Baseline Report on the Tertiary Canal Survey

Final Report

December 7, 2010

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Randall Blair
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I. INTRODUCTION

As a former Soviet republic, Armenia was left with the legacy of a centrally planned economy that was highly dependent on its Soviet trading partners and poorly equipped to function with the lack of infrastructure investment and support after Soviet withdrawal. Many rural residents use subsistence farming to supplement low incomes (Republic of Armenia 2003), but rural poverty rates remain high, with nearly one in four rural households living below the poverty line (National Statistical Service of Armenia 2009).

Independence also left Armenia with an oversupply of rural infrastructure that has not been properly maintained for the past 20 years. A study by the World Bank (2004) found that irrigation systems were in a poor state or entirely non-operational for more than 52 percent of previously irrigated land in the country. The study found reductions in the proportion of arable land being irrigated, declining from 54 percent in the early 1990s to 39 percent in 2003. Rural roads were in no better condition, with 61 percent in poor or very poor condition, and only 16 percent fully passable during the winter. Finally, the study found that only 60 percent of farms were efficiently irrigated as a result of the high cost of water, high water losses, and high electricity costs. Common throughout rural Armenia, these conditions increase the cost of farm operations and exacerbate rural isolation.

In issuing its 2003 Poverty Reduction Strategy Paper, the Armenian government identified rural development as the key to poverty reduction and overall economic growth (Republic of Armenia 2003). The strategy paper argued that improving rural infrastructure could help maintain and improve living standards among rural residents, which could in turn lead to future economic growth in rural areas and throughout the country. In response to the findings highlighted in the strategy paper, the Armenian government proposed a five-year program of strategic investment to improve rural infrastructure through funding provided by the Millennium Challenge Corporation (MCC).

The aim of the Millennium Challenge Account with Armenia (MCA-Armenia) is to increase household income and reduce poverty in rural Armenia through improved performance of the country's agricultural sector. The MCA-Armenia program was designed to include three interrelated projects: (1) the rehabilitation of rural roads; (2) the rehabilitation of irrigation infrastructure; and (3) the provision of training, technical assistance, and access to credit for farms and agribusiness ("the Water-to-Market project").[1] MCC has commissioned rigorous impact evaluations to separately examine each of the main components of the MCA-Armenia program.

The evaluation of irrigation infrastructure will be subdivided into two evaluations. The first, to which this report relates, is Mathematica's evaluation of the rehabilitation of tertiary canals. The evaluation of tertiary canal rehabilitation will draw on data collected before and after tertiary canal rehabilitation. Data on a range of outcomes—including crop production, diversity, and household income—will be collected in communities selected for rehabilitation as well as in matched comparison communities in which canals were not rehabilitated as part of the program. Using a difference-in-differences approach, we will compare changes over time in outcomes among farmers

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

in areas with tertiary canal rehabilitation to changes over time in outcomes among farmers in matched comparison areas. Tertiary canal rehabilitation began in early 2010 and is expected to be completed by fall 2011; we expect to collect follow-up data from winter 2012 to spring 2013 and report impact estimates in late 2013. A second evaluation will be conducted to examine the impacts of other irrigation infrastructure rehabilitation, as described in further detail in Section A of this chapter.

This report presents baseline data from the Tertiary Canal Survey (TCS), which serves as the primary data source for evaluating the rehabilitation of tertiary canals component of the irrigation infrastructure project. In particular, we describe farmer characteristics as well as baseline values of measures that will eventually be used to assess the impacts of tertiary canal rehabilitation. This summary will provide an understanding of the current irrigation and agricultural situation in rural Armenia, as well as valuable context for the impact evaluation. Additionally, examining measures of household well-being before the program has been implemented is informative to provide a basis for comparison with household well-being following the tertiary canal rehabilitation activities. This early analysis of the TCS will also provide an opportunity to learn what worked well in this round of data collection, and to identify survey instrument improvements so that future iterations of the TCS best address the policy questions of greatest interest to the evaluation. Perhaps most importantly, this baseline analysis allows us to assess the comparability of tertiary canal communities and comparison communities. To ensure unbiased impact estimates, tertiary canal and comparison communities should have no systematic differences across a range of key indicators at the time of the baseline survey.

The remainder of Chapter 1 is structured as follows: Section A describes the MCA-Armenia irrigation rehabilitation project, Section B outlines our impact evaluation, and Section C describes the TCS.

A. The MCA-Armenia Irrigation Rehabilitation Project

Given the importance of irrigation to the agricultural economy of Armenia, improving irrigation infrastructure is a major component of MCC's investments in the country. MCA-Armenia's irrigation rehabilitation efforts cover several different types of irrigation infrastructure, including main canals, the Ararat Valley drainage system, pumping stations, gravity schemes, and tertiary canals. However, for most of the larger infrastructure investments (such as gravity schemes or main canals), only a handful of projects will be implemented. The original intent of the irrigation project was to rehabilitate infrastructure in most parts of the country. From an evaluation design perspective, the only feasible design would have been some variant of a pre-post design. However, devaluation of the dollar, combined with higher than anticipated costs of the rehabilitation of the irrigation schemes, led to a fairly large scaling down of the irrigation infrastructure to be rehabilitated. While scaling down efforts opened up the possibility of identifying some comparison areas for a more rigorous design, the number of schemes where improvements were planned (other than the tertiary canals) proved to be too few to support a rigorous evaluation. The available sample size is limited, and because each of the larger projects is unique, identifying comparison areas that are well-matched is difficult. MCC still intends to evaluate these larger projects to the extent possible, but because of the evaluation design challenges described above, the findings will only be suggestive of project impacts.

In contrast, the tertiary canal rehabilitation efforts are more conducive to a rigorous impact evaluation for a few reasons. First, being smaller investments, there is a sufficient number of tertiary canals that serve communities throughout the country, allowing for good statistical precision in

estimating program impacts. We estimate that, even with conservative assumptions about community attrition, the minimum detectable impact on household poverty rates is approximately 5.5 percentage points. Second, because not all communities that have tertiary canals in need of improvement will actually get tertiary canal improvements, it is possible to find sufficient comparison communities to allow us to confidently estimate the counterfactual of what would have happened in the absence of rehabilitation. In addition, the goal of improvements for all of the different types of infrastructure (other than drainage) is to increase water availability and reliability. Having rigorous estimates of the impact of more water and more reliable access to water on farm productivity as a result of the tertiary canal improvements will also inform us about the likely impact of the other types of irrigation infrastructure, to the extent that their measurable effects on water availability and reliability are similar. Because this more rigorous evaluation is possible, the tertiary canals will be evaluated separately from the other irrigation projects.

Tertiary canals route irrigation water from larger irrigation infrastructure such as main canals or reservoirs to farmers' fields. Because many of the canals were originally constructed in the Soviet era using concrete materials, they have deteriorated and disintegrated in many places, leading to severe water losses. Other tertiary canals were created by digging channels in the ground, which has produced ground seepage and substantial water losses. MCA-Armenia estimates that only 25-40 percent of irrigation water actually reaches the fields in most villages with tertiary canals.

MCA-Armenia plans to rehabilitate tertiary canals serving over 100 communities. Communities interested in having their tertiary canals rehabilitated submit an application to MCA-Armenia with detailed information on the length (kilometers) of the canal (or canals) to rehabilitate, the number of farmers expected to benefit, estimated water losses, and other information on the potential benefits they expect to achieve. MCA-Armenia then conducts engineering and economic analyses of the projects to determine which rehabilitation projects will be funded. As mentioned above, MCA-Armenia provides most of the financing for the rehabilitated canals, but villages are responsible for paying a small portion of the construction costs; if they are unable to provide the co-funding, the canal will not be rehabilitated. This co-funding arrangement is designed in large part so that villages feel ownership over the canals and are more likely to maintain them over the longer term. A handful of these tertiary rehabilitations have been completed already (primarily as pilots). Work began on the remaining communities selected for rehabilitation as part of the MCA projects in spring 2010.

B. Impact Evaluation Design

Although a random assignment design is considered the most rigorous evaluation approach, randomly selecting which canals would be rehabilitated was deemed infeasible. Initially, the implementation team thought that qualified applications for tertiary canals might exceed project resources, and randomly selecting the canals to be rehabilitated (or using some ordering mechanism by projected rates of return) was considered. However, based on the number of applications received, combined with some flexibility in allocation of funding across irrigation projects, MCA-Armenia plans to fund all of the eligible canals.

As an alternative to random assignment, we have developed a comparison group design as a means of estimating the counterfactual of what would have happened in the communities if their tertiary canals were not rehabilitated. Establishing the counterfactual is an important element of most program evaluations; it is especially crucial for evaluating a program designed to affect agriculture outcomes, as these outcomes are particularly vulnerable to external factors such as weather and market prices, and recently, the world economic crisis. Hence, simply comparing agricultural outcomes for the same communities before and after rehabilitation would not provide

convincing impact estimates. Under this comparison group approach, tertiary canals for which rehabilitation is planned—or canals serving the treatment group—were matched to other canals sharing similar geography, pre-rehabilitation conditions, and crops. Examining how outcomes change for farmers in the comparison group (whose canals were not rehabilitated) will help us estimate how those outcomes would have changed in the absence of the rehabilitation efforts.

The comparison group design focuses on comparing communities served by rehabilitated tertiary canals (hereafter "tertiary canal" or equivalently "treatment" communities) to similar communities whose infrastructure was not rehabilitated (hereafter "matched comparison communities").[2] We will estimate the impacts of the program by comparing the post-rehabilitation outcomes for these two sets of communities. Crucially, the analysis will compare how the outcomes have changed relative to the same outcomes measured before the rehabilitation. This approach, which estimates program impacts as the difference-in-differences for the treatment and the comparison group, is stronger than simply comparing post-rehabilitation outcomes for the treatment and comparison groups because it allows us to adjust for pre-existing differences in the two groups. Under certain conditions, comparison group designs have been shown to replicate the findings from randomized controlled trials (Cook, Shadish, and Wong 2008). Still, for this approach to be credible, we must be able to identify comparison communities that are very similar to treatment communities, at least on observable characteristics.

For each community that benefited from the canal rehabilitation project, we identified a comparison community that, prior to the rehabilitation, was very similar on the characteristics that could be expected to affect the key outcomes: agricultural production and irrigation conditions.[3] Matched comparison groups are often chosen using statistical methods such as propensity score matching that, for each tertiary canal, would find as close of a match as possible on the many community characteristics that could affect these outcomes. However, a statistical matching approach would require a data file or documentation containing information such as main crops grown, number of farmers, irrigation sources, etc. for all of the communities in the regions where irrigation projects were planned, as well as all communities that could serve as possible comparison communities. Such a reliable data file or documentation does not exist and would require considerable effort to create.

We used two main processes as we set about to identify suitable comparison communities for each tertiary canal. Our primary approach was to rely on the input of MCA staff who are knowledgeable about the agricultural conditions in these communities and who closely worked with Water User Association (WUA) directors to identify similar communities.[4] Although the process was not a formal, statistical matching procedure, we attempted to systematize the process to keep the matches as objective as possible. It was important to match treatment and comparison communities before the project could feasibly produce changes in the characteristics of treatment communities,

[2] Some communities have more than one canal, and the rehabilitated canal serves only a subset of farmers in the village. In these cases, the survey and analysis will focus on farmers served by the rehabilitated canal. In the subsequent discussion, we focus on the illustrative example of a single canal per community for expositional simplicity.

[3] More than one comparison community was selected for some communities that benefited from the rehabilitation project.

[4] WUA directors are in charge of all the communities that are part of their association, and are deeply familiar with the cropping patterns, water use (amount and source) and other relevant aspects of the communities.

so that the matching process did not obscure actual program impacts. The initial set of matched comparison communities was selected with a focus on the following three criteria: geography, pre-rehabilitation irrigation conditions, and crops grown. In particular, for selection, comparison communities had to be in the same geographic area and served by the same WUA; had to have similar pre-rehabilitation irrigation conditions as the communities that would benefit from the rehabilitation project (such as similar water losses and source of irrigation water, e.g., from a main canal or a gravity scheme); and had to grow similar crops. That the comparison community grew similar crops was an especially vital criterion, as there can be considerable variation in the crops grown from one village to the next, even within a region. One village might have many farmers who cultivate orchards or grapes, while another mainly produces wheat. These two types of crops have vastly different income potential, and experience very different benefits from irrigation improvements. Hence, these two villages would not make a suitable match.

A given tertiary canal community could potentially be matched to multiple comparison communities if more than one community was a good match on the above criteria. We have included all such matches in our impact study (and survey) so as to maximize the sample size and, hence, statistical precision. In a few cases, multiple tertiary canal communities may share a set of comparison villages if they have similar characteristics. MCA-Armenia also identified five tertiary canal communities that did not have a suitable comparison community; these five were excluded from the study and data collection.

In addition, to get a second, independent assessment of the comparability of these matches, the survey team also investigated the suitability of each matched comparison community when they went into the field for baseline data collection. First, as part of the "pilot" effort, the survey team visited about 10 treatment communities that were selected for tertiary rehabilitation as well the potential matches for these communities to "ground truth" the matches and see how similar the communities were in terms of the crops grown and canals' conditions (and also to help devise approaches to drawing the sample of farmers to be surveyed). In addition, as part of the data collection process, the survey team obtained information from the village mayors on the three main criteria listed above, and also considered other community characteristics that could indicate that, for a variety of reasons, the planned comparison community did not provide a compelling match. In most instances, the original matches were found to be credible, and only a handful of the initial matched comparisons exhibited differences on the key characteristics. When necessary, the survey team worked with the WUA directors to identify comparison communities to replace the original match.

