FINAL REPORT

Evaluation of the Transition to High-Value Agriculture Project in Moldova: Baseline Findings from the 2013–2014 Farm Operator Survey

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I. INTRODUCTION

Moldova has traditionally enjoyed a strong agricultural sector, especially in high-value agriculture (HVA) products such as fruits and vegetables. Since the collapse of the Soviet Union, however, Moldova has seen a decline in the agricultural sector accompanied by a decline in its living standards. This has raised new challenges related to the production, processing, and transportation of HVA products, as well as access to export markets. Despite recent improvements in its overall economy, Moldova remains one of the poorest countries in Europe (United Nations Development Programme 2013).

Moldova’s location, topography, and fertile soil put it in an excellent position to expand the production and sales of HVA products as a means both to redress poverty and to make Moldova more competitive in the global marketplace. But the country’s ability to grow its agricultural sector also depends on stimulating investment, learning about modern agricultural techniques, raising the quality of its exports, and improving key aspects of its infrastructure, such as irrigation and transportation.

To address some of these challenges, the Millennium Challenge Corporation (MCC), through its 2010–2015 compact with Moldova, is sponsoring two projects: the Transition to High-Value Agriculture (THVA) and Road Rehabilitation projects. MCC contracted with Mathematica Policy Research to evaluate the effectiveness of the THVA project, which comprises several activities intended to increase rural incomes and catalyze future investments in high-value agriculture. The THVA project includes several activities: (1) the Irrigation Sector Reform Activity and Centralized Irrigation System Rehabilitation Activity (ISRA-CISRA), which are two complementary activities that aim to improve access to irrigation on agricultural land; (2) the Growing High-Value Agriculture Sales (GHS) activity, which aims to increase sales of HVA by developing and expanding markets, providing training, providing technical assistance, and improving the enabling environment for HVA; and (3) the Access to Agricultural Finance (AAF) activity, which provides financing for investments related to HVA production, processing, and sales, as well as for investments related to irrigation. The ultimate purpose of the evaluation of the THVA project is to determine the effectiveness of the project activities at increasing investment in high-value agriculture, the extent to which they are likely to reduce poverty, and the main mechanisms underlying (or limiting) their effects.

Although several THVA project activities are being implemented throughout Moldova, some have a more specific geographic focus. In particular, ISRA-CISRA is being conducted in up to 11 Centralized Irrigation Systems (CISs) in the central and southern regions of the country. CISs in Moldova typically include one or more pumping stations and (in some cases) reservoirs, along with a series of subterranean pipes that carry water from rivers or other sources to farmers’ fields. Most of the current systems were operational during the Soviet era but have since fallen into disrepair. ISRA transfers the management of these systems from the government of Moldova to local water user associations; CISRA rehabilitates the irrigation infrastructure in these systems (for example, by replacing pumps and pipes) to deliver water to farmers’ fields.

The selected CIS areas are expected to benefit from the full package of THVA project activities. These include ISRA-CISRA and other activities focused on the CIS areas, as well as activities that are being implemented more broadly in locations throughout Moldova (including but not limited to locations in the CIS areas) or at the national level. Because the THVA project activities are designed to be highly complementary in driving investments in high-value agriculture and long-term reductions in poverty, understanding the effectiveness of the project in these areas is of primary interest for the THVA evaluation.

The THVA evaluation will rely on two complementary components. The first is an impact evaluation, which focuses on measuring the impacts of the project in the CIS areas that will benefit from the full package of project activities. The impact evaluation will use a matched comparison group design that compares changes in farmers' outcomes in these targeted CIS areas (treatment areas) to changes in outcomes of farmers in comparable CIS areas (comparison areas) that will not benefit from the full package. The second component is a performance evaluation, which will draw primarily on qualitative data from a variety of stakeholders and will triangulate information from these and other sources to gain a complete understanding of project implementation, successes, and challenges. The two components of the THVA evaluation are intended to complement each other and, in combination, provide a holistic assessment of the THVA project to address the evaluation research questions.

