Evaluation of Water-to-Market Training in Armenia

October 19, 2012

Kenneth Fortson
Anu Rangarajan
Randall Blair
Joanne Lee
Valentine Gilbert

MATHEMATICA
Policy Research

Contract Number:
MCC-10-0114-CON-20/TO04

Mathematica Reference Number:
06916

Submitted to:
Millennium Challenge Corporation
875 Fifteenth St., NW
Washington, DC 20005-1203
Project Officer: Rebecca Goldsmith

Submitted by:
Mathematica Policy Research
505 14th Street, Suite 800
Oakland, CA 94612-1475
Telephone: (510) 830-3700
Facsimile: (510) 830-3701
Project Director: Kenneth Fortson

Evaluation of Water-to-Market Training in Armenia

October 19, 2012

Kenneth Fortson
Anu Rangarajan
Randall Blair
Joanne Lee
Valentine Gilbert

MATHEMATICA
Policy Research

MATHEMATICA
Policy Research

www.mathematica-mpr.com

Improving public well-being by conducting high-quality, objective research and surveys

Princeton, NJ ■ Ann Arbor, MI ■ Cambridge, MA ■ Chicago, IL ■ Oakland, CA ■ Washington, DC

ACKNOWLEDGMENTS

We greatly appreciate the hard work of many people whose efforts contributed to this report. We especially thank our monitoring and evaluation colleagues: Rebecca Goldsmith, Edith Petrosyan, Stephanie Price, and Emily Andrews of MCC; and Lusine Kharatyan, Lusine Yeremyan, Shushan Kurkchiyan, and Ester Hakobyan of MCA-Armenia. Their input at all stages of the project has been invaluable. Rebecca Goldsmith contributed several of the photographs included in the present report as well. We also appreciate the cooperation and insights of the Water-to-Market program managers at MCA-Armenia and MCC, including Stephanie Haile, Kathy Farley, Sergey Meloyan, and Anahit Petrosyan.

Additionally, we thank MCC's Resident Country Mission Director Alex Russin and MCA-Armenia's CEO Ara Hovsepyan. Throughout the lifespan of the Compact with Armenia, their interest in and support for M&E generally and impact evaluation particularly has been invaluable for cultivating an environment in which rigorous impact evaluation is possible and the results receive appropriate attention.

We also thank the many implementation staff at ACDI/VOCA, VISTAA, and the Rural Finance Facility for answering numerous questions about their programs. The partnership between the program implementation and monitoring and evaluation teams has been uncommonly strong. We especially thank Richard Hurelbrink, Artak Harutyunyan, and Hrachya Zakoyan of ACDI/VOCA; and Makrita Avjyan and Meri Nikoghosyan of VISTAA for making this partnership a success.

This report would not be possible without the thorough and resourceful data collection implemented by our colleagues at AREG and Avag. We especially thank Ada Babloyan, Bagrat Harutyunyan, Tigran Harutyunyan, Karen Sargsyan, and Hovhannes Keshishyan of AREG; and Melik Gasparyan, Nairuhi Jrbashyan, and Vahram Avanesyan of Avag, for their collaboration. We also appreciate the hard work of their team of interviewers and the many farmers who participated in the survey. In addition to quantitative data, the present report draws on qualitative data about program implementation collected for reports by Socioscope and MCA-Armenia's Compact Completion Report team. We thank the professionals involved in these reports for the valuable information provided therein. Steve Anderson of MCC also provided helpful information on program costs.

Our colleagues at Mathematica have provided guidance and suggestions throughout the project, particularly Phil Gleason, who carefully reviewed and provided excellent comments that greatly improved the report. Jane Fortson and Peter Schochet were instrumental in helping us develop the evaluation designs. We also thank Sheena Flowers for her diligence and patience in formatting this report and Jennifer Baskwell and Sarah Hutches for additional production support. Seth Morgan provided valuable background research. Dale Anderson provided careful editing of the draft report. And last but definitely not least, Laurie Schulte does a wonderful job tracking and managing the project staffing and resources. We have also benefitted from helpful comments from Chris Udry and Alan de Brauw.

All of the above organizations and individuals have contributed tremendously to this report and to the project more generally, but any remaining errors are the fault of the authors alone.

CONTENTS

EXECUTIVE SUMMARY vii

I. INTRODUCTION 1

A. Overview of the Compact and the Water-to-Market Activity 1

B. Implementation of WtM Training 5

II. EVALUATION APPROACH AND DATA 8

A. Research Questions 8

B. Evaluation Design 8

C. Sampling Approach 10

D. Description of Analysis Sample 12

III. IMPACTS ON AGRICULTURAL PRACTICES 16

A. Implementation Findings 16

B. On-Farm Water Management Practices 17

C. HVA Practices 19

IV. IMPACTS ON AGRICULTURAL PRODUCTION 23

V. IMPACTS ON INCOME AND POVERTY 28

A. Household Income 28

B. Poverty Rates 30

VI. CONCLUSIONS AND LESSONS LEARNED 34

REFERENCES 37

APPENDIX A. METHODS

APPENDIX B. ADDITIONAL TABLES

APPENDIX C. FARMING PRACTICES SURVEY: ROUND 3 INSTRUMENT

APPENDIX D. ESTIMATING HOW MANY HOUSEHOLDS PARTICIPATED IN A TRAINING

TABLES

Table 1. Impacts of WtM Training on Production, Land Cultivated, and Market Value of Harvests xviii

Table 2. Impacts of WtM Training on Annual Household Income (USD) xix

Table I.1. Summary of WtM Training 6

Table II.1. Data Sources and Research Design Used to Answer Primary Research Questions for WtM Training 9

Table II.2. Distribution of Training in Community Clusters in the Research Sample, by Zone 10

Table II.3. Individual and Household Characteristics (percentages except where indicated) 13

Table II.4. Respondent Households Who Completed Training During First Two Years of WtM Training, by Zone (percentages) 14

Table III.1. Impacts of WtM Training on Land Owned or Rented and Irrigated (hectares) 19

Table III.2. Impacts of WtM Training on Cultivated Crops (percentages) 22

Table III.3. Impacts of WtM Training on Use of Collection Centers (percentages) 22

Table IV.1. Impacts of WtM Training on Production, Revenues, and Market Value of Harvests 25

Table IV.2. Impacts of WtM Training on Production, Revenues, and Market Value of Harvests, by Zone 26

Table IV.3. Impacts of WtM Training on Agricultural Expenditures (USD) 27

Table V.1. Impacts of WtM Training on Annual Economic Household Income (USD) 29

Table V.2. Impacts of WtM Training on Annual Economic Household Income, by Zone (USD) 29

Table V.3. Impacts of WtM Training on Poverty Rates (percentages) 32

Table V.4. Impacts of WtM Training on Poverty Rates, by Zone (percentages) 32

Table V.5. Impacts of WtM Training on Consumption Relative to Poverty Lines (means) 33

Table V.6. Impacts of WtM Training on Consumption Relative to the Lower Poverty Line, by Baseline Consumption Level (means) 33

FIGURES

Figure 1. Overview of the Compact with Armenia viii

Figure 2. Logic Model for the WtM Activity.......... x

Figure 3. Distribution of Trained Communities and Communities in the Research Sample, by Marz xiii

Figure 4. Cumulative Numbers of Farmers Who Participated in OFWM or HVA Training by the End of Each Compact Year xv

Figure 5. Impacts of WtM Training on OFWM Practices (percentages) xvi

Figure 6. Impacts of WtM Training on Industrial-Economical and Social-Environmental HVA Practices (percentages).......... xvii

Figure I.1. Overview of the Compact with Armenia 2

Figure I.2. Logic Model for the WtM Activity.......... 4

Figure I.3. Cumulative Numbers of Farmers Who Participated in OFWM or HVA Training by the End of Each Compact Year 7

Figure II.1. Distribution of Trained Communities and Communities in the Research Sample, by Marz 11

Figure III.1. Impacts of WtM Training on OFWM Practices (percentages) 18

Figure III.2. Impacts of WtM Training on Industrial-Economical HVA Practices (percentages).......... 20

Figure III.3. Impacts of WtM Training on Social-Environmental HVA Practices (percentages).......... 21

EXECUTIVE SUMMARY

Armenia was left with the legacy of a centrally planned economy when it declared independence from the Soviet Union in 1991. The Armenian economy was highly dependent on its Soviet trading partners and poorly equipped to function with the lack of infrastructure investment and support after Soviet withdrawal. In 1994, the Armenian government adopted a comprehensive stabilization and reform program in which farmland was privatized and redistributed as small plots. However, many of the beneficiaries of this redistribution had little expertise in farming or had mainly worked on collective farms before the reform and as a result did not have the knowledge required to effectively manage their own farms. Further, much of the irrigation infrastructure continued to deteriorate, falling into disrepair and disuse.

The aim of the Millennium Challenge Corporation's Compact with Armenia ("the Compact"), a five-year agreement signed in March 2006, was to increase household income and reduce poverty in rural Armenia through improved performance of the country's agricultural sector. The Compact, managed by the Millennium Challenge Account with Armenia (MCA-Armenia), was originally designed to include two projects: (1) the Rehabilitation of Rural Roads Project and (2) the Irrigated Agriculture Project.[1] The Irrigated Agriculture Project comprised two complementary activities, the Infrastructure Activity through which irrigation infrastructure would be rehabilitated, and the Water-to-Market Activity (hereafter WtM), which would provide training, technical assistance, and access to credit for farms and agribusiness. WtM was intended to help farmers harness the improvements in irrigation to introduce new technologies and shift to production of high-value agricultural crops, both of which would increase their annual income.[2] By improving living standards among rural residents, these investments were designed to lead to future economic growth in rural areas and throughout the country. Figure 1 summarizes the overall goal of the Compact and how each activity was designed to help accomplish the overall goal.

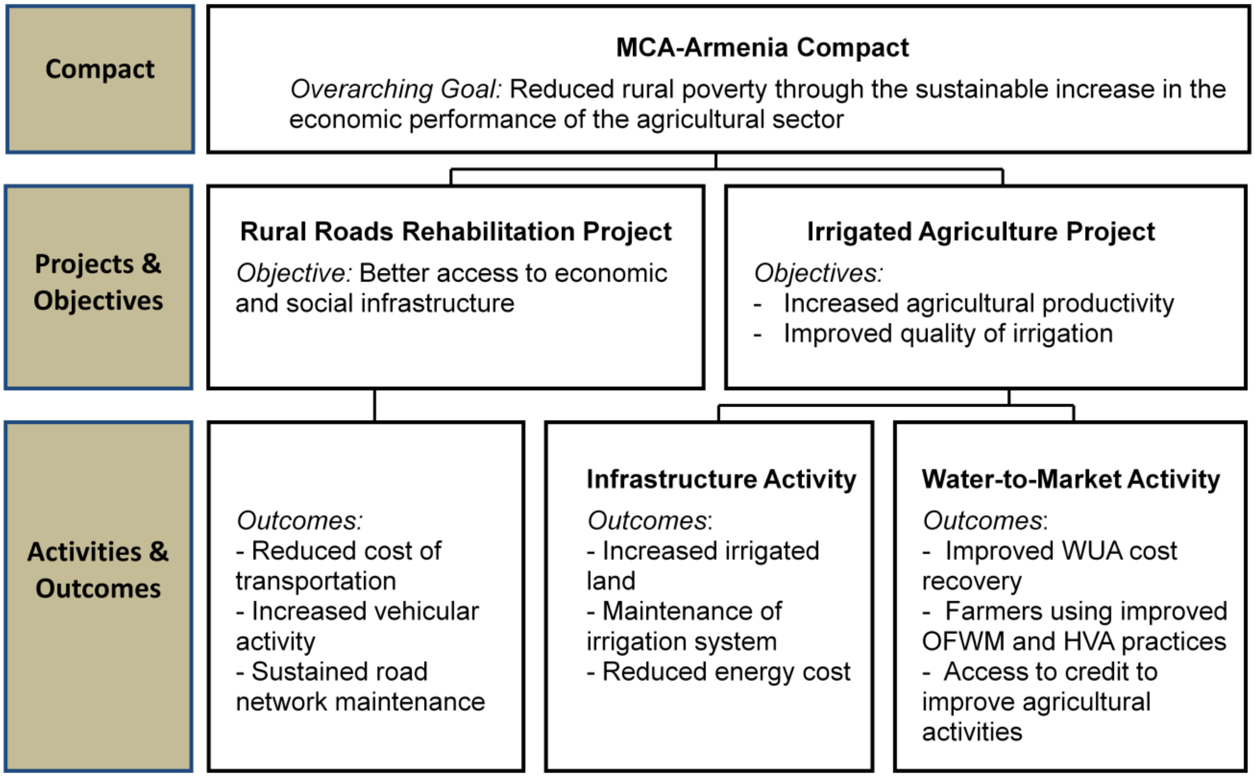
The Millennium Challenge Corporation (MCC) has commissioned rigorous impact evaluations to examine the Rehabilitation of Rural Roads Project, the Infrastructure Activity, and the WtM Activity. The evaluation of WtM comprises evaluations of four components of WtM as described in the next section. This report focuses on the evaluation of the largest component of WtM, which includes training in On-Farm Water Management (OFWM) and High-Value Agriculture (HVA). We start with an overview of the WtM Activity and the logic underlying each component of WtM. Evaluations of the other components of the WtM Activity will be presented in a separate report.

---

[1] At the June 2009 MCC Board meeting, the decision was made not to continue funding any further road construction and rehabilitation under the $236 million Compact due to concerns about democratic governance. Approximately 25 km of pilot roads had been completed prior to this decision. As of July 2012, 150 km of MCC-funded road designs are now being funded by the World Bank.

[2] According to a 2005 World Bank paper (Gulati et al. 2005), high-value crops are defined as crops that have relatively high economic value per kilogram, per hectare, or per calorie, such as fruits and vegetables. In Armenia, high-value agriculture consists of all crops that are not grain or grass.

Figure 1. Overview of the Compact with Armenia



A. Overview of the WtM Activity

The WtM Activity included multiple elements designed to work in concert with each other and with the Infrastructure Activity to improve agricultural profitability and household well-being. The Institutional Strengthening Subactivity (ISSA) provided general technical support to water user associations (WUAs), the regional organizations that manage the distribution of and payment for irrigation water in Armenia. ISSA also provided assistance to three Water Supply Agencies (WSAs) that operate and maintain irrigation dams and pumping stations. The aim was to create more efficient and consistent irrigation supply for WUA members. ISSA also included an irrigation policy reform component, in which a reform strategy was developed through a participatory process with stakeholders.

The Improved Profitability of WUA Member Subactivity included three sub-subactivities more directly affecting farmers who belong to WUAs. The largest of these, and the focus of this report, is the OFWM and HVA Training Sub-subactivity (hereafter "WtM training"), which included two types of training:

- **On-Farm Water Management (OFWM) training,** implemented by ACDI/VOCA and its partners VISTAA and Euroconsult, included both classroom and practical components and the establishment of demonstration plots to demonstrate irrigation technologies in practice. The goal of this training was for farmers to adopt new and more efficient irrigation techniques, which would lead to increased and more cost-effective agricultural production and higher sales.

- **High-Value Agriculture (HVA) training**, implemented by ACDI/VOCA and its partners, consisted of establishing demonstration plots and conducting training sessions for farmers on high-value crop substitution and cropping intensity. The goal of HVA training was for farmers to adopt new cropping techniques and high-value crops, which would lead to increased and more diverse agricultural production, as well as increased sales.

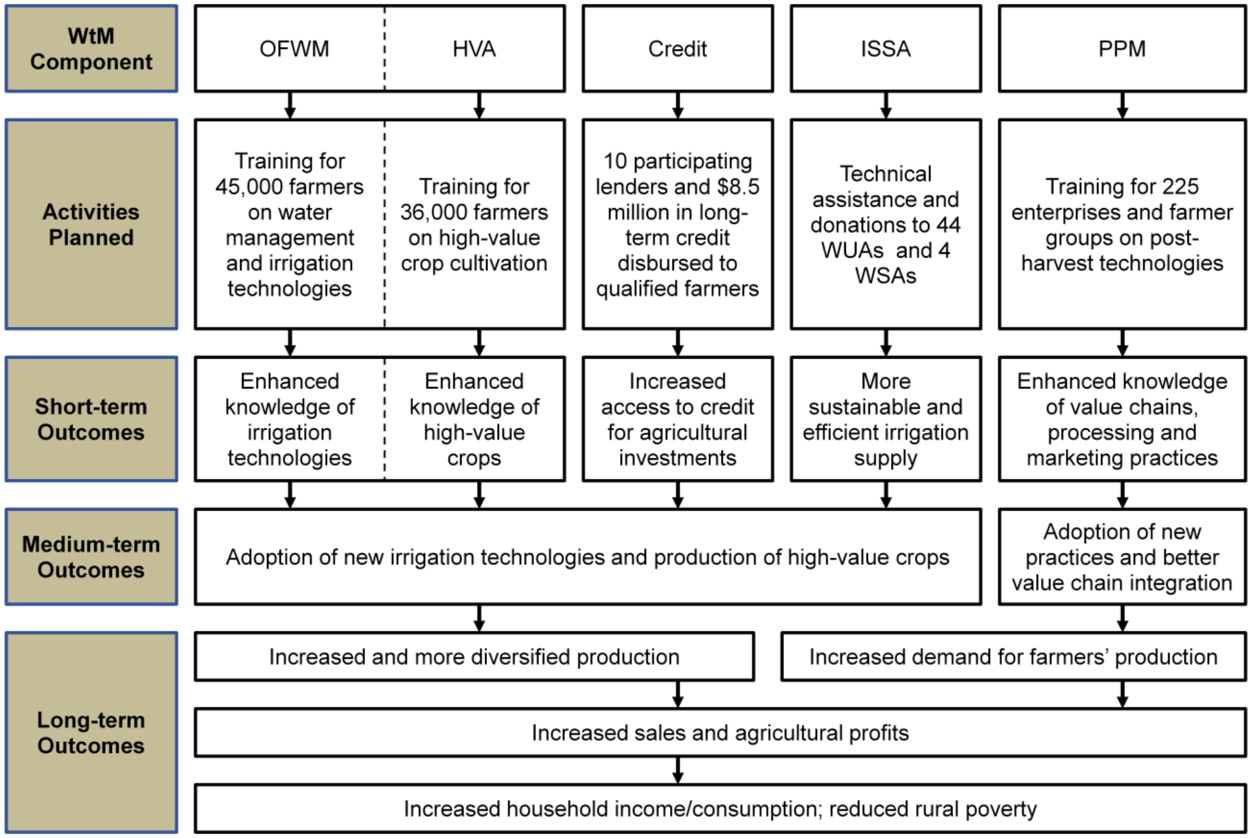
The Credit Sub-subactivity (hereafter "WtM credit") made long-term credit available to qualified farmers who participated in WtM training and met other selection criteria. Lastly, under the Post-Harvest, Processing, and Marketing (PPM) Sub-subactivity, implemented by ACDI/VOCA, enterprises and producer groups were to be trained in processing technologies, food safety, quality standards, financial analysis, and developing commercial linkages. The objective of PPM was to improve post-harvest preservation procedures, strengthen processing enterprises, and provide WtM beneficiary farmers with increased opportunities to sell their products.

A high degree of interaction was envisioned between the OFWM and HVA training components, as water management techniques learned in OFWM could be used to cultivate new high-value crops introduced in HVA training. Because new water management and production technologies introduced in OFWM and HVA training—such as drip irrigation systems and greenhouses—required investment capital, training beneficiaries could apply for WtM credit to finance these investments.[3] In addition, many water users who benefited from ISSA could participate in WtM training and were eligible to apply for WtM credit. Thus, the short-term goal of ISSA, more sustainable and efficient irrigation water supply, could feasibly facilitate farmers' transition to new water management techniques, new crops, and new production technologies financed with WtM credit. The synergy created by these components, along with improved irrigation infrastructure financed under the Compact's Infrastructure Activity, could lead to increased and more diversified production.

MCA also planned substantial interaction between PPM and other components, as processing enterprises strengthened by PPM assistance could form stronger linkages with WtM beneficiary farmers and create greater demand for farmers' production. Through these interactions among components, all WtM components were designed to result in increased sales and agricultural profits, as well as improved household well-being among beneficiary farmers (Figure 2).

[3] Participating in OFWM or HVA training was a prerequisite for WtM credit.

Figure 2. Logic Model for the WtM Activity



B. Research Questions for WtM Training

We examined the following two broad sets of questions:

1. ***How was WtM training implemented?*** What were the characteristics of training participants, and how were these participants identified and recruited? What assistance was provided to participants through training?

2. ***What were the impacts of WtM training?*** What were the impacts on practices or use of new technologies as a result of training? What were the impacts on household income and poverty?

We used a combination of quantitative and qualitative data to answer these research questions. To answer questions regarding implementation, we used qualitative data sources, including qualitative process analysis reports completed by Socioscope (Socioscope 2010 and Socioscope 2011), MCA-Armenia's draft Compact Completion Report (2011), and our own observations from field visits and interviews. To answer questions regarding impacts, we used quantitative data from baseline and follow-up household surveys.

The quantitative analyses examine estimated program effects on many outcomes. When examining many estimates, it is likely that some of the estimates will be statistically significant—either positively or negatively—by chance, even if the program had no true effects. For this reason, we consider the pattern of findings rather than only individual estimates when we interpret results to assess whether WtM training was effective so that we can distinguish true program effects (positive or negative) from chance differences.

C. Components of WtM Training

The objective of WtM training, which included both OFWM and HVA training, was to educate farmers on techniques intended to improve farm profitability by using agricultural inputs more efficiently, thus increasing production and the value of crops cultivated. The trainings were targeted to members of WUAs, and farmers who participated in training also became eligible to apply for WtM credit.

The OFWM training covered region-specific water management techniques to conserve water by emphasizing low-cost irrigation technologies such as modified furrow sizes and soil moisture meters. HVA training focused on growing new crops or on ways to cultivate high-value crop varieties by using higher-quality seeds, establishing greenhouses, or other methods. HVA practices can be divided into industrial-economical improvements, which emphasize increases in farmers' own production or profits, and social-environmental improvements, which promote safe and environmentally friendly practices.

Each type of training comprised 3 to 4 days of theoretical lessons in classrooms supplemented with practical lessons at a demonstration farm nearby. Each training session included 20 to 25 farmers from one or more neighboring communities and was led by an agricultural expert from the same region. The two types of training were offered separately, but many farmers attended both.

Classroom Training on OFWM

A critical part of WtM training was to establish and maintain a number of farms as demonstration farms for training purposes. These farms were outfitted with irrigation technologies discussed in training and had demonstration plots of high-value crops. Each demonstration farm was carefully selected to serve one to five communities, and farmers who received training were encouraged to revisit the farms after the official training to see OFWM and HVA practices in use. ACDI also operated tours of the demonstration farms for trained farmers during key months of the agricultural year. A primary factor in designating demonstration farms was whether the farmer was willing to set up and operate a demonstration farm and to promote other farmers' understanding of the demonstrated technologies. Other selection criteria included the site's proximity to other farms in the community, topography, and soil characteristics.