C. Tertiary Canal Survey

The primary data source for the impact evaluation of the tertiary canal rehabilitation is a new farming household survey tailored to this impact evaluation, the Tertiary Canal Survey (TCS). MCA-Armenia amended its contract with the consortium that fielded the Farming Practices Survey, AREG and its partner Jen Consulting—hereafter referred to collectively as AREG—to field the baseline TCS. The key outcomes of interest from the TCS include crops cultivated, crop production, agricultural profit, household income, and poverty levels during the previous year. The TCS also features questions about the reliability and quality of irrigation water during the last agricultural season. We will conduct two rounds of the TCS: a baseline and a follow-up survey. The baseline TCS was fielded between December 2009 and March 2010; crucially, it ended before the next irrigation season began and before the rehabilitation projects were completed. The follow-up is scheduled to begin in late 2012 and finish in early 2013.

Sample frame for the surveys. The target population for the TCS is beneficiary farmers with plots served by the tertiary canals that will be rehabilitated and farmers with plots served by similar canals in the matched comparison communities. Ideally, respondents for the TCS would be randomly sampled from the farming households served by the rehabilitated tertiary canals and the matched comparison group. However, a sample frame from which we could sample such farmers does not exist. Developing such a frame by going directly to the affected areas is complicated by the fact that farmers may not live in immediate proximity to their plot. The initial plan was for the survey team to work with village mayors to fully enumerate all tertiary farmers who would constitute the sample frame from which a subset of respondents would be randomly sampled, but piloting this process revealed that it was too time-consuming to be feasible, as it required two separate visits to each village—one visit to develop the list of farmers, and a second to interview the random sample. This jeopardized the survey team's ability to complete the baseline survey before the canal rehabilitation started and the next irrigation season began, at which point it could no longer serve as a true baseline.

Instead, the survey team worked with village mayors to identify the farmers served by each tertiary canal, and then the mayors helped the survey team arrange interviews with a subset of these farmers. In the treatment communities, they identified farmers who would potentially benefit from the canal planned for rehabilitation. In the comparison communities, the survey team attempted to interview farmers served by the comparison canal who grew similar crops and had land sizes similar to the associated treatment group farmers. In addition, we selected a slightly larger number of respondents in the comparison communities to allow for more matching options in case a few of the comparison group farmers were actually dissimilar to the associated treatment group farmers.[5,6] Finally, we used interviews with village mayors to examine the extent to which the respondent households were comparable to the other households in the villages; this helped assess the extent to which the findings from our sample would generalize to the broader population.

Although over 100 canals are scheduled for rehabilitation, our impact analysis focuses on 98 canals scheduled for rehabilitation. It does not include 14 additional canals rehabilitated by MCA-Armenia: (1) four pilot canals were rehabilitated before the other canals and would likely have been utilized in the previous agricultural season, so we could not obtain the informative pre-intervention baseline data that would be necessary for these canals to be included in the evaluation; (2) five canals are in small cities where it was not feasible to develop reliable lists of respondent farmers; and (3) five other canals did not have suitable matched comparison canals, as discussed previously.

The total sample size and number of communities includes approximately 3,000 farming households across 175 communities. Ninety-eight of these are in the tertiary canal group, and the remaining 77 communities are in the comparison group. Every tertiary canal community is matched to at least one comparison community, and some comparison communities are matched to more

[5] While we are concerned about "selection bias" in the sense that the community leaders who applied for tertiary canal rehabilitation may be more motivated or more able to mobilize resources in the community for the application, we are not sure the extent to which this selection bias would affect the farmers that the mayors identify as having land near the tertiary canals and hence will benefit from the improved irrigation.

[6] With more respondents in comparison communities, we can explore the option of matching each farmer in any given treatment community with the farmer in the corresponding comparison community that is most similar in terms of land, crop mix, agricultural income, and other key characteristics. This option will be explored during the impact analysis.

than one tertiary canal community. Table I.1 provides a summary of the geographical distribution of the treatment communities—that is, communities in the tertiary canal group—and comparison communities. In each tertiary canal community, about 15 farmers were interviewed. Approximately 20 farmers were interviewed in each comparison community.

Table I.1. Distribution of Village Clusters by Treatment Status and Agricultural Zone

	Ararat Valley	Pre-Mountainous Zone	Mountainous Zone	Sub-Tropical Zone	Total Communities
Treatment Communities	44	23	28	3	98
Comparison Communities	32	20	22	3	77
Total	**76**	**43**	**50**	**6**	**175**

Because the climate and agricultural conditions vary considerably across zones, we present many estimates separately by agricultural zone. Ararat Valley is located in the area surrounding Yerevan; it is the most agriculturally prosperous zone in the country, both because its climate is most favorable and because of its proximity to Yerevan. The Mountainous Zone, which covers much of the northern part of the country, has the most challenging agricultural conditions. The weather is harsher, and the terrain makes it harder to maintain reliable irrigation systems or access markets, thus rendering cultivation of fruits and vegetables unprofitable. The Pre-Mountainous Zone lies mostly between these two, both in terms of geography and agricultural conditions, and also stretches into northeastern Armenia. A small number of tertiary canal projects are in the Sub-tropical Zone, which is concentrated in Syunik. These communities are included in the overall estimates, but considering the small number (3 treatment communities and 3 matched comparison communities), we do not report separate estimates for the Sub-tropical Zone.

Some of the tertiary canals currently planned may ultimately not be implemented if, for example, the community is unable to pay their portion of the funding required. Construction delays may also mean that canals are not completed in time to be included in the analysis. Any canals dropped after data collection will be excluded from the impact analysis, along with their matched comparison communities.[7]

[7] Although the analysis can be adjusted to account for these dropped communities, the smaller sample size will reduce the statistical precision of the impact estimates. Our power calculations reported previously make conservative assumptions about attrition to account for this likelihood.

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II. HOUSEHOLD CHARACTERISTICS AND FARMER PRACTICES AT BASELINE

The goal of the MCA-Armenia tertiary canal rehabilitation activities is to increase farmers' access to and reliability of irrigation water. This, in turn, is intended to allow farmers to adopt more effective irrigation and farming practices, cultivate higher-value crops, and increase production. These positive changes in conditions and productive practices will eventually improve farmer income and reduce rural poverty. The primary measures included in the 2009-2010 Tertiary Canal Survey (TCS) instrument reflect these key outcomes. We included other descriptive information in the instrument to facilitate the impact analysis. Altogether, three broad categories of information were collected: (1) household characteristics, (2) variables intended to measure intermediate effects of the intervention such as irrigation usage and farming practices, and (3) variables intended to measure program effects, including crop production, agricultural sales, and household income. (The complete survey instrument is provided in Appendix A.) In this chapter, we examine the baseline characteristics of the households and farmers in our sample, as well as pre-intervention measures of intermediate outcomes such as water use and farming practices. In the next chapter, we describe pre-intervention measures of key outcomes of interest to the evaluation.

Household Characteristics. Examining household characteristics provides important context about the sample, and allows us to understand the types of households included in the sample and how they compare with the broader population of rural Armenia. These characteristics will also serve as important explanatory variables in our regression models. Table II.1 summarizes the household characteristics included in the TCS instrument.

Table II.1. Household Characteristics

Measures	Time Frame
Geographic Information. The village, marz, and WUA of the household.	As of Survey Date
Land Holdings. The amount of arable land, orchards, and vineyards owned or rented by the household, and the size of the household's kitchen plot.	As of Survey Date
Household Roster. List of all household members, relationship to the head of household, gender, age, education level, years the household head has been farming.	As of Survey Date

WUA = Water User Association.

Variables Measuring Intermediate Effects. We would expect tertiary canal improvements to have an impact on households' incomes only if we observe that a substantial proportion of the targeted farmers are leveraging the improvements in irrigation water by irrigating more land or increasing the number of times they are able to irrigate, adopting more effective farming practices, and adopting a higher-value mix of crops. Examining intermediate measures for the comparison group also establishes the counterfactual—the irrigation to which farmers would have had access, the services that farmers in villages would have received, and the practices they would have adopted in the absence of irrigation rehabilitation efforts. The findings reported in this chapter on irrigation services prior to the intervention indicate that baseline quality of irrigation systems and utilization of irrigation technologies is poor; this suggests that many farmers could potentially benefit greatly from improved irrigation that will be available following rehabilitation. Table II.2 summarizes the key intermediate variables that can be examined using the TCS data.

Table II.2. Measures of Intermediate Effects

Measures	Time Frame
Water Usage. Amount of land that could be irrigated; amount of land that actually was irrigated; amount of land watered using other sources (such as well or drinking water); frequency of irrigation.	Last Agricultural Season
Quality of Irrigation System. Perceived overall quality of irrigation in the village; perceived changes in quality from previous year; main irrigation problems in the village; timeliness and sufficiency of irrigation water.	Last Agricultural Season
Investment in Agricultural Technology or Equipment. Ownership of personal reservoir or water pump; adoption of irrigation practices and technologies.	Last Agricultural Season
Agricultural Costs. Expenditures on fertilizers, pesticides, irrigation water, hired labor, rented equipment and taxes (individually and in total).	Last Agricultural Season
Cropping Patterns. Specific crops grown, especially high-value crops; amount of land devoted to cultivation of each crop; reason(s) for changes in cropping patterns.	Last Agricultural Season

A. Household Characteristics

The demographics and structure of the households surveyed provide context for the types of households included in the communities where tertiary canals will be rehabilitated. Tables II.3 and II.4 describe the characteristics of the households in our sample.[8] In Table II.3, we present a detailed summary of the head of each household surveyed, or the person with primary responsibility for making farming decisions. We also present a detailed description of the survey respondent. While the head of household and the survey respondent were often the same person, 27 percent of TCS respondents identified another family member as the head of household.

As shown in Table II.3, over one-third of heads of household were age 60 or older, and the average age of household heads was 56. Approximately 30 percent of the heads of household in the sample were younger than age 50. Nearly 13 percent of heads of household were females, and a substantial majority of the household heads (85 percent) had completed either secondary or vocational secondary school.

Because of the comparatively high average age of the heads of household and the substantial number of multigenerational families in our sample, there is some concern that respondents identified the head of household as the eldest person in the household regardless of whether that person was primarily responsible for the farming decisions. For example, the person who runs the farm may have identified his or her elderly mother or father as the head of household because the home belongs to that parent. However, because the survey administrators were instructed to speak with the person in the household with primary responsibility for farming decisions, the respondent may serve as a better approximation of the person running the farm than does the reported head of household. For this reason, Table II.3 also includes key characteristics of the survey respondents. In

[8] Here and throughout the report, baseline measures are reported for the pooled sample of treatment and control group farmers. Chapter IV provides measures separated by farmers in treatment and comparison communities.

Table II.3. Head of Household and Respondent Characteristics (Percentages Unless Otherwise Indicated)

	Head of Household	Respondent
Age		
<40	7	20
40–49	23	28
50–59	34	32
60 and older	36	20
(Average)	56.4	49.6
Female	13	13
Education		
Less than secondary	15	10
Secondary	41	41
Secondary (vocational)	24	27
More than secondary	19	23

Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

Table II.4. Household Characteristics (Percentages Unless Otherwise Indicated)

Multigenerational Family	50
Household Members	
4 or fewer	38
5	24
6	20
7 or more	18
(Average)	5.0
Children in Household	
0	38
1	22
2	26
3 or more	13
(Average)	1.2

Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

contrast to those identified as the heads of household, respondents were on average almost seven years younger, and a greater percentage of respondents had finished secondary school (90 percent versus 85 percent of heads of household).

As illustrated in Table II.4, exactly half of households in the survey are multigenerational families, with at least one grandparent residing in the household. The majority of families also include at least one child younger than age 18. On average, households have approximately 5.0 members. This is larger than estimates from the 2008 Integrated Living Conditions Survey of Households (ILCS), which found that a typical rural Armenian household comprises 4.3 members.

B. Farms and Irrigation Practices

In this section, we examine several characteristics of households' farms and agricultural practices, including: (1) farms and capital, (2) irrigation practices, and (3) farming expenditures.

1. Farms and Capital

As evident in Table II.5, most of the farms in our sample are small; about half (50 percent) of farmers cultivated one hectare (10,000 square meters) or less during the last agricultural season. However, 22 percent of farmers cultivated two or more hectares, and the average land area cultivated by respondents was slightly above one and a half hectares. Thus, although around half of farmers cultivated a hectare or less, a minority of farmers in the sample with relatively large farms cause the average farm size to be larger than the median farm.[9] As shown by median values of zero in Table II.5 under land area of vineyards and orchards, the typical farmer surveyed does not own or rent land devoted to vineyards or orchards. Across all zones, arable land makes up a large proportion of total land cultivated.

The overall distribution of farm sizes masks considerable variation across the three agricultural zones. Ararat Valley has the smallest farms, on average; 64 percent of farmers in Ararat Valley cultivated a land area of one hectare or less. In contrast, only 23 percent of farmers in the Mountainous Zone cultivated one hectare or less. Examining relatively large farms, more than four out of ten famers in the Mountainous Zone reported cultivating over two hectares of land, compared to less than two out of ten farmers in the other two zones.

As evident in Table II.5, the variation in farm size across zones appears to be related to differences in animal ownership across zones. The largest farms are in the Mountainous Zone, which also has the most cows and sheep per household, on average. It is likely that farmers in the Mountainous Zone use more arable land to grow feed for animals than farmers in other zones.

2. Irrigation Practices

At baseline, farmers reported irrigating a large fraction of their land during the last season. On average, farmers irrigated nearly half of their arable land, and over three-quarters of their orchards, vineyards, and kitchen plots (Table II.6). Irrigation water was used far more widely than drinking water, well water, and natural sources to water arable land, orchards, vineyards, kitchen plots, and other types of land. On average, farmers reported watering around seven percent of their arable land with natural sources such as rivers, lakes, and rainwater. Farmers also reported watering about 12 percent of their kitchen plots with well water, on average. However, these additional water sources appear to be used only to supplement the use of irrigation water on arable land and kitchen plots.

[9] The median is the value in the exact middle of the distribution (the 50th percentile). Similar to an average (or mean), a median is a measure of the "typical" land area for farmers in the sample, but the advantage of the median is that it is not sensitive to distributional outliers that could skew the average area upward or downward.