This report describes data that were collected to provide a baseline for the THVA impact evaluation. The Millennium Challenge Account-Moldova (MCA-Moldova) collected these data from farm operators in early 2014 through the 2013–2014 Moldova Farm Operator Survey. These data were intended to serve three main purposes: (1) to provide baseline levels of key outcomes in treatment areas to inform programmatic targets[1]; (2) to enable us to assess the degree of similarity between the treatment and comparison CIS areas at baseline, and therefore determine the likely validity of our comparison group design; and (3) to obtain baseline outcome measures to use as control variables to strengthen the eventual impact analysis, both by improving the match between treatment and comparison groups and by improving statistical precision.

Farm operators interviewed as part of the 2013–2014 Farm Operator Survey provided information on farm characteristics, production, revenue, and costs, as well as other outcomes. The survey focused on farm outcomes from the 2013 agricultural season (ending October 2013) and collected data from 3,913 farm operators in 62 communities between February and April 2014. These included operators in the treatment CIS areas, comparison CIS areas, and border areas, which are areas adjacent to or near the treatment areas in which some farmers will be able to connect to the rehabilitated irrigation systems.

Although some THVA activities were already under way at the time the 2013–2014 Farm Operator Survey data were collected, the irrigation system rehabilitation—which is expected to interact with other activities to drive changes in treatment areas—had not been completed. Therefore, we view the 2013–2014 Farm Operator Survey as informative of pre-rehabilitation levels of key outcomes. We cannot completely rule out that some changes (for example, in crop patterns) might already have occurred in anticipation of rehabilitation; however, we expect them to be small relative to the changes once the systems are rehabilitated. Further, the analysis in this

[1] In addition to the outcomes discussed in this report, MCA-Moldova requested baseline values for specific outcomes mentioned in their monitoring and evaluation plan to enable them to assess progress toward their targets. We present these outcomes in Appendix C.

report will verify that there were no substantive treatment-comparison differences in cultivation, farm profits, or other key outcomes prior to rehabilitation.

An earlier round of the Farm Operator Survey, conducted in 2012–2013 (capturing outcomes from the 2012 agricultural season), was originally intended to be the baseline for the impact evaluation. However, the 2013–2014 data offer several advantages as a baseline, because they (1) include a border area sample; (2) include a comparison area that was added to replace one of the planned comparison areas, which was likely to benefit from rehabilitation; (3) reflect changes to the boundaries of the treatment CIS areas between 2012 and 2013; (4) rely on a much larger sample of small farm operators; and (5) are more likely to reflect outcomes in a typical year compared to the 2012–2013 round, which was substantially affected by a severe drought that took place in 2012. Therefore, we intend to rely primarily on the 2013–2014 round as the baseline, although the 2012–2013 round might still be informative about some topics, including knowledge of the compact and early interactions with water user associations.[2]

Additional quantitative and qualitative data collection activities, which we describe in further detail in Chapter X, will also inform the THVA evaluation. For the impact evaluation, the main additional data sources will be up to two follow-up rounds of the Farm Operator Survey in 2018–2019 and 2020–2021 (three and five full seasons after rehabilitation of all systems, respectively). The performance evaluation will rely largely on several rounds of primary qualitative data collected before system rehabilitation (2013, 2014, and early 2015) and after rehabilitation (late 2015, 2017, 2019, and 2021), together with additional data sources related to specific project activities.

In the rest of this chapter, we describe the THVA project, the evaluation design, and the Farm Operator Survey in greater detail. In the chapters that follow, we present descriptive statistics for key characteristics and outcomes measured in the Farm Operator Survey, separately for treatment and comparison areas. Specifically, Chapter II briefly describes household, farm, and plot characteristics; Chapter III discusses farm production, farm profits, and household income; Chapter IV discusses irrigation practices and water user association interactions; and Chapters V, VI, and VII discuss training, use of improved practices, and credit, respectively. Throughout, we test for differences between treatment and comparison areas to help assess the likely validity of our comparison group design. In Chapter VIII, we introduce border areas into the analysis by combining the treatment and border areas and testing for differences between this combined group and the comparison areas. In Chapter IX, we present information on gender differences in farm participation, differences in outcomes between male- and female-operated farms, and differences in reports between farm operators and their spouses. We conclude in Chapter X.