HVA Demonstration Farms

D. Evaluation Approach

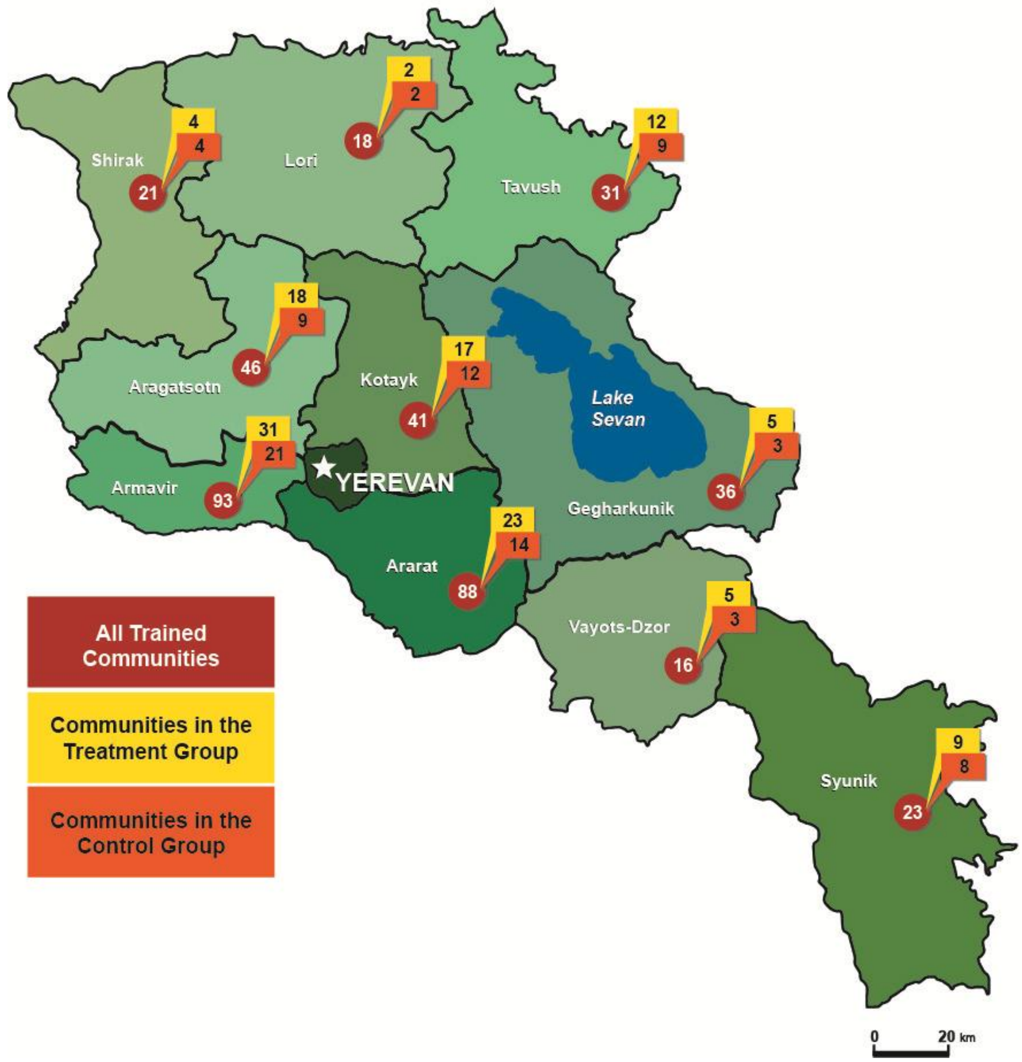
To assess the impacts of WtM training, we used a phase-in random assignment design, whereby communities were randomly assigned into a treatment group and a control group. Farmers in treatment communities were offered training, whereas farmers in control communities were not offered training during the evaluation period. Nearly 300 communities (out of over 400 eventually provided training) that were determined to have adequate access to irrigation water in 2007 were randomly assigned to one of three groups: the treatment group (eligible to receive training starting in Compact Year 2), the control group (eligible to receive training in Compact Year 5), and a nonresearch sample of communities (which could receive training in Compact Years 3 or 4). For transparency, we developed a computer program to conduct the random assignment, and the assignment was run in public.

Our sample for the evaluation includes 189 community clusters covering 211 communities; 112 of these clusters were in the treatment group, and 77 were in the control group. Figure 3 illustrates how the communities in the treatment and control groups are distributed among all trained communities. The impacts of WtM training were estimated by comparing outcomes of the treatment group with outcomes of the control group over time. Since only members of the treatment group had access to WtM credit, the impact estimates encapsulate the effects of access to WtM credit.

The Farming Practices Survey (FPS) was developed for the impact evaluation of the WtM training activity. Fielded by a consortium of AREG, an Armenia-based NGO, and Jen Consult, the FPS is a longitudinal survey of farming households interviewed at three points in time: at baseline in 2007 (before the program was implemented), one year after training began, and three years after training began (the final follow-up in 2010). The evaluation includes 3,547 farming households in the treatment and control communities that were interviewed at baseline and again at final follow-up.

Households were selected for FPS interviews at baseline based on their likelihood of participating in training, as assessed by mayors using criteria provided by the survey team and based on the criteria used to recruit training participants. As a result, the sampled households are not representative of all households in the treatment and control areas. Rather, the sample is designed to represent households that are likely to have participated in training if training were offered in their communities. The FPS asked each household about their cropping patterns, irrigation and agricultural practices, crop yields, agricultural revenues and costs, other household expenditures, household employment, and other sources of household income.

Figure 3. Distribution of Trained Communities and Communities in the Research Sample, by Marz



Sources: Administrative data and 2010–2011 Farming Practices Survey.

According to FPS data, surveyed treatment and control group farmers had similar demographic characteristics and land holdings at baseline. At the time of the follow-up survey, the average respondent was 55 years old and households averaged slightly less than 2 hectares of farm land at baseline. These similarities between treatment and control group farmers provide evidence that randomization produced similar treatment and control groups. In addition, about three-fifths of the treatment group farmers reported having completed training at follow-up, and only about 10 percent of control group farmers reported completing training.[4] These different participation rates suggest that project implementers largely adhered to the randomized phase-in design.

E. Implementation

Communities were selected for training eligibility based on availability of adequate sources of irrigation or the expectation of reliable water after infrastructure rehabilitation. Training was provided in over 400 communities over the life of the Compact. The communities considered for training early in the Compact period were those whose irrigation status was assessed as already favorable when implementation began. According to initial plans, several additional communities without adequate irrigation systems would receive training at a later date, when the irrigation infrastructure activity was expected to be underway, so these communities were included in WtM training with the expectation that they would soon have improved irrigation infrastructure. Due to delays in infrastructure rehabilitation, however, many of these additional communities still did not have reliable irrigation systems by the time training was complete—over half of the treatment communities were served by at least one irrigation project that was rehabilitated later in the Compact.[5] Moreover, some communities that were initially assessed as having adequate irrigation were later found to not have reliable irrigation in actuality.

Within targeted communities, recruiting focused on individuals who were members of WUAs. This focus was based on the idea that the greatest benefits from training would accrue to farmers with access to irrigation water. Training coordinators used posters and additional advertisements at village centers to raise awareness of the training among farmers. Village mayors further assisted coordinators by encouraging participation and identifying WUA members most likely to participate.[6] While the criterion of being a WUA member guided recruitment, it was not a requirement for training. Over the course of implementation, a small portion of individuals were trained who were not active farmers or WUA members.

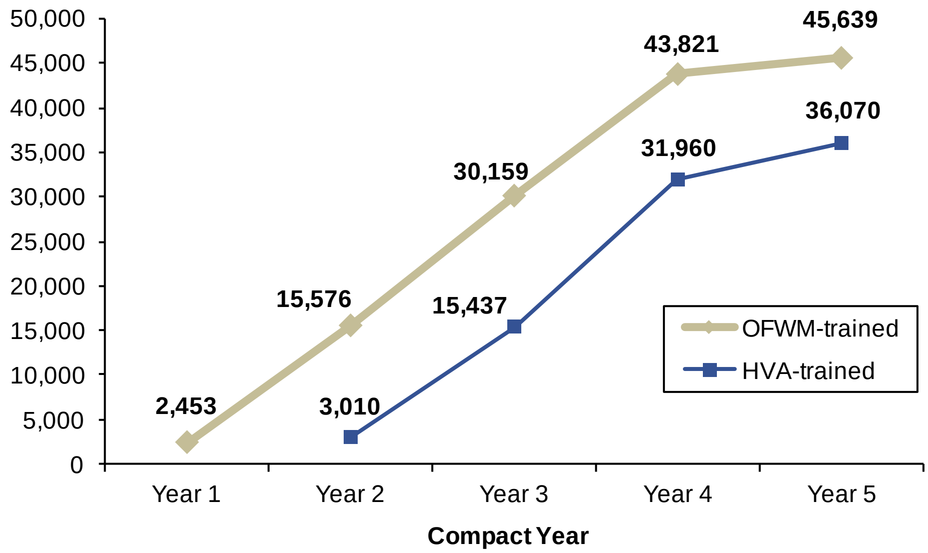
The implementers were successful in meeting program targets. Initial implementation targets were to train 60,000 farmers in OFWM and then train half of these farmers in HVA as well. When the complementarities from offering both trainings became apparent, the OFWM target was lowered to 45,000 to allow the HVA target to be raised to 36,000. By mid-2011, ACDI had surpassed the revised OFWM target by 600 farmers and met the revised HVA target. Figure 4 shows that implementers served a large portion of trained farmers in Years 2, 3, and 4 of the Compact. The implementers' ability to meet very high targets for the number of famers trained in HVA and OFWM techniques is notable. All other WtM components met their program targets as well but served fewer farmers directly. For instance, about 1,100 loans were distributed through WtM credit.

[4] The FPS asked households if they or someone else in their household attended agricultural training (WtM or otherwise). It also asked farmers if they received a certificate for attending training. Certificates were given to farmers who completed WtM training but are not usually given to other training participants. This helped us to distinguish participation in WtM training from other training that may have been offered without relying on respondents to know who provided the training.

[5] Some communities in which irrigation infrastructure was rehabilitated were added to WtM training later in the Compact at the request of the community and approval of MCA, but these communities were provided training too late to be included in the impact evaluation.

[6] Mass media were avoided to limit potential spillovers to control communities.

Figure 4. Cumulative Numbers of Farmers Who Participated in OFWM or HVA Training by the End of Each Compact Year



Source: MCA–Armenia Indicator Tracking Table (2011).

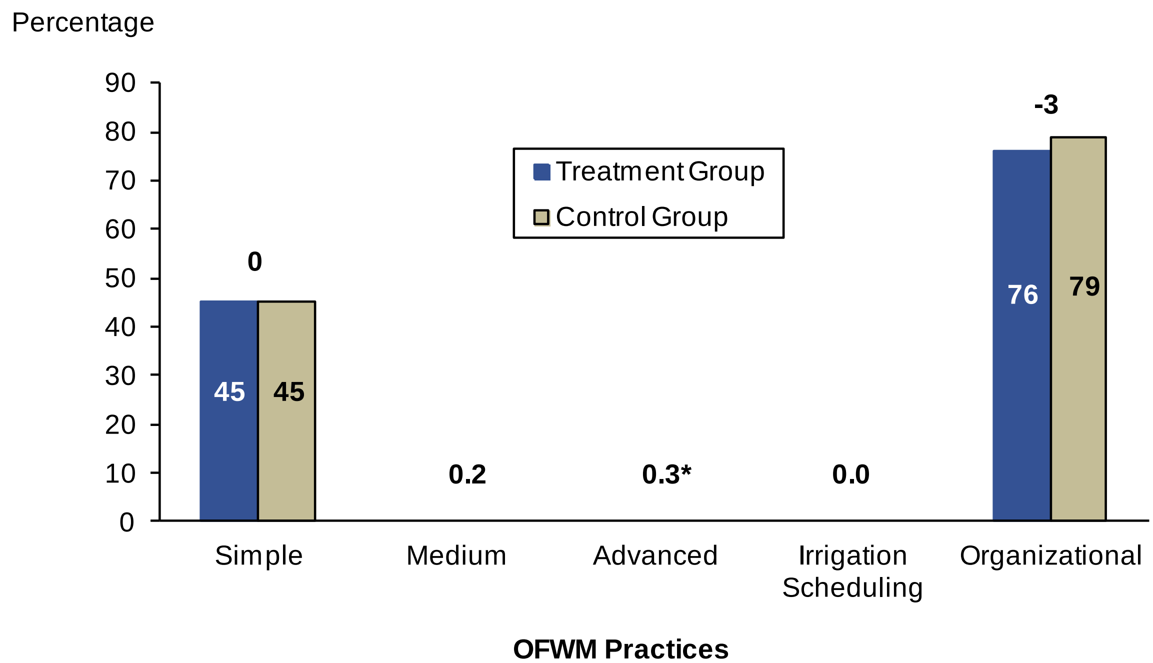
Training participants valued the trainers' knowledge about agriculture, particularly regional agricultural conditions. During in-person interviews, farmers who had been trained recalled key OFWM and HVA concepts and appreciated that trainings were led by regional agricultural experts (Socioscope 2010). These regional experts had a strong understanding of local climatic and soil conditions, which were highly relevant to transitioning to high-value crops. Training was also highly desired in some communities. In these areas, community members organized up to 5 additional trainings because the initial training schedule did not have sufficient slots (MCA-Armenia 2011c).

However, high training targets made it difficult to concentrate resources on farmers who were most likely to benefit from trainings. According to Socioscope, some of the training sessions included participants who were not actively farming, such as the elderly. Furthermore, some field staff and village mayors overemphasized the credit component to potential training participants, believing that insufficient numbers of farmers would attend training without the incentive of credit. As a result, many farmers who were not interested in OFWM and HVA practices attended the sessions, primarily because they believed that doing so would qualify them to receive credit. In this sense, trainers' time and attention was somewhat diverted from teaching those farmers who were interested in the subject matter being taught.

F. Impacts

Farmers generally adopted only simple and organizational OFWM practices, and training did not appear to affect the adoption of these practices. At baseline, few farmers used any OFWM practices, and nearly all farmers' such practices that were reported were simple improvements such as modified furrow spacing (Figure 5). At the time of the follow-up, nearly half the farmers reported using simple practices, but few farmers adopted medium improvements (such as gated pipes) or advanced improvements (such as drip irrigation).[7] As many control group farmers reported using simple OFWM practices as treatment group farmers. Organizational improvements, such as the preparation of irrigated land or having a copy of the farm's WUA water contract, were used by most farmers, but there were no significant impacts on adoption rates. Finally, we saw no evidence that training increased the area of land irrigated.

Figure 5. Impacts of WtM Training on OFWM Practices (percentages)



Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Impact estimate for advanced improvements was statistically significant at the 10-percent level but adoption rates were low. Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. See Appendix A for description of estimation methods.

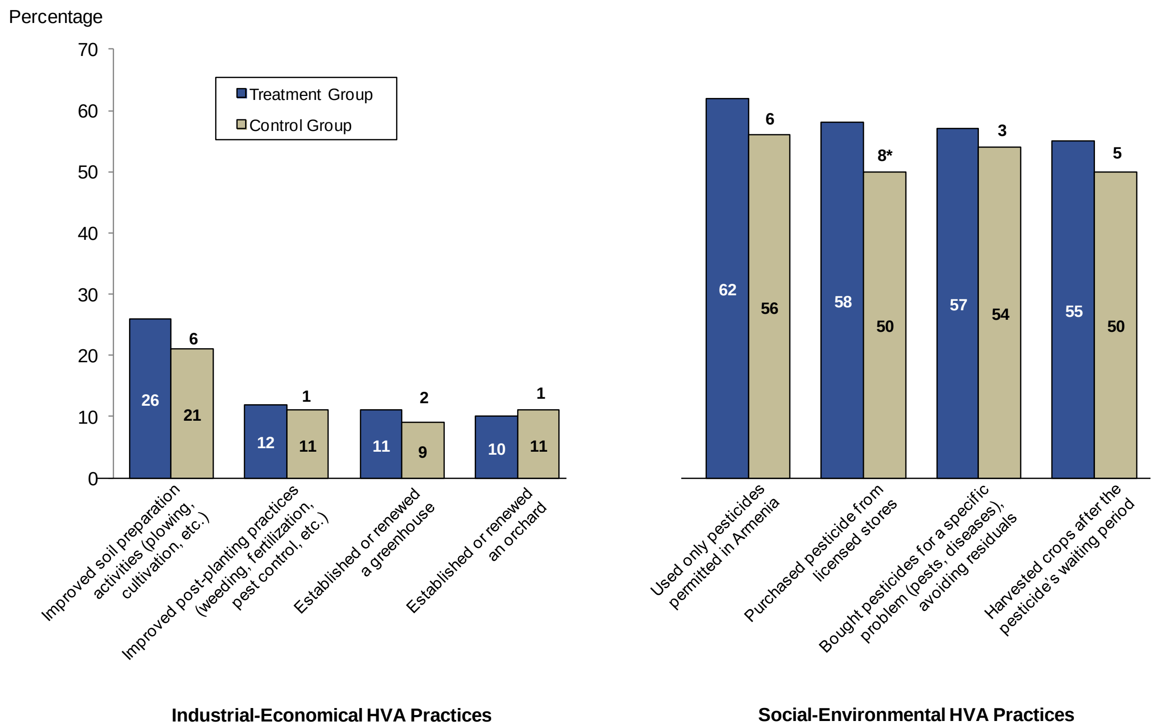
*/**/*** Significantly different from 0 at the .10/.05/.01 levels, respectively, two-tailed test.

There were small, positive impacts on the adoption of HVA practices. A variety of HVA practices were covered in the trainings. These include industrial-economical practices such as fertilization or establishing a greenhouse, which emphasized gains in efficiency or the value of production. HVA practices also included social-environmental practices, which focused on

[7] The increase in use of simple OFWM practices observed for the treatment and control groups appears to have been due to a difference in reporting from baseline and final follow-up rather than a change in the practices used by farmers. The baseline survey asked farmers whether they had used furrow row spacing but the explanation interviewers provided to respondents was vague; as a result, few farmers reported using furrow row spacing. At follow-up, farmers answered a more precisely worded question, whether they had used "modification of furrow sizes (length, width, depth, and inter-furrow area)." Subsequent informal conversations with farmers confirmed that the farmers had not actually changed their behaviors relating to this practice.

environmentally friendly, socially responsible practices that may not translate directly into gains in productivity or profits but could have long-term effects on farmers' health, consumers' health, or the environment. As seen in Figure 6, improved soil preparation was the most widely used industrial-economical HVA practice; it was employed by 26 percent of the treatment group and 21 percent of the control group (*p*-value of 0.11). Among social-environmental practices, farmers in the treatment group were 8 percentage points more likely to report purchasing pesticides from licensed stores, and this impact estimate is statistically significant at the 0.10 level (*p*-value: 0.08). No other statistically significant impacts were observed for the use of either industrial-economical practices or social-environmental HVA practices.

Figure 6. Impacts of WtM Training on Industrial-Economical and Social-Environmental HVA Practices (percentages)



Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

HVA = High-Value Agriculture.

The small but positive impacts on select HVA practices were not accompanied by any statistically significant impacts on the types of crops being cultivated or total production. High proportions (over 90 percent) of treatment and control farmers reported cultivating HVA crops, but there were no statistically significant treatment-control differences in the proportion of farmers cultivating individual crops or crop types (not shown). Similarly, we found no statistically significant impacts on total production, production of HVA crops, production of non-HVA crops, or land area used to cultivate HVA or non-HVA crops (Table 1). When we examined impacts by zone, we found some evidence of impacts on agricultural production in the Mountainous Zone, where production of non-HVA crops and revenues and value from HVA crops increased significantly (not shown). When we examined production of specific types of crops, we found impacts for two major categories of HVA crops (grapes and potatoes), but they are a mix of negative and positive impacts. Given the large number of statistical tests that were conducted and the lack of systematic impacts on agricultural practices, these findings may be due to chance.

The effect of training on crop sales and values was also statistically insignificant. There were no significant impacts on sales of HVA or non-HVA crops as a result of WtM training. The estimated impact of $165 for market value of all crops is not statistically significant. Treatment farmers' non-HVA crops were also valued about $42 more than control farmers' HVA production but was on the margin of statistical significance at the 10 percent level (*p*-value: 0.10).

Table 1. Impacts of WtM Training on Production, Land Cultivated, and Market Value of Harvests

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Agricultural Production (metric tons)				
Total	6.0	5.8	0.2	0.63
HVA crops	3.8	3.8	0.0	0.97
Non-HVA crops	1.9	1.7	0.1	0.39
Land under Cultivation (hectares)				
Total	1.2	1.2	0.0	0.78
HVA crops	0.4	0.4	0.0	0.50
Non-HVA crops	0.7	0.7	0.0	0.57
Market Value of Harvest (USD)				
Total	1,874	1,709	165	0.21
HVA crops	1,487	1,391	96	0.43
Non-HVA crops	323	281	42	0.10
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars. HVA = High-Value Agriculture.

We observed positive differences in agricultural income and profit, but the differences were not statistically significant. We measured agricultural income as the total value of all produced crops, including those that are sold or consumed by the household. Next, we calculated agricultural profit as the difference between the total value of the harvest and all agricultural costs.[8]

[8] Agricultural costs were computed as the simple sum of expenditures during the last agricultural season on fertilizers and pesticides, irrigation, hired labor, equipment, tools, taxes and duties, seeds and seedlings, cellophanes, and any other major agricultural expenses. Amortization of large investments and payments for agricultural credit were not included, but few farmers reported large amounts of other major expenses, so this would not materially affect the estimate.

In addition, we defined economic income as the sum of agricultural profit and nonagricultural income. As seen in Table 2, at final follow-up, households in the treatment group had an average of $166 more agricultural profit (p-value: 0.13) and $206 more economic income (p-value: 0.17) than households in the control group. The differences are almost entirely attributable to the previously reported differences in the average market value of farmers' harvests, with similar significance levels. Our findings of positive but statistically insignificant impacts on economic income were present within three agricultural zones, the exception being Ararat Valley (not shown). In Ararat Valley, a positive and statistically significant impact of $185 on nonagricultural income contributed to a statistically significant impact of $515 on economic income. Finally, we observed no differences between the poverty rates of treatment and control group members overall, although a statistically significant increase in poverty was observed in the Mountainous zone (not shown).

Table 2. Impacts of WtM Training on Annual Household Income (USD)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Nonagricultural Income	2,275	2,276	–2	0.98
Agricultural Income				
Total value of harvest	1,874	1,709	165	0.21
Agricultural profit (value – costs)	1,006	841	166	0.13
Total Economic Income	3,386	3,180	206	0.17
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

In 2009 and 2010, Armenia experienced two events that could influence the estimated impact on household income: adverse agricultural conditions and the global financial crisis. The weather conditions in 2010 caused agricultural production to decrease nationally, and the global financial crisis may have affected the behavior of lenders. If the events equally affected farmers in the treatment and control groups, then the impacts would be the same in the absence of these events. On the other hand, the estimated impacts on household income could have been muted if, for example, farmers who participated in training were unable to obtain loans to invest in new technologies or invested in new technologies that did not reap benefits because of the agricultural conditions. Conversely, estimated impacts could have been larger than normal if trained farmers adopted technologies that allowed them to weather the agricultural conditions better. However, the 2010 agricultural conditions should not have affected farmers' adoption of new technologies, as those decisions would have been made before the year's weather conditions were known.

Because there is little evidence that many farmers adopted new technologies in 2010, it is unlikely that the weather conditions muted the estimated impacts on household income. Survey data were not collected for the 2009 agricultural season, but there was also little evidence of impacts on adoption in data from the 2008 agricultural season (not reported), before the global financial crisis, so it is not likely that the global financial crisis reduced adoption of practices in 2009 or 2010.

G. Conclusions and Lessons Learned

MCC and MCA had envisioned an integrated and complementary set of activities designed to improve agricultural production and reduce rural poverty in Armenia. Water-to-Market (WtM) training provided On-Farm Water Management (OFWM) training to 45,000 farmers and High-Value Agriculture (HVA) training to 36,000 farmers, meeting revised targets for training. The final cost of WtM training was about $14.3 million USD.

We did not find evidence that training substantially improved measures of farmers' well-being such as income, avoidance of poverty, or consumption. We also did not find evidence of impacts on adoption of new OFWM practices that might suggest that longer-term impacts could develop over time. Perhaps such practices were not adopted due to institutional factors such as lack of monetary incentives to conserve water or lack of credit to invest in technologies to increase cultivation of higher-value crops. However, there were some positive impacts of WtM training on HVA practices involving proper pesticide use, which could possibly lead to future improvements in farmers' and consumers' health, although the magnitude of these impacts was small.