Table II.5. Respondents' Land and Livestock Holdings by Zone (Percentages Unless Otherwise Indicated)

	Ararat Valley	Pre-Mountainous	Mountainous	All Zones
Area of Total Land Cultivated (Square Meters)				
5,000 or less	21	27	9	19
5,001 to 10,000	43	30	14	31
10,001 to 15,000	17	16	17	18
15,001 to 20,000	7	10	17	11
20,000 or more	12	17	42	22
Average	12,368	12,325	27,826	16,825
(Median)	(8,000)	(8,800)	(17,500)	(10,100)
Area of Arable Land Cultivated (Square Meters)				
Average	7,355	7,467	24,624	12,300
(Median)	(4,000)	(4,500)	(15,000)	(6,000)
Area of Orchards Cultivated (Square Meters)				
Average	1,015	1,434	236	985
(Median)	(0)	(0)	(0)	(0)
Area of Vineyards Cultivated (Square Meters)				
Average	1,719	535	581	1,117
(Median)	(0)	(0)	(0)	(0)
Area of Kitchen Plot (Square Meters)				
Average	1,783	1,637	2,445	1,917
(Median)	(1,500)	(1,200)	(2,000)	(1,500)
Area of Other Land Cultivated (Square Meters)				
Average	307	571	405	399
(Median)	(0)	(0)	(0)	(0)
Average Number of Cattle Owned (Square Meters)	0.7	1.4	2.9	1.5
Average Number of Pigs Owned (Square Meters)	0.4	0.5	0.7	0.5
Average Number of Sheep and Goats Owned (Square Meters)	0.3	0.9	3.5	1.3

Source: 2009-2010 Tertiary Canals Survey (TCS).

Note: Averages include respondents that reported no values.

Sample Size = 2,997 (1,300 in Ararat Valley, 744 in the Pre-Mountainous Zone, 848 in the Mountainous Zone, and 105 in the Subtropical Zone; not reported separately).

Among all types of land, farmers reported irrigating their kitchen plots and arable land most frequently during the last year. Farmers irrigated their kitchen plots between six and seven times last year, and irrigated their arable land four times last year, on average. Average irrigation times were longest for arable land and other land types, at around 12 hours of irrigation. In contrast, orchards and vineyards were irrigated for only 8 hours at a time, on average. For most land types, slightly over half of respondents reported receiving water when they needed it.

As with average farm size, regional differences in irrigation practices are evident in Table II.7. The contrast between the Mountainous Zone and Ararat Valley is especially pronounced when comparing the percentage of land irrigated with any water source. Farmers in the Mountainous Zone watered only 34 percent of their total land, compared with 76 percent of total land in Ararat Valley (Table II.7). Interestingly, only farmers in the Mountainous Zone reported watering more than 10 percent of their total land with natural sources, such as rivers and lakes.

Table II.6. Respondents' Watered Land Area (Percentages Unless Otherwise Indicated)

	Respondents' Cultivated Land				
	Arable Land	Orchards	Vineyards	Kitchen Plot	Other Land
Land Irrigated with Any Water Source	45	86	89	77	8
Land Irrigated with:					
Irrigation water	44	80	83	66	8
Deep well and artesian well water	2	3	3	12	0
Natural sources/river/lake/ collected rainwater, etc.	7	2	3	4	1
Drinking water	0	0	0	3	0
Average Times Land Irrigated by Network in 2009	4.1	0.8	0.8	6.5	0.0
Average Irrigation Time (Hours)[a]	11.6	8.0	7.8	3.9	12.2
Respondents That Received Water When Needed Last Season	53	51	55	57	25
Respondents That Received as Much Water as Needed Last Season	62	65	68	66	88

Source: 2009-2010 Tertiary Canals Survey (TCS).

Note: Percentages reported for different sources do not match total percentages for any water source due to the use of multiple sources of irrigation for some land.

[a]Conditional on reporting irrigating at least one time in the previous year.

Sample Size = 2,997

Table II.7. Respondents' Watered Land Area, by Zone (Percentages)

	Respondents' Total Cultivated Land That Is Watered Using:			
Water Source	Ararat Valley	Pre-Mountainous	Mountainous	All Zones
Any Water Source	76	52	34	57
Irrigation Water	69	52	33	54
Deep Well and Artesian Well Water	8	0	0	4
Natural Sources/River/Lake/Collected Rainwater, etc.	1	6	13	6
Drinking Water	0	2	0	1

Source: 2009-2010 Tertiary Canals Survey (TCS).

Note: Percentages reported for different sources do not total percentages for any water source due to the use of multiple sources of irrigation for some land.

Sample Size = 2,997

About one-third of respondents reported that they did not irrigate their land last season (Table II.8). The large majority of these farmers reported they did not irrigate because the water did not reach their farm due to technical reasons.

Table II.8. Reasons Respondents Did Not Irrigate Land Last Season (Percentages)

Respondent Did Not Irrigate Land Last Season	30
Among Those That Did Not Irrigate, Reason:	
Water did not reach farm due to technical issues	77
Water did not reach farm due to organizational or managerial issues	6
Lands were not cultivated	6
Could not pay for irrigation	3
Not necessary due to weather	2
Water was not delivered by WUA as promised	1
Other	5

Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 932 for reason question.

As shown in Table II.9, three quarters of farmers in our sample are WUA members, with greater membership in Ararat valley and in the pre-mountainous zones. Although tank and pump ownership varies by region, less than one-quarter of farmers in any region have a personal tank, well or reservoir, or have a personal pump to pump water. About one-third of farmers in any region attended both OFWM and HVA training, and one in ten farmers attended only OFWM training (Table II.9). Around one-half of farmers in the full sample reported verifying or modifying furrow geometric parameters, either in their kitchen plot or other land. A similar percentage (47 percent) reported preparing land for irrigation. As illustrated, farmers' use of dams, gated pipes, hydrants, sprinkler irrigation, and drip irrigation during the last agricultural season was minimal. The limited utilization of these methods is consistent with (less-detailed) findings in the 2008 ILCS.

Table II.9. Respondents' Irrigation Practices (Percentages)

	Ararat Valley	Pre-Mountainous	Mountainous	All Zones
Respondents:				
Are WUA members	86	77	58	75
Have a personal tank, artesian well, or reservoir	20	4	5	12
Have a personal pump to pump water	22	2	5	12
Attended OFWM and HVA training	37	27	24	30
Attended OFWM training only	10	12	11	10
Attended HVA training only	2	6	5	4
In Last Agricultural Season, Respondents:				
Verified/modified furrow geometric parameters	62	48	44	53
Prepared land for irrigation	50	47	43	47
Obtained copy of own water supply contract from WUA	22	11	7	15
Updated annex of water supply contract	3	3	0	2
Submitted an application to WUA	0	1	1	1
In Last Agricultural Season, Respondents Used:				
Plastic or metal dams	5	3	7	5
Gated pipes	0	1	2	1
Hydrants	0	4	0	1
Sprinkler irrigation	0	1	1	1
Drip irrigation	1	0	0	1

Source: 2009-2010 Tertiary Canals Survey (TCS).

Note: Irrigation practices include practices used in either the respondent's kitchen plot or other land.

Sample Size = 2,997

Overall, the vast majority of farmers reported very little change in their water supply over the past 12 months (Table II.10). In all zones, nearly three-quarters of farmers reported that their irrigation systems remained unchanged in terms of timeliness and quantity. In addition, over half of farmers in the full sample rated the condition of their irrigation system as bad or very bad. In all regions, the bad condition of tertiary canals, the lack of tertiary canals in the village, and the bad condition of the main canals were cited as the main water system problems. Interestingly, 43 percent of farmers reported that the irrigation system was repaired during 2009 (Table II.11). Farmers cited the local WUA—and to a lesser extent the community council—as the parties responsible for repairs in most cases. According to respondents, only seven percent of repairs in 2009 involved MCA-Armenia.

Table II.10. Satisfaction and Problems with Irrigation System (Percentages)

	Ararat Valley	Pre-Mountainous	Mountainous	All Zones
Respondents Reporting That Water Supply:[a]				
Improved in terms of timeliness	11	8	12	11
Improved in terms of quantity	12	7	14	12
Remained unchanged	73	73	72	72
Got worse in terms of timeliness	11	15	8	11
Got worse in terms of quantity	8	11	10	9
Respondents Rating the Condition of Their Irrigation System as:				
Good or very good	13	7	6	10
Satisfactory	41	37	36	38
Bad	26	32	29	28
Very bad	20	24	29	24
Water System Problems (Up to 3 Cited by Each Respondent):				
Bad condition of tertiary canals inside the village	57	63	45	55
The lack of tertiary canals inside the village	52	41	39	46
Bad condition of the main canals	15	45	56	35
Disorganized work of the water supplier	4	11	11	8
Absence of clear-cut water supply schedule in the village	7	5	9	7
Don't see any serious problem	6	7	3	6
Bad condition of pump for deep well	4	1	4	3
Bad condition of artesian well	4	0	4	3
Bad condition of regular irrigation pump	2	2	6	3
Other	4	4	9	5

Source: 2009-2010 Tertiary Canals Survey (TCS).

[a]Percentages do not total 100 because some original response categories were combined. Original categories were: Improved only in terms of timeliness; Improved only in terms of quantity; Improved both in terms of timeliness and quality; Remained unchanged; Got worse only in terms of timeliness; Got worse only in terms of quantity; Got worse in terms of timeliness and quantity. Respondents who reported that the water supply improved in terms of timeliness and quality—or got worse in terms of timeliness and quantity—were counted in both the timeliness and quantity response options.

Sample Size = 2,997

Table II.11. Irrigation System Repairs (Percentages)

System Was Repaired During 2009	43
System Was Repaired by:[a]	
The WUA	77
The rural community/community council	37
MCA-Armenia	7
Respondent alone or with other farmers	7
Another party	2

Source: 2009-2010 Tertiary Canals Survey (TCS).

Note: Categories are not mutually exclusive.

[a]Responses do not sum to 100 because respondents could cite more than one actor.

Sample Size = 2,997 for the first variable and 1,247 for all following variables.

3. Farming Expenditures

The operation of a farm requires expenditures on inputs such as fertilizer, irrigation, and labor. These expenditures are important components in measurements of profits from agriculture. Table II.12 details the annual expenditures for the farmers in our sample.[10] The largest expenses for

Table II.12. Respondents' Average Annual Farm Expenditures (AMD)

Respondent Expense for:	Ararat Valley Average (Median)	Pre-Mountainous Average (Median)	Mountainous Average (Median)	All Zones Average (Median)
Fertilizer and Pesticides	104,718 (70,000)	30,165 (12,000)	62,053 (14,000)	73,206 (30,000)
Irrigation Payments	54,874 (32,000)	24,573 (12,000)	21,803 (5,000)	37,692 (15,000)
Hired Labor and Hired Equipment or Tools	109,339 (40,000)	41,677 (7,000)	129,123 (56,000)	96,925 (30,000)
Taxes and Duties	23,055 (15,000)	11,148 (8,000)	23,488 (11,000)	20,158 (12,000)
Seeds	59,890 (0)	9,387 (0)	105,508 (0)	59,422 (0)
Other Major Expenses	44,293 (0)	3,723 (0)	9,425 (0)	23,543 (0)
Total Agricultural Expenses	**396,169 (226,000)**	**120,673 (65,000)**	**351,399 (146,000)**	**310,945 (148,000)**

Source: 2009-2010 Tertiary Canals Survey (TCS).

AMD = Armenian drams.

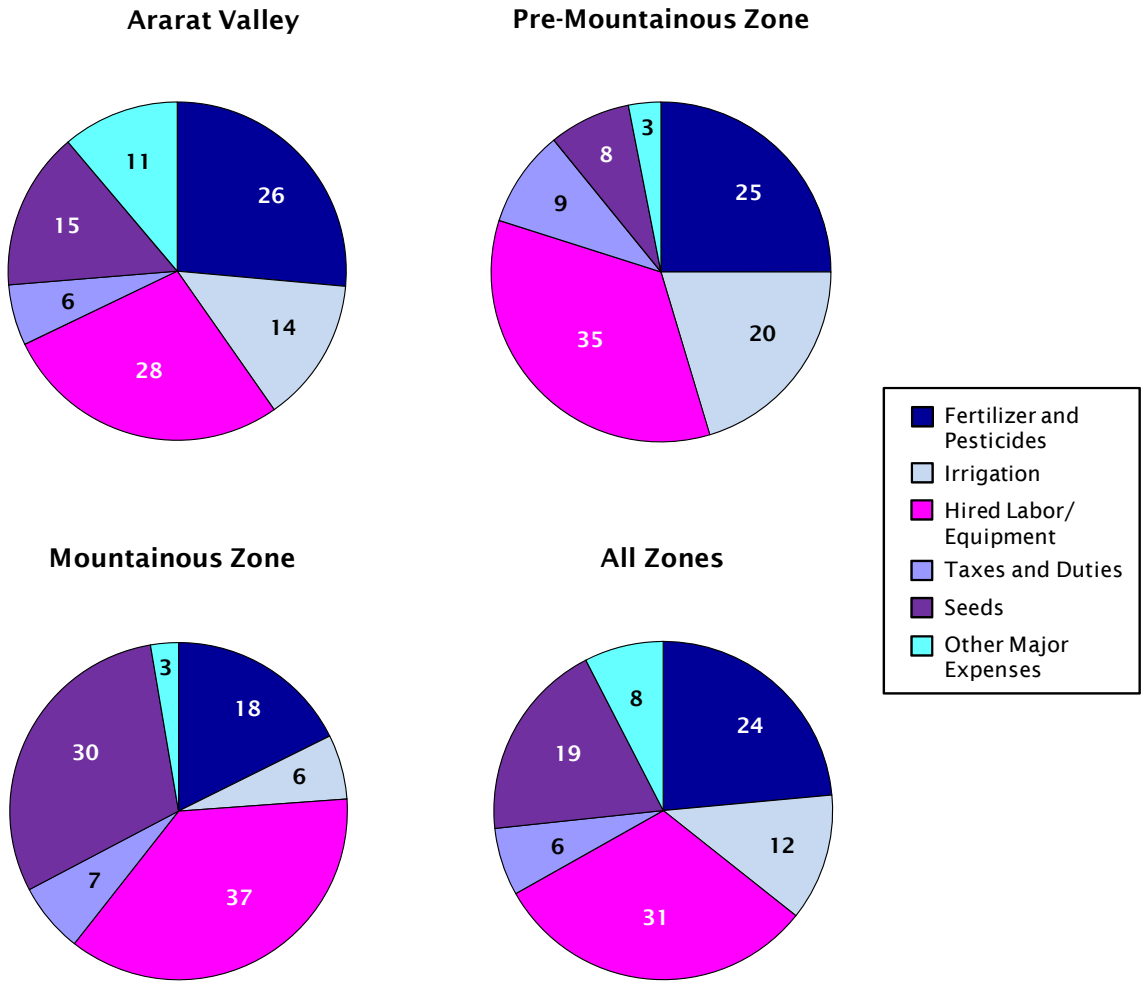
Sample Size = 2,997

[10] Questions about agricultural expenses, production, and sales asked respondents about the last agricultural season. Because Armenia has only one agricultural season per year, respondents' reported expenses, production, and sales served as a close proxy for annual expenses, production, and sales.

farmers in the sample were for hired labor and hired equipment and parts, which accounted for at least 28 percent of the total expenditures in any region. As with other measures described previously, the relationship of the mean and the median on all cost measures suggests a distribution in which a minority of relatively high-spending households causes the mean to be substantially higher than the median. The median amount spent on seeds and other major expenses was actually zero drams because more than half of the farmers in the sample reported no expenditures in these areas.