A. The THVA project

The THVA project consists of four complementary activities (and several sub-activities) that are designed to address different constraints to HVA production and sales. The project activities, their timing, and their geographic focus are summarized in Table I.1 (for further detail, see the

[2] Despite the differences between these two rounds, the findings from the 2012–2013 round (Borkum et al. 2015a) were broadly similar to the findings from the 2013–2014 round (which we describe in this report) for key outcomes such as HVA cultivation, irrigation, and farm profits.

evaluation design report, Borkum et al. 2015b). As mentioned above, some of these activities focus on the 11 selected CIS areas while others have a broader geographic focus.

Table I.1. THVA project activities

Activity	Description	Timing	Geographic focus
Irrigation Sector Reform Activity (ISRA)	Provided technical assistance and training to create local water user associations and build their capacity to manage and maintain the CISs. Supported the transfer of the management and operations of the CISs from the government of Moldova to the water user associations under a new legal framework.	Started in 2010; management transfer complete in 10 systems by mid-2015	11 selected CIS areas
	Supported the creation of a river-basin management system to ensure a sustainable long-run supply of water in Moldova.	Started in 2013	Entire country
Centralized Irrigation System Rehabilitation Activity (CISRA)	Rehabilitates irrigation infrastructure to deliver water to farmers' fields.	Construction started in 2013; expected to be complete by late 2015 (end of compact)	10 of the selected CIS areas[a]
Growing High-Value Agricultural Sales (GHS) Activity[b]	Includes several complementary subactivities to increase sales of HVA by addressing constraints specific to selected crops' value chains. These sub-activities include (1) HVA market development and expansion (including end-market studies and linkages to potential investors); (2) farmer training to upgrade production and meet buyer requirements; (3) demand-driven technical assistance to enterprises, associations, and cooperatives; (4) the improvement of an enabling environment for HVA; and (5) farmer training and field demonstrations to support the transition to HVA and the use of irrigation in the targeted CIS areas.	Started in 2011; will continue through March 2016 (post-compact)	Entire country; one subactivity (farmer training and field demonstrations) that started in 2014 focuses on the 10 rehabilitated CIS areas.
Access to Agricultural Finance Activity[c]	Loans to farmers and rural entrepreneurs for investments related to HVA production, processing, and sales.	First loan disbursed in 2012; will continue post-compact	Initially entire country; then restricted to raions (districts) including the 11 selected CIS areas; then expanded to neighboring raions, as well; currently, entire country
	Hire-purchase program (administered by 2KR) for irrigation equipment or farming equipment and machinery for irrigated land.	First purchase made in 2015; will continue post-compact	Entire country

[a]One of the selected CIS areas for ISRA, 6-9 Cahul, will not be rehabilitated.

[b]Part of the Agricultural Competitiveness and Enterprise Development Project, funded jointly by MCC and the United States Agency for International Development.

[c]Also included the investment development services subactivity, which was designed to enable farmers and rural entrepreneurs to develop relevant investment projects on a cost-sharing basis with Moldovan development investment providers. However, in practice, implementation of this subactivity was very limited.

CIS = centralized irrigation system, HVA = high-value agriculture.