Our study suggests some lessons for future programs considering similar WtM activities:

More modest training targets and better selection of training beneficiaries may help ensure that more farmers adopt practices. The findings from the evaluation of WtM training suggest that inducing farmers to change their behaviors is challenging, particularly when there are numerous constraints to adopting new practices. In addition, because the implementer had high targets to meet in a prescribed timeframe, the recruitment of farmers may 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 lead to a higher net total benefit even if the footprint of the program is smaller.

Training could have been better aligned with the needs of beneficiary farmers. The implementers tailored training sessions to match the agricultural conditions and needs of the different zones in Armenia. However, the training sessions in each area provided all farmers who attended training with the same type of information and followed a similar format of classroom and practical instruction. While these trainings included some simple practices, they also included many costly practices (which may 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 the practices of irrigation and cultivation being taught in the training. For example, small-scale farmers who lack investment capital could have received training that focused only on simple and inexpensive OFWM practices. Lessons on demonstration farms could have been structured accordingly. Trainings could also have taken into account whether farmers had access to reliable water or when their irrigation infrastructure was scheduled for rehabilitation. Such an approach could have used farmers' and trainers' time more efficiently and placed emphasis on practices that had a higher probability of being adopted. In other cases, all farmers may have benefitted more from training being better-aligned with the Armenian context. For example, although the OFWM training focused on water conservation, farmers in Armenia pay for water based on the amount of land and crops they intend to irrigate; as a result, there is no private incentive to conserve water.

Programs may consider a more targeted approach to selecting farmers for training as well as credit that would facilitate better linkages between the two components. Levels of

WtM lending were disproportionately low compared to levels of WtM training, and only a very small proportion of trained farmers received WtM credit. This produced dissatisfaction among farmers who participated in training with the expectation of receiving credit and also probably resulted in inefficiencies in that farmers were trained in technologies they could not afford to adopt. Future agricultural assistance programs may consider a more targeted (and perhaps joint) selection of farmers for training as well as credit. For example, if only creditworthy farmers were selected for training in more advanced methods—and credit was provided upon the successful completion of training—farmers' expectations of credit would be more realistic and a greater proportion of trained farmers would have sufficient capital to invest in technologies featured in training. This combination of advanced training and credit could be offered to one segment of the target population, whereas another segment of small-scale (and presumably not creditworthy) farmers could receive training in simple and inexpensive practices.

Synchronizing implementation of training and post-harvest and marketing assistance programs could strengthen both components. PPM could have helped to identify broken links in agricultural value chains or the needs of Armenia's agricultural enterprises and the steps required to meet those needs. This information could have fed into the training program to help farmers change their practices and the crops they cultivate to meet market needs. However, WtM training and PPM were implemented in isolation from one another. A contributing factor to that separation was that WtM training began well before PPM, which was necessary in order to meet the high training targets. Also, the provision of PPM services to farmer groups was not tied to WtM training, nor was the formation of farmer groups who could receive PPM services encouraged as part of WtM training.

I. INTRODUCTION

A. Overview of the Compact and the Water-to-Market Activity

Armenia was left with the legacy of a centrally planned economy when it declared independence from the Soviet Union in 1991. The Armenian economy was highly dependent on its Soviet trading partners and poorly equipped to function with the lack of infrastructure investment and support after Soviet withdrawal. In 1994, the Armenian government adopted a comprehensive stabilization and reform program that dramatically lowered inflation and led to steady economic growth beginning in 1995. Evidence from the Integrated Living Conditions Survey, however, suggests that this growth occurred primarily in urban areas. As of 2004, the poverty rate in rural areas was 32 percent (National Statistical Service, 2010).

As part of the aforementioned reforms in the early 1990s, farm lands were privatized and redistributed as small plots. However, many of the beneficiaries of this redistribution had little expertise in farming or had mainly worked on collective farms and as a result did not have the knowledge they required to effectively manage their own farms. Many farming households cultivate high-value agriculture (HVA) crops such as fruits and vegetables, but they grow them only in small amounts and for household consumption. Grains such as wheat constitute most of the crops produced, but grains have limited commercial viability in Armenia and are not considered HVA crops (Fortson, Player, Blair, and Rangarajan, 2008).

The aim of the Millennium Challenge Corporation's Compact with Armenia ("the Compact"), a five-year agreement signed in March 2006, was to increase household income and reduce poverty in rural Armenia through improved performance of the country's agricultural sector. The Compact, managed by the Millennium Challenge Account with Armenia (MCA-Armenia), was originally designed to include two projects: (1) the Rehabilitation of Rural Roads Project and (2) the Irrigated Agriculture Project.[9] The Irrigated Agriculture Project comprised two complementary activities, the Infrastructure Activity through which irrigation infrastructure would be rehabilitated, and the Water-to-Market Activity (hereafter WtM), which would provide training, technical assistance, and access to credit for farms and agribusiness. WtM was intended to help farmers harness the improvements in irrigation to introduce new technologies and shift to production of high-value agricultural crops, both of which would increase their annual income. By improving living standards among rural residents, these investments were designed to lead to future economic growth in rural areas and throughout the country. Figure I.1 summarizes the overall goal of the Compact and how each activity was designed to help accomplish the overall goal.

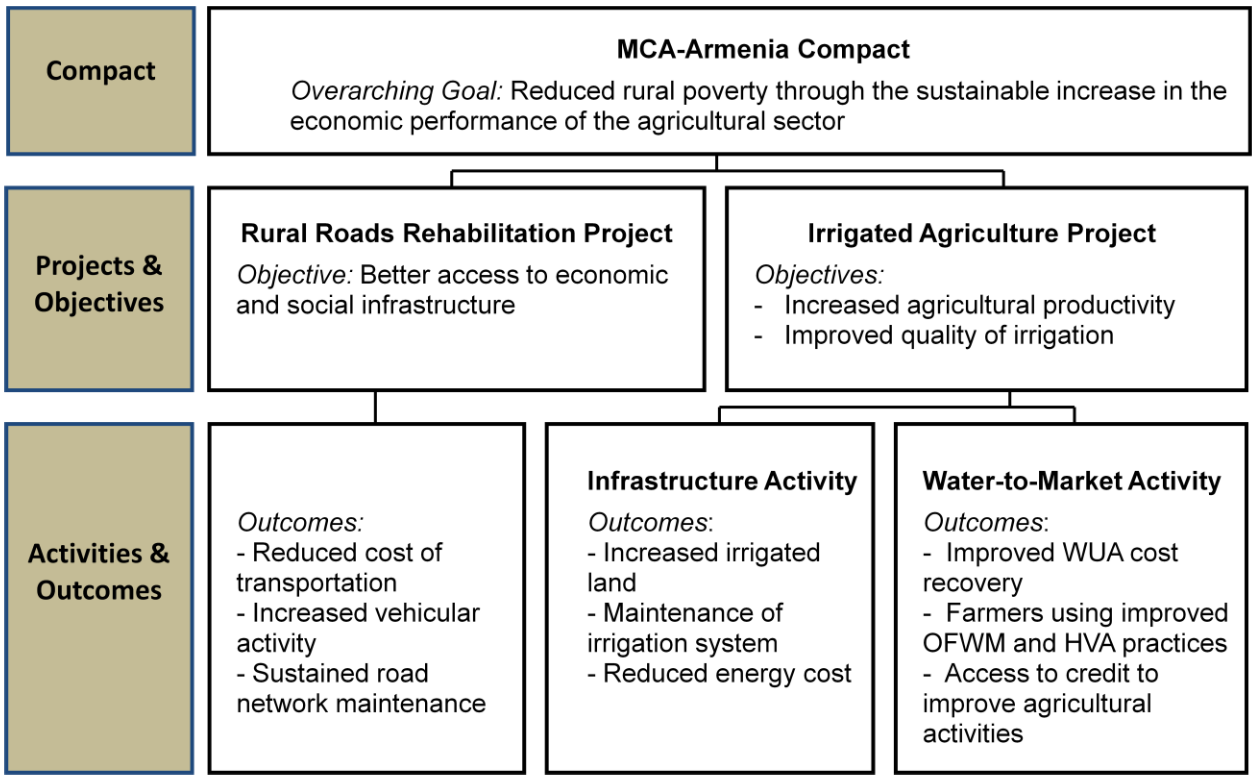
The Millennium Challenge Corporation (MCC) has commissioned rigorous impact evaluations to examine the Rehabilitation of Rural Roads Project, the Infrastructure Activity, and the WtM Activity. The evaluation of WtM comprises evaluations of four components of WtM as described in the next section. This report focuses on the evaluation of the largest component of WtM, which includes training in On-Farm Water Management (OFWM) and High-Value Agriculture (HVA). We

---

[9] At the June 2009 MCC Board meeting, the decision was made not to continue funding any further road construction and rehabilitation under the $236 million Compact due to concerns about democratic governance. Approximately 25 km of pilot roads had been completed prior to this decision. As of July 2012, 150 km of MCC-funded road designs are now being funded by the World Bank.

start with an overview of the WtM Activity and the logic underlying each component of WtM. Evaluations of the other components of the WtM Activity will be presented in a separate report.

Figure I.1. Overview of the Compact with Armenia



The WtM Activity included multiple elements designed to work in concert with each other and with the Infrastructure Activity to improve agricultural profitability and household well-being. The Institutional Strengthening Subactivity (ISSA) provided general technical support to 44 water user associations (WUAs), the regional organizations that manage the distribution of and payment for irrigation water in Armenia. ISSA also provided assistance to three Water Supply Agencies (WSAs) that operate and maintain irrigation dams and pumping stations. The aim was to create more efficient and consistent irrigation supply for WUA members. ISSA also included an irrigation policy reform component, in which a reform strategy was developed through a participatory process with stakeholders.

The Improved Profitability of WUA Member Subactivity included three sub-subactivities more directly affecting farmers who belong to WUAs. The largest of these, and the focus of this report, is the OFWM and HVA Training Sub-subactivity (hereafter "WtM training"), which included two types of training:

- **On-Farm Water Management (OFWM) training** consisted of sessions aimed at helping farmers learn to use new irrigation technologies. As part of this component, demonstration plots were also established to demonstrate the irrigation technologies in practice. According to original plans, a total of 60,000 farmers in 350 communities were scheduled to be trained in water management practices from 2007 to 2010. This was later revised to 45,000 farmers. MCA contracted with ACDI/VOCA and its partners, VISTAA and Euroconsult, (hereafter referred to collectively as ACDI) to implement the training. The goal of this training was for farmers to adopt new and more efficient irrigation techniques, which would lead to increased and more cost-effective agricultural production and higher sales.

- **High-Value Agriculture (HVA) training** consisted of establishing demonstration plots and conducting training sessions for farmers on high-value crop substitution and cropping intensity. A total of 30,000 farmers who also received OFWM training were scheduled to be trained by ACDI in HVA from 2007 to 2011. This was later increased to 36,000 farmers when program implementers concluded that there were benefits and synergies from offering farmers both OFWM and HVA training and consequently agreed with MCA and MCC to revise the targets for both sets of training to better align them. The goal of HVA training was for farmers to adopt new cropping techniques and high-value crops, which would lead to increased and more diverse agricultural production, as well as increased sales.

The Credit Sub-subactivity (hereafter "WtM credit") made $8.5 million in long-term credit available to qualified farmers who participated in WtM training and met other selection criteria. Lastly, under the Post-Harvest, Processing, and Marketing (PPM) Sub-subactivity, implemented by ACDI/VOCA, enterprises and producer groups were to be trained in processing technologies, food safety, quality standards, financial analysis, and developing commercial linkages. The objective of PPM was to improve post-harvest preservation procedures, strengthen processing enterprises, and provide WtM beneficiary farmers with increased opportunities to sell their products.

A high degree of interaction was envisioned between the OFWM and HVA training components, as water management techniques learned in OFWM could be used to cultivate new high-value crops introduced in HVA training. Because new water management and production technologies introduced in OFWM and HVA training—such as drip irrigation systems and greenhouses—required investment capital, training beneficiaries could apply for WtM credit to finance these investments.[10] In addition, many water users who benefited from ISSA could participate in WtM training and were eligible to apply for WtM credit. Thus, the short-term goal of ISSA, more sustainable and efficient irrigation water supply, could feasibly facilitate farmers' transition to new water management techniques, new crops, and new production technologies financed with WtM credit.[11,12] MCA also planned substantial interaction between the PPM and other components, as processing enterprises strengthened by PPM assistance could form stronger linkages with WtM beneficiary farmers and create greater demand for farmers' production. The synergy created by these components, along with improved irrigation infrastructure financed under the Compact's Infrastructure Activity, could lead to increased and more diversified production, increased sales and agricultural profits, and improved household well-being among beneficiary farmers (Figure I.2).

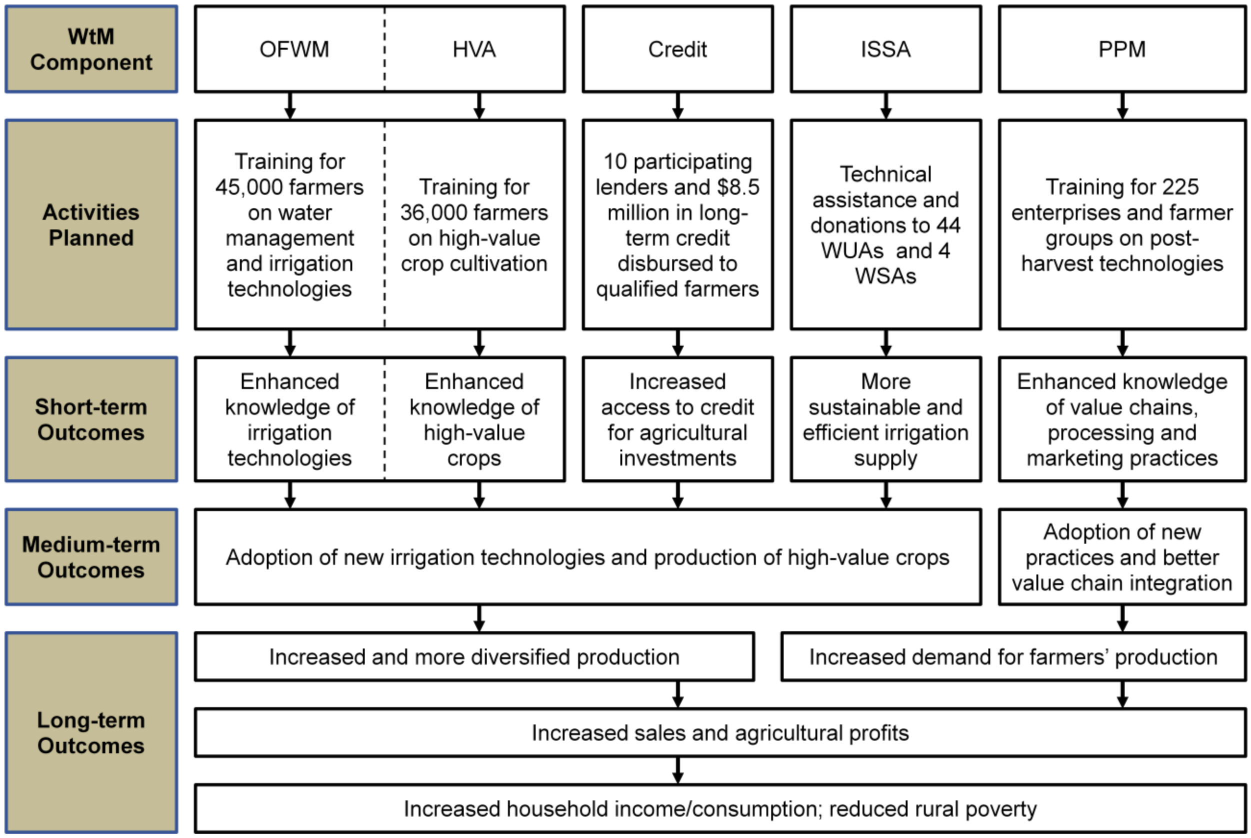
---

[10] Participating in OFWM or HVA training was a prerequisite for WtM credit.

[11] Improved irrigation outcomes under ISSA were also dependent upon the completion of irrigation infrastructure improvements under MCA's Infrastructure Activity. Under the activity, 6 main irrigation canals, 5 gravity systems, 17 pump stations, and tertiary canals in about 100 communities would be repaired or built with investments totaling $120 million.

[12] WtM training featured additional synergies with ISSA, in that training featured modules on farmers' rights and responsibilities as water users and WUA members.

Figure I.2. Logic Model for the WtM Activity



The evaluation of training used a phase-in random assignment design, whereby communities were randomly assigned into a treatment group, whose farmers were offered training, and a control group, whose farmers were not offered training during the evaluation period.[13] The impacts of WtM training were estimated by comparing outcomes of the treatment group with outcomes of the control group based on the 2010 agricultural season, which came three years after the treatment group was first offered training but before the control group farmers were offered similar training. Random assignment is considered the gold standard of evaluation designs because the treatment and control group are expected to be no different, on average, except for the treatment group's receipt of the treatment, which in this case is access to training. Consequently, any differences between the outcomes of the two groups can be credibly attributed to the training program.

The Farming Practices Survey (FPS) was developed specifically for the impact evaluation of WtM training. The FPS is a longitudinal survey of farming households interviewed at three points in time: at baseline (before the program was implemented), one year after training began, and three years after training began. The FPS includes 3,547 households who were interviewed at baseline and again in the final round; these households span 211 communities. The FPS asks each household about their cropping patterns, irrigation and agricultural practices, crop yields, agricultural revenues

[13] To ensure geographic balance of the treatment and control groups, random assignment was stratified by WUA. Some of the smaller, neighboring communities were grouped into clusters of communities and randomly assigned together.

and costs, other household expenditures, household employment, and other sources of household income.

B. Implementation of WtM Training

The objective of WtM training was to educate farmers on techniques intended to improve farm profitability by increasing agricultural production, increasing the value of crops cultivated, and using agricultural inputs more efficiently. Training topics were organized and presented to farmers in two parts: OFWM training and HVA training. Both types of training were targeted to members of WUAs. OFWM training covered region-specific water management practices and technologies to conserve water. HVA training focused on growing new crops or on ways to cultivate higher-value crop varieties by using higher-quality seeds, establishing greenhouses, or other methods. HVA practices can be divided into industrial-economical improvements, which emphasize increases in farmers' own production or profits, and social-environmental improvements, which promote safe and environmentally friendly practices.

The initial implementation targets were to train 60,000 farmers in OFWM and then train half of them in HVA as well. When the complementarities from offering both trainings became apparent (and the devaluation of the dollar relative to the Armenian dram caused a reassessment of program resources), the OFWM target was lowered to 45,000 to allow the HVA target to be raised to 36,000. All training was implemented by ACDI/VOCA and its partners, VISTAA and Euroconsult, which we refer to collectively as ACDI. A typical training session included 20 to 25 farmers from one or more neighboring communities and was led by a local agricultural expert or irrigation engineer. Table I.1 presents a summary of WtM training.

A key theme in implementing training was tailoring sessions to the climatic and agricultural conditions of the region. Each session was led by an agricultural expert from the same region, and the content of the training was customized to each region. Participants were all from the same region, so concerns and experiences were based on a shared context. The training also supplemented three to four days of theoretical lessons in classrooms with practical lessons at a nearby demonstration farm. Each demonstration farm was carefully 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. ACDI also operated tours of the demonstration farms for trained farmers during key months of the agricultural season. A primary factor in designating demonstration farms was whether the farmer was willing to set up and operate a demonstration farm and to promote other farmers' understanding of the demonstrated technologies. In return for farmers' willingness to operate a demonstration farm, ACDI provided the farmer with the needed equipment. Other selection criteria included the site's proximity to other farms in the community, topography, and soil characteristics.

Table I.1. Summary of WtM Training

Objective	Provide training for farmers to transition to more profitable, market-oriented agricultural activities.
Target Population	Farmers in rural areas of Armenia who are members of Water User Associations (WUAs). WUA members were targeted because they are likely to be active farmers with access to irrigation water, but membership was not strictly required to receive training.
Funding	$14.3 million (USD), approximately $310 per participating household
Implementing Parties	ACDI/VOCA in partnership with VISTAA and Euroconsult
Time Frame	2007 to 2011
Activities/Assistance	Each training involved 20-25 farmers from one or more neighboring communities and was led by an agricultural expert from the farmers' region. Training involved • Three or four days of in-class lessons. • Practical lessons on a demonstration farm set up and maintained for OFWM or HVA training. Each demonstration farm served one to five communities. Demonstration farm lessons were typically held after the classroom lessons. • Optional tours of demonstration farms for trained farmers during key months of the agricultural cycle. These tours were intended to help farmers remember practices covered in training. OFWM training emphasized low-cost irrigation for small-scale farming operations. HVA training emphasized cultivation of new, higher-revenue crops and higher-value varieties of common crops, such as organic varieties.
Implementation Targets	
OFWM Training	The initial target was to train 60,000 farmers. The plan was revised to provide OFWM training to fewer farmers (45,000) and provide HVA training to more of these farmers.
HVA Training	The initial target was to train 30,000 farmers. The revised plan provided HVA training to 36,000 farmers. Seventy-eight percent of these farmers also participated in OFWM training.

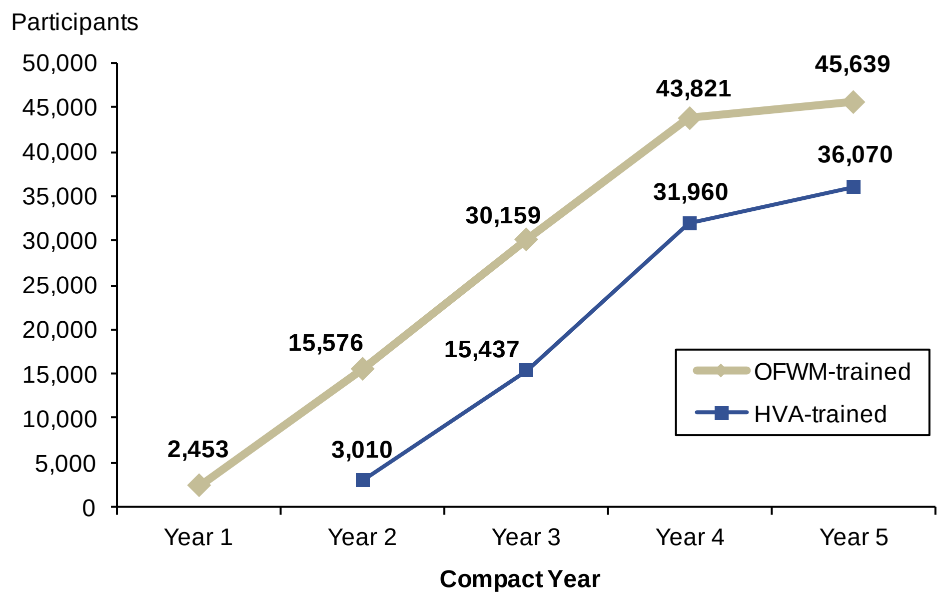
1. Targeted Communities and Farmers

WtM training was provided to communities that were expected to benefit from training. A critical factor in determining whether a community would benefit from training was whether it had adequate, reliable sources of irrigation or would have such a source when its irrigation infrastructure was rehabilitated as part of the Compact. The communities considered for training early in the Compact were those whose irrigation status was assessed as already favorable. Additional communities were considered later in the Compact, by which point the irrigation infrastructure activity was expected to be underway. Due to delays in infrastructure rehabilitation, however, many of the trained communities still did not have reliable irrigation systems after training was complete—over half of the treatment communities were served by at least one irrigation project that was rehabilitated later in the Compact.[14] Training was provided in over 400 communities over the life of the Compact.

