Management	3,547	0.006	-0.003	0.009
Prepared Compost and Used It as Organic Fertilizer	3,547	0.002	-0.001	0.040
Did Not Burn Organic Waste Remaining After Harvesting Crops	3,547	0.001	-0.001	0.001

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

HVA = High-Value Agriculture; WtM = Water-to-Market.

Table 6. Impacts of WtM Training on Cultivated Crops (proportions)

	N	Control Mean	Estimated Impact	Standard Error
HVA Crops	3,547	0.929	0.009	0.013
Grapes	3,547	0.287	-0.006	0.019
Other fruits or nuts	3,547	0.713	-0.044	0.031
Tomatoes	3,547	0.383	-0.035	0.031
Vegetables and herbs	3,547	0.448	-0.015	0.031
Potatoes	3,547	0.281	-0.002	0.018
Non-HVA Crops	3,547	0.514	-0.012	0.026
Grains	3,547	0.318	0.025	0.022
Grass	3,547	0.288	-0.032	0.022

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

HVA = High-Value Agriculture; WtM = Water-to-Market.

Table 7. Impacts of WtM Training on Production, Land Under Cultivation, and Market Value of Harvests

	N	Control Mean	Estimated Impact	Standard Error
Agricultural Production (metric tons)				
Total	3,392	5.785	0.214	0.444
HVA Crops	3,392	3.813	0.015	0.373
Grapes	3,547	0.912	-0.269**	0.132
Other fruits or nuts	3,547	0.519	0.016	0.072
Tomatoes	3,547	0.431	0.088	0.068
Vegetables and herbs	3,392	0.715	0.060	0.133
Potatoes	3,547	0.275	0.124**	0.050
Non-HVA Crops	3,547	1.749	0.137	0.160
Grains	3,547	0.478	0.093	0.057
Grass	3,547	1.186	0.042	0.134
Land Under Cultivation (hectares)				
Total	3,547	1.155	0.016	0.056
HVA Crops	3,547	0.433	-0.018	0.027
Non-HVA Crops	3,547	0.694	0.028	0.050
Market Value of Harvests (U.S. dollars)				
Total	3,547	1,708.87	165.39	130.68
HVA Crops	3,547	1,391.15	96.16	122.03
Grapes	3,547	320.28	-80.34**	40.51
Other fruits or nuts	3,547	292.10	5.44	39.62
Tomatoes	3,547	138.93	38.18*	22.77
Vegetables and herbs	3,547	221.55	63.23	38.93
Potatoes	3,547	94.59	46.77***	17.96
Other HVA crops	3,547	57.95	-4.49	12.43
Non-HVA Crops	3,547	280.66	42.31	25.71
Grains	3,547	155.11	24.67	19.52
Grass	3,547	111.03	6.18	12.79
Other non-HVA crops	3,547	0.75	4.54	3.44

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

HVA = High-Value Agriculture; WtM = Water-to-Market.

Table 8. Impacts of WtM Training on Annual Household Income (U.S. dollars except where indicated)

	N	Control Mean	Estimated Impact	Standard Error
Nonagricultural Income	3,516	2,276.33	-1.55	73.46
Agricultural Income				
Total value of harvest	3,547	1,708.87	165.39	130.68
Agricultural profit (value – costs)	3,547	840.71	165.77	108.42
Total Income	3,516	3,179.91	205.73	149.71

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

WtM = Water-to-Market.

Table 9. Impacts of WtM Training on Poverty Rates (proportions)

	N	Control Mean	Estimated Impact	Standard Error
Households Below Food Poverty Line	3,547	0.056	-0.003	0.011
Households Below Lower Poverty Line	3,547	0.152	0.003	0.019
Households Below Upper Poverty Line	3,547	0.282	0.000	0.024

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

Table 10. Impacts of WtM Training on Consumption Relative to Poverty Lines (proportions)

	N	Control Mean	Estimated Impact	Standard Error
Consumption Relative to Food Poverty Line	3,547	2.585	-0.040	0.062
Consumption Relative to Lower Poverty Line	3,547	1.790	-0.028	0.043
Consumption Relative to Upper Poverty Line	3,547	1.459	-0.023	0.035

Note: Estimates use nonresponse weights and regression adjustment as described in the text.

*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

WtM = Water-to-Market.

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