The program logic (Appendix A) emphasizes the complementary nature of many of the project activities, especially in the CIS areas in which the full package of activities is being implemented.[3] In these areas, the program logic suggests that increased access to affordable and well-managed irrigation water through ISRA-CISRA will enable farmers to invest in production of high-value crops, whereas the GHS activity (which is mainly being implemented more widely across Moldova but includes one component focused on the CIS areas) will enable these farmers to better understand and meet market requirements for these crops. The program logic suggests that the AAF loan program (which, for part of the implementation period, focused specifically on the raions [districts] in which these areas are located), will further enhance the ability of farmers who cultivate high-value crops to meet market requirements and benefit from higher prices through improved access to post-harvest infrastructure. Although not yet included in the program logic, the 2KR hire purchase program is designed to further complement the other THVA activities by encouraging investments in irrigation and HVA production, with the goal of increasing HVA production and sales. Together, these activities are intended to increase production of high-value crops, increase the sales volumes of and prices received for these crops, and ultimately to increase household incomes and reduce poverty. The THVA impact evaluation will help us assess whether the expected outcomes in the program logic have been achieved or are on target to be achieved.

B. Targeted CIS areas

As discussed above, the 11 CIS areas targeted for the THVA project were selected from among about 80 systems in Moldova. The selection was conducted through an iterative process involving MCC, MCA-Moldova, Apele Moldovei, and AcvaProiect. Selection was based on several criteria, including the number of farm operations, registered demand for water, water source/quality, technical status of the system, energy efficiency, potential support for water user associations, irrigation experience, risk, and profitability of the system. Systems that were uneconomical to rehabilitate—such as those with high pumping costs or those that had been destroyed—were not selected, nor were systems that were no longer serving farmers. Among systems meeting key criteria, selection also considered the expected economic rate of return, which compares the expected costs and benefits of rehabilitation.

The THVA project activities are expected to work in concert to improve agricultural production and sales in the targeted CIS areas. These improvements will primarily affect a predefined geographic area in each CIS, referred to as the CIS command area, which will be served by the rehabilitated irrigation system. Because MCC no longer plans to fund irrigation rehabilitation in one of the originally targeted CIS areas, CIS 6-9 Cahul, the impact evaluation will focus on the remaining 10 targeted systems (Table I.2); more specifically, it will focus primarily on the CIS command areas in these 10 systems. (Because CIS 6-9 Cahul was included in the original project design and ISRA supported the establishment of a water user association there, we still plan to include this system in the THVA performance evaluation.)

[3] In one of the 11 treatment CIS areas, 6-9 Cahul, the irrigation system will not be rehabilitated through the compact given existing drainage issues. In addition, in treatment CIS 6-6 Chircani-Zirnesti, only a subset of the command area (certain modules) will be rehabilitated through MCC funding. Therefore, in practice, MCC funding will be used to fully rehabilitate 9 systems and partly rehabilitate one. As we describe below, the impact evaluation will focus on these 10 systems, although the performance evaluation will include all 11 systems.

Land outside the command area might also have access to the rehabilitated irrigation systems (and therefore irrigation water). In particular, the rehabilitated systems will be engineered so that some farmers operating land adjacent to or near the command areas will be able to connect to the CIS (through connection points); the systems will have the capacity to accommodate some farmers operating in nearby areas. These areas are known as *border* or *extension* areas. Farmers operating border area lands near the 10 CIS areas targeted for rehabilitation are also potential beneficiaries of these activities and will be included in the impact evaluation.

Table I.2. Characteristics of CIS treatment areas

			Command areas		Border areas	
CIS[a]	Raion	Water source	Size (ha)	Number of plots	Size (ha)	Number of plots
3-2 Blindesti	Ungheni	Prut River	642	657	1,044	1,652
3-6 Grozesti	Nisporeni	Prut River	1,100	2,093	310	700
5-4 Leova Sud	Leova	Prut River	980	2,167	312	1,508
6-6 Chircani-Zirnesti	Cahul	Prut River	2,265	3,887	0	570
11-6 Jora de Jos	Orhei	Nistru River	1,300	3,101	382	1,903
11-7 Lopatna	Orhei	Nistru River	512	1,322	308	761
12-3 Cosnita	Dubasari	Nistru River	2,483	7,729	0	484
14-2 Criuleni	Criuleni	Nistru River	778	1,158	546	1,153
14-11 Puhaceni	Anenii Noi	Nistru River	920	4,846	294	1,581
14-13 Roscani	Anenii Noi	Nistru River	700	1,328	341	1,415
Total	**--**	**--**	**11,680**	**28,288**	**3,537**	**11,727**

Source: 2013–2014 Moldova Farm Operator Survey listing and MCA-Moldova.