Within targeted communities, ACDI focused recruiting efforts on individuals who were members of WUAs. This focus was based on the idea that the greatest benefits from training would accrue to farmers with access to irrigation water. However, these criteria were not requirements for training. Training coordinators from ACDI 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 by ACDI for more intensive recruitment efforts.

ACDI trained a total of 45,639 farmers in OFWM practices and 36,070 farmers in HVA practices (Figure I.3). The exact amount of overlap is not known, but we estimated that about 78 percent of farmers trained in HVA had also participated in OFWM training, and that about 47,800 households participated in at least one training session. (See Appendix D for details.) OFWM training started first and HVA began one year later. In most communities where both were offered, HVA training was offered one year after OFWM training.

Figure I.3. Cumulative Numbers of Farmers Who Participated in OFWM or HVA Training by the End of Each Compact Year



Source: MCA–Armenia Indicator Tracking Table (2011).

[14] Some communities in which irrigation infrastructure was rehabilitated were added to the training subactivity later in the Compact at the request of the community and approval of MCA, but these communities were provided training too late to be included in the impact evaluation.

II. EVALUATION APPROACH AND DATA

A. Research Questions

The evaluation answers the following research questions, informed by the structure and content of OFWM and HVA trainings:

1. What were the characteristics of farmers served by the program?
2. How was WtM training implemented? Did farmers report barriers to adoption of agricultural practices in training?
3. What were the impacts of WtM training on OFWM and HVA agricultural practices?
4. What were the impacts of WtM training on agricultural production of HVA and non-HVA crops? Did these impacts vary across agricultural zones?
5. What were the impacts of WtM training on household income? What were the impacts of WtM training on the poverty rate?

We use the Farming Practices Survey (FPS) to describe farmers in communities that received WtM training and to estimate impacts of WtM training. The FPS was administered at baseline (2007-2008), interim follow-up (2008-2009) and final follow-up (2010-2011). The FPS is a longitudinal survey designed specifically for this impact evaluation, and it was fielded by a consortium of AREG, an Armenia-based NGO, and Jen Consulting (hereafter referred to collectively as AREG). The final (round 3) follow-up survey instrument is included as Appendix C. We based our discussion of implementation findings on the WtM Qualitative Process Analysis Report (QPA) (Socioscope 2010) and the 2011 Compact Completion Report (CCR) (MCA-Armenia forthcoming). MCA-Armenia commissioned the WtM QPA from Socioscope and the Strategic Development Agency, an NGO, (hereafter referred to collectively as "Socioscope") in 2009 as an intermediate implementation evaluation. The CCR reports implementation findings at the end of the Compact, in 2011, to examine whether WtM processes had changed since 2009.

B. Evaluation Design

We executed a phase-in random assignment design to estimate impacts of WtM training. Random assignment was used because, when implemented carefully, it is the most rigorous way to measure a program's impact. This method allows the creation of two groups at baseline that are statistically comparable and differ only in their receipt of the intervention. Consequently, any changes observed in the outcomes of these groups over time can be attributed to the intervention.

The quantitative analyses estimate the effects of training at key points on many outcomes. When examining many estimates, it is likely that some of the estimates will be statistically significant—either positively or negatively—by chance, even if the program had no true effects. For this reason, we consider the pattern of findings rather than only individual estimates when we interpret results to assess whether WtM training was effective so that we can distinguish true program effects (positive or negative) from chance differences. We summarize our primary research questions and the data sources and research design used to answer each of them in Table II.1.

Table II.1. Data Sources and Research Design Used to Answer Primary Research Questions for WtM Training

Primary Research Questions	Data Sources	Research Design
How was WtM training implemented?	WtM Qualitative Process Analysis Report; Compact Completion Report	Mixed methods, with a focus on qualitative data
What were the impacts of WtM training on OFWM and HVA agricultural practices, agricultural production, and household well-being?	2007–2008 and 2010–2011 Farming Practices Surveys	Phase-in random assignment

Our evaluation design began with a set of nearly 300 communities determined to have adequate access to irrigation water in 2007. We randomly assigned these communities to three groups, each of which would receive training in one of three phases: (1) Year 2 of the Compact, (2) Years 3 or 4 of the Compact, or (3) Year 5 of the Compact.[15] Some smaller, neighboring communities were grouped together and randomly assigned together as one cluster. Clusters could include as many as five communities, but most communities were assigned individually.[16]

This phase-in random assignment design was used to estimate the impacts of training by comparing outcomes of communities assigned to receive training in Year 2 of the Compact (hereafter called the treatment group) with outcomes of communities assigned to receive training in Year 5 of the Compact (hereafter called the control group). By measuring outcomes in Year 5, we can compare outcomes for communities that had at least two 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). Communities that were randomly assigned to receive training in Years 3 or 4 of the Compact were excluded from this analysis because the timing of training was not sufficiently different from Year 2 to detect differences from the treatment group's outcomes. For transparency, we developed a computer program to conduct the random assignment, and the assignment was run in public.

The random assignment process ensured regional balance by randomly assigning 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. Stratified random assignment was necessary because farmers across Armenia's agricultural regions face distinct agricultural conditions. For example, Ararat Valley is considered the most fertile region for crops and had the best-maintained irrigation infrastructure before the Compact. The mountainous area of Armenia ("Mountainous Zone"), in contrast, has poorer quality soil and harsher weather, so farmers in this region tend to have larger farm sizes and more livestock than farmers in Ararat Valley. Randomly assigning communities separately within each WUA also ensured that each WUA had some trained communities and no

[15] Our randomization excluded communities that received training during WtM's pilot phase (Year 1 of the Compact) or already had demonstration farms set up by ACDI (Fortson, Player, Blair, and Rangarajan 2008).

[16] Communities instead of individuals were assigned to receive trainings because the training sessions are community-level interventions. Had assignment been based on individuals, it would not have been feasible to bar individuals assigned to the control group from attending training in their communities; in addition, any individuals who received training could possibly share the information with other farmers in the same community. Communities and clusters were generally far enough apart that farmers in the control group would be unlikely to participate in trainings or interact frequently with trained farmers.

WUA would have an unusually bad draw. The probability of being assigned to the treatment group was approximately the same for almost all WUAs. The exceptions were the WUAs in the Mountainous Zone, which had a smaller proportion of communities and clusters selected to be in the research sample, as described in the Baseline Report on the Farming Practices Survey (Fortson, Player, Blair, and Rangarajan 2008).

Our analysis sample included 189 community clusters.[17] One-hundred and twelve of these clusters are in the treatment group, and 77 are in the control group (Table II.2). These 189 community clusters cover 211 communities.[18] Because the Subtropical Zone has only 8 community clusters, we do not present estimates specific to households in that zone in this report, but many estimates are reported separately for the Ararat Valley, Pre-Mountainous, and Mountainous zones. The geographic distribution of communities in our research sample was similar to the geographic distribution of all communities that were trained (Figure II.1). In this discussion of the evaluation design, it was important to distinguish between communities and clusters; beyond this point, we refer to communities and all clusters that contain multiple communities as "communities" to simplify our discussion of the findings.

Table II.2. Distribution of Training in Community Clusters in the Research Sample, by Zone

	All Zones	Ararat Valley	Pre-Mountainous	Mountainous	Subtropical
Year 2: Treatment Clusters	112	42	54	11	5
Year 5: Control Clusters	77	28	36	10	3
Total Clusters for Analysis	189	70	90	21	8
Total Communities for Analysis	211	80	100	22	10

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

C. Sampling Approach

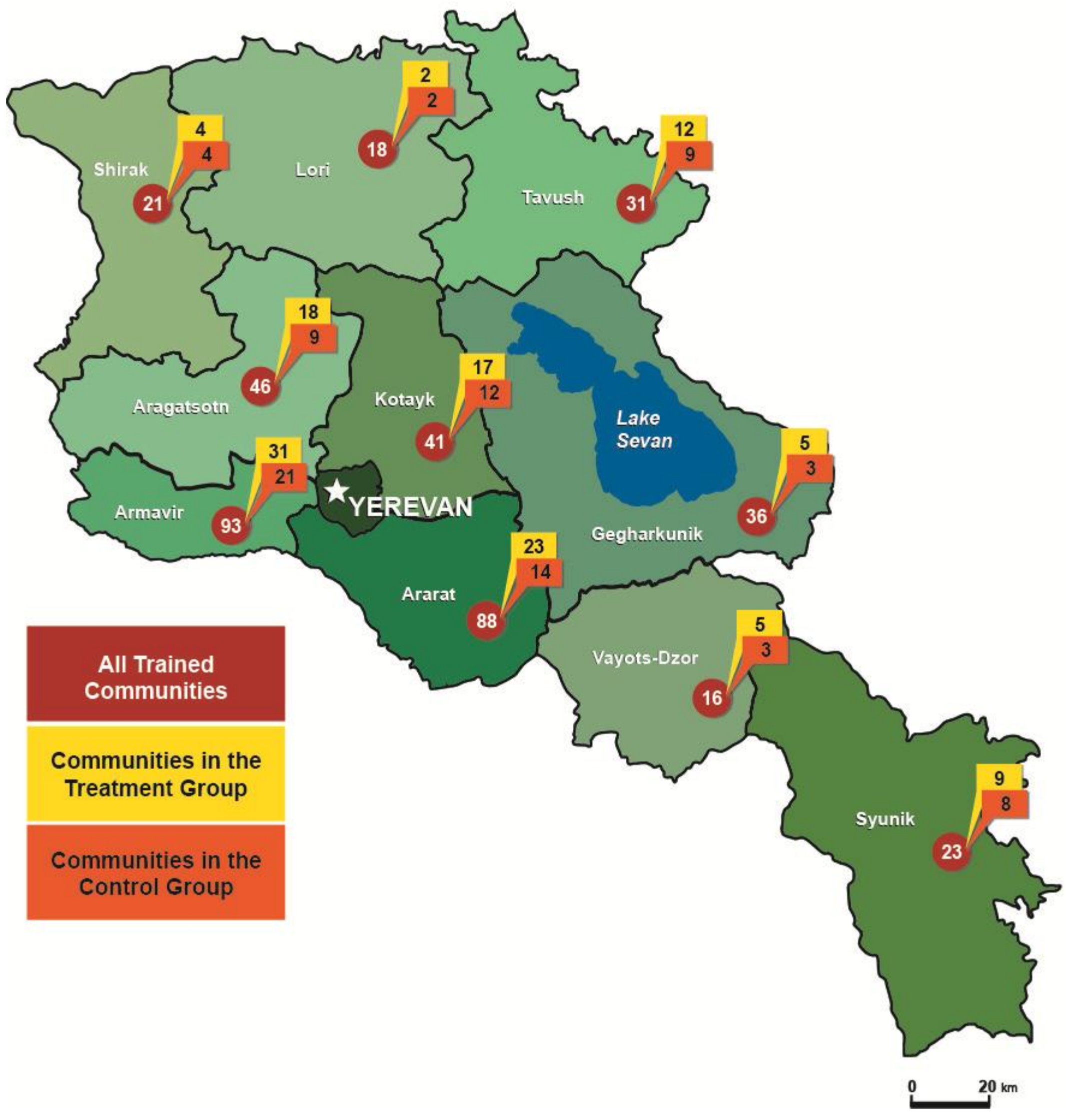
Because the research question was whether training programs affected household well-being, it was important that the survey sample identify farmers who are likely to participate in training. This would maximize the chance that farmers who were interviewed would also participate in training. Although we could readily identify participating farmers in the treatment villages, it was difficult to get such a sample frame in the control villages, where training would not be offered for at least three or more years. Hence, there was a big challenge in identifying a relevant sample frame for the FPS.

[17] Table II.2 excludes a few communities surveyed at baseline that are not in our analysis sample, such as two villages that were found to have almost no active farmers. One village that had been inaccessible for the baseline FPS due to heavy snow was not included in the analysis. Additionally, community leaders in three communities that were the sole treatment or control community in their respective WUAs refused to cooperate with the final follow-up survey. Since that left no valid comparison of the treatment and control groups in these WUAs, our analysis excludes all communities in their WUAs.

[18] Two-hundred and two communities were scheduled to receive training but were not in our research sample. In total, 413 communities were scheduled to receive training.

An alternate approach would have been to select a random set of farmers in each village without regard to their likelihood of participating in training, and then assess the percent of farmers who participated. However, our goal was to assess how effective training was for those who received it, so we wanted to maximize the chances of finding farmers that were likely to participate in training.

Figure II.1. Distribution of Trained Communities and Communities in the Research Sample, by Marz



Sources: Administrative data and 2010-2011 Farming Practices Survey.

Our initial approach to developing the sample frame was to draw names of farmers from lists of members maintained by WUAs. However, early efforts to verify this approach revealed that many of these lists were outdated and could not be used to draw the sample. For instance, in some cases, the WUA member might be a grandmother who is no longer farming, and the actual farmers are various household members of her family that farm on different plots. In other cases, the actual WUA member was no longer in the village and had migrated to urban areas or out of the country. Based on these assessments, an alternate approach was suggested whereby MCA-Armenia requested that the WUAs work with village mayors to compile a list of farmers in each village who met some specific criteria related to actively engaged in farming. The criteria were designed to align with the characteristics of farmers participating in ACDI's training programs, most notably, being actively engaged in farming as assessed by the mayor, having modest farm area, living in the community for several years, and being of working age (between 25 and 70 years old). The number of farmers' names requested depended on the size of the village but averaged about 60.

Pretesting the lists provided by mayors revealed that even these lists were of mixed quality, often because the WUAs had not consulted with the mayors in compiling them. In some cases, the lists included farmers that were no longer in the village, individuals that were no longer farming, and deceased individuals. In such cases, AREG updated the sample frame with the assistance of village mayors and marz officials, either at the marz offices or in the village itself. AREG and mayors targeted the households of farmers who were most likely to benefit from the training programs: those who were actively engaged in farming and had lived in the community for several years.

Final follow-up surveys were completed in 2010 and 2011 by 3,547 households (a 75 percent response rate) from the baseline sample.[19, 20] Our analysis of the FPS data used nonresponse weights to correct for possible survey nonresponse bias and regression adjustment to improve statistical precision and to account for chance differences between the treatment and control groups. Reported means for the treatment and control groups are also regression adjusted. The construction of nonresponse weights, imputation procedures for select variables, and regression specifications are described in Appendix A.

We supplemented our quantitative analysis with findings from the Qualitative Process Analysis (Socioscope 2010), ACDI's Adoption Report (2011), MCA-Armenia's draft Compact Completion Report (forthcoming), and our own observations from field visits and interviews. Socioscope (2010) conducted a qualitative analysis of over 100 focus groups and interviews of farmers and other stakeholders between August and December of 2009. Socioscope also examined the implementation of the training program by observing over 20 trainings, demonstration farms, and collection centers. ACDI (2011) administered a survey to measure adoption rates of OFWM and HVA practices among a sample of trained farmers. The survey also contained questions on why trained farmers did not implement some practices and what practices were planned for the next agricultural season. MCA-Armenia's Compact Completion Report (forthcoming) examined the implementation of the training program in 2010 and 2011 to see if processes had changed since the Socioscope (2010) report.

D. Description of Analysis Sample

Table II.3 shows the demographic and basic farm characteristics of the analysis sample. We would ideally examine characteristics of the primary decision maker in each household, but our approach for identifying the primary decision maker was imperfect. We initially focused on the head of household, as identified by the respondent, but many respondents identified the oldest person in

[19] 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 agricultural season preceding training in these communities, so those farmers would not yet have benefitted from training.

[20] An interim survey round was conducted in 2008-2009. The interim round was originally intended to provide estimates of intermediate impacts, particularly adoption of agricultural practices soon after training was complete. However, training was rolled out such that many of the treatment communities had not been offered training as of the 2008 agricultural season, while others had. Hence, it is neither appropriate for measuring intermediate impacts nor for using as baseline data. However, it is still useful for measuring training participation rates as discussed below.

the household as the head even when that person was too old to likely be the household's primary decision maker.[21] As an alternative way to identify the primary decision maker, we also examined characteristics of the survey respondent. Whenever feasible, survey administrators were instructed to select as the respondent the person with primary responsibility for household farming decisions; however, the lead farmer was not always available. Examining characteristics of both the respondent and the identified head of household—both of whom were often the primary decision maker, but not always—is suggestive of the characteristics of the lead farmers in each household; however, considering the ambiguity of these designations, we do not provide separate estimates of the impacts based on characteristics of the respondent or the household head.

Table II.3. Individual and Household Characteristics (percentages except where indicated)

	Treatment Group Mean	Control Group Mean	Difference	*p*-value
Demographic Characteristics				
Head of Household's Age (years)	55	55	0	0.94
Female-Headed Household	9	8	0	0.72
Head of Household's Education				
Less than secondary	13	13	0	0.80
Full secondary	45	47	-2	0.53
Secondary vocational	27	25	2	0.30
More than secondary	15	16	-1	0.62
Respondent's Age (years)	51	51	0	0.62
Female Respondent	14	14	0	0.98
Respondent's Education				
Less than secondary	11	9	2	0.19
Full secondary	45	47	-2	0.52
Secondary vocational	27	27	1	0.65
More than secondary	17	18	-1	0.50
Total People in Household	5.1	5.1	0.0	0.89
Number of Children in Household	1.2	1.2	0.0	0.39
Total Land Owned or Rented (hectares)	1.8	1.8	0.1	0.79
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Treatment and control group percentages and means were estimated using nonresponse weights. Demographic characteristics are measured in the 2010-2011 FPS. Land holdings are measured in the 2007-2008 FPS. Reported differences may not equal the difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

On average, the treatment and control groups had similar characteristics and land holdings at baseline, which is further support that random assignment was implemented well. This gives us

[21] Because the primary decision maker is unknown, we cannot describe individual characteristics of beneficiaries with certainty. While this is important contextual information, it should not affect our impact estimates because outcomes are defined at the household level. We are able to accurately describe characteristics of the household. The second aspect of this issue relates to gender-specific impact estimates. Because of the aforementioned ambiguities, impacts separated by gender of the respondent or head of household cannot be interpreted meaningfully. As a result, we do not estimate any gender-specific impacts. While it was not possible in this impact evaluation to clearly define the primary decision maker, this issue is a valuable lesson for future MCC projects to consider.

confidence for interpreting WtM training as the cause of differences in outcomes between the treatment and control groups. Overall, few households reported a female head of household (about 9 percent) or had a female respondent (14 percent). Most heads of household and respondents had completed secondary school or higher. The average respondent was 51 years old, and the average head of household was a few years older, as expected. Households had about one and a half hectares of farm land on average, and only a small proportion of land was used for orchards or vineyards.[22]

WtM training was offered in all of the treatment communities in our sample, but not all farmersin these communities chose to attend or complete training. Likewise, WtM training was not offered in control communities until late in the Compact, but some farmers in control group communities could travel to other communities to attend training in prior years.[23] We could only plausibly observe impacts of WtM training if our treatment group was substantially more likely to complete training during the first years when training was offered, before it became available to the control group farmers (Table II.4). Although about 10 percent of control households reported completing WtM training during the first two years of training, nearly three-fifths of treatment group households completed training in those years. These tabulations do not count households that reported completing WtM training at the final follow-up FPS but not previously, as most of these farmers had just been trained.

Table II.4. Respondent Households Who Completed Training During First Two Years of WtM Training, by Zone (percentages)

	All Zones	Ararat Valley	Pre-Mountainous	Mountainous
Treatment	59	58	57	63
Control	10	12	9	10

Sources: 2007-2008 and 2008-2009 Farming Practices Surveys.

Note: Treatment and control group percentages were estimated using nonresponse weights. See Appendix A for description of estimation methods.

The control households who reported completing WtM training could possibly be explained by several factors, all of which likely occurred to some degree. First, some farmers traveled to other locations to attend training. Anecdotal evidence suggests that this occurred some, especially when treatment and control communities were nearby, but it was infrequent. Second, some farmers may have attended other training programs with similar features, including receipt of a certificate confirming completion. Third, and most likely, some farmers may have incorrectly reported that

[22] At baseline, the treatment and control communities were statistically comparable as expected because of the random assignment procedure. In 60 comparisons of the treatment and control communities (Appendix C of Fortson et al. 2008), we found 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. This represents an 8 percent rejection rate, compared to a 10 percent rejection rate that we would expect due to chance.

[23] The FPS asked households if they or someone else in their household attended training. It also asked farmers if they received a certificate for attending training. Certificates were given to farmers who completed WtM training but are not usually given to training participants. This helped us to distinguish participation in WtM training from other training that may have been offered without relying on respondents to know who provided the training.

they attended training and received a certificate. Both treatment and control farmers may have misreported in this way, which would inflate the reported WtM training rates for both groups.

III. IMPACTS ON AGRICULTURAL PRACTICES

The medium-term objectives of WtM training were to increase adoption of HVA and OFWM practices covered in training. These practices were intended to improve water usage and promote production of HVA crops. We used information from Socioscope (2010) and quantitative data to determine whether HVA and OFWM training changed farmers' agricultural practices.

A. Implementation Findings

Socioscope (2010) reported that training participants valued the trainers' knowledge about agriculture, particularly regional agricultural conditions. Farmers who had been trained recalled key OFWM and HVA concepts and appreciated that trainings were led by regional agricultural experts. Training was also highly desired in some communities. In these areas, community members organized up to 5 additional trainings because the initial training did not have space for them (MCA-Armenia 2010).

However, a major finding in Socioscope (2010) was that the high targets for the number of farmers trained were difficult to satisfy while focusing on the intended set of beneficiaries. For example, some training sessions included participants who were not actively farming, such as the elderly. Furthermore, some village mayors and ACDI field staff overemphasized loans available through the WtM credit component for potential training participants, believing that insufficient numbers of farmers would attend training without that incentive. Many farmers in multiple communities attended training believing that it would directly qualify them for MCA credit. These farmers were not otherwise interested in the substance of the training programs.[24]

Even among farmers who were the intended beneficiaries of training, a number of factors deterred them from adopting the methods or techniques presented in the training. Although the OFWM training focused on water conservation, farmers in Armenia pay for water based on the amount of land and crops they intend to irrigate; as a result, there is no private incentive to conserve water. ACDI (2011) found that farmers believed drip irrigation to be the best OFWM technique, and it was a practice that many learned of because of the training, but it is a relatively expensive improvement. The most common reason given by farmers for not using OFWM and HVA practices was financial constraints (Socioscope 2010; ACDI 2011; MCA-Armenia forthcoming). This issue relates both to farmers' trying to get credit through training and the small impacts seen on advanced OFWM techniques.

Another commonly reported reason for not adopting OFWM and HVA practices was a lack of irrigation infrastructure. While training was intended to complement irrigation rehabilitation, rehabilitation projects were not completed in most communities until near the end of the Compact. Moreover, many communities identified as having good irrigation water prior to irrigation rehabilitation were later recognized as in fact having poor irrigation water. As a result, the ability of treatment farmers to implement OFWM and HVA techniques may have been stymied by a lack of reliable access to irrigation water.

[24] In early 2012, MCA-Armenia staff stated that they discouraged the promotion of WtM credit to meet training targets. However, ACDI/VOCA's training targets (and payment structure based on meeting those targets) motivated field staff to use the promise of credit to enroll as many eligible farmers as possible in training programs.

Overall, WtM training faced serious implementation challenges in finding intended beneficiaries and making improvements accessible. The repeated theme in interviews, focus groups, and surveys of farmers was a lack of resources to implement new practices. The remainder of this section examines the quantitative medium-term impacts on OFWM and HVA agricultural practices separately that were estimated from the FPS.

B. On-Farm Water Management Practices

OFWM training covered a variety of practices to use water more effectively, ranging from pre-planting practices such as modifying furrow sizes to growing-season actions such as using monitoring tools like soil moisture meters. Farmers were asked at baseline and follow-up to select all of the OFWM practices they used from a list of training topics. The FPS did not gather information on how well the practices were implemented. Practices covered by the OFWM training were then categorized by MCA-Armenia and ACDI into five groups: simple, medium, advanced, related to irrigation scheduling, and related to organization. At baseline, few farmers used any OFWM practices, and nearly all of the practices used were simple. For example, furrow spacing was the most commonly used irrigation practice at baseline, but it was used by only 7 percent of farmers. No other technique was used by more than 1 percent of farmers at baseline.