Zone comparisons in Table II.12 show that farmers in Ararat Valley had the highest average total expenditures of any zone (396,169 drams, or about $1,100), followed by farmers in the Mountainous Zone (351,399 drams, or about $975). In particular, farmers in Ararat Valley had higher average expenditures on irrigation payments and fertilizer/pesticides relative to farmers in other zones. In contrast, farmers in the Mountainous Zone spent more on seeds and hired labor/equipment than farmers in the other two zones. As illustrated in Figure II.1, farmers in the Pre-Mountainous Zone spend the highest portion of their total annual farm expenditures on irrigation payments (20 percent versus 14 percent and 6 percent in Ararat Valley and the Mountainous Zone, respectively).

Figure II.1. Respondents' Annual Farm Expenditures by Zone (Percentages)



Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

III. FARMER PRODUCTION AND INCOME AT BASELINE

In this chapter, we describe the baseline, or pre-intervention, measures of the agricultural production, income, and poverty of farmers in the study sample. These are the key final outcomes that MCC and MCA-Armenia aim to affect with tertiary canal improvements.

Crop sales, wages, and other sources of income are an important focus of the TCS instrument. Because a full accounting of all sources of household income would require far longer to obtain than the allotted time for each interview, the survey concentrates on sources of income that are most directly affected by irrigation infrastructure improvements—specifically, income from agricultural production and employment by the farmer and his or her immediate family. Also related to household income, the TCS questionnaire requests an estimate of expenditures on key categories of income and consumption from other sources. Table III.1 summarizes the key measures of agricultural production, income and consumption that can be examined using the TCS data.

All of these measures will be included in the subsequent round of the TCS, permitting comparisons of how they have changed over time, and in particular, how the outcomes at the end of the follow-up period (in 2012) compare to the values at baseline, before the irrigation rehabilitation activities began. In the remainder of this chapter, we present summary statistics on the baseline measures of farm productivity and household income.

Table III.1. Measures of Agricultural Production and Income

Measures	Time Frame
Agricultural Production. Total amount of specific crops grown; amount of crops grown per square meter; total value of all crops cultivated.	Last Agricultural Season
Livestock. Number of cows, pigs, and sheep owned.	As of Survey Date
Revenue from Agricultural Production. Value of crops sold; total value of all crops (including those sold, bartered, or consumed).	Last Agricultural Season
Profit from Agricultural Production. Revenues minus costs—the income from agricultural activities.	Last Agricultural Season
Income from Employment. Whether household head, spouse, and any grown children were employed (besides work on the family farm); total earnings from employment.	Last Year
Income from Pensions, Remittances, or Social Programs. Can also be added to profits and employment income to construct a rough measure of total income.	Last Year
Total Household Income. Agricultural profits plus income from employment or other sources.	Last Year
Household Consumption. Expenditure on purchased food, health care, housing products, utilities, and transportation; cost of purchased goods, plus value of crops consumed by the household.	Last Year

HVA = high-value agriculture.

A. Crop Production and Sales

As illustrated in Table III.2, the majority of farmers that completed the TCS grew some kind of nuts or fruit other than grapes and tomatoes during the last agricultural season.[11] However, no other type of crop was grown by a majority of farmers. Vegetables and herbs were the next most common crops grown (44 percent), followed by tomatoes (37 percent), grains (35 percent), potatoes (34 percent), grapes (30 percent), and grass (25 percent). Crops that did not fit in these categories (for example, planting stock, flowers and sorgo) were grown considerably less frequently. (See Appendix Table B.1 for itemized frequencies of specific crops produced and sold.)

Table III.2. Respondents Growing and Selling Crops (Percentages)

Crop	Respondents Growing	Respondents Selling
Grains	35	6
Grape	30	17
Other Fruit/Nuts	62	17
Tomato	37	10
Vegetables/Herbs	44	16
Potato	34	8
Grass	25	4
Other	12	3

Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

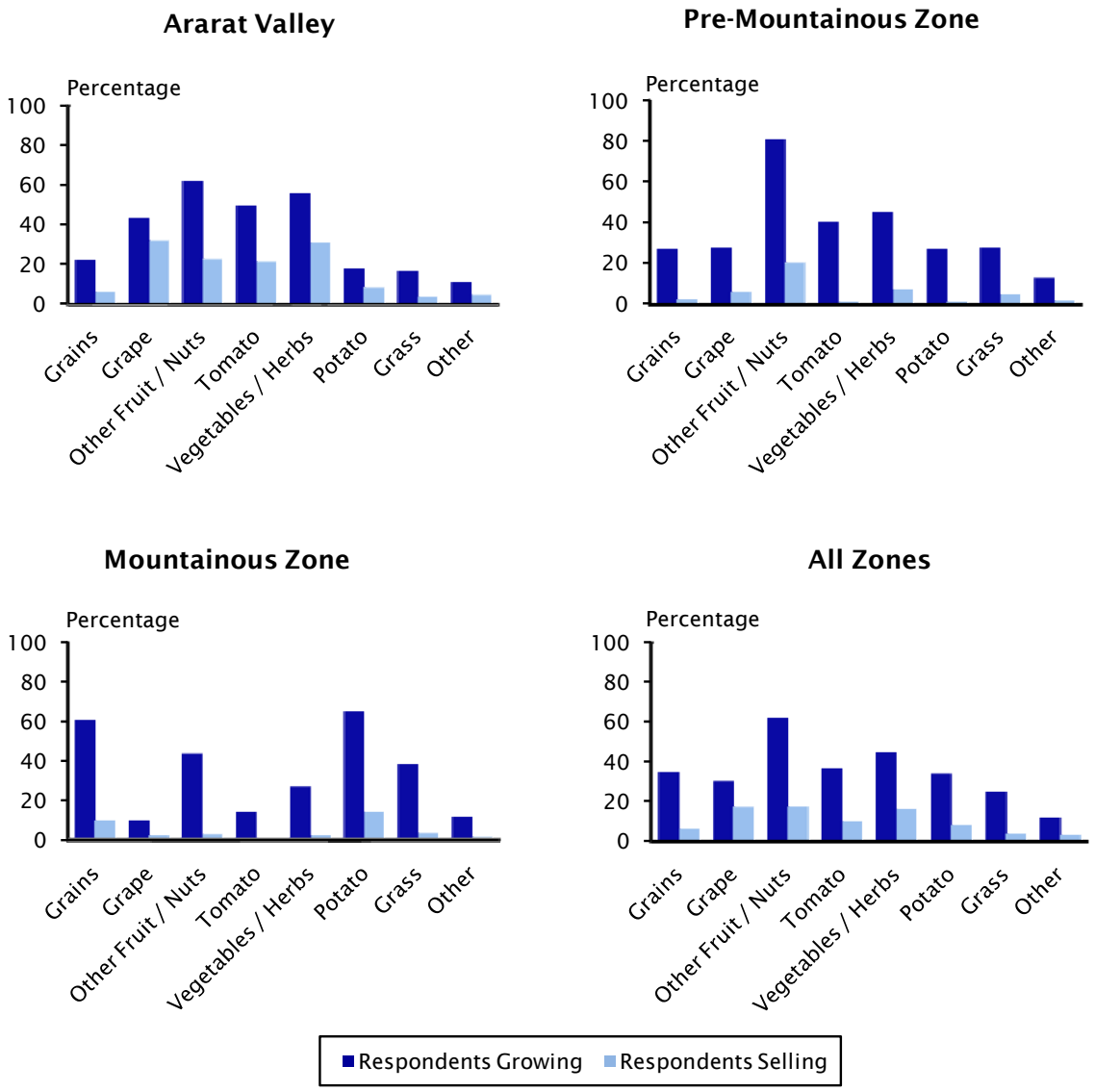
For nearly all crop types, less than half of farmers who grew each crop actually reported selling the crop. The most commonly sold crop categories were fruit and nuts (17 percent) and grapes (17 percent), followed by vegetables and herbs (16 percent). The remaining crop types were sold much less frequently. Thus, it appears that many households grew crops exclusively for their own consumption, not as a source of income. In fact, 49 percent of the survey sample reported no sales of any crop, and 25 and 14 percent of the sample reported selling only one and two crops, respectively (not shown). In addition, crop bartering was very uncommon among respondents: less than 2 percent of households in the sample reported bartering any crop during the last agricultural season.[12]

The farm characteristics outlined in Chapter II suggest substantial cross-zone variation in farm sizes, irrigation practices, and farm expenditures. An investigation of the types of crops grown and sold exhibits similar variation across zones (Figure III.1). A greater proportion of the Mountainous Zone farmers grew grains, potatoes, and grass than in any other zone, but few of the Mountainous Zone farmers who grew these crops sold them. In contrast, the farmers in Ararat Valley who grew each crop type were more likely to sell them.

[11] This is similar to results from the 2007 Farming Practices Survey (FPS), which found that around 60 percent of respondents grew at least one kind of nut or fruit other than grapes and tomatoes. The most commonly grown crops in this category were apples and apricots, with 34 and 38 percent of respondents reporting growing apples and apricots, respectively, during the last agricultural season.

[12] There is no higher incidence of bartering among households that did not sell any crops. Less than 1.5 percent of producers that reported no sales of any crop reported bartering one or more crops.

Figure III.1. Respondents Growing and Selling Crops by Zone (Percentages)



Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

Table III.3 displays respondents' average amount of farm production and sales, both unconditional on reporting production and sales, and conditional on reporting production and sales.[13] With the exception of grass and grains, the majority of each of the crops produced by farmers in the sample was sold (see unconditional values in the two left-hand columns). This seems at odds with the results in Table III.2, which reported that less than half of farmers who produced other fruits and nuts, tomatoes, vegetables and herbs, and potatoes sold these crops. Considering these figures together suggests that there are many farmers growing small amounts of these crops and not selling their production, and there are relatively few who are growing large amounts of these crops and selling the majority of their production. For example, the top 10 percent of the tomato growers surveyed produced 8.7 tons of tomatoes and sold nearly all of their production (8.6 tons on average). In contrast, the other 90 percent of tomato growers surveyed produced only 40 kilograms of tomatoes and sold only 2 kilograms of tomatoes, on average (not shown). This is to be expected, as most farmers in the study sample produced a small amount of any given crop (for example, a few tomato vines) intended for home consumption, whereas a small portion of commercial farmers in the study sample harvested a large amount of the crop with the intent to sell it at a local or regional market. This would explain the very high average amounts of tomatoes and potatoes sold—8.9 and 13.6 tons, respectively—among farmers who reported selling these crops (see conditional values in the two left-hand columns of Table III.3).