Note: Table presents characteristics of the treatment CIS command areas. Sizes of command areas and border areas are estimates as of January 1, 2015, and were provided by MCA-Moldova. Numbers of plots are based on the 2013–2014 Farm Operator Survey listing, which is different from the sample frame in that it includes land belonging to the local public administration, land for which the operator is not known, and land operated by farmers from other systems. Because rehabilitation plans have changed since the 2013–2014 Farm Operator Survey listing, the size and number of plots may refer to different geographic areas.

[a]Treatment CIS 6-9 Cahul is omitted because MCC no longer plans to fund irrigation system rehabilitation; therefore, it will not be included in the impact evaluation.

CIS = centralized irrigation system, ha = hectares.

C. Evaluation design

To provide context for the analysis in this report, we provide an overview of the THVA evaluation design, with a focus on the impact evaluation that the 2013–2014 Farm Operator Survey data were designed to inform. Further details on the evaluation design are available in the THVA evaluation design report (Borkum et al. 2015b).

1. Research questions

The evaluation of the THVA project seeks to answer the following research questions, which are closely linked to the program logic:

1. Were the expected results realized from the THVA program logic (with priority on the medium-term outcomes)? *For example, to what extent did hectares of irrigated crops, hectares under intensive and non-intensive high-value agriculture, prices, and sales increase in the CIS and border areas? Were transition rates as expected as projected in the economic rate of return?*
2. If results were not realized, why not? *Was it because the logic was incorrect or incomplete, assumptions did not hold, or the project was not implemented as designed? Were there other external factors that affected the results?*
3. What was the contribution of each activity/sub-activity to the results that were realized (this includes analysis of each sub-activity for ISRA, CISRA, GHS, and AAF)? *If farmers transitioned to high-value agriculture, why?*
4. How did THVA affect land ownership, leasing, and land values in the CIS and border areas?
5. How are the results from the project distributed?
    a. Are there different results for subgroups of beneficiaries, particularly small farmers and women-headed households? *If so, why?*
    b. Did wages paid to farm laborers in CIS areas increase?
    c. How much did work days or hours on the farm change for men and for women?
    d. How much did formal employment change in HVA farms or HVA enterprises for male and female workers?
6. Are there indications that some of the long-term outcomes will be realized?
    a. Are there indications that farm income will increase in the CIS and border areas?
    b. Are there indications that the THVA Project will be successful in its objective of creating an irrigation and high-value agriculture production model that could be replicated throughout Moldova?
    c. Are there indications that the THVA Project will be successful in its objective of creating a sustainable model for irrigation and HVA production?
7. What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?
8. What is the ex post economic rate of return of the THVA Project?

To answer these questions, we will conduct a mixed-methods evaluation of the THVA project that includes an impact evaluation and a largely qualitative performance evaluation. The impact evaluation will focus on obtaining quantitative estimates of the effects of the package of activities taking place in targeted CIS areas, using data collected from farm operators in 2013–2014 (the baseline data described in this report) and up to two subsequent rounds, in 2018–2019 (first follow-up) and 2020–2021 (second follow-up). The performance evaluation will focus on assessing the implementation, successes, and challenges of the project activities more broadly. It will rely on primary qualitative data, quantitative data from AAF loan recipients, administrative data, and document review; these data will be collected between 2013 and 2021.

2. Impact evaluation

The impact evaluation will rely on a matched comparison group design. Effectively, this design will compare the changes in outcomes for a group of farms or farm plots in CIS areas selected for the project (the treatment group) with outcome changes for a group of farms or farm plots in other similar CIS areas (the comparison group). We will use changes in outcomes for the comparison group to estimate the counterfactual (that is, the changes that would have occurred for the treatment group in the absence of the activities); any difference in outcome changes between the two groups will then be attributed to the THVA activities that occurred in the treatment areas but not the comparison areas.