The treatment and control groups adopted similar levels of OFWM techniques (Figure III.1; specific improvements shown in Table B.1). Impact estimates are shown above the bars in the figure. Training focused on teaching OFWM techniques, so the lack of impacts indicates that training did not successfully meet the fundamental objective of affecting farmers' practices.

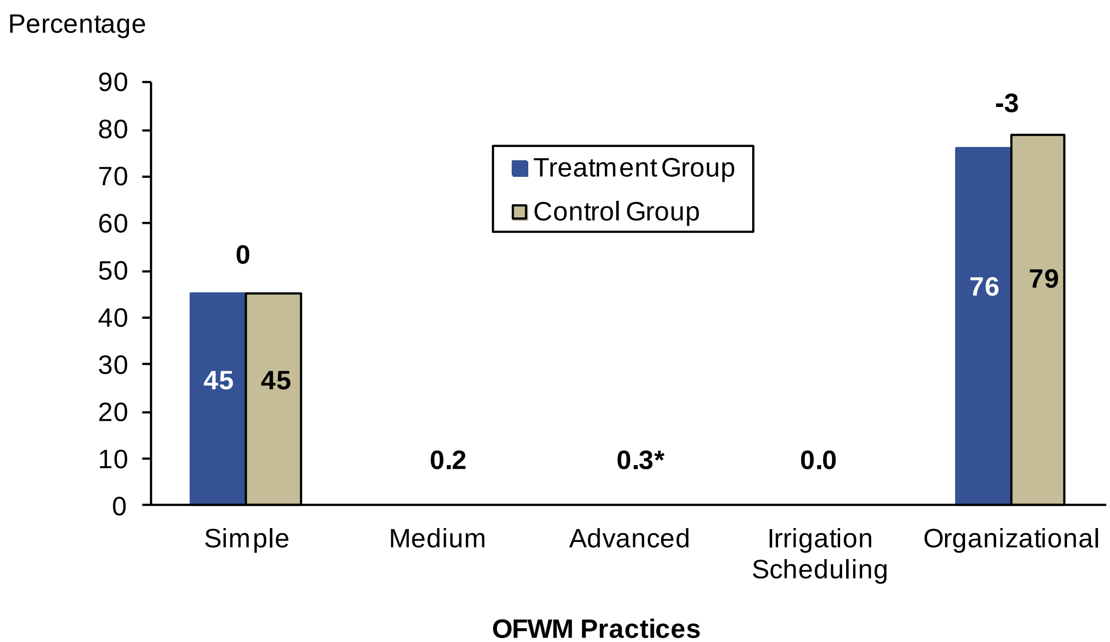
Both the treatment and control groups were much more likely to report using OFWM practices, particularly simple improvements, at follow-up than had been the case at baseline. Simple OFWM practices were used by about 45 percent of the treatment and control group at final follow-up. Furrow size modification accounts for much of this rate (Table B.1); no other simple OFWM practice was used by more than 4 percent of the treatment or control groups. The increase in use of furrow size modifications observed for the control group appears to have been due to a difference in reporting between baseline and final follow-up rather than a change in the practices used by control group farmers. The baseline survey asked farmers whether they had used furrow row spacing but the explanation interviewers provided to respondents was vague; as a result, few farmers reported using furrow row spacing. At follow-up, farmers answered a more precisely worded question, whether they had used "modification of furrow sizes (length, width, depth, and inter-furrow area)." Subsequent informal conversations with farmers confirmed that the farmers had not actually changed any behaviors relating to this practice.

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 was statistically significant (*p*-value: 0.06). However, the adoption rates for these improvements were less than half a percent even among the treatment group.[25]

[25] 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.

There was informal evidence that there may have been 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, there were many farmers who had adopted drip irrigation in greenhouses on their kitchen plots, 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 poised financially to make agricultural investments. Although the estimates we present suggest there was very limited adoption of advanced practices, we take these interviews as evidence that there may have been impacts concentrated in a small number of pilot phase communities.

Figure III.1. Impacts of WtM Training on OFWM Practices (percentages)



Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Organizational improvements, such as the preparation of irrigated land or having a copy of the farm's WUA water contract, were used by most farmers, but there were no significant impacts on adoption rates. We observed that 76 percent of the treatment group and 79 percent of the control group implemented an organizational improvement. Organizational improvements were not tracked in the baseline FPS, so we cannot compare the rates prior to training.

There was also no evidence that training increased the area of land irrigated (Table III.1).[26, 27] Treatment group farmers had slightly less total agricultural land and irrigated land than the control group. Another implication of Table III.1 is that farmers in the FPS sample had access to irrigation for a substantial portion of their land. As a result, access to irrigation water does not seem to have constrained farmers in the FPS sample from adopting OFWM practices.

Table III.1. Impacts of WtM Training on Land Owned or Rented and Irrigated (hectares)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Total Agricultural Land				
All	1.6	1.7	0.0	0.49
Irrigated	0.7	0.8	-0.1	0.15
Arable Land				
All	1.2	1.2	0.0	0.93
Irrigated	0.4	0.4	0.0	0.32
Orchard				
All	0.1	0.1	0.0	0.30
Irrigated	0.1	0.1	0.0	0.29
Vineyard				
All	0.1	0.1	0.0	0.29
Irrigated	0.1	0.1	0.0	0.31
Kitchen Plot				
All	0.2	0.2	0.0	0.61
Irrigated	0.1	0.1	0.0	0.71
Other				
All	0.0	0.0	0.0	0.28
Irrigated	0.0	0.0	0.0	0.68
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. These outcome measures have been censored at the 98th percentile. See Appendix A for description of estimation methods.

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

C. HVA Practices

HVA training covered a wide range of practices intended to increase crop yields, improve soil quality, and increase crop values. The final follow-up FPS presented farmers with an extensive list of

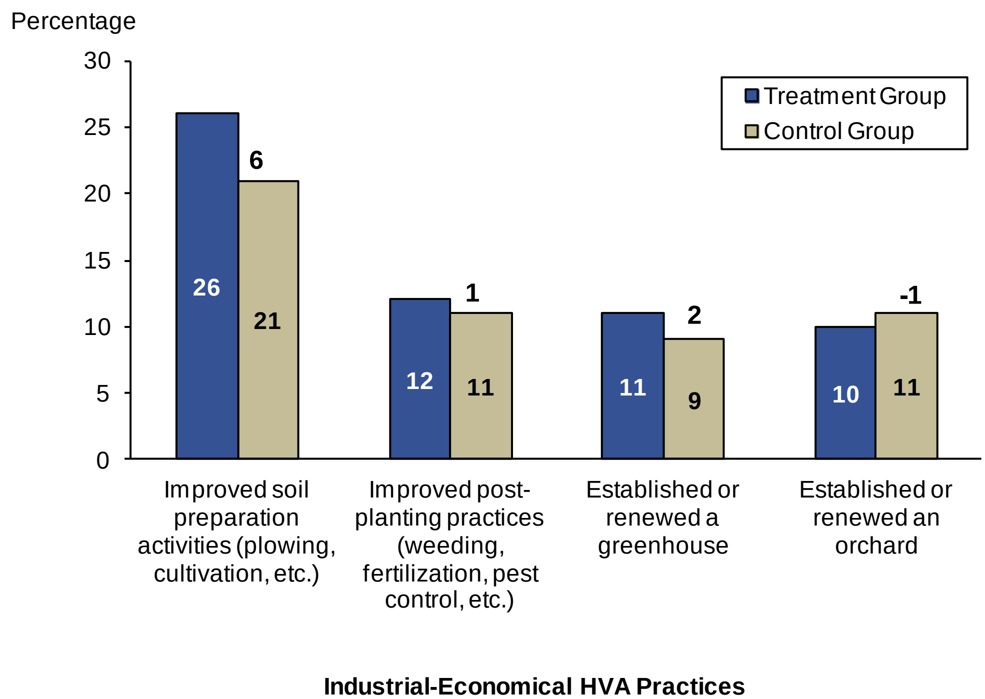
[26] To prevent outliers from unduly affecting the impact estimates and standard errors, we have censored the outcome measures in Table II.6 at the 98th percentile. Results from uncensored measures for this and other censored outcome measures are available in Appendix B in Table B.9.

[27] Standard errors for training impact estimates for key outcomes, as well as the associated minimum detectable impacts, are reported in Appendix B, Table B.13.

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. The most prevalent industrial-economical practices are shown in Figure III.2, with the full list of all these practices shown in the appendix (Table B.2). Impact estimates are presented above the bars in Figure III.2.

Figure III.2. Impacts of WtM Training on Industrial-Economical HVA Practices (percentages)



Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

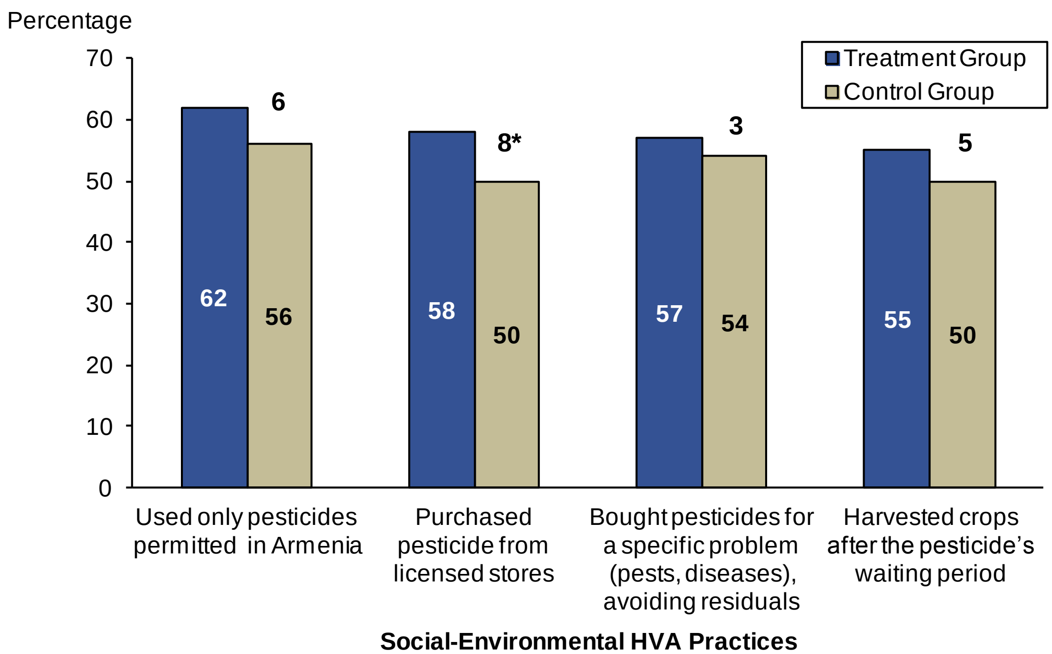
HVA = High-Value Agriculture.

Farmers in the treatment group were 6 percentage points more likely than farmers in the control group to use soil preparation improvements such as plowing and soil cultivation (*p*-value: 0.11). Improved soil preparation activities, which could increase crop yields, were the most widely used industrial-economical HVA practice; they were employed by 26 percent of the treatment group and 21 percent of the control group. Other impacts on industrial-economical practices were neither large nor statistically significant. This finding includes greenhouse farming, which is relatively expensive, even though greenhouse farming was one of the HVA practices from training that was most frequently recalled by trained farmers (Socioscope 2010). 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.

Social-environmental practices focus on environmentally friendly, socially responsible practices that may not translate directly into gains in productivity or profits but could have long-term effects on farmers' health, consumers' health, or the environment. Proper, safe use of pesticides was emphasized in training, and social-environmental practices were among the HVA practices that trained farmers were most likely to remember (Socioscope 2010). Usage rates of social-environmental HVA practices were generally higher than for industrial-economical HVA practices, particularly those relating to pesticides. We show treatment and control means for the most prevalent social-environmental HVA practices in Figure III.3; the list of all social-environmental HVA practices approved for training appears in the appendix (Table B.3).

Farmers in the treatment group were 8 percentage points more likely to report purchasing pesticides from licensed stores, and this impact estimate is statistically significant at the 0.10 level (p-value: 0.08). No other statistically significant impacts were observed for the use of social-environmental HVA practices. Treatment farmers were also 6 percentage points more likely than control group farmers to exclusively use pesticides permitted in Armenia (*p*-value: 0.15).

Figure III.3. Impacts of WtM Training on Social-Environmental HVA Practices (percentages)



Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

HVA = High-Value Agriculture.

The small but positive impacts on select HVA practices were not accompanied by any statistically significant impacts on the types of crops being cultivated (Table III.2). Cultivation of HVA crops was ubiquitous among farmers in the treatment group and control group at final follow-up, with more than 92 percent of treatment and control farmers cultivating at least one HVA crop.

Over half of respondents cultivated non-HVA crops. Similarly, there were no notable differences between the treatment and control groups in the land area devoted to cultivating specific crops (Table B.4).

Table III.2. Impacts of WtM Training on Cultivated Crops (percentages)

	Treatment Group Percentage	Control Group Percentage	Impact	*p*-value
HVA crops	94	93	1	0.50
Grape	28	29	-1	0.75
Other fruits or nuts	67	71	-4	0.16
Tomato	35	38	-4	0.26
Vegetables and herbs	43	45	-2	0.62
Potato	28	28	0	0.92
Non-HVA crops	50	51	-1	0.64
Grain	34	32	3	0.24
Grass	26	29	-3	0.15
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

HVA = High-Value Agriculture.

At the time of the final FPS, the MCA-funded collection centers were not yet operational, but pre-existing collection centers were available. If trained farmers were more likely to use these pre-existing centers, there might be potential for program linkages in future years. However, no such evidence was found. We estimated a statistically significant, negative impacts on the usage of a collection center (-6 percentage points) but no significance difference in the average amount of produce taken to a collection center (Table III.3). We do not believe there was a programmatic reason that the control group would more frequently use collection centers; more likely, the statistically significant negative impact is a spurious relationship due to chance.

Table III.3. Impacts of WtM Training on Use of Collection Centers (percentages)

	Treatment Group Percentage	Control Group Percentage	Impact	*p*-value
Used Collection Center	8	13	-6**	0.04
Percent of Produce Taken to Collection Center	6	10	-4	0.16
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods. Percentages of produce taken to collection centers include farmers who reported zero values.

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

IV. IMPACTS ON AGRICULTURAL PRODUCTION

The WtM training long-term objectives include increased production overall as well as greater emphasis on HVA cultivation, both of which should lead to increased farm profits.[28] Our analysis of the impact of WtM training on production quantities and values are shown in Table IV.1. Impacts on production and revenues of other, specific crops within these categories are examined further in Appendix B (Tables B.5–B.7). All estimates are annual values for the 2010 agricultural season.

Throughout this section and the next, we report estimates for outcome measures that have been censored at the 98th percentile. As discussed in more detail in Appendix A, we found no evidence that high outcome outliers were attributable to the training program, but 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. Our core findings do not materially change when we censor high outliers, but this allows us to report estimates that are more representative of the typical Armenian farmer. We censored each outcome measure individually, so some reported estimates for totals may not equal the sums of their respective components. Results from the uncensored measures are included in Appendix B (Table B.10).

We found no statistically significant impacts on total production, production of HVA crops, or production of non-HVA crops (see the top panel of Table IV.1). Among the subcategories of HVA crops, the only the -0.3 ton impact on grape production and 0.1 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.

Examining individual crops, treatment farmers sold significantly more potatoes (the middle panel of Table IV.1) and earned $32 more in potato revenues than control farmers. The increase in potato revenues was statistically significant at the 0.05 level. This significant increase was offset by a negative and statistically significant impact estimate on revenues from grapes (-$67; p-value: 0.09). The estimated impact on revenues from HVA was $40 annually, but it was not statistically significant. Revenues from non-HVA crops were almost identical for the treatment and control groups.

Agricultural revenue is limited as a measure of production because it does not reflect any crops consumed by the household, which can also be considered income for the farmer. Because many farmers, especially those outside of Ararat Valley, are subsistence farmers who sell little of their harvest, revenues do not reflect the full value of farmers' production. Therefore, we also calculated harvest values that include sales as well as the value of households' own consumption of their production.[29]

---

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

[29] We calculate 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

The impact of training on the total value of farmers' harvests was large but not statistically significant (the bottom panel of Table IV.1). The estimated impact of $165 was approximately a 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 again found a significant negative impact on grapes that is partially offset by a significant positive impact on potatoes. We also observed positive, marginally significant impacts on harvest values of tomatoes ($38; *p*-value: 0.10) and vegetables and herbs ($63; *p*-value: 0.11)

Although the overall estimated impacts were not statistically significant, there may still be positive impacts of training on harvest values that cannot be detected with our sample. However, 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—this large but insignificant impact estimate for total market value is more likely to be due to chance. This impact estimate would be considered more stable if we had observed systematic positive impacts on intermediate measures. We explore this issue in more depth when we discuss similarly large and insignificant impacts on household income.

We present estimates of impacts on crop production, revenues, and harvest values by zone in Table IV.2.[30] Separating these impacts is valuable because the baseline report found pronounced differences in production patterns across zones, and trainings were tailored to the specific agricultural conditions in each zone. At baseline, Ararat Valley had the highest crop sales and harvest values, primarily due to production of fruits, tomatoes, grapes, and vegetables. This zone is also close in proximity to the large markets in Yerevan, so there are greater opportunities to sell HVA crops (Socioscope 2010). In contrast, in the Mountainous Zone at baseline, grains and potatoes contributed most to total harvest values, and a large portion was consumed by households instead of sold.

(continued)

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 with the reported sale amount.

[30] We do not present estimates specific to the Subtropical Zone because there were not enough respondents to generate reliable estimates.

Table IV.1. Impacts of WtM Training on Production, Revenues, and Market Value of Harvests

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Agricultural Production (metric tons)				
Total	6.0	5.8	0.2	0.63
HVA crops	3.8	3.8	0.0	0.97
Grape	0.6	0.9	-0.3**	0.04
Other fruits or nuts	0.5	0.5	0.0	0.83
Tomato	0.5	0.4	0.1	0.20
Vegetables and herbs	0.8	0.7	0.1	0.65
Potato	0.4	0.3	0.1**	0.01
Non-HVA crops	1.9	1.7	0.1	0.39
Grain	0.6	0.5	0.1	0.11
Grass	1.2	1.2	0.0	0.76
Land under Cultivation (hectares)				
Total	1.2	1.2	0.0	0.78
HVA crops	0.4	0.4	0.0	0.50
Non-HVA crops	0.7	0.7	0.0	0.57
Revenues from Crops Sold (USD)				
Total	1,263	1,219	44	0.70
HVA crops	1,164	1,124	40	0.72
Grape	213	280	-67*	0.09
Other fruits or nuts	206	214	-8	0.80
Tomato	150	119	31	0.14
Vegetables and herbs	240	192	48	0.17
Potato	72	40	32**	0.03
Other HVA crops	26	32	-5	0.55
Non-HVA crops	74	65	10	0.40
Grain	32	27	5	0.47
Grass	22	21	1	0.87
Other non-HVA crops	4	1	4	0.24
Market Value of Harvests (USD)				
Total	1,874	1,709	165	0.21
HVA crops	1,487	1,391	96	0.43
Grape	240	320	-80**	0.05
Other fruits or nuts	298	292	5	0.89
Tomato	177	139	38*	0.10
Vegetables and herbs	285	222	63	0.11
Potato	141	95	47***	0.01
Other HVA crops	53	58	-4	0.72
Non-HVA crops	323	281	42	0.10
Grain	180	155	25	0.21
Grass	117	111	6	0.63
Other non-HVA crops	5	1	5	0.19
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars. HVA = High-Value Agriculture.

Total production, total revenues, and total harvest values were not statistically different for treatment and control farmers within the Ararat Valley and Pre-Mountainous zones. However, WtM training statistically significantly increased the average production of treatment farmers in the Mountainous Zone by 1.9 tons, which contributed an average of $253 more in revenues and $641 more value to households. The differences in production and harvest value were shared by HVA and non-HVA crops. The positive findings for total production and value of harvests were statistically significant at the 0.05 and 0.01 levels, respectively, and the impact on revenues in the Mountainous Zone was statistically significant at the 0.10 level.

Though the sample sizes were larger for Ararat Valley than for the Mountainous Zone, only the Mountainous Zone impacts were significant. This phenomenon was because average revenue and harvest value were substantially higher and more variable in Ararat Valley than in the Mountainous Zone, as discussed in the baseline report (Fortson et al. 2008). The Mountainous Zone's impacts were much higher relative to its pretraining averages than were the other zones' impacts.[31]

Table IV.2. Impacts of WtM Training on Production, Revenues, and Market Value of Harvests, by Zone

	All Zones	Ararat Valley	Pre-Mountainous	Mountainous
Agricultural Production (metric tons)				
Total	0.2	-0.1	0.2	1.9**
HVA crops	0.0	0.0	0.0	0.7
Non-HVA crops	0.1	0.0	0.2	0.9**
Land under Cultivation (hectares)				
Total	0.0	-0.1	0.1	0.1
HVA crops	0.0	0.0	0.0	0.0
Non-HVA crops	0.0	0.0	0.1	0.1
Revenues from Crops Sold (USD)				
Total	44	143	-78	253*
HVA crops	40	124	-73	199*
Non-HVA crops	10	26*	5	29
Market Value of Harvests (USD)				
Total	165	248	52	641***
HVA crops	96	172	11	327**
Non-HVA crops	42	27	51	168*

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods. We do not present estimates specific to the Subtropical Zone because there were not enough respondents to generate reliable estimates.

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

USD = United States dollars. HVA = High-Value Agriculture.

[31] There were no significant impacts on OFWM agricultural practices (simple, medium, advanced, irrigation scheduling, or organizational improvements) in the Mountainous Zone. Farmers in the Mountainous Zone were significantly more likely to buy pesticide from licensed stores and to avoid buying pesticides in damaged packaging.

The last component of agricultural income is agricultural expenditures, including expenditures from the last agricultural season on fertilizers, pesticides, irrigation water, hired labor, rented equipment, and taxes. Since WtM taught farmers about new practices, many of which are costly, adoption could have also required farmers' investment in new crops and technologies to increase, with corresponding increases in their expenditures. We found no statistically significant impacts on agricultural expenditures, in total or by type (Table IV.3). Farmers spent the most on hired labor, equipment, and tools; fertilizers and pesticides; seeds and seedlings; and irrigation.

Table IV.3. Impacts of WtM Training on Agricultural Expenditures (USD)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Total	817	811	6	0.88
Irrigation	116	119	−3	0.62
Seeds and seedlings	89	86	3	0.73
Fertilizers and pesticides	216	215	1	0.93
Hired labor, equipment, and tools	262	257	6	0.76
Taxes and duties	49	53	−4	0.18
Cellophanes	37	34	3	0.70
Other major expenses	8	3	5	0.26
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

V. IMPACTS ON INCOME AND POVERTY

The long-term goal of WtM training was to increase household income. Our analysis of farmer well-being examines both household income and poverty rates for the treatment and control groups. Poverty is a different measure of well-being than income because poverty is based on the value of goods consumed by the household. Consumption-based measures have the advantage of being less susceptible to annual fluctuations than income, making them a more stable measure of well-being.

A. Household Income

The FPS 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.

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 income used the total value of all produced crops. The total value of crops included those that are sold, bartered, or consumed by the household, as described previously.[32] Agricultural profit was then calculated as the difference between total value of the harvest minus agricultural costs, and economic income was defined as the sum of agricultural profit and nonagricultural income. Each of the outcomes examined in this section have been censored individually at the 98th percentiles. Uncensored results are available in Appendix B.