Table III.3. Respondents' Average Farm Production and Sales (Metric Tons)

	Unconditional on Reporting Production/Sales		Conditional on Reporting Production/Sales	
Crop	Produced	Sold	Produced	Sold
Grains	1.1	0.4	3.2	6.2
Grape	1.0	0.9	3.6	5.1
Other Fruit/Nuts	1.3	1.0	2.5	6.0
Tomato	0.9	0.9	2.9	8.9
Vegetables/Herbs	1.0	0.9	2.6	5.5
Potato	1.6	1.1	5.2	13.6
Grass	0.9	0.2	4.0	5.6
Other	0.1	0.1	1.1	4.4

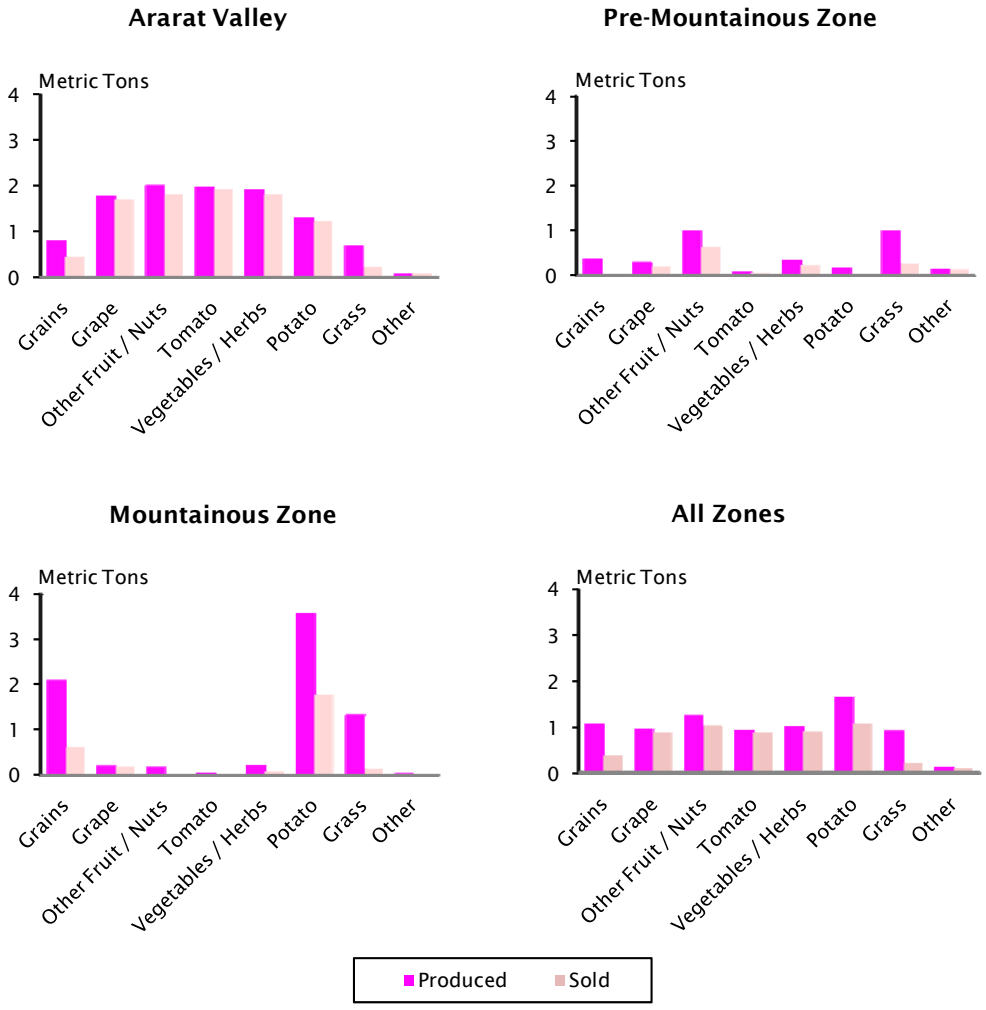
Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

[13] The difference between conditional and unconditional estimates is that unconditional estimates use a value of 0 tons to reflect that the respondent did not produce or sell the crop in question, whereas conditional estimates leave this value blank if the respondent did not produce or sell the crop in question. As a result, unconditional estimates are the average amount produced and sold for the entire study sample—including farmers that didn't produce or sell the crop—and conditional estimates are the average amount produced and sold among those farmers in the sample who reported producing and/or selling the crop in question.

Figure III.2 displays respondents' average farm production and sales by zone; production and sales are unconditional on reporting producing or selling the crops in question.[14] Ararat Valley farmers produced and sold more grapes, fruit and nuts, tomatoes, and vegetables and herbs than farmers in any other zone by a considerable margin. Although farmers in the Mountainous Zone produced much larger quantities of grains, potato and grass than farmers in any other zone, they sold relatively small proportions of these crops per farm. For example, farmers in the Mountainous Zone sold about half of the potatoes they produced, whereas farmers in Ararat Valley sold 94 percent of their potato production. Thus, it appears that people in the Mountainous Zone consumed a large portion of what they produced, whereas the farmers in Ararat Valley sold the majority of their crops.

Figure III.2. Respondents' Average Farm Production and Sales by Zone (Metric Tons)



Source: 2009-2010 Tertiary Canals Survey (TCS).

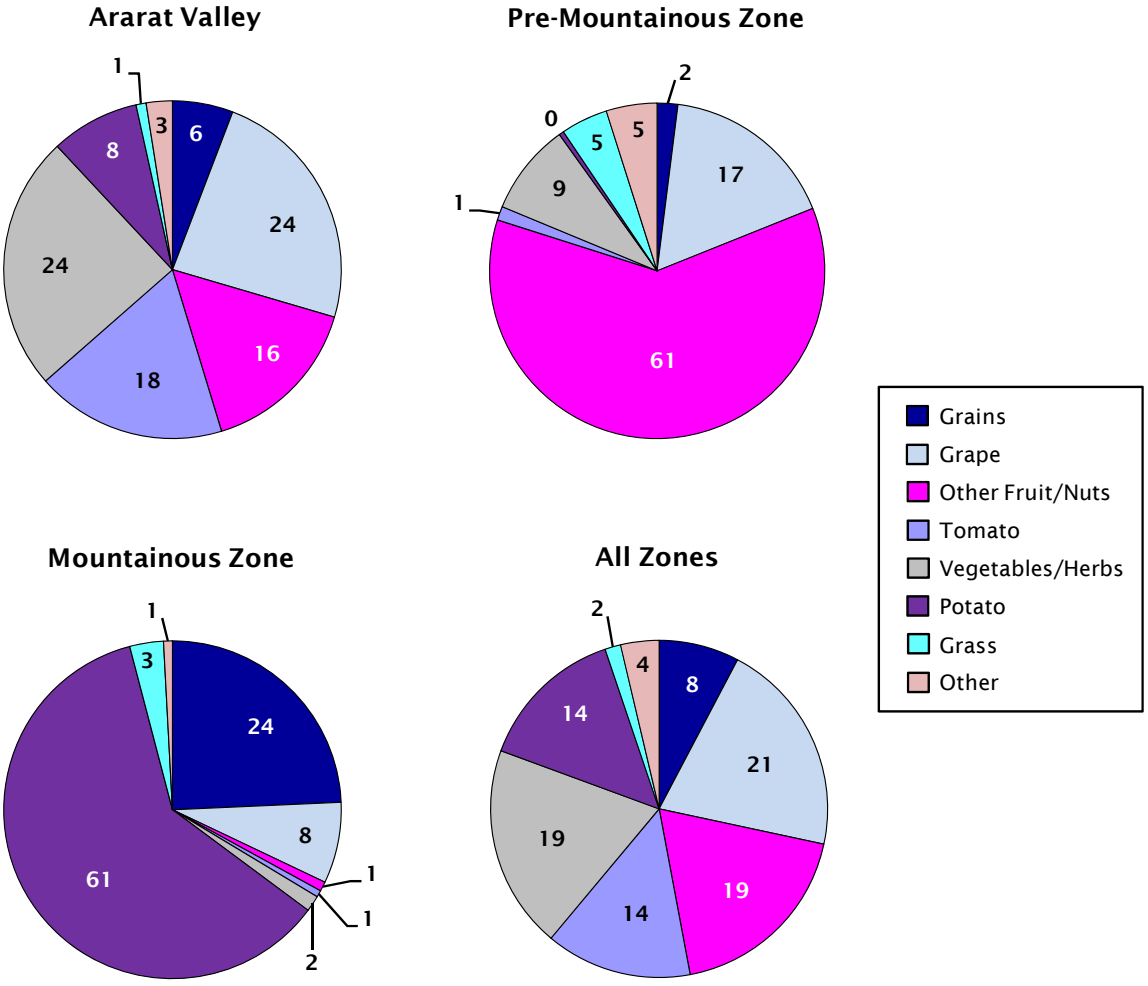
Sample Size = 2,997

[14] In other words, the averages include zeroes for the farmers who do not grow or sell the crops. For example, the average reported grain production includes farmers who did not report growing any grain.

With the exception of the Mountainous Zone, respondents in all zones derived more than half of their total agricultural revenue from sales of grapes, fruits and nuts, and tomatoes (Figure III.3). Farmers in the Mountainous Zone, however, earned little income from sales of these crops; roughly 85 percent of their revenue during the last season came from the sale of potatoes and grains.

Farmers' total income from selling crops is an important outcome that will be a focus of the evaluation. Table III.4 reports respondents' average sales figures by crop type. The average farm had revenues of around 490,000 Armenian drams (about $1,350) during the last season.[15] Not

Figure III.3. Respondents' Sales by Zone (Percentages)



Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

[15] All conversions assume 1 US dollar equals 361 Armenian drams.

surprisingly, over 50 percent of the total sales were grape, other fruit and nuts, and vegetables and herbs. This was followed by sales of potatoes, tomatoes, and grain. However, a substantial portion of crop production (particularly outside Ararat Valley) was not sold at market, but rather consumed by the household. These are crops that the household would otherwise have to purchase in the market. To account for this home consumption, we calculated the total value of crops produced by each household. Because the main objective of tertiary canal reconstruction is to improve agricultural production—as opposed to agricultural sales—this measure of total production value will more fully capture the outcome measure of greatest relevance to the impact evaluation.

Respondents' average crop values are presented in the second column of Table III.4. For crops that were sold, we used each farmer's reported sale price to estimate the value of the total amount produced, including portions that were not sold. For crops that weren't sold, we used the median sale price of crops reported by other farmers in the WUA, marz, and region to estimate the value of each crop they produced.[16,17,18] Although fruit and nuts is still the largest single component of the

Table III.4. Respondents' Average Crop Sales and Values (AMD)

Crop	Sales	Value (Production x Price)
Grains	37,767	99,532
Grape	101,608	114,120
Other Fruit/Nuts	91,516	140,805
Tomato	69,047	76,286
Vegetables/Herbs	95,597	105,572
Potato	69,510	105,933
Grass	7,455	32,035
Other	18,008	22,429
Total	**490,509**	**696,712**

Source: 2009-2010 Tertiary Canals Survey (TCS).

AMD = Armenian drams.

Sample Size = 2,997

[16] We implemented these conversions for each specific type of crop. For example, we estimated the value of apples, grapes, and figs separately. We also conducted two sensitivity checks: one in which we calculated the value of sold and non-sold crops strictly based on median prices (and not each farmer's reported price received for crops), and one in which we calculated the value of sold crops using each farmer's reported price received and the value of non-sold crops using median prices. These methods varied slightly from our primary method of calculating the value of all sold crops using each farmer's reported price received, the value of non-sold portions of crops by using each farmer's reported price received for the sold portion of the crop, and the value of non-sold crops using median prices. However, all methods yielded similar estimates for the average value of crops produced by surveyed households.

[17] The median is the value in the exact middle of the distribution (the 50th percentile). Similar to an average (or mean), a median is a measure of the "typical" price for farmers in the sample, but the advantage of the median is that it is not sensitive to distributional outliers that could skew the average price.

[18] First, we attempted to use the median crop price in the respondent's WUA. If the crop was not reported sold in the WUA, we used the median crop price in the respondent's marz. If the crop was not reported sold in the respondent's marz, we used the median crop price in the respondent's region.

total value of the harvest, grains, potatoes, and grass play a much larger relative role in the value of the total harvest than they do in the total sales because these crops were more likely than fruit and nuts to be harvested but not sold. On average, farmers' annual production was valued at over 697,000 drams (over $1,900). This is a 42 percent increase in value from the average total sales reported by farmers.

Figures III.4 and III.5 show crop sales and value for farmers in Ararat Valley, the Pre-Mountainous Zone, the Mountainous Zone, and the full study sample overall and by type of crop, respectively. Because farmers in Ararat Valley produced greater quantities of high-value crops like fruits and vegetables—and sold a larger proportion of these crops than farmers in other zones—their average sales and value were much higher than farmers from other regions. Average total sales of farmers in the Mountainous Zone were slightly higher than sales of farmers in the Pre-Mountainous Zone. However, average total crop values of farmers in the Mountainous Zone were substantially higher than crop values of farmers in the Pre-Mountainous Zone. This is related to the propensity of farmers in the Mountainous Zone to produce large amounts of potato and grain, but sell only a relatively small portion of these crops.

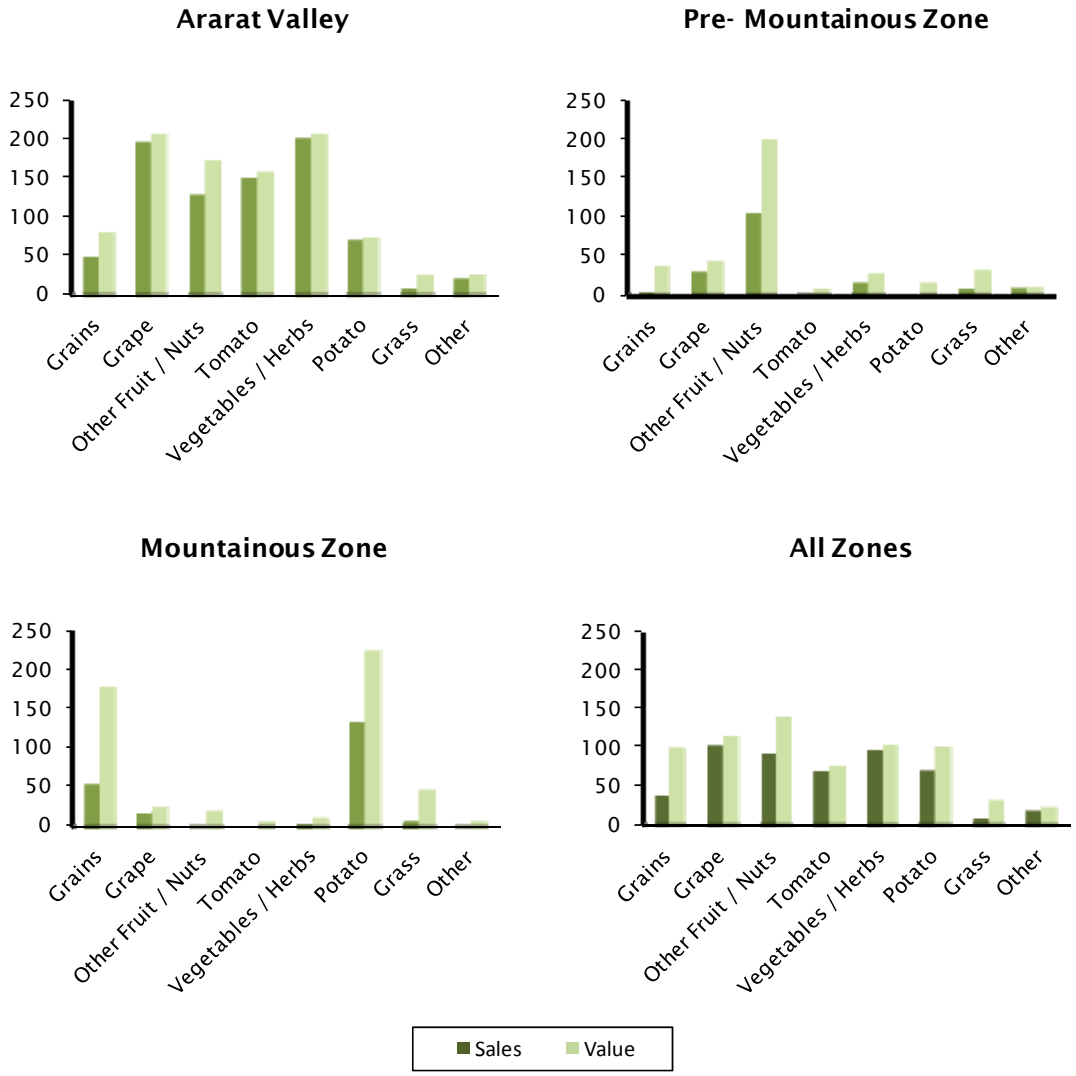
Figure III.4. Respondents' Average Total Crop Sales and Value by Zone (1,000 AMD)

Source: 2009-2010 Tertiary Canals Survey (TCS).