The key assumption for unbiased impact estimates in a matched comparison group design is that any changes in outcomes due to external factors unrelated to the THVA project (for example, levels of rainfall, market conditions, and other interventions) are not systematically different in the two groups. Therefore, the internal validity of the design depends on the quality of the match between the treatment and comparison groups. If the comparison group provides a good approximation of the counterfactual (that is, if the match is good), it accounts for time-varying external factors that could affect outcomes.

To ensure as close a match as possible, we identified a set of comparison CIS areas that are similar to the treatment CIS areas in terms of observable characteristics of the areas, and of the features of the systems themselves, that could affect outcomes (as described in more detail below). Our comparison group consists of farms and farm plots in these comparison areas. Because of the small number of prospective CIS comparison areas and the many important dimensions along which they vary, we could not identify perfect matches for the treatment areas along all dimensions. Therefore, when constructing impact estimates, we will use data on the baseline level of outcomes and other farmer characteristics to statistically adjust for any remaining observable treatment-comparison differences that could be related to outcomes.

To identify these comparison CIS areas, we implemented a multistage matching procedure. In the first stage, we identified for each treatment CIS area the set of unaffected CIS areas meeting key criteria (where possible), including geographic proximity to the treatment area (within a radius of 25 kilometers), the same water source as the treatment area, the same baseline functionality as the treatment system, and the same baseline water user association status as the treatment area.[4] It was important to ensure similarity along these characteristics, because they could all potentially affect the key outcomes of interest (for example, geographically proximate CIS areas are likely to experience similar environmental and local market conditions).

In the second stage, we used a quantitative matching procedure to identify the best matches for each treatment area from the set of potential matches identified in the first stage. Specifically, we calculated the mean squared difference between each treatment area and its potential comparisons based on the following matching variables (where available): total land area, total area of irrigated land, maximum pumping height, pumping distance from water source, volume of water used, and electricity used. These were the only CIS characteristics available when we

[4] Some unaffected CIS areas had formed water user associations that were not directly related to the ISRA-CISRA activity.

conducted the matching, and they are relevant because they could be related to access to and availability of irrigation in each area. The potential comparison area with the minimum mean squared difference for a given treatment area was selected as its comparison for the study. Some of the treatment CIS areas were assigned the same comparison area with this procedure. This reduced the number of comparison areas below the 11 we had planned, which would have reduced the statistical power of the evaluation. Therefore, to maintain a total of 11 comparison areas, we added a second- or third-best comparison for some treatment CIS areas from the potential matches identified in the first stage, so that they had more than one comparison.

In the final stage, the potential match or matches for each treatment area were validated through discussions with several key stakeholders, data on cropping patterns, and listing of farm operators. From those discussions and data, we learned that some identified matches were not comparable to treatment areas for reasons that were not apparent in the administrative data that we used for matching, such as urbanicity, cropping patterns, and the number of farmers. We therefore revised the list of matches when the identified match was poor, by identifying new comparison CIS areas for a given treatment area; these areas either were entirely new or were drawn from the existing list of comparisons for other treatment areas. To identify the new matches, we relied primarily on the first-stage matching criteria, but relaxed the proximity constraint to 35 kilometers. Again, we validated these new matches through discussions with key stakeholders and data on cropping patterns before finalizing them.

Through the matching process, we identified 11 comparison CIS areas, each matched to one or more of the treatment CIS areas. Because the treatment-comparison matches were not always one-to-one, we grouped CIS areas into strata that can include more than one treatment or comparison CIS (Table I.3). All treatment areas in a given stratum are intended to be similar to all comparison areas in the stratum; in the ultimate impact analysis, we will, in effect, combine the stratum-specific impact estimates. Both treatment and comparison systems are located along the Nistru and Prut rivers; as a result of the matching approach, comparison systems are located geographically near their matched treatment systems (Figure I.1).

Table I.3. Treatment and comparison CIS areas, by stratum