At final follow-up, households in the treatment group had an average of $166 more in agricultural profit (p-value: 0.13) and $206 more in economic income (*p*-value: 0.17) than households in the control group. This represents a 20 percent increase in economic profit and a 6 percent increase in economic income relative to the control group (Table V.1). The differences are almost entirely attributable to the previously reported differences in the average market value of farmers' harvests, with similar significance levels.

Our finding of positive but statistically insignificant impacts on economic income was generally mirrored within zones (Table V.2), though splitting them into subgroups causes the estimates to be less precise and be more likely to yield chance differences. Only the Mountainous Zone had statistically significant impacts on agricultural profit ($535), though not on economic income. Ararat Valley had smaller estimated impacts on agricultural income but a marginally significant impact on nonagricultural income, and a statistically significant estimated impact on household income of $515.

---

[32] As a check, Appendix Table B.8 shows the impacts on monetary agricultural income, which is based on the value of crops sold and excludes the value of crops consumed in the household. We do not find statistically significant impacts on monetary income from agriculture.

Table V.1. Impacts of WtM Training on Annual Economic Household Income (USD)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Nonagricultural Income	2,275	2,276	–2	0.98
Agricultural Income				
Total value of harvest	1,874	1,709	165	0.21
Agricultural profit (value – costs)	1,006	841	166	0.13
Total Economic Income	3,386	3,180	206	0.17
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

Table V.2. Impacts of WtM Training on Annual Economic Household Income, by Zone (USD)

	All Zones	Ararat Valley	Pre-Mountainous	Mountainous
Nonagricultural Income	–2	185*	–64	–293
Agricultural Income				
Total value of harvest	165	248	52	641***
Economic profit (value – costs)	166	298	–2	535***
Total Economic Income	206	515*	–5	192

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods. We do not present estimates specific to the Subtropical Zone because there were not enough respondents to generate reliable estimates.

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

USD = United States dollars.

We conducted a series of specification checks to further explore the (potentially) economically meaningful but statistically insignificant overall impact on household income. The purpose of these explorations was to assess whether sampling variability was obscuring legitimate positive impacts of training. We examined how variation in economic income affected our overall impact estimate on economic income. Using the same regression model, we estimated the impact without censoring households' economic income at the 98th percentile (Table B.12). Simply including a small number of extreme values of economic incomes in the analysis increased our overall impact for economic income to $457. The estimate based on censoring economic income at the 98th percentile is less sensitive to further censoring. For example, if we censor all incomes higher than the 95th percentile, the impact decreases to $166. None of the estimates using censored incomes are statistically different from 0. Similar findings resulted when we used a median regression model or examined the overall impact estimate on a household's percentile of economic income, both of which are less sensitive to outlier values. All of these alternative models indicated that a small number of farmers with the highest incomes drove the large impact estimate over all zones when outcomes were not censored.

Although we attempted to identify and recode entries that were erroneous (Appendix A), it remains possible that some of the outliers among the highest earning farmers may be due to inaccurate reports or data entry errors. Another possibility is that these were legitimate values that happen to be somewhat higher on average for the treatment group than the control group, unrelated to the program. A third possibility is that training truly benefitted a small proportion of the sample in substantial ways. We explored this latter hypothesis by examining the characteristics and adoption rates of farmers with economic income in the top one percent. The proportions of this group in the treatment and control group mirrored the overall sample. Additionally, none of the top one percent and only one farmer in the top two percent adopted any of the medium or advanced improvements that might have plausibly caused substantial impacts on production. Further, their other adoption rates were not appreciably different than rates of other farmers. This exploratory analysis was not conclusive, but it does suggest that the outliers are unlikely to be a small subset of farmers who benefitted strongly from training.

In 2009 and 2010, Armenia experienced two events that could influence the estimated impact on household income: adverse agricultural conditions and the global financial crisis. The weather conditions in 2010 caused agricultural production to decrease nationally, and the global financial crisis may have affected the behavior of participating WtM lenders. If the events equally affected farmers in the treatment and control groups, then the impacts would be the same in the absence of these events. On the other hand, the estimated impacts on household income could have been muted if, for example, farmers who participated in training invested in new technologies that did not reap benefits because of agricultural conditions or were unable to obtain loans to invest in new technologies. Conversely, estimated impacts could have been larger than normal if trained farmers adopted technologies that allowed them to better weather the adverse agricultural conditions. However, 2010 agricultural conditions should not have affected farmers' adoption of new technologies, as those decisions would have been made before the year's weather conditions would have been known. Because there is little evidence that farmers adopted new technologies in 2010, it is unlikely that the weather conditions muted the estimated impacts on household income. Survey data were not collected for the 2009 agricultural season, but there was also little evidence of impacts on adoption in data from the 2008 agricultural season (not reported), before the global financial crisis, so it is not likely that the global financial crisis adversely affected adoption of practices in 2009 or 2010.

B. Poverty Rates

Our approach to poverty measurement was based on the calculations used for the Integrated Living Conditions Survey (ILCS), an annual household survey conducted by Armenia's National Statistical Service (NSS). We first sum the value of all consumption by the household, including food, health care, other nondurable goods, and durable goods. This sum was adjusted based on the number of adults and children in the household to determine consumption per person. Then, our estimate of total consumption per person was compared to three distinct poverty lines calculated for 2010 by NSS in collaboration with the World Bank: the "food poverty line," the "lower general poverty line," and the "upper general poverty line" (NSS 2010). The food poverty line represents the cost to consume the average caloric requirement for a person in Armenia.[33] The lower and upper general poverty lines add the values of some nonfood consumption to the food poverty line.[34] The food poverty line is the lowest of the poverty lines, and the upper general poverty line is the highest of the poverty lines, so poverty rates calculated with the food poverty line will be lower than those rates calculated with the upper general poverty line.[35]

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 expensive and was not feasible in the FPS. Instead, each round of the FPS 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 FPS added questions on consumption of education and other annual costs, which were also 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 expenditures. Finally, we applied an adjustment factor to account for durable goods.[36]

There were no significant impacts on the poverty rates associated with the three poverty lines (Table V.3). The overall poverty rates in our sample using the lower and upper poverty lines were 15 and 28 percent, respectively.

---

[33] The average caloric requirement for an Armenian is 2,232 calories per day, as calculated in 2004 by NSS 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.

[34] The lower and upper general poverty lines replace the complete poverty line discussed in Fortson et al. (2008) and used before 2009. The complete poverty line also added a minimum value of nonfood consumption to the food poverty line. ILCS calculated the complete poverty line until 2009, when it instituted a series of methodological changes. It improved the accuracy of its calculations by taking into account a greater variety of food items and the exact number of days each household member in its survey was present in the household. We cannot directly compare our calculations with the poverty rates in the baseline report because ILCS also assumes now that a household consumes a durable good uniformly over its life expectancy and applies the same price deflator to the costs of food and nonfood goods. Previously, ILCS took into account the reported ages of durable goods and used separate price deflators for food and nonfood goods (NSS 2010).

[35] 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 (NSS 2010).

[36] The adjustment factor is 9.4 percent and is the same factor used in Fortson et al. (2008). It is based on the proportion of total consumption due to durable goods in the 2004 ILCS survey.

Table V.3. Impacts of WtM Training on Poverty Rates (percentages)

	Treatment Group Percentage	Control Group Percentage	Impact	*p*-value
Households Below Food Poverty Line	5	6	0	0.75
Households Below Lower Poverty Line	16	15	0	0.88
Households Below Upper Poverty Line	28	28	0	0.99
Sample Size	**2,133**	**1,413**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Examining specific zones, we found one statistically significant impact on the lower poverty rate in the Mountainous Zone, which increased by 6 percentage points (Table V.4). This significant impact is not part of a pattern of significant negative findings for the Mountainous zone and may be due to chance; we estimated a positive and statistically significant impact on revenues and harvest values in the Mountainous Zone (Table IV.2). Only treatment farmers in Ararat Valley were estimated to have lower rates of poverty than the control group consistently across the different poverty lines, but the differences were not statistically significant.

Table V.4. Impacts of WtM Training on Poverty Rates, by Zone (percentages)

	All Zones	Ararat Valley	Pre-Mountainous	Mountainous
Households in Food Poverty	0	−1	−1	1
Households Below Lower Poverty Line	0	−3	0	6*
Households Below Upper Poverty Line	0	−4	2	4

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods. We do not present estimates specific to the Subtropical Zone because there were not enough respondents to generate reliable estimates.

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

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 V.5). For example, the average household in the treatment group had consumption equivalent to 254 percent of the food poverty line. The estimated impacts on consumption were negative but not statistically significant.

Table V.5. Impacts of WtM Training on Consumption Relative to Poverty Lines (means)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Consumption Relative to Food Poverty Line	254	258	−4	0.52
Consumption Relative to Lower Poverty Line	176	179	−3	0.52
Consumption Relative to Upper Poverty Line	144	146	−2	0.52
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

To further explore the possibility of distributional effects, we grouped households based on their consumption at baseline relative to the complete poverty line (CPL) measure in use at that time and calculated the impact of WtM training on each group's consumption at final follow-up. Each grouping contained over 200 households except for the group that consumed over 4 times the complete poverty line, which had slightly fewer than 150 households. For simplicity, we only report findings for consumption relative to the lower poverty line at follow-up. There was no impact on consumption for any grouping of households (Table V.6).

Table V.6. Impacts of WtM Training on Consumption Relative to the Lower Poverty Line, by Baseline Consumption Level (means)

Baseline Consumption Level	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Below CPL at Baseline	298	312	−13	0.21
1–2 Times CPL at Baseline	258	260	−2	0.78
2–3 Times CPL at Baseline	265	264	1	0.92
3–4 Times CPL at Baseline	212	228	−16	0.24
4 or More Times CPL at Baseline	292	284	9	0.63
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

CPL = Complete Poverty Line.

Household consumption and income are related measures of household well-being. Income is the outcome of greatest interest to MCC, but income is a highly variable outcome that is measured somewhat imprecisely. Consumption is measured much more precisely, and that the consumption estimates suggest no impact of WtM training bolsters the interpretation that it is unlikely that WtM training affected household income.

VI. CONCLUSIONS AND LESSONS LEARNED

Summary of Findings

MCC and MCA had envisioned an integrated and complementary set of activities designed to improve agricultural production and reduce rural poverty in Armenia. Water-to-Market (WtM) training provided On-Farm Water Management (OFWM) training to 45,000 farmers and High-Value Agriculture (HVA) training to 36,000 farmers, meeting revised targets for training. The final cost of WtM training was about $14.3 million USD. The initial targets were 60,000 farmers for OFWM training and 30,000 farmers for HVA training. These targets were revised to better reflect the complementarities of the training topics, and also because of budget considerations after the Armenian dram was devalued. However, training was sometimes given to people who were unlikely to benefit, such as the elderly. Many farmers attended training because they believed that training would lead to receipt of MCA credit.

There was little evidence that WtM training increased adoption of key agricultural practices, with only a handful of exceptions. Financial limitations were the most common reason given for not implementing OFWM and HVA practices. Another common barrier was a lack of irrigation infrastructure. Training was intended to complement irrigation rehabilitation, but rehabilitation projects were not completed in most communities until near the end of the Compact period. Institutional factors may have also inhibited adoption of OFWM practices, including the lack of monetary incentives to conserve water and limited access to credit. Farmers were unable or unwilling to invest in cultivating higher-value crops.

We did not find evidence that training substantially improved long-term measures of farmers' well-being such as income, poverty, or consumption. That we did not find evidence of impacts on adoption of new OFWM practices or HVA practices also suggests that it is unlikely that longer-term impacts could yet develop for the full beneficiary population. However, we note that impacts were measured after a difficult agricultural year, with ambiguous implications for impacts in a typical year.

Lessons Learned

The findings from the evaluation of WtM training suggest that inducing farmers to change their behaviors is challenging, particularly when there are numerous constraints to adopting new practices. Our study suggests some lessons for future programs considering similar training activities:

More modest training targets and better selection of training beneficiaries may help ensure that more farmers adopt practices. Because the implementer had extremely large targets to meet in a prescribed timeframe, the recruitment of farmers may 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 lead to a higher net total benefit even if the footprint of the program is smaller.

Different types of beneficiary farmers may benefit from different types of training. The implementers tailored training sessions to match the agricultural conditions and needs of the different zones in Armenia. However, the training sessions in each area provided all farmers who attended training with the same type of information. While these trainings included some simple practices, they also included many costly practices (which perhaps may 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.

> **Lessons for Training Programs**
>
> Inducing farmers to change their behaviors is challenging, particularly when there are other unresolved constraints preventing them from adopting new practices. Future training programs could possibly serve farmers better by conducting more intensive trainings for smaller numbers, in which case more time could have been spent following up with farmers to resolve adoption constraints.

An alternate training strategy would be to tailor the content of training more directly to farmers' ability to invest in the practices of irrigation and cultivation being taught in the training. For example, small-scale farmers who lack investment capital could have received training that focused only on simple and inexpensive OFWM practices. Conditions of the local irrigation infrastructure could also have been taken into consideration in the training material. Such an approach could have used farmers' and trainers' time more efficiently and placed emphasis on practices that had a higher probability of being adopted.

Linking Program Components

The findings from the evaluation of WtM training also highlighted ways that WtM components could have interacted more efficiently to improve farmer outcomes. Our study suggests some lessons for future programs considering similar activities:

> **Strengthening Program Links**
>
> Agricultural assistance programs that include multiple subactivities can become more effective if the implementation of subactivities bolster each other's aims. Future assistance programs could target farmers to receive tailored combinations of program services. Such complementarities were planned for WtM but implementation of separate subactivities was not always synchronized to realize those complementarities.

A more targeted approach to selecting farmers for training as well as credit could facilitate better linkages between the two components. Levels of WtM lending were disproportionately low compared to levels of WtM training, and only a very small proportion of trained farmers received WtM credit. This produced dissatisfaction among farmers who participated in training with the expectation of receiving credit and also probably resulted in inefficiencies in that farmers were trained in technologies they could not afford to adopt.

Future agricultural assistance programs may consider a more targeted (and perhaps joint) selection of farmers for training as well as credit. For example, if only creditworthy farmers were selected for training in more advanced methods—and credit was provided upon the successful completion of training—farmers' expectations of credit would be more realistic and a greater proportion of trained farmers would have sufficient capital to invest in technologies featured in training. This combination of advanced training and credit could be offered to one segment of the target population, whereas another segment of small-scale (and presumably less creditworthy) farmers could receive training in simple and inexpensive practices or support in becoming more creditworthy.

Synchronizing implementation of training and post-harvest and marketing assistance programs could strengthen both components. PPM could have helped to identify broken links in agricultural value chains or the needs of Armenia's agricultural enterprises and the steps required to meet those needs. This information could have fed into the training program to help farmers change their practices and the crops they cultivate to meet market needs. However, WtM training and PPM were implemented in isolation from one another. A contributing factor to that separation was that training began well before PPM, which was necessary in order to meet the high training targets. Also, the provision of PPM services to farmer groups was not tied to the training subactivity, nor was the formation of farmer groups who could receive PPM services encouraged as part of WtM training.

REFERENCES

ACDI. *Water to Market Activity: Report of Sociological Survey on Adoption Rates of Improvements Presented in WtM Trainings.* Yerevan, Armenia: ACDI/VOCA, 2011.

Food and Agriculture Organization (FAO) of the United Nations. *Food Security and Agriculture Highlights: Armenia, January-March 2011*. http://www.fao.org/docrep/014/am603e/am603e00.pdf

Fortson, K., D. Player, R. Blair, and A. Rangarajan. *Baseline Report on the Farming Practices Survey.* Princeton, NJ: Mathematica Policy Research, Inc., 2008.

Gulati, A, N. Minot, C. Delgado, and S. Bora. *Growth in High-Value Agriculture in Asia and the Emergence of Vertical Links with Farmers.* Washington, DC: The World Bank, December 2005.

International Fund for Agricultural Development. Project Completion Report Validation, Rural Areas Economic Development Programme, Republic of Armenia, October 2011. http://www.ifad.org/evaluation/public_html/eksyst/doc/validation/2011/armenia.pdf

MCA-Armenia. *Closure Report on Legislative Changes in the Irrigation Sector, Institutional Strengthening of Irrigation Management Entities Sub-activity (ISSA)*, Yerevan, Armenia: Millennium Challenge Account-Armenia, 2011a.

MCA-Armenia. *Indicator Tracking Table (ITT).* Yerevan, Armenia: Millennium Challenge Account-Armenia, 2011b.

MCA-Armenia. *The Program is Over: All About Results.* Yerevan, Armenia: Millennium Challenge Account-Armenia, 2011c.

MCA-Armenia. *Compact Completion Report.* Yerevan, Armenia: Millennium Challenge Account-Armenia, forthcoming

McConnell, S., E. Stuart, K. Fortson, P. Decker, I. Perez-Johnson, B. Harris, and J. Salzman. *Managing Customers' Training Choices: Findings from the Individual Training Account Experiment.* Washington, DC: Mathematica Policy Research, Inc., 2006.

Merkley, G. "Armenia Trip Report. Project Quality Assurance Review for the Institutional Strengthening of Water Management Entities Subactivity." Manuscript, 2010.

National Statistical Service. *Measuring Poverty in Armenia: Methodological Explanations.* Yerevan, Armenia: National Statistical Service of Armenia, 2010.

Socioscope. *MCA-Armenia Irrigated Agriculture Project: Water-to-Market Activity Qualitative Process Analysis.* Yerevan, Armenia: Socioscope, 2010.

Trenholm, C., B. Devaney, K. Fortson, L. Quay, J. Wheeler, and M. Clark. *Impacts of Four Title V, Section 510 Abstinence Education Programs.* Princeton, NJ: Mathematica Policy Research, Inc., 2007.

APPENDIX A

METHODS

A. Regression Models

This section discusses our empirical strategies for estimating impacts of WtM training. We discuss the general regression model for estimating impacts in Section A, nonresponse weights in Section B, and identification and resolution of outliers in Section C.

1. Regression Specification

We estimated impacts of WtM training on key outcomes using the following general regression model, applied to a sample of farmers surveyed at both baseline and at follow-up:

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

where $y_{ijk,post}$ is the outcome of interest (for example, farm 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 baseline characteristics that are 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 impact of a program.

Random assignment was stratified by WUA. Communities within a given WUA were randomly assigned to the treatment condition according to predetermined ratios of treatment and control households. The regression model was designed to account for these random assignment features. The WUA fixed effects were used to account for the WUA-level stratification; they had the added benefit of explaining region-level variation in outcomes. Because entire communities (or in some cases, small clusters of neighboring communities) were randomly assigned together, we also needed to account for the fact that households within these communities may have had correlated outcomes, represented by the community-specific error term in Equation (1). Community-level correlations were accounted for using Huber-White standard errors.

2. Selection of Regression Control Variables

The impact evaluation for WtM training used a random assignment design in which communities were randomly assigned to a treatment group (in which training was offered) or a control group (in which training was not offered). Because assignment to the treatment group was random, household characteristics were uncorrelated with treatment status, and adjusting for baseline controls was not necessary to obtain unbiased impact estimates. However, controlling for baseline measures could improve statistical precision of the impact estimates if the regression controls were correlated with the key outcome measures.

Regression controls have statistical advantages for the empirical model, but an excessive number of unnecessary baseline controls could overfit the models and inflate standard errors. To balance these considerations, we used a sequential variable selection algorithm to identify the household control variables in X_{ijk}. This algorithm rests on the strength of observed relationships between candidate control variables and outcome measures.

The first step in our algorithm was to identify outcome measures that would represent the range of domains impacted by the training program. Selecting a small set of outcomes to use in developing the regression model ensured that the model selection process did not become computationally intensive but still selected a set of household controls that could predict outcome measures in different domains. We chose three outcome measures to use in the model selection process: adult-equivalent consumption, agricultural profits, and adoption of a simple On-Farm Water Management (OFWM) practice. To prevent outliers in these outcome measures from influencing the model selection, we censored adult-equivalent consumption and agricultural profits at their respective 98th percentiles (See Section C).

Next, we identified candidate, or potential, measures of household characteristics at baseline to explain each outcome measure at follow-up. These candidate measures included each household's baseline values of agricultural production for all crop categories, baseline agricultural costs, baseline employment income, baseline non-employment income, baseline land holdings, and the outcome measure recorded at baseline. The crop category–specific values of agricultural production were evaluated jointly as a candidate control. The outcome measure recorded at baseline was predetermined to be in the final specification, but we included it in this process to account for its correlations with other candidate variables. To limit the influence of outliers at baseline, we censored each of the candidate measures at their respective 98th percentiles in the analysis sample for the WtM training evaluation. We also censored the baseline measures for the outcomes of adult-equivalent consumption and agricultural profits.

Additionally, the regression model for training included as a candidate covariate whether the survey respondent was female; this step was taken because at baseline the training treatment and control groups were different to a statistically significantly degree on this measure. Other candidate controls included measures of household composition at final follow-up: the number of adults of prime working age (18 to 55), the number of elderly adults, and the number of children. These are preferable to using the baseline household composition measures because they should be more predictive of outcomes at final follow-up and because household composition should not have been impacted by WtM training.

For each selected outcome, we regressed the outcome on one candidate control variable at a time, using stratum fixed effects and nonresponse weights, as discussed in subsequent sections of the Appendix. To assess the empirical strength of the predictive power of each candidate control, we looked at the *t*-test for the coefficient of the candidate control variable. Any variables with *p*-values of 0.20 or smaller from the *t*-tests were retained for the next stage of the algorithm. Variables without higher *p*-values were dropped from the selection process. The *p*-value for the crop category-specific values of agricultural production at baseline came from a joint F-test of statistical significance.

In the second stage, we sorted candidate measures by their *p*-values from the first stage. Beginning with the candidate measure that had the smallest (most significant) *p*-value, we added the remaining candidate measures one at a time to the model. If the newly added candidate measure still had a *p*-value of 0.20 or smaller, it was kept as a control in the model. If not, it was excluded. Earlier covariates were retained even if adding the newest candidate measure lowered their *p*-values below 0.20. This process was then repeated for the other key outcomes.

When this series of steps was completed for each outcome, we created lists of all those controls that had been identified for at least one outcome (Table A.1). The covariates identified by specific outcomes varied.

The extent to which the regression models improved statistical precision varied substantially across outcome measures, but for most of the key outcome measures, the regression R^2 was about

0.20. This number was higher for variables that did not change much over time (such as types of crops cultivated) and lower for variables that changed considerably or were not measured at baseline. We note that regression controls explained less variation than we had hoped when we designed the evaluation of training; we had expected R^2 values between 0.30 and 0.40.

Table A.1. Control Measures Identified by the Sequential Variable Selection Algorithm for the Estimation Models in the Training Evaluation

	Regression Controls Identified by Each Outcome		
Controls	Adult-Equivalent Consumption	Agricultural Profits	Adoption of a Simple OFWM Practice
Training Analysis			
Employment income (USD) at baseline	X		
Market values (USD) of crop production at baseline, by crop category	X	X	
Agricultural expenditures at baseline	X		X
Total land (hectares) at baseline	X		
Number of children at follow-up	X		X
Number of prime-age adults at follow-up	X	X	X
Number of elders at follow-up	X		X
Outcome measure at baseline	X		X

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Employment income, market values of crops, agricultural expenditures, land holdings, adult-equivalent consumption, and agricultural profits were censored at the 98th percentile.

3. Regression-Adjusting Means

Although the training treatment was randomized, compositional differences could have occurred by chance. To account for these differences in observable characteristics, we present regression-adjusted means of the treatment and control groups for each outcome in the training evaluation. Regression adjustments were made according to the following procedure, which used nonresponse weights throughout to estimate means and parameters.