AMD = Armenian drams.

Sample Size = 2,997

Figure III.5. Respondents' Average Crop Sales and Values by Zone (1,000 AMD)



Source: 2009-2010 Tertiary Canals Survey (TCS).
AMD = Armenian drams.
Sample Size = 2,997

B. Income and Poverty

Household income will be one of the primary outcomes of the evaluation. Table III.5 displays two alternative measures of respondents' annual household income. The upper section summarizes the average of respondents' annual net monetary income. The first row summarizes the annual net income of the respondent households from nonagricultural sources (most of which comes from employment in non-agricultural jobs). The second row presents the average annual net monetary profits of the farms, equal to the total of the crop sales minus the total operating costs, and the average sum of the items in the first two rows is presented in the third row.[19] As shown in the table,

[19] All agricultural production and sales were reported for the last agricultural season. Since Armenia has only one major growing season, these reports were interpreted as farmers' annual agricultural production and sales.

the majority of net monetary income for households in our survey comes from nonagricultural sources.

Zone comparisons in the upper section of Table III.5 illustrate that annual net monetary income varies significantly across zones. Households in Ararat Valley had the highest average net monetary income at 1,503,002 Armenian drams (about $4,150), while households in the Mountainous Zone had the lowest average net monetary income at 782,027 drams (about $2,150). Net monetary incomes in the Pre-mountainous Zones were between these two extremes at 1,101,159 drams (about $3,050). Interestingly, only households in Ararat Valley had a positive median monetary agricultural profit. In other words, Ararat Valley is the only zone in which a typical farmer was likely to make more money from agricultural sales than he or she spent on agricultural costs.

As described earlier, many farmers (particularly in the Mountainous Zone) consumed a large portion of the crops they produced rather than purchasing them in the marketplace. Thus, from an economic perspective, these consumed crops can be considered part of the household's income. The bottom panel of Table III.5 presents an alternative measure of annual net household income that includes the value of the crops that farmers consume. As with the top panel, nonagricultural income is included in the total. The economic profit, however, is calculated using the total value of the crops harvested minus the operating costs. The average of the total annual net economic income is presented in the final row. The difference between the monetary income and the economic income is due to the value of the crops that are consumed by the household. Accounting for the value of the consumed crops increases the total annual net income by approximately 17 percent, on average.

Table III.5. Respondents' Average Annual Household Income (AMD)

	Ararat Valley Average (Median)	Pre-Mountainous Average (Median)	Mountainous Average (Median)	All Zones Average (Median)
Net Monetary Income				
Nonagricultural income	1,074,865 (720,000)	1,047,660 (804,000)	913,015 (600,000)	1,019,383 (700,000)
Monetary agricultural profit (crop sales—costs)	428,137 (74,000)	53,499 (-28,500)	-130,988 (-98,000)	179,563 (-22,000)
Total Net Monetary Income	**1,503,002 (1,054,000)**	**1,101,159 (786,000)**	**782,027 (453,000)**	**1,198,947 (770,000)**
Net Economic Income				
Nonagricultural income	1,074,865 (720,000)	1,047,660 (804,000)	913,015 (600,000)	1,019,383 (700,000)
Economic agricultural profit (crop value—costs)	566,207 (226,800)	253,106 (90,000)	185,595 (35,500)	385,767 (105,000)
Total Net Economic Income	**1,641,072 (1,184,600)**	**1,300,766 (997,205)**	**1,098,610 (670,000)**	**1,405,150 (957,000)**

Source: 2009-2010 Tertiary Canals Survey (TCS).

Note: Averages and medians include zeros for respondents that did not produce and/or sell crops.

AMD = Armenian drams.

Sample Size = 2,997

Zone comparisons in the lower section of Table III.5 illustrate that annual net economic income varies across zones, but to a lesser degree than net monetary income. Mirroring the distribution of monetary income, farms in Ararat Valley had the highest average economic income at 1,641,072 Armenian drams (about $4,550), while farms in the Mountainous Zone had the lowest average economic income at 1,098,610 drams (about $3,050). Net economic income in the Pre-mountainous Zone was between these two values at 1,300,766 drams (about $3,600).

As a final measure of well-being, we calculated poverty rates for our sample. Calculations of poverty are complex, and formulating accurate estimates requires detailed information on a number of dimensions. Our approach is based on the poverty rate calculations used for the Integrated Living Conditions Survey of Households (ILCS) and developed in collaboration with the World Bank. This approach first calculates the value (in AMD) of everything consumed by the household, including food, other nondurable goods, and durable goods. Total consumption is then compared to the poverty line. The ILCS uses two distinct poverty lines. The "food poverty line" is based on the cost to consume a minimum number of calories per day. The "complete poverty line" includes the cost of consuming a minimum number of calories per day plus an allowance for basic, nonfood needs, such as clothing and shelter. The poverty lines are adjusted based on the number of adults and children in the household. Both of these poverty lines are independently derived by NSS (in collaboration with the World Bank) and provided to us.

The ideal method for measuring household consumption is to use a household diary, which is completed each day. This approach minimizes reporting errors and is the methodology used for the ILCS. However, such an approach is also expensive and time-consuming and was not feasible within the constraints of the TCS. Instead, our measure is based on reports of expenditures in a typical month on food (purchased), housing products, public utilities, transportation, and other expenses, as well as yearly expenditures on healthcare and education. These measures are then coupled with the estimated value of the portion of agricultural production that was consumed by the household. The TCS did not ask about durable goods; therefore, we adjusted our estimates of consumption by a factor of 9.4 percent, based on the share of consumption attributable to durable goods in the ILCS.

The household's own production is clearly an important component of consumption. As shown in the first row of Table III.6, around 7 percent of households in our sample are below the food poverty line and 16 percent are below the complete poverty line when consumption of own production is excluded. These poverty rates drop slightly when consumption of own production is included, to 5 percent below the food poverty line and 12 percent below the complete poverty line.

Table III.6. Respondent Households Living in Poverty (Percentages)

	Food Poverty	Complete Poverty
Excluding Consumption of Own Crop Production	6.9	15.9
Including Consumption of Own Crop Production	4.9	11.8
ILCS Estimates for Rural Armenia (2008)	1.7	22.9
Average Household Consumption Relative to Poverty Line	3.15	2.14

Source: 2009-2010 Tertiary Canals Survey (TCS) and 2008 Integrated Living Conditions Survey of Households (ILCS).

Sample Size = 2,997

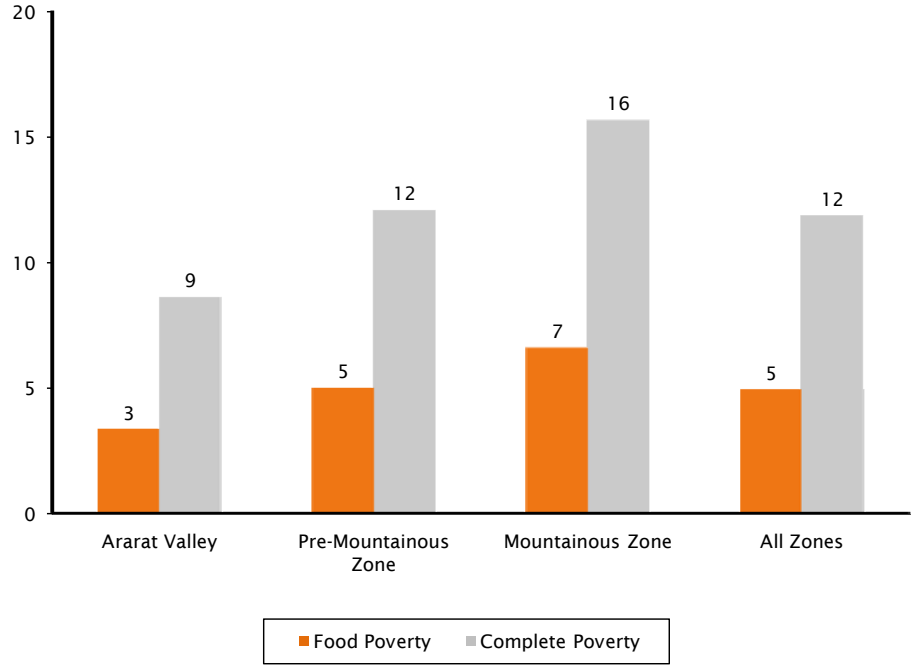
We also estimate that the average household is above the poverty line. On average, household consumption is 3.15 times the food poverty line and 2.14 times the complete poverty line. These will be important indicators to track in the impact analyses, since MCC's programs are likely to affect not only households near the poverty line, but households above it as well.

The magnitude of poverty rates relative to the food poverty line estimated from the TCS is somewhat comparable to ILCS estimates for all rural Armenians, though the estimates of complete poverty rates differ somewhat. The two sets of estimates differ for methodological reasons and because of differences in the sample. As described previously, the ILCS uses a more comprehensive methodology for estimating household consumption. The estimates also differ from ILCS estimates because the TCS sample is not designed to be representative of all villages in Armenia; they are the villages in which tertiary canal improvements will be implemented and matched comparison villages with similar characteristics. Similarly, the TCS targets farmers specifically and, thus, is not a random sample of all households in rural Armenia.

An examination of poverty rates by zone indicates that Ararat Valley has food poverty and complete poverty rates of approximately half of the Mountainous Zone (Figure III.6). Interestingly, the average household in Ararat Valley has a similar standard of living as the average household in the Pre-Mountainous and Mountainous Zones, as the average household in any zone is living between 3.0 and 3.3 times the food poverty line and between 2.0 and 2.2 times the complete poverty line (Figure III.7). Reconciling these two findings, there is a slightly larger concentration of households in the Mountainous Zone with relatively high levels of consumption: nine percent of households in the Mountainous Zone live above four times the complete poverty line, compared to six and four percent in Ararat Valley and the Pre-Mountainous Zone, respectively. These high levels of consumption among a minority of households in the Mountainous Zone skew average household consumption upward despite relatively high poverty rates in the zone.

Figure III.8 shows the distribution of respondent households above and below the Complete Poverty Line (CPL). As illustrated, only 12 percent of respondent households live below the CPL if their own food consumption is included in poverty estimates. However, a large portion of the study sample—over 40 percent—lives between 1 and 2 times the CPL.

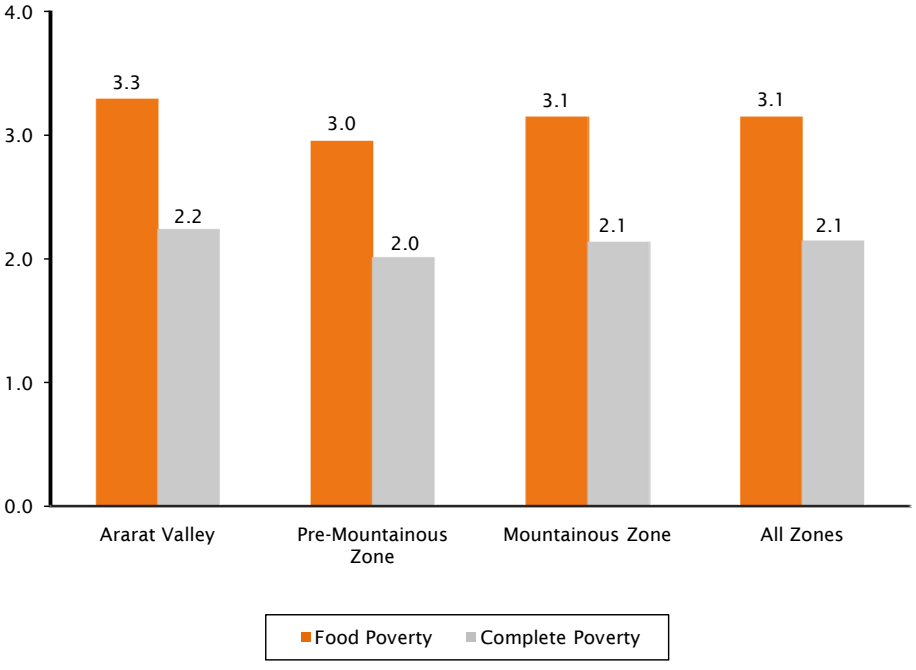
Figure III.6. Respondent Households Living in Poverty by Zone (Percentages)



Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

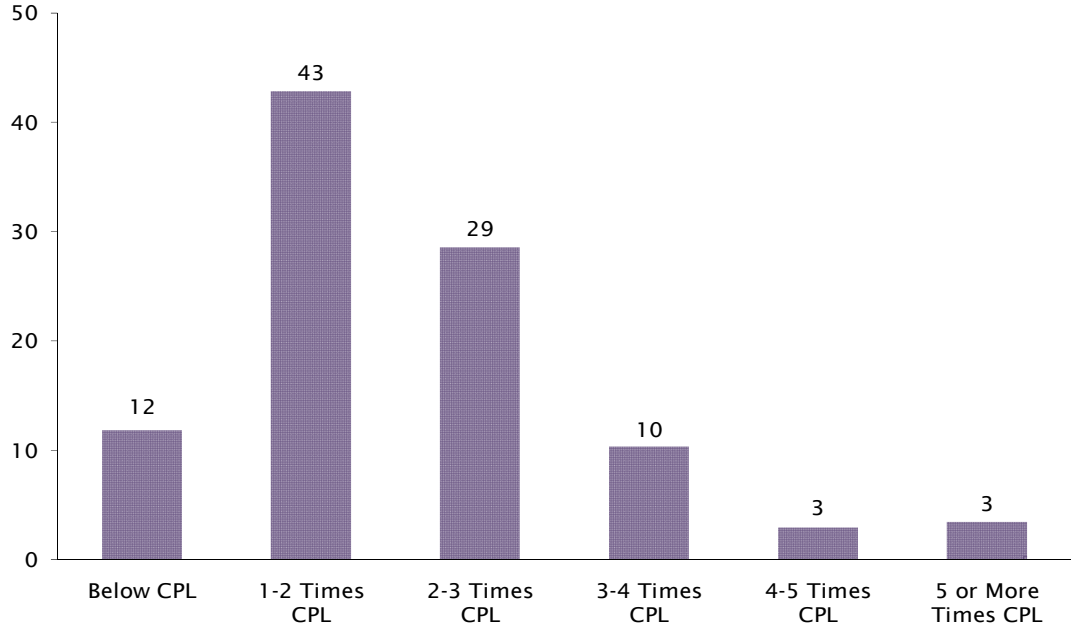
Figure III.7. Respondents' Average Living Conditions in Relation to Food and Complete Poverty Lines by Zone



Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

Figure III.8. Respondent Households Above and Below Complete Poverty Line (CPL) (Percentages)



Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 2,997

IV. DIFFERENCES BETWEEN TREATMENT AND COMPARISON GROUPS AT BASELINE

The evaluation of tertiary canal rehabilitation uses a design in which villages where tertiary canals are scheduled for rehabilitation are matched to similar villages with canals that will not be rehabilitated. The purpose of this matching procedure is to be able to compare the outcomes of farmers served by rehabilitated canals to farmers served by non-rehabilitated canals. This allows us to establish the counterfactual, that is, what would have happened in the absence of the rehabilitation project. Because the villages are matched on important characteristics such as crops grown and pre-intervention canal conditions, differences between the farmers in treatment and comparison groups are expected to be relatively small, on average, prior to the rehabilitation.

One of the advantages of a baseline survey is that we can verify whether the farmers in the treatment villages are similar to the farmers in the comparison villages prior to receiving the intervention. Examining these differences for the key outcome measures is the subject of this chapter.

A. Baseline Differences in Household Characteristics

Overall, the characteristics of the households and survey respondents are very similar for the treatment group and the matched comparison group. Whether we look at the head of household (top panel of Table IV.1) or the survey respondent (bottom panel), the average ages are the same and the distribution of educational attainment is similar. Heads of household in treatment villages are less likely to be female than in the comparison group. When we consider the survey respondents, however, there are no differences. Treatment group households also have significantly larger household sizes, but the magnitude of the difference (0.2 household members) is not substantively meaningful. The few significant differences do not exhibit a pattern and appear to be by chance.

Table IV.1. Individual and Household Characteristics (Percentages Except When Indicated)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Head of Household				
Average Age (Years)	56.3	56.5	-0.2	0.781
Female	10	15	-4	0.030**
Education				
Less than secondary	15	15	0	0.775
Full secondary	40	43	-3	0.322
Secondary vocational	26	23	3	0.184
More than secondary	20	19	1	0.671
			F-Test:	**0.078***
Respondent				
Average Age (Years)	50.1	49.3	0.8	0.264
Female	12	14	-1	0.471

Table IV.1 *(continued)*

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Education				
Less than secondary	10	9	1	0.543
Full secondary	38	43	-5	0.036**
Secondary vocational	28	25	3	0.221
More than secondary	23	22	2	0.384
Average Number of People in Household	5.2	4.9	0.2	0.019**
Average Number of Children in Household	1.2	1.1	0.1	0.199
			F-Test:	**0.108**

Source: 2009-2010 Tertiary Canals Survey (TCS).

*/**/***Difference between treatment group mean and comparison group mean is significant at the 0.10/0.05/0.01 level.

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total).

B. Baseline Differences in Irrigation and Agricultural Practices

Baseline irrigation practices also look very similar for the treatment villages and the matched comparison villages (Table IV.2). Treatment group farmers are slightly more likely to utilize some practices, such as owning a personal water pump, and comparison farmers are more likely to use other practices, such as verifying or modifying furrow parameters. The treatment group is somewhat more likely to have attended on-farm water management training and/or high-value agriculture, although the difference is only marginally significant. These trainings are designed to affect many of the same outcomes as tertiary canal rehabilitation, so it will be important to control for training participation in the final impact evaluation so as not to confound impacts due to tertiary canal rehabilitation with effects of the trainings.

Table IV.2. Irrigation Practices (Percentages)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Respondents:				
Are WUA members	79	71	8	0.133
Have a personal tank, artesian well, or reservoir	12	12	0	0.947
Have a personal pump to pump water	14	10	4	0.211
Attended OFWM training only	12	9	3	0.331
Attended HVA training only	3	4	-1	0.508
Attended OFWM and WVA training	36	27	9	0.052*
In Last Agricultural Season, Respondents:				
Verified/modified furrow geometric parameters	49	55	-6	0.359
Prepared land for irrigation	47	48	-1	0.884
Obtained copy of own water supply contract from WUA	13	16	-3	0.705
Updated annex of water supply contract	4	1	2	0.183
Submitted an application to WUA	1	0	0	0.525

Table IV.2 *(continued)*

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
In Last Agricultural Season, Respondents Used:				
Plastic or metal dams	7	3	4	0.173
Gated pipes	1	1	0	0.591
Hydrants	0	1	-1	0.390
Sprinkler irrigation	0	1	0	0.539
Drip irrigation	1	0	1	0.179
			F-Test:	**<0.001*** **

Source: 2009-2010 Tertiary Canals Survey (TCS).

*/**/***Difference between treatment group mean and comparison group mean is significant at the 0.10/0.05/0.01 level.

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total).

There is a stronger pattern of differences in farm expenditures for the two groups (Table IV.3). Although irrigation is the only category with a statistically significant difference, the treatment group spent more on average for each category of farm input that was measured in the TCS. Consequently, treatment group farmers spent about 40 percent more than the comparison group farmers on total agricultural expenditures, on average. Although this average difference is large, it is only marginally statistically significant because of the considerable variability in this outcome measure. Nevertheless, this will be an important factor to control for in the final impact analysis due to the large baseline differences between treatment and comparison groups, as well as the fact that expenditures on agricultural inputs are highly correlated with agricultural production, a key outcome measure.

C. Baseline Differences in Crop Production and Sales

Treatment and comparison group farmers cultivated similarly sized plots of land, on average (Table IV.4). There are no consequential differences between the two groups in either the total area of land cultivated or the area devoted to specific purposes, such as orchards, vineyards, or kitchen plots.

Table IV.3. Average Farm Expenditures (AMD)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Fertilizer and Pesticides	82,685	66,019	16,666	0.186
Irrigation	44,707	32,374	12,332	0.050**
Hired Labor and Hired Equipment or Tools	115,097	83,148	31,949	0.113
Taxes and Duties	21,674	19,008	2,666	0.327
Seeds	70,279	51,191	19,088	0.447
Other Major Expenses	36,402	13,794	22,608	0.209
Total Agricultural Expenses	**370,844**	**265,534**	**105,310**	**0.094***
			F-Test:	**<0.001*** **

Source: 2009-2010 Tertiary Canals Survey (TCS).

*/**/***Difference between treatment group mean and comparison group mean is significant at the 0.10/0.05/0.01 level.

AMD = Armenian drams.

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total).

Table IV.4. Average Area of Land Cultivated (Square Meters)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Total Land	17,882	16,024	1,858	0.444
Arable Land	13,065	11,721	1,344	0.583
Orchards	968	998	-30	0.901
Vineyards	1,219	1,040	179	0.557
Kitchen Plot	1,893	1,935	-42	0.767
Other	455	356	99	0.594
			F-Test:	**0.808**

Source: 2009-2010 Tertiary Canals Survey (TCS).

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total)

Cropping patterns between treatment and comparison groups are also similar overall (Table IV.5). Treatment and comparison group farmers are equally likely to cultivate grapes, other fruits, tomatoes, vegetables, potatoes, and grasses, and their average crops sales and harvest values are very similar for all of these crops. However, farmers in the treatment group are 11 percentage points more likely to cultivate grain. The total value of their grain production is correspondingly higher than farmers in the comparison group, and they earn more through sales of grain as well. All of the differences in grain cultivation, sales, and value are statistically significant.

Table IV.5. Crops Cultivated, Harvested, and Sold (Percentages and AMD)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Percentage Cultivating Each Crop				
Grains	41	30	11	0.021**
Grape	29	31	-2	0.715
Other Fruit/Nuts	60	63	-3	0.589
Tomato	36	37	-1	0.825
Vegetables/Herbs	45	44	2	0.730
Potato	37	31	5	0.332
Grass	24	26	-2	0.665
Other	11	12	-1	0.818
Average Crop Sales (AMD)				
Grains	61,630	19,676	41,954	0.030**
Grape	87,923	111,984	-24,060	0.515
Other Fruit/Nuts	91,950	91,187	763	0.979
Tomato	85,218	56,788	28,430	0.367
Vegetables/Herbs	108,903	85,510	23,393	0.516
Potato	90,654	53,481	37,173	0.430
Grass	7,653	7,304	349	0.902
Other	16,790	18,932	-2,142	0.874
Average Crop Values (AMD)				
Grains	137,935	70,417	67,518	0.011**
Grape	102,216	123,146	-20,930	0.580
Other Fruit/Nuts	155,856	129,395	26,461	0.426
Tomato	90,624	65,417	25,207	0.423
Vegetables/Herbs	118,364	95,875	22,489	0.536
Potato	137,623	81,908	55,715	0.315
Grass	31,193	32,673	-1,480	0.849
Other	20,900	23,587	-2,686	0.849

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
			F-Test:	**0.007*****

Table IV.5 *(continued)*

Source: 2009-2010 Tertiary Canals Survey (TCS).

*/**/***Difference between treatment group mean and comparison group mean is significant at the 0.10/0.05/0.01 level.

AMD = Armenian drams.

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total).

D. Baseline Differences in Household Income and Poverty

Finally, we examine baseline differences for the two key outcomes for the Compact with Armenia. These outcomes—household income and poverty—will be the focus of the impact evaluation. The treatment and comparison groups have similar agricultural profits and income (Table IV.6). As discussed in Chapter III, we have two sets of calculations for these outcomes, one measuring monetary income and the other economic income. The estimated averages are very close with either approach and none of the measures exhibit significant differences. However, the F-test for overall significance indicates there are some underlying differences for the full set of measures across the two groups. Considering the importance of these measures in the final impact evaluation, baseline income will be a key control variable.

Table IV.6. Average Household Income (AMD)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Nonagricultural Income	1,069,055	981,726	87,329	0.339
Monetary Agricultural Profit (Crop Sales—Costs)	179,876	179,327	549	0.995
Total Net Monetary Income	**1,248,931**	**1,161,053**	**87,878**	**0.513**
Nonagricultural Income	1,069,055	981,726	87,329	0.339
Economic Agricultural Profit (Crop Value—Costs)	423,866	356,883	66,983	0.401
Total Net Economic Income	**1,492,920**	**1,338,609**	**154,311**	**0.236**
			F-Test:	**0.036****

Source: 2009-2010 Tertiary Canals Survey (TCS).

*/**/***Difference between treatment group mean and comparison group mean is significant at the 0.10/0.05/0.01 level.

AMD = Armenian drams.

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total).

Poverty rates are also similar for the two groups (Table IV.7). The treatment group has a slightly greater prevalence of food poverty, a difference that is significant at the 10 percent level, but this is likely explained by it being a low-prevalence outcome for this sample. Estimates of household consumption relative to the poverty lines are almost identical for the treatment and comparison groups.

Table IV.7. Households Living in Poverty (Percentages)

	Treatment Group Mean	Comparison Group Mean	Difference	*p*-Value
Households in Food Poverty (Including Consumption)	6.1	4.0	2.2	0.091*
Households in Complete Poverty (Including Consumption)	13.0	11.0	1.9	0.352
Average Household Consumption Relative to Food Poverty Line	3.18	3.14	0.04	0.721
Average Household Consumption Relative to Complete Poverty Line	2.16	2.13	0.03	0.721
			F-Test:	**0.411**

Source: 2009-2010 Tertiary Canals Survey (TCS) and 2008 Integrated Living Conditions Survey of Households (ILCS).

*/**/***Difference between treatment group mean and comparison group mean is significant at the 0.10/0.05/0.01 level.

Sample Size = 1,470 treatment households and 1,527 comparison households (2,997 total).

V. CONCLUSION

As described in Chapter I, the analysis of the baseline Tertiary Canal Survey (TCS) data has three main objectives. The first objective—which was the emphasis of Chapters II and III in this report—is to describe the sample of farming households at baseline. The second objective is to compare and contrast the treatment and comparison groups; this was the emphasis of Chapter IV. The third objective is to identify improvements to the questionnaire or data collection approaches so that future iterations of the TCS best address the policy questions of greatest interest to the Millennium Challenge Corporation (MCC) and the Millennium Challenge Account with Armenia (MCA-Armenia). Related to the first and second objectives, Section A of this final chapter provides a summary of our findings from Chapters II-IV. Related to the second objective, Section B focuses on improvements to the TCS and summarizes our plans for future analyses.