For each outcome in the training evaluation, we first estimated the parameters in the general regression model [Equation (1)]. Using the estimated parameters, we predicted the outcome measure $\hat{y}_{ijk,post}$ for every household in the analysis assuming they were all in the treatment group. This is reasonable because the households in the treatment and control groups are statistically comparable at baseline. We then calculated the regression-adjusted treatment mean as the average for these predicted values. To determine the regression-adjusted control mean, we repeated this process but assumed that every household was in the control group.

4. Binary Outcomes

For outcome measures that were binary variables, such as adoption of specific agricultural practices or whether a household cultivates a specific type of crop, the linear regression models just described have two theoretical problems. (A linear regression model applied to a binary outcome measure is called a linear probability model; we use this terminology hereafter.) The first potential problem with a linear probability model is that predicted probabilities may be less than 0 or greater than 1. The second problem is that the error terms in the model will violate distributional assumptions, in which case statistical inference could be incorrect. To overcome these problems, researchers often use probit or logit models to estimate impacts when the outcome measure is a binary variable.

However, probit and logit models introduce practical problems of their own. Most notably, subsamples must be dropped from the analysis sample for probit and logit models when a control variable or set of variables perfectly predicts outcomes for that subsample. However, dropping subsamples from the analysis leads to misleading impact estimates and regression-adjusted means. This is especially problematic in the present context, where a vector of WUA fixed effects must be included in the model for the training evaluation. Any outcome measure that does not vary within a given WUA will result in all observations in that WUA being dropped from the analysis for that outcome measure.

Linear probability models do not have this practical problem, and the theoretical problems are rarely realized in practice. We tested the validity of the linear probability model against a probit model in the present context using two key binary outcome measures: poverty status (relative to the lower general poverty line) and the adoption of an OFWM organizational improvement. Besides being central to the analysis, these two binary outcome measures were chosen because few WUAs were dropped when we use the probit model. No WUAs were dropped from the probit model for the poverty measure, and only two WUAs were dropped for the OFWM organizational improvements measure. In the latter case, we dropped the same two WUAs from the linear probability model we ran for these comparisons. For both of these outcome measures, the estimated impacts were identical when rounded to the nearest percentage point, and the *p*-values were similar, suggesting that statistical inference based on the linear probability model was still valid. Moreover, across all of the binary outcomes examined in this report, we did not find any regression-adjusted treatment or control means below 0 or above 1 when using the linear probability model. We have also conducted extensive validation checks for other studies and found that linear probability, probit, and logit yield very similar results (McConnell et. al 2006, Trenholm et. al 2007).

For these reasons, we used linear probability models to estimate impacts of the training program on nearly all binary outcomes included in the present report. The only exceptions were for binary outcomes with rates less than 1 percent or greater than 99 percent. For outcomes with such little variation, linear probability, probit, and logit models become unstable, and in the present context, also would have little meaning. For these outcomes, we instead report a simple difference in means for the research groups instead of using regression adjustment.

B. Nonresponse Weights

This section describes our approach to dealing with survey nonresponse. As discussed in Chapters I and II, there was no viable sample frame initially, so the survey firm worked with village mayors as part of the baseline FPS fieldwork to develop lists of farming households who would respond to the FPS. Subsequent rounds of the FPS attempted to interview the same households as at baseline. Hence, the data for each round of the FPS were designed to be representative of the set of 4,854 households who responded to the baseline FPS. Of those 4,854 households , 4,715 were in communities retained for our impact analysis.[48] Of that number, 3,547 households responded to the

[48] As described in Chapter II, 3 WUAs were dropped from our analysis because the sole treatment or control community in those WUAs refused to participate in subsequent rounds of the FPS.

final follow-up survey, representing a 75-percent response rate among communities retained in our impact analysis. Response rates by marz and research group (treatment and control) are presented in Table A.2. The numbers of respondents in the treatment and control groups within each marz are shown in Table A.3.

Table A.2. Survey Response by Marz and Research Group (percentages)

Marz	Treatment Group Percentage	Control Group Percentage	Difference	*p*-value
Aragatsotn	76	68	8**	0.05
Ararat	79	81	–2	0.44
Armavir	71	77	–6**	0.02
Gegharqunik	74	77	–3	0.69
Kotayq	73	74	–1	0.72
Lori	49	70	–21**	0.05
Shirak	86	81	5	0.34
Syunik	75	77	–3	0.64
Tavush	76	81	–4	0.30
Vayots Dzor	79	77	2	0.79
Total	**74**	**76**	**–3**	

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

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

Table A.3. Numbers of Respondents by Marz and Research Group

Marz	Treatment Group	Control Group	Total
Aragatsotn	303	120	423
Ararat	441	290	731
Armavir	580	364	944
Gegharqunik	83	37	120
Kotayq	290	208	498
Lori	21	30	51
Shirak	86	81	167
Syunik	113	82	195
Tavush	161	146	307
Vayots Dzor	55	56	111
Total	**2,133**	**1,414**	**3,547**

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Although response rates were reasonably high, impact estimates could be biased if survey respondents differed from nonrespondents in ways that are correlated with outcomes of interest. To adjust for differences in observed characteristics between the two groups, we created weights for each household that had responded to the final follow-up survey. Using these nonresponse weights, the analysis of the data on households who responded to the final follow-up survey was representative of the baseline survey respondents along dimensions of observed characteristics.

The first step to creating weights for nonresponse was to estimate logistic regression models of the probability that a sample member responded to the final follow-up survey. The models were estimated using the 4,715 respondents from WUAs in our analysis sample. The dependent variable was whether the household had also responded to the final follow-up survey. Any characteristic of the household that may have been correlated with survey response and was reported on the baseline survey was a candidate to be a covariate in the model. The covariates we considered included the value of total agricultural production, agricultural expenditures, total land, employment income, other income, number of prime-age adults, number of elderly adults, number of children, and whether the household's head was female. We evaluated the agricultural production values by crop category as one set of covariates.

The set of covariates for the logistic regression model was chosen systematically in a process that mirrors the development of our regression models for the impact estimation (described in Section A.2 of this appendix). First, we ran simple logistic models that predicted response propensity based on each of the candidate covariates, one at a time, along with the stratification variables. Each covariate or set of covariates (for agricultural production value by crop category) that had a *p*-value of 0.20 or less in these simple models was retained as a candidate for the response propensity model. We then sorted the candidate covariates from most significant (smallest *p*-value) to least (largest *p*-value that is still less than 0.20). Starting with the most significant covariate(s), each covariate that remained from the first step was added to the response propensity model, one at a time. If the new covariate still had a *p*-value of 0.20, it was retained in the model. If the new covariate had a *p*-value greater than 0.20, it was dropped. In either case, we then proceeded to the next covariate. The number of adults in the household at baseline and the household's total value of crop production were important predictors that were retained in this model, in addition to WUA indicators and treatment status.

The second step in creating nonresponse weights was to use the predicted values from the response propensity models to create weighting cells. Within each research group (treatment and control), five weighting cells were created that were determined by the size of the predicted likelihood that the household responded to the survey. This resulted in a total of 10 (5 x 2) weighting cells. The same nonresponse weight was assigned within each of these 10 cells. Calculating nonresponse weights within cells defined by predicted values, rather than using the predicted values directly, avoids large design effects due to outlier weights that can arise by chance.

The third step was to create the nonresponse weight for each cell. The nonresponse weight was calculated by dividing the total number of households in each cell by the total number of households that responded to the survey in each cell. For example, consider a control group household with a predicted response propensity based on the logistic model of 0.75. This puts the household in the lowest of the five ranked cells within its research group. There were 200 households within this cell (including the household described above). Of those 200 households, 144 responded to the final follow-up survey. Hence, if the household responded to the final follow-up survey, its nonresponse weight would be 200/144 = 1.39.

Finally, the weights were rescaled such that the sum of weights for the treatment group and the sum of weights for the control group each equal the original sample size of 4,715.

C. Outliers

Our approach to address outliers distinguishes between extreme values that are inconsistent with the respondent's other reported information and, hence, likely to be errors, and extreme values that may reflect rare farmers who may truly be high up in the distribution.

We recoded several outliers in the data that were inaccurate records of farming households. The most common problem was that production amounts were erroneously reported in drams rather than metric tons, likely because in the survey instrument the fields for value in drams and quantities in metric tons are next to each other. These farmers were identified systematically based on their reported amounts harvested and sold at baseline versus follow-up using the process outlined below.

First, we identified specific crop harvests and amounts sold where the farmer's report changed by over 200 tons from baseline to follow-up. Our analysis sample contained 14 of these harvests and sale amounts for barley, grape, peach, sweet cherry, potato, red beet, haricot, and gramma. We next examined each farmer's cultivated land areas and crop revenues in more detail to check whether the dramatic increase or decrease could be justified. None of the 14 identified harvests and sale amounts were accompanied by large changes in crop land area or revenues. Finally, we replaced the outlying number based on the information about land and crop revenues. For many of these 14 harvests, this consisted of treating a reported amount sold as the revenues for that crop. Similarly, we found 7 additional records that were recoded because they implied implausible prices per unit sold.

Then, we addressed outliers for which there was insufficient evidence to conclusively determine if the reported value was accurate. Our approach was to systematically censor measures of income, production, expenses, and land holdings at the 98th percentile for each measure, separately at baseline and follow-up. We censored these outliers that are potentially accurate because their influence on the model would make the impact estimates less relevant for the typical farmer, and because we suspect that there was some misreporting that we could not address among this small subsample. We conducted sensitivity analyses to assess the influence of these plausible outliers, as described in the report.

APPENDIX B

ADDITIONAL TABLES

Table B.1. Impacts of WtM Training on OFWM Practices (percentages)

	Treatment Group Percentage	Control Group Percentage	Impact	*p*-value
Simple Improvements	45	45	0	0.94
Modification of furrow sizes	44	43	1	0.78
Plastic cover for ditch	3.3	2.9	0.4	0.78
Siphons	0.5	0.1	0.3	0.31
Spiles	0.5	0.2	0.3	0.36
Dams (metal or plastic)	0.1	0.1	0.0	0.91
Medium Improvements	0.2	0.0	0.2	--
Movable gated pipes	0.1	0.0	0.1	--
Hydrants	0.0	0.0	0.0	--
Advanced Improvements	0.5	0.1	0.3*	0.06
Sprinkler irrigation	0.1	0.0	0.1*	0.08
Micro-sprinkler irrigation	0.1	0.0	0.1	0.16
Drip irrigation	0.2	0.1	0.1	0.55
Irrigation Scheduling Improvements	0.1	0.1	0.0	0.86
Soil moisture meter	0.1	0.1	0.0	0.86
ET gauge	0.0	0.0	0.0	--
Organizational Improvements	76	79	-3	0.27
Preparation of irrigated land	60	61	-2	0.74
Water measurement at farm gate	0.0	0.1	0.0	0.71
Have copy of water supply contract from WUA	45	45	1	0.89
Updated the annex to the water supply contract	10	9	1	0.77
Presented water order to the WUA about cultivated crops	19	16	3	0.52
Placed written water order	0.4	0.9	-0.5	0.54
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Table B.2. Impacts of WtM Training on Industrial-Economical HVA Practices (percentages)

	Treatment Group Percentage	Control Group Percentage	Impact	*p*-value
Produced High-Value Crops for Budget Reasons	2.8	2.6	0.2	0.88
Produced Nontraditional Crops	0.1	0.2	-0.1	0.49
Changed Crop or Variety Based on Demand	3.7	3.7	0.0	1.00
Mixed Crops	1.8	3.2	-1.4	0.26
Produced Multiple Yields	2.3	2.2	0.2	0.86
Established or Renewed an Orchard	10	11	-1	0.73
Established or Renewed a Greenhouse	11	9	2	0.44
Improved Soil Preparation Activities (plowing, cultivation, etc.)	26	21	6	0.11
Used High-Quality, Disease-Resistant Seeds or Planting Material	5.8	5.6	0.2	0.94
Improved Post-Planting Practices (weeding, fertilization, pest control, etc.)	12	11	1	0.73
Shifted Time of Harvest by Using Plastic Tunnels or Planting Seedlings	1.4	2.0	-0.6	0.48
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

HVA = High-Value Agriculture.

Table B.3. Impacts of WtM Training on Social-Environmental HVA Practices (percentages)

	Treatment Group Percentage	Control Group Percentage	Impact	*p*-value
Used Nonchemical Methods of Pest and Disease Management	0.3	0.6	-0.3	0.29
Used Only Pesticides Permitted in Armenia	62	56	6	0.15
Purchased Pesticide from Licensed Stores	58	50	8*	0.08
Did not Purchase Pesticides in Damaged Packaging	50	44	6	0.22
Used Safety Equipment When Working with Pesticides	49	49	0	0.91
Bought Pesticides for a Specific Problem (diseases, insects), Avoiding Residuals	57	54	3	0.46
Harvested Crops after the Pesticide's Waiting Period	55	50	5	0.26
Did not Burn or Discard Residual Pesticide into the Ditch or Mudflow Conduits	45	41	4	0.41
Did not Use Excessive Amounts of Chemical Fertilizer(s)	23	20	2	0.54
Did not Burn Organic Waste Remaining after Harvesting Crops	0.0	0.1	-0.1	0.32
Prepared Compost and Used It as Organic Fertilizer	0.1	0.2	-0.1	0.42
Used Organic Fertilizers with Appropriate Methods	12	12	0	0.95
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group percentages were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Table B.4. Impacts of WtM Training on Respondent Households' Land Areas for Crops (hectares)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Total	1.2	1.2	0.0	0.78
HVA crops	0.4	0.4	0.0	0.50
Grape	0.1	0.1	0.0	0.18
Other fruits or nuts	0.2	0.2	0.0	0.56
Tomato	0.0	0.0	0.0	0.94
Vegetables and herbs	0.0	0.0	0.0	0.47
Potato	0.0	0.0	0.0	0.27
Non-HVA crops	0.7	0.7	0.0	0.57
Grain	0.4	0.4	0.0	0.42
Grass	0.3	0.3	0.0	0.99
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Table B.5. Impacts of WtM Training on Production of Crops (metric tons)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
High-Value Agriculture				
Grape	0.6	0.9	-0.3**	0.04
Other Fruits or Nuts	0.5	0.5	0.0	0.83
Apple	0.0	0.0	0.0	0.20
Peach	0.0	0.0	0.0	0.82
Apricot	0.0	0.0	0.0	0.35
Pear	0.0	0.0	0.0	0.95
Prunes	0.0	0.0	0.0	0.19
Plum	0.0	0.0	0.0	0.62
Fig	0.0	0.0	0.0	0.96
Pomegranate	0.0	0.0	0.0*	0.09
Sweet cherry	0.0	0.0	0.0	0.87
Cherry	0.0	0.0	0.0	0.47
Cornel	0.0	0.0	0.0	0.22
Quince	0.0	0.0	0.0*	0.08
Watermelon	0.1	0.1	0.0	0.49
Melon	0.2	0.1	0.1	0.24
Lemon	0.0	0.0	0.0	--
Malta orange	0.0	0.0	0.0***	0.00
Walnut, hazelnut	0.0	0.0	0.0	0.44
Strawberry	0.0	0.0	0.0	0.35
Tomato	0.5	0.4	0.1	0.20
Other Vegetables or Herbs	0.8	0.7	0.1	0.65
Pumpkin	0.0	0.0	0.0	0.87
Cucumber	0.1	0.2	0.0	0.65
Eggplant	0.1	0.1	0.0	0.77
Pepper	0.0	0.0	0.0	0.93
Cabbage	0.1	0.1	0.0	0.50
Carrot	0.1	0.0	0.1	0.26
Squash	0.0	0.0	0.0	0.29
Onion	0.0	0.0	0.0	0.47
Garlic	0.0	0.0	0.0	0.19
Red beet	0.0	0.0	0.0	0.22
Greens	0.0	0.0	0.0	0.67
Potato	0.4	0.3	0.1**	0.01
Other HVA	0.0	0.0	0.0	0.45
Sunflower	0.0	0.0	0.0	0.50
Haricot	0.0	0.0	0.0	0.59
Tobacco	0.0	0.1	0.0	0.59
Sorgo	3.9	0.6	3.3*	0.08
Planting stock	0.0	0.0	0.0	--

Table B.5. ***(continued)***

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Non-High-Value Agriculture				
Grain	0.6	0.5	0.1	0.11
Wheat	0.4	0.3	0.1	0.19
Barley	0.1	0.1	0.0*	0.07
Maize	0.0	0.0	0.0	0.88
Emmer wheat	0.0	0.0	0.0	0.53
Grass	1.2	1.2	0.0	0.76
Natural grass	0.3	0.3	0.0	0.54
Gramma or other feed	0.8	0.9	–0.1	0.63

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods. Because of difficulties measuring the amount of flower production in a way that is comparable to other crops, we omit flowers from this table.

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

Table B.6. Impacts of WtM Training on Revenues from Crops Sold (USD)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
High-Value Agriculture				
Grape	213	280	-67*	0.09
Other Fruits or Nuts	206	214	-8	0.80
Apple	1	1	1	0.13
Peach	14	13	1	0.78
Apricot	34	45	-12	0.56
Pear	3	2	1	0.79
Prunes	8	3	5	0.19
Plum	0	3	-3*	0.08
Fig	1	1	-1	0.34
Pomegranate	0	3	-2	0.11
Sweet cherry	12	9	3	0.40
Cherry	1	1	0	0.93
Cornel	2	4	-2	0.27
Quince	0	0	0*	0.09
Watermelon	13	14	-2	0.54
Melon	25	19	6	0.61
Lemon	0	0	0	--
Malta orange	0	4	-4**	0.01
Walnut, hazelnut	10	11	-1	0.91
Strawberry	22	29	-8	0.40
Tomato	150	119	31	0.14
Other Vegetables or Herbs	240	192	48	0.17
Pumpkin	0	0	0	0.91
Cucumber	41	45	-5	0.69
Eggplant	19	15	4	0.45
Pepper	17	16	1	0.73
Cabbage	19	21	-2	0.71
Carrot	17	3	14	0.15
Squash	5	2	3**	0.03
Onion	15	31	-16	0.14
Garlic	2	0	2	0.21
Red beet	1	0	0	0.55
Greens	11	9	2	0.39
Potato	72	40	32**	0.03
Other HVA	26	32	-5	0.55
Sunflower	13	4	9*	0.06
Haricot	6	10	-3	0.32
Tobacco	10	15	-4	0.61
Sorgo	4	1	4	0.24
Planting stock	0	0	0	--
Flowers	21	15	6	0.42

Table B.6. *(continued)*

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Non-High-Value Agriculture				
Grain	32	27	5	0.47
Wheat	16	14	2	0.52
Barley	4	3	2	0.34
Maize	8	13	−5	0.34
Emmer wheat	7	4	3	0.66
Grass	22	21	1	0.87
Natural grass	2	3	−1	0.45
Gramma or other feed	20	19	1	0.75
Other Non-HVA	4	1	4	0.24

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

Table B.7. Impacts of WtM Training on Market Value of Harvests (USD)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
High-Value Agriculture				
Grape	240	320	-80**	0.05
Other Fruits or Nuts	298	292	5	0.89
Apple	29	19	10	0.12
Peach	18	17	1	0.81
Apricot	10	8	2	0.44
Pear	4	4	0	0.72
Prunes	1	1	0	0.21
Plum	0	0	0	0.65
Fig	2	2	-1	0.52
Pomegranate	1	4	-2	0.11
Sweet cherry	2	3	0	0.70
Cherry	0	0	0	0.38
Cornel	0	0	0	0.22
Quince	3	1	3*	0.09
Watermelon	13	14	-2	0.53
Melon	25	19	6	0.62
Lemon	0	0	0	--
Malta orange	1	7	-7***	0.00
Walnut, hazelnut	16	18	-2	0.65
Strawberry	23	29	-7	0.48
Tomato	177	139	38*	0.10
Other Vegetables or Herbs	285	222	63	0.11
Pumpkin	0	0	0	0.95
Cucumber	51	55	-3	0.78
Eggplant	24	21	3	0.53
Pepper	22	21	1	0.79
Cabbage	26	27	-1	0.83
Carrot	24	2	22	0.22
Squash	6	2	3*	0.08
Onion	2	2	0	0.39
Garlic	5	2	4	0.22
Red beet	2	0	1	0.11
Greens	11	8	3	0.33
Potato	141	95	47***	0.01
Other	53	58	-4	0.72
Sunflower	15	7	8	0.12
Haricot	28	32	-4	0.61
Tobacco	10	15	-4	0.61
Sorgo	5	1	5	0.19
Planting stock	0	0	0	--
Flowers	21	15	7	0.40

Table B.7. *(continued)*

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Non-High-Value Agriculture				
Grain	180	155	25	0.21
Wheat	115	102	13	0.30
Barley	26	18	8*	0.07
Maize	1	1	0	0.97
Emmer wheat	17	12	6	0.53
Grass	117	111	6	0.63
Natural grass	24	22	3	0.61
Gramma or other feed	82	83	−1	0.93
Other Non-HVA	5	1	5	0.19

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

Table B.8. Impacts of WtM Training on Respondents' Annual Monetary Household Income (USD)

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Nonagricultural Income	2,275	2,276	−2	0.98
Agricultural Income				
Total agricultural sales	1,263	1,219	44	0.70
Monetary profits (sales - costs)	423	357	67	0.50
Total Monetary Income	2,792	2,697	95	0.50

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

Table B.9. Impacts of WtM Training on Land Owned and Irrigated (hectares), Uncensored

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Total Agricultural Land				
All	1.8	1.8	0.0	0.87
Irrigated	0.8	0.9	-0.1	0.16
Arable Land				
All	1.3	1.3	0.0	0.98
Irrigated	0.4	0.5	0.0	0.41
Orchard				
All	0.1	0.2	-0.1*	0.05
Irrigated	0.1	0.2	-0.0**	0.05
Vineyard				
All	0.1	0.1	0.0	0.29
Irrigated	0.1	0.1	0.0	0.30
Kitchen Plot				
All	0.2	0.2	0.0	0.47
Irrigated	0.1	0.1	0.0	0.48
Other				
All	0.1	0.1	0.1	0.40
Irrigated	0.0	0.0	0.0	0.53
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Table B.10. Impacts of WtM Training on Production, Revenues, and Market Value of Harvests (USD except where indicated), Uncensored

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Agricultural Production (Metric Tons)				
Total	6.7	7.2	-0.4	0.59
HVA crops	4.5	4.7	-0.2	0.77
Grape	0.8	1.2	-0.4*	0.04
Other fruits or nuts	0.8	0.8	0.0	0.93
Tomato	0.9	0.7	0.2	0.28
Vegetables and herbs	1.2	1.2	0.0	0.92
Potato	0.6	0.5	0.1	0.21
Non-HVA crops	2.2	2.5	-0.3	0.59
Grain	0.7	0.6	0.1	0.31
Grass	1.5	1.9	-0.4	0.45
Land under Cultivation (hectares)				
Total	1.3	1.2	0.1	0.30
HVA crops	0.5	0.5	0.0	0.60
Non-HVA crops	0.8	0.7	0.0	0.40
Revenues from Crops Sold				
Total	1,737	1,503	235	0.43
HVA crops	1,638	1,386	251	0.40
Grape	279	376	-97	0.11
Other fruits or nuts	268	322	-54	0.33
Tomato	231	151	80*	0.07
Vegetables and herbs	657	388	270	0.30
Potato	124	64	60**	0.03
Other HVA crops	76	88	-12	0.66
Non-HVA crops	103	112	-9	0.67
Grain	61	68	-6	0.72
Grass	39	39	-1	0.96
Other non-HVA crops	5	1	4	0.25
Market Value of Harvests				
Total	2,443	2,032	411	0.19
HVA crops	2,064	1,695	369	0.23
Grape	305	410	-105*	0.08
Other fruits or nuts	418	414	5	0.95
Tomato	287	173	114**	0.02
Vegetables and herbs	721	413	308	0.23
Potato	220	184	36	0.39
Other HVA crops	108	109	-1	0.97
Non-HVA crops	381	335	46	0.19
Grain	217	200	17	0.58
Grass	158	132	26	0.17
Other non-HVA crops	6	1	5	0.20
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars. HVA = High-Value Agriculture.

Table B.11. Impacts of WtM Training on Annual Economic Household Income (USD), Uncensored

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Nonagricultural Income	2,359	2,333	26	0.77
Agricultural Income				
Total value of harvest	2,443	2,032	411	0.19
Agricultural profit (value - costs)	1,577	1,147	431	0.15
Total Economic Income	3,941	3,485	457	0.15
Sample Size	**2,133**	**1,414**		

Sources: 2007-2008 and 2010-2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

USD = United States dollars.

Table B.12. Impacts of WtM Training on Consumption Relative to Poverty Lines (means), Uncensored

	Treatment Group Mean	Control Group Mean	Impact	*p*-value
Consumption Relative to Food Poverty Line	265	266	−1	0.89
Consumption Relative to Lower Poverty Line	183	184	−1	0.89
Consumption Relative to Upper Poverty Line	149	150	−1	0.89
Sample Size	**2,133**	**1,414**		

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods.

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

Table B.13. Standard Errors and Minimum Detectable Impacts of WtM Training on Key Outcomes

	Treatment Group Mean	Control Group Mean	Impact	Standard Error	Minimum Detectable Impact
Simple OFWM Practices (%)	45.2	44.9	0.4	4.6	12.9
Established or Renewed a Greenhouse (%)	10.6	9.0	1.6	2.1	5.9
Land Under Cultivation for HVA Crops (hectares)	0.42	0.43	–0.02	0.03	0.08
Agricultural Profits (USD)	1,006	841	166	978	273
Economic Income (USD)	3,386	3,180	206	150	419
Households Below the Lower Poverty Line (%)	15.5	15.2	0.3	1.9	5.2

Sources: 2007–2008 and 2010–2011 Farming Practices Surveys.

Note: Measured at follow-up, treatment and control group means were regression adjusted for differences in baseline characteristics and estimated using nonresponse weights. Reported impact may not equal difference in reported treatment and control means due to rounding. See Appendix A for description of estimation methods. The minimum detectable impacts assume a confidence level of 95 percent, two-tailed tests, and 80 percent power, resulting in a factor of 2.8. The minimum detectable impact uses the estimated standard error multiplied by this factor.

APPENDIX C

FARMING PRACTICES SURVEY: ROUND 3 INSTRUMENT

Don't Know 96
Refused to Answer 97

FARMING PRACTICES SURVEY
Round III 2010-2011

QUESTIONNAIRE No

Marz Code	Cluster/settlement code	Sample list type **1.** baseline respondent **2.** baseline hh other member **3.** Tier One **4.** Tier Two **5.** MCA-Armenia credit borrower survey	Respondent ID	Interviewer Code	Questionnaire is valid Coordinator's signature	Questionnaire is checked Quality Control Member signature

Hello, my name is **(First name, last name)**.I represent AREG SCYA NGO, which implements Farming practices survey in the RA marzes by the order of "Millennium Challenge Account-Armenia". The published research will never report your answers linked to your name and will greatly contribute to the elaboration of projects directed to the agricultural development in Armenia.

Name of respondent

____

First Name, Middle Name, Last Name

Contacts of the respondent: phone number (code+number) ____________________________
Mobile (code+number) ____________________________

Date (day.month.year) ________________________________

Start time (hh/mm) ________________________________

Don't Know 96
Refused to Answer 97

HOUSEHOLD DESCRIPTION

A. LAND AND LIVESTOCK

A1. How many years have you been farming (excluding years in which the kitchen plot was cultivated alone)?

1. _______________ years
98. Only ever cultivated a kitchen plot

A2. Did any changes take place in total area of your land in the last year.
1. Yes
2. No (then => A4)

A3. If yes, what was the main reason?
1. Purchase of additional land
2. Selling of the land
3. Divorce
4. division between other members of the family
5. ownership registration change
6. Other (specify)________________________________

A4.What is the total area of the land* owned and/or rented by your household and how much of your land did you actually irrigate during the last agricultural season, in 2010?

		Total agricultural land, ha	Of which:		
			Was possible to irrigate by network, sqm	Actually irrigated in 2010, sqm	of which: by irrigation network water, sqm
		1	2	3	4
1	Total, of which				
2	Arable land				
3	Orchards				
4	Vineyards				
5	The plot near the house/kitchen plot				
6	Other				

*** the rented out land should not be included in the area**

A5. What sources of irrigation do/did you use in 2010?

		Did you Irrigate by?			
		Irrigation water	Drinking water	Deep well and artesian well water	Natural sources/river/lake/collected rainwater, etc.
		1	2	3	4
1.	Arable land				
2.	Orchards				
3.	Vineyards				
4.	The plot near the house/kitchen plot				
5.	Other				

Don’t Know 96
Refused to Answer 97

A6. Do you have livestock?

1. Yes, ***to the Interviewer: fill in the table*** A7 ***below.***
2. No (then =>B1)

A7. Information on households’ livestock

N	Item	Available livestock
1	Cow	
2	Pig	
3	Sheep and goat	

B. ROSTER OF CROPS GROWN DURING THE LAST AGRICULTURAL SEASON AND CHANGES THEREIN

B1. Crop production and utilization in the field (including kitchen plot) during the last year.
To the Interviewer: Use Card 1 to fill in the table and fill the numbers in fixed format.

						Of which:		
N	Item (*Input Code using the Card 1*)	1. In the field 2.In the kitchen plot 3.Both	How much was cultivated? *Fill in the responses for each type of crops in format which is specified in Card 1 (only one column for each crop should be filled in: either sq.m, or number of trees).*	How much was irrigated/watered? *Fill in the responses for each type of crops in format which is specified in Card 1 (only one column for each crop should be filled in: either sq.m, or number of tree).*	Total amount harvested in the last season	How much was sold?		How much was bartered?
			sq. m./ number of trees	sq. m./ number of trees	Using units specified in Card 1	Using units specified in Card 1	AMD	Using units specified in Card 1
	1	2	3	4	5	6	7	8
1.								
2.								
3.								
4								
5.								
6.								
7.								
8.								
9.								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Don't Know 96
Refused to Answer 97

B2. During the past agricultural season, did you do any of the following practices?
To the Interviewer: Provide the respondent with Card 2. Check all applicable answers

Practice code	Used at the kitchen plot	Used at other land
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25.		
26.		

B3. During recent agricultural season, did you grow different crops from the previous year?

1. Yes
2. No (then =>B5)

B4. What is the main reason you changed your cropping pattern?

1. Improved irrigation
2. Lack of water
3. Weather
4. Market conditions
5. Cost of inputs
6. Government subsidies
7. Trying new varieties of crops
8. Access to training
9. Because of land resting
10. Other (specify)_______

B5. During the last agricultural season, did you bring any of your produce to a consolidation or collection center for it to be sorted and transported for selling?

1. Yes
2. No (then =>C1.)

B6. Approximately what fraction of your produce did you take to the consolidation center? (%)______________________

Don’t Know 96
Refused to Answer 97

C. WATER USE

C1. Do you have a personal tank, artesian well, or reservoir that you use to water crops?
1. Yes
2. No

C2. Do you have a personal pump that you use to pump water?
1. Yes
2. No

C3. What irrigation practices did you use during the last agricultural season at your kitchen plot and at other land?
To the Interviewer: Show CARD 3. Check all possible answers and fill the codes into the space below.
66. None of mentioned (then=>C5)

1. at the kitchen plot

2. at other land

C4. Did any of these practices help you save labor?
1. Yes
2. No

C5. Did you incorporate any agricultural practices that changed the way you use fertilizers or pesticides?
1. Yes
2. No

D. FARMING EXPENDITURES

D1.

N	Items	How much was spent on the mentioned items during the last season? AMD (or foreign currency expressed in AMD)	How much was spent on the mentioned items during the last season? ***To the Interviewer: If items were bartered, write down the quantity of mentioned products expressed in drams, for example potatoes for 5000 AMD***
		1	2
1	All kind of fertilizers and pesticides		
2	Irrigation		
3	Hired labor and hired equipment or tools (including spare parts, fuel etc.)		
4	Taxes and duties		
5	Seeds and seedlings		
6	Cellophanes		
7	Other major expenses (specify)		

Don't Know 96
Refused to Answer 97

E. Trainings

E1. During the past year, was any farming or irrigation training offered in your community or nearby communities?
1. Yes
2. No (then =>F1)
96. Don't know (then =>F1)

E2. Did you or anyone else in your household attend any of the trainings?
1. Yes
2. No (then => F1)

E3. What kind of training was it? (*To the Interviewer: Check all that apply*)
1. water use and irrigation
2. land cultivation and crop production
3. other (describe)_________

E4. Did the person(s) who attended receive a certificate at the end of training?

1. Yes
2. No

F. Agriculture Equipment

F1. Do you currently own or rent any of the following?

No	Equipment	Check if **Yes owner**	Check if **Yes rent/borrow**
		1	2
1	Trucks and Tractors		
2	Combine		
3	Seed planter		
4	Sprayer		
5.	Kirov 6		

55. I don't have it

Don’t Know 96
Refused to Answer 97

G. Agricultural Credit

G1. Have you applied for a loan during last 5 years?

1. Yes
2. No (Go to section H)

G 2. Agricultural credit history in last 2 years or loan outstanding now that were received more than 5 years ago.

									1. Greenhouse 2. Orchards 3. Cold storage 4. Dry fruit 5. Livestock 6. Equipment (tractor) 7. Seeds/seedling/sprout 8. Land purchase/ renting 9. Non-agricultural purposes 10. Other			
N	**Source/Credit provider** ***/USE CARD 4/***	**MCA credit** **1.Yes** **2.No**	**Amount applied for (AMD)**	**Amount received (AMD)** **In case application was rejected put “0” and go to the next line/ loan**	**Date received (year, month)**	**Annual interest rate**	**Are you on schedule with your payments?** **1.Yes** **2.No**	**Maturity data (year, month)**	**Purposes (up to 2)**	**Collateral** **1. yes** **2. no⇒ go to the next loan/line**	**Collateral type:** **1.Land** **2.Real estate** **3.Machinery** **4.Car** **5.Other**	**Collateral value, AMD**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.						**%**						
2.						**%**						
3.						**%**						
4.						**%**						

Don't Know 96
Refused to Answer 97

H. CONSUMPTION AND MONETARY INCOME OF HH MEMBERS

H1. How much is spent by your family for the following purposes during a typical month?

Cost Item	*Drams*
1. Food	
2. Housing products (e.g. soup, washing powder etc).	
3. Public utilities (electricity, telephone, apartment rent, water, cell phone)	
4. Transport	
5. Other monthly costs ***(specify)***	

H2. How much was spent by your family for the following purposes last year?

Cost Item	*Drams*
1. Healthcare	
2. Education	
3. Other annual costs	

H3. How much monetary income did your household receive from the following sources last year?

Income	*AMD*
1. Pension	
2. Remittances from HH absent members (abroad or other RA cities)	
3. Giving for rent land, transport, other	
4. Other benefits (social)	

Don't Know 96
Refused to Answer 97

I 1. I would like to make a complete list of all the members of your household, both present and absent. By saying a household I mean people who usually live together, share the same housekeeping and have the same budget. At first, I would like to write down the name of the person who makes most of agricultural decisions in your household, then his spouse, their children and then other members of the household. Do not include the visitors.
To the Interviewer: Circle the number of respondent in the column of h/h members.
Questions from 5 and 6 should be asked for farmer, spouse and their children over 16 only.

No of h/h member	Household members and their relationship to the head of h/h 1.head 2.spouse 3.son/daughter 4.son in law/ daughter in law 5.grandchild 6.father/mother of head / spouse 7.sister/brother 8.other relatives of the head 9. persons that do not have any relationship to the head	Gender 1. male 2. female	Age (write down number)	If any of the household members who usually live here are currently absent, indicate by marking "**1**" in their row	During any stage of the last agricultural season, which people in the household were actively working in agriculture as their main activity? 1. Yes 2. No	What is the level of education completed? (starting from 16- year- olds) 1.non-educated 2.incomplete primary 3.primary 4.incomplete general secondary 5.general secondary 6.incomplete secondary 7.secondary (full) 8.secondary vocational 9.incomplete higher 10. higher 11. post-graduate
	1	2	3	4	5	6
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Don't Know 96
Refused to Answer 97

J. OCCUPATION AND PAID JOBS OF HH MEMBERS

J. Did any of your hh members have any paid work during last year? Please specify which of them. We would like to ask several questions about their occupation and jobs.
Should be asked for hh members over 16 only.

66. No one

No of h/h member having job during last year (using Codes from the first column of I1)	Mainly what kind of job it was? 1. Agricultural work for others inside the village 2. Agricultural work for others outside the village 3. Non-agricultural work inside the village 4. Non-agricultural work outside the village 5. Other (specify)	Was that job: 1. full time monthly paid job 2. one-time short-term job 3. periodical short-term job 4. Other	In which of the following sectors your hh members were mostly involved for their non-agricultural jobs? 1. Construction 2. Transportation 3. Food and service sector 4. Trade 5. Crafts 6. Education 7. Healthcare 8. Village Mayor Office/ WUA/ other community services 9. Armed Forces 10. NGO sector 11. Other	How much was earned during last year by your household members having any paid jobs in AMD?	If the HH members received any in-kind (non financial) payment for that job, how much was earned valued in AMD during last year? ***Write down the amount of in-kind payment in AMD.*** ***55. Received in-kind payment: Value unknown***
1	**2**	**3**	**4**	5	**6**

Thank you for cooperation.

End time (hh:mm)______________________________

CARD 1

Code	Crop	Cultivation, irrigation units	Selling units
1.	Wheat	sq.m	t.
2.	Emmer Wheat	sq.m	t.
3.	Barley	sq.m	t.
4.	Maize	sq.m	t.
5.	Apple	number of trees	t.
6.	Grape	sq.m	t.
7.	Peach	number of trees	t.
8.	Apricot	number of trees	t.
9.	Pear	number of trees	t.
10.	Prunes	number of trees	t.
11.	Plum	number of trees	t.
12.	Fig	number of trees	t.
13.	Pomegranate	number of trees	t.
14.	Sweet Cherry	number of trees	t.
15.	Cherry	number of trees	t.
16.	Cornel	number of trees	t.
17.	Quince	number of trees	t.
18.	Water melon	sq.m	t.
19.	Melon	sq.m	t.
20.	Pumpkin	sq.m	t.
21.	Lemon	number of trees	t.
22.	Malta orange	number of trees	t.
23.	Walnut, hazelnut	number of trees	t.
24.	Strawberry	sq.m	t.
25.	Tomato	sq.m	t.
26.	Cucumber	sq.m	t.
27.	Eggplant	sq.m	t.
28.	Pepper	sq.m	t.
29.	Cabbage	sq.m	t.
30.	Carrot	sq.m	t.
31.	Squash	sq.m	t.
32.	Onion	sq.m	t.
33.	Garlic	sq.m	t.
34.	Potato	sq.m	t.
35.	Red beet	sq.m	t.
36.	Sunflower	sq.m	t.
37.	Haricot	sq.m	t.
38.	Tobacco	sq.m	t.
39.	Sorgo	sq.m	bunches
40.	Greens (coriander, basil, parsley, tarragon, etc.)	sq.m	bunches
41.	Grass (natural)	sq.m	t.
42.	Planting Stock	number	number
43.	Flowers	sq.m	pieces
44.	Gramma or other special feed	sq.m	t.
45.	Other fruits (specify)	Specify	Specify
46.	Other vegetables (specify)	specify	Specify

Card 2

1. **High value crop production instead of low value based on crop budget calculations**
2. **Crop/variety change based on market (fresh or processing) demand or request.**
3. **Orchard establishment or renewing (using regular trees)**
4. **Orchard establishment or renewing (using dwarf trees)**
5. **Greenhouse (glass) establishment or renovation**
6. **Greenhouse (plastic) establishment or renovation**
7. **Mixed cropping (associated cropping - planting more than one crop at a same time on the same place) to reduce the production risks**
8. **Production of non-traditional crops**
9. **Usage of high quality, disease resistant seeds/varieties or planting material (seedlings, potato tubers)**
10. **Multiple crop production (getting more than one yield per year)**
11. **Improved practices on soil preparation (plowing, cultivation etc.)**
12. **Improved post planting practices for vegetables in the open field (weeding, fertilization, pest & disease control etc.)**
13. **Shifting time of harvesting by using plastic tunnels or seedlings**
14. **Have used only the pesticides permitted in the Republic of Armenia**
15. **Have bought pesticide from licensed stores**
16. **Have bought pesticides only for a specific problem (diseases, insects), avoiding the residuals**
17. **Have paid attention on the packaging and the tare completeness of pesticides: did not bought damaged or pesticides with flowing**
18. **Have used personal protection equipments while working with pesticides (gloves, goggles, respirator, apron, top-boots and others)**
19. **Have done harvesting following the pesticide's waiting period**

20. Have not burned pesticides' residuals and tare, or throw them to the ditch/mudflow conduits anymore

21. Have used non-chemical methods of pest and diseases management (vegetal infusions, traps, seizing belts)

22. Have paid attention on the normalized usage of chemical fertilizers (avoid the over fertilizing (for example, saltpeter fertilizer))

23. Have stopped burning the plant remaining (the remaining of cereal after the harvesting), leaves and other organic wastes remained after the agricultural works (plant remaining and others)

24. Have prepared compost and have used it as an organic fertilizer

25. Have used organic fertilizers applying the right technology of manure treatment, composting, biohumus, green fertilizing (sideration), bacterial substances and others

26. Other (specify)

27. None of the above

CARD 3

1. **Proper preparation of irrigated land (collecting stones, adjusting slopes, weeding etc.)**
2. **Modification of furrow sizes (length, width, depth and inter-furrow area)**
3. **Ditch covering with plastic cover**
4. **Siphons**
5. **Dams (metal or plastic)**
6. **Moveable gated pipe**
7. **Spiles**
8. **Hydrants**
9. **Sprinkler irrigation**
10. **Micro sprinkler irrigation**
11. **Drip irrigation**
12. **Soil moisture meter (Watermark, Tensiometer etc.)**
13. **ET gauge data**
14. **Water measurement at farm gate (through YAGYUS or V-notch weir)**
15. **Have taken my copy of water supply contract signed with WUA**
16. **Presented order to the WUA about the cultivated crops**
17. **Have updated the Annex to the water supply contract**
18. **Have placed water order in a written form**
19. **Other (specify)**

CARD 4

1. Sef international UCO
2. “AGBA LIZING” UCO
3. “AGROLIZING LIZING CREDIT ORGANIZATION” LtD
4. “Izmirlyan-Eurasia" UCO
5. “AREGAK” UCO
6. “Finka” UCO
7. “Nor Horizon” UCO
8. “NORVIK” UCO
9. “Malatia UCO” LTD
10. “GARNI INVEST” UCO
11. “Ecumenic Church Credit Foundation” UCO
12. “GFC General financial and credit company “ UCO
13. “Farm Credit Armenia” UCO
14. “Card Agro Credit” UCO
15. “Aniv” UCO
16. “Anelik Bank”
17. “AREXIMBANK”
18. “ArdshinInvestBank”
19. “ArtsackBank”
20. “Armenian Development Bank”
21. “HSBC-Armenia”
22. “Byblos Bank Armenia”
23. “InecoBank”
24. “ConverseBank”
25. “AGBA-CREDIT AGRICOL BANK”
26. “ARMECONOMBANK”
27. “ARMBISNESSBANK”
28. “VTB-Armenia Bank”
29. “AraratBank”
30. “AMERIABANK”
31. “MELLAT BANK”
32. “PrometeyBank”
33. “UNIBANK”
34. “PRO CREDIT BANK”
35. Other (specify)

APPENDIX D

ESTIMATING HOW MANY HOUSEHOLDS PARTICIPATED IN TRAINING

Accurate data on the number of households trained are not available, so we instead estimated the number of households that were involved in training using databases prepared by VISTAA to track individual training participants. The databases include names, passport IDs, telephone numbers, birth dates, genders, and community and region in which the training was provided, all of which were collected when training participants registered for training. This appendix explains how we used these data to estimate how many households had a member who participated in training.

As reported in Chapter I, 45,639 farmers attended On-farm Water Management (OFWM) training and 36,070 attended High-Value Agriculture (HVA) training—a total of 81,709 person-trainings. To convert these person-trainings into counts of households who participated in at least one training session, we considered four factors that could cause a household to be counted more than once. First, and the main cause of double-counting households, many farmers attended both types of training. Second, some farmers may have attended more than one session of the same type of training (for example, two OFWM sessions), in which case they would be counted twice. Third, some farmers attended training together with other members of the same household. Fourth, sometimes one person from a household attended OFWM training while another attended HVA training. We calculated the number of trained households in three different ways, and each method is intended to address these factors.

Our first approach, which we use for the estimates reported in Chapter I, is based on HVA attendees' self-reports on whether they had also attended OFWM training. These self-reports were collected by VISTAA when farmers registered for HVA training. Seventy-nine percent of HVA attendees reported that they had also attended OFWM training. We also used passport IDs to determine how many farmers had attended OFWM more than once and likewise HVA more than once. Ninety-seven percent of recorded attendees were attending their first session of a given type. Based on these percentages and the OFWM and HVA counts provided above, we estimate that 51,700 different farmers attended at least one training session. Finally, we did a crude calculation to determine in how many cases farmers were attending training with another family member. This calculation examined how frequently two farmers with the same surname were signed up consecutively on the sign-in sheet; in most cases, our visual inspection of names, birth dates, and genders suggested that such cases were likely to either be spouses or a parent and (adult) son or daughter. We estimated that about 8 percent of participants were attending with someone who likely lived in the same household. Therefore, using our first approach, we estimate that about 47,800 households participated in at least one training session.

A limitation of the first approach is that it relies on self-reports from HVA participants to determine overlap between the HVA and OFWM participants. Self-reports could be biased either because HVA participants remembered an unrelated training session they previously attended, or if some HVA participants misrepresented OFWM attendance because they incorrectly perceived that attending OFWM was a prerequisite. If so, our estimates of overlap between OFWM and HVA would be upwardly biased, and our estimates of total trainees would be downwardly biased. Some farmers might also report that they had attended OFWM when it was actually someone else in the household who had attended, though because we only seek to count households, this would be acceptable for our purposes. To address this possible bias, our second approach uses passport IDs to estimate the number of unique training participants. Based on passport IDs, we estimate that there were about 58,000 unique training participants, accounting for overlap in OFWM and HVA as well as participants who repeated attendance at the same type of training. We then use a similar adjustment as before to account for family members who attended together. Using our second approach, we estimate that 53,700 households participated in training. However, inaccuracies in the passport records cause this approach to undercount the overlap between OFWM and HVA participants. In particular, the formats for the passport IDs are not consistent throughout the files; we corrected the most common inconsistencies, but others remain and lead to mismatched IDs. We also found several examples that suggest there are data entry errors creating further mismatches. Other IDs are incomplete or missing altogether. Still, this second approach is useful as a check of the first approach. It suggests that the potential biases of the first approach due to self-reporting are unlikely to cause an underestimation of all training participants.

The first two approaches may overestimate the number of trained households by underestimating how often farmers from the same household attended training. In particular, our adjustments only accounted for participants who had the same last name and registered consecutively. Some household members may have signed in non-consecutively, or one family member may have attended OFWM and another attended HVA, neither of which would be accounted for in the first two approaches. In our third approach, we attempted to account for these factors by only counting each surname once within each community. Using this third approach, we find that 23,400 households participated in training. However, because many surnames are frequent in Armenia, we suspect that this approach grossly undercounts the number of trained households. On the other hand, spouses often do not have the same last name, so there is still some upward bias present in this approach as well, though it is unlikely to offset the downward bias due to repetitive surnames for unrelated families.