A. Summary of Findings

TCS data give us important contextual information for the evaluation. Survey responses indicate that the heads of household in our sample are likely to have completed secondary school, and the households are often multigenerational, with one or two children under the age of 18. The households work on farms that average less than two hectares; however, farm size varies by agricultural zone. Although the sample was not designed to be representative of all rural Armenians, this contextual information will allow us to understand how the households in the study compare to the broader population of rural Armenia.

Baseline survey responses also illustrate the potential for the tertiary canal rehabilitation to improve irrigation conditions. At baseline, considerable areas of land were not watered, and farmers often could not grow higher-value crops due to unreliable water supplies. Only about half of farmers received irrigation water when they needed it, and one-third did not receive enough water at all. This suggests there is a large potential to improve irrigation conditions.

The key outcome that the tertiary canal rehabilitation activity seeks to influence is household well-being. The survey provides evidence that many of the households in our sample were living in poverty at baseline. Approximately 5 percent of our sample was below Armenia's food poverty line, and 12 percent was below the complete poverty line. Moreover, income was low for other households in the sample as well, not just those below the poverty line. The average household in our sample reported consumption that would place them at just over 2 times the poverty line. These baseline results demonstrate the potential for the intervention to have an impact on poverty levels among households in our sample.

For most of the outcome measures, the treatment and comparison groups are very similar. For example, there are no statistically significant treatment-comparison differences in irrigation practices and the cultivation, sales, and value of most types of crops, or average agricultural income and household income. However, there are observable differences on a handful of outcomes: treatment group farmers are more likely to cultivate grain and their corresponding wheat production is significantly higher; agricultural expenditures are higher among the treatment group than among the comparison group; and poverty rates are slightly higher for the treatment group than the comparison farmers (although the latter two results are only on the margin of statistical significance). Although these differences are mostly small, they indicate that the treatment and comparison groups are not perfectly matched. Thus, the baseline data will be crucial so that the impact analysis can control for any preexisting differences between the two groups.

B. Lessons Learned and Plans for Future Analyses

Overall, the implementation for the first round of the TCS was successful. Although this was the first time the TCS was fielded, it was modeled closely after the Farming Practices Survey (FPS), the primary data source for the impact evaluation of the Water-to-Market activities. AREG personnel had fielded two rounds of the FPS before they fielded the baseline TCS, and the lessons learned during the two rounds of the FPS were applied to the TCS. As such, most of the challenges associated with collecting these agricultural data already had been identified and resolved. A handful of TCS questions will be modified in the next round; most notably, we will simplify the questions about area of land that was watered and the water source used. Another important finding from the baseline TCS is that the methodology used to identify respondent farmers in the treatment villages and their comparison counterparts was reasonably successful. This gives us confidence that the resulting samples will lend themselves to a credible impact evaluation.

As summarized in Chapter I, the main impact evaluation will be conducted based on the final round of the TCS that will be fielded in late 2012 and early 2013, after tertiary canals rehabilitation will have been completed in the treatment group villages. At that point, we will analyze the impacts of tertiary canal rehabilitation by comparing outcomes for farmers in treatment group villages to outcomes of comparison group villages that have had no canal rehabilitation. We anticipate that the final impacts report will be completed in fall 2013.

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APPENDIX A

TERTIARY CANAL SURVEY (TCS) INSTRUMENT

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Don't Know 96
Refused to Answer 97

TERTIARY CANALS SURVEY
Round I 2009-2010

QUESTIONNAIRE No

Marz Code	Cluster/settlement code	Respondent ID	Interviewer Code	Questionnaire is valid Coordinator's signature

Hello, my name is **(First name, last name):** I represent AREG SCYA NGO, which implements Tertiary Canals Survey in the RA marzes by the order of "Millennium Challenge Account-Armenia". The survey data will be used only in a summarized form and will greatly contribute to the elaboration of projects directed to the agricultural development in Armenia. Your reliable answers are very important for us.

Name of respondent

_____

First Name, Middle Name, Last Name

Contacts of the respondent: phone number (code+number) _____

Mobile (code+number) _____

Start time (hh/mm) _____

Don't Know 96
Refused to Answer 97

Date (day.month.year) _____

A. LAND AND LIVESTOCK

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

1. _____ years
2. Only ever cultivated a kitchen plot

A2. 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 2009?

		Total agricultural land, ha	Of which:		
			Was possible to irrigate by network, ha	Actually irrigated in 2009, ha	of which: by irrigation network water, ha
		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

A3. What sources of irrigation do/did you use in 2009?

		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				

A4. If you do not irrigate your own or rented land or the part of it during the last agricultural season (2009), then what is the main reason?

1. **Cannot pay for irrigation**
2. **Over normative land**
3. **Water does not reach my farm due to technical reasons**
4. **Water does not reach my farm due to organizational/managerial reasons**
5. **Water is not delivered the way as it was promised by WUA**
6. **Related to climatic conditions it was not necessary**
7. **These lands are not cultivated**
8. **Other (specify) _____**

A5. Do you have livestock?

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

Don't Know 96
Refused to Answer 97

A6. Information on households' livestock

N	Item	Available livestock
1	Large horned cattle	
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 unit 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 unit 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					1			
12								
13								
14								
15								
16								
17								
18								
19								
20								

B2. During recent agricultural season, did you grow different crops from the previous year?

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

Don't Know 96
Refused to Answer 97

B3. 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)_____

C. WATER USE

C1. How much of your cultivated land is watered through the following ways (not including your kitchen plot)?

1. Irrigation water (pipeline/canal)	sq. m
2. Deep or other well or drinking water (pipeline)	sq. m
3. Exclusively natural sources, rivers/ rain water	sq. m

C2. Do you have a personal tank, artesian well, or reservoir that you use to water crops?

1. Yes
2. No

C3. Do you have a personal pump that you use to pump water?

1. Yes
2. No

C4. Did you attend OFWM and/or HVA training?

1. Yes OFWM only
2. Yes HVA only
3. Yes OFWM and HVA
4. No

C5. What irrigation practices did you use during the last agricultural season at your kitchen plot and at other land?

To the Interviewer: Show CARD 2. Check all possible answers and fill the codes into the space below.

66. None of mentioned (then=>C6)

1. at the kitchen plot

2. at other land

Don't Know 96
Refused to Answer 97

C6. How many times did you irrigate the plots you have during the last agricultural season, and how long it took to irrigate each time?

		Total agricultural land, ha	How many times did you irrigate the land by irrigation network water in 2009	How long did it take to irrigate every time (hours)	Did you receive water when you needed during the last agricultural season (2009) 1. Yes 2. No	During the last season (in 2009) did you receive as much water as you needed? 1. Yes 2. No
		1	2	3	4	5
1	**Total, of which**					
2	Arable land					
3	Orchards					
4	Vineyards					
5	The plot near the house/kitchen plot					
6	Other					

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	Other major expenses (specify)		

E. Irrigation

E. 1. Are you a WUA member?

1. **Yes**
2. **No**
3. **Do not know**

Don't Know 96
Refused to Answer 97

E.2. Did the irrigation water supply improve compared to 2008?

1.Improved only in terms of timeliness of irrigation supply
2.Improved only in terms of quantity of irrigation water
3.Improved both in terms of timeliness and quantity
4.Remained unchanged
5.Got worse only in terms of timeliness of irrigation supply
6.Got worse only in terms of quantity of irrigation water
7.Got worse only in terms of timeliness and quantity

E.3. Can you estimate the quantity of irrigation water that you consumed during the last agricultural season?

To the interviewer: put the code 998,if the respondent cannot estimate

Cubic meters

E.4. Was the irrigation system of your village repaired or rehabilitated during 2009, if yes, then by whom?

		1.Yes 2.No 3. Don't know
1.	By yourself alone or with other farmers	
2.	By the rural community/community council	
3.	By the Water Users Association	
4.	By the Government	
5.	By the MCA-Armenia	
6.	Other_____(specify)	

E.5. How do you evaluate the condition of the irrigation system in your village?

1.	Very good	⇒ **F.1.**
2.	Good	⇒ **F.1.**
3.	Satisfactory	
4.	Bad	
5.	Very bad	

E.6. What are the main problems of the irrigation system in your village?

<u>To the interviewer</u>. Up to t*hree answers are allowed; please indicate them ranked in descending order of significance.*

1.	Bad condition of the main canals
2.	The lack of tertiary canals inside the village
3.	Bad condition of tertiary canals inside the village
4.	Bad condition of pump for deep well
5.	Bad condition of artesian well

Don't Know 96
Refused to Answer 97

6.	Bad condition of regular irrigation pump
7.	Absence of clear-cut water supply schedule in the village
8.	Disorganized work of the water supplier
9.	Other _____(specify)

F. CONSUMPTION AND MONETARY INCOME OF HH MEMBERS

F1. 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)	
4. Transport	
5. Other monthly costs ***(specify)***	

F2. How much was spent by your family for the following purposes last year?

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

F3. 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

G1. 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 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? (from 16 years of age) 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

H. OCCUPATION AND PAID JOBS OF HH MEMBERS

H. 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 column "No of h/h member" of H1)	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.	Appricot	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

Don't Know 96
Refused to Answer 97

CARD 2

N	Types of improvements / skills
	Appropriate preparation of irrigated land for irrigation (cleaning the land from stones, slope verification, weeding, etc)
2	**Verifying/modifying furrow geometric parameters (length, depth, width)**
3	**Have lined the ditch with polyethylene**
4	**Siphons**
5	**Plastic or metal dams**
6	**Gated pipes**
7	**Spiles with gates**
8	**Hydrants**
9	**Sprinkler irrigation**
10	**Micro sprinkler irrigation**
11	**Drip irrigation**
12	**Soil moisture measurement device (watermark, tensiometer or**
13	**ET gage**
14	**Water metering at the beginning of the land plot (YAGYUS or V-notch)**
15	***Have taken the example of the water supply contract with WUA***
16	***Have submitted an application to WUA about the cultivated***
17	***Have updated the annex of water supply contract***
18	***Have submitted a written application on water supply***
19	***Other (specify)***

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APPENDIX B

CROPS HARVESTED AND SOLD BY RESPONDENT HOUSEHOLDS

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Table B.1. Crops Harvested and Sold by Respondent Households

Crop	Percentage Growing	Average Harvest Area (Square Meters)	Average Tons Produced	Average Tons Produced Per Hectare	Average Value Produced (AMD)	Average Value Per Ton Produced (AMD)	Percentage Selling	Percentage Selling Among Respondents Growing	Average Tons Sold	Average Value Sold (AMD)	Average Value Per Ton Sold (AMD)
Grains	35	5,114	1.1	2.1	99,532	94,787	6	17	0.4	37,767	101,370
Wheat	29	3,795	0.8	2.2	77,924	93,561	5	17	0.3	32,949	96,024
Barley	11	1,119	0.2	1.5	13,307	80,703	1	8	0.0	1,593	82,790
Grape	30	1,100	1.0	8.7	114,120	119,143	17	56	0.9	101,608	117,160
Other Fruit and Nuts	62	2,818	1.3	4.4	140,805	112,450	17	28	1.0	91,516	89,579
Apricot	38	822	0.2	2.8	30,577	134,369	6	16	0.2	20,716	129,645
Apple	34	604	0.1	1.9	13,599	118,193	2	7	0.1	5,731	107,056
Peach	24	544	0.2	3.5	32,079	166,980	6	25	0.2	24,528	161,310
Pear	15	19	0.0	7.1	7,015	530,366	0	2	0.0	370	525,847
Walnut, hazelnut	12	93	0.0	0.8	12,078	1,647,996	1	4	0.0	1,461	1,646,615
Prunes	8	30	0.0	3.5	1,228	114,482	0	4	0.0	295	256,122
Sweet cherry	8	100	0.0	0.9	5,276	570,921	1	8	0.0	3,419	733,007
Plum	6	35	0.0	1.6	897	156,583	0	5	0.0	307	250,600
Cherry	6	14	0.0	2.4	937	277,897	0	1	0.0	7	255,562
Watermelon	4	268	0.5	20.3	22,452	41,258	3	78	0.5	21,974	41,167
Tomato	37	272	0.9	34.2	76,286	82,121	10	27	0.9	69,047	78,158
Vegetables and Herbs	44	512	1.0	19.6	105,572	105,019	16	37	0.9	95,597	107,350
Cucumber	24	129	0.3	20.0	36,774	142,153	7	27	0.2	34,303	143,414
Eggplant	16	74	0.2	22.6	14,823	88,220	4	26	0.2	13,503	88,389
Pepper	16	94	0.1	16.0	21,089	140,669	4	27	0.1	19,781	145,159
Greens	9	70	0.1	8.9	12,132	193,903	5	48	0.1	11,853	192,263
Cabbage	5	51	0.2	39.4	7,185	35,682	2	32	0.2	6,517	35,958
Carrot	4	32	0.1	24.1	4,445	56,961	2	42	0.0	2,387	53,994
Onion	4	20	0.0	10.0	3,799	189,762	1	25	0.0	2,538	157,815
Potato	34	877	1.6	18.7	105,933	64,461	8	23	1.1	69,510	65,883

Table B.1 *(continued)*

Crop	Percentage Growing	Average Harvest Area (Square Meters)	Average Tons Produced	Average Tons Produced Per Hectare	Average Value Produced (AMD)	Average Value Per Ton Produced (AMD)	Percentage Selling	Percentage Selling Among Respondents Growing	Average Tons Sold	Average Value Sold (AMD)	Average Value Per Ton Sold (AMD)
Grass	25	2,482	0.9	3.7	32,035	35,093	4	15	0.2	7,455	37,142
Gramma or other special feed	18	1,673	0.7	4.2	25,782	36,730	3	17	0.2	6,712	36,953
Natural grass	8	809	0.2	2.6	6,253	29,646	1	8	0.0	742	38,938
Other	12	202	0.1	5.2	22,429	214,836	3	25	0.1	18,008	192,947
Haricot	9	29	0.0	5.4	4,620	294,241	1	12	0.0	1,874	305,743

Note: Only separately reports crops cultivated by more than 3 percent of farmers in the sample.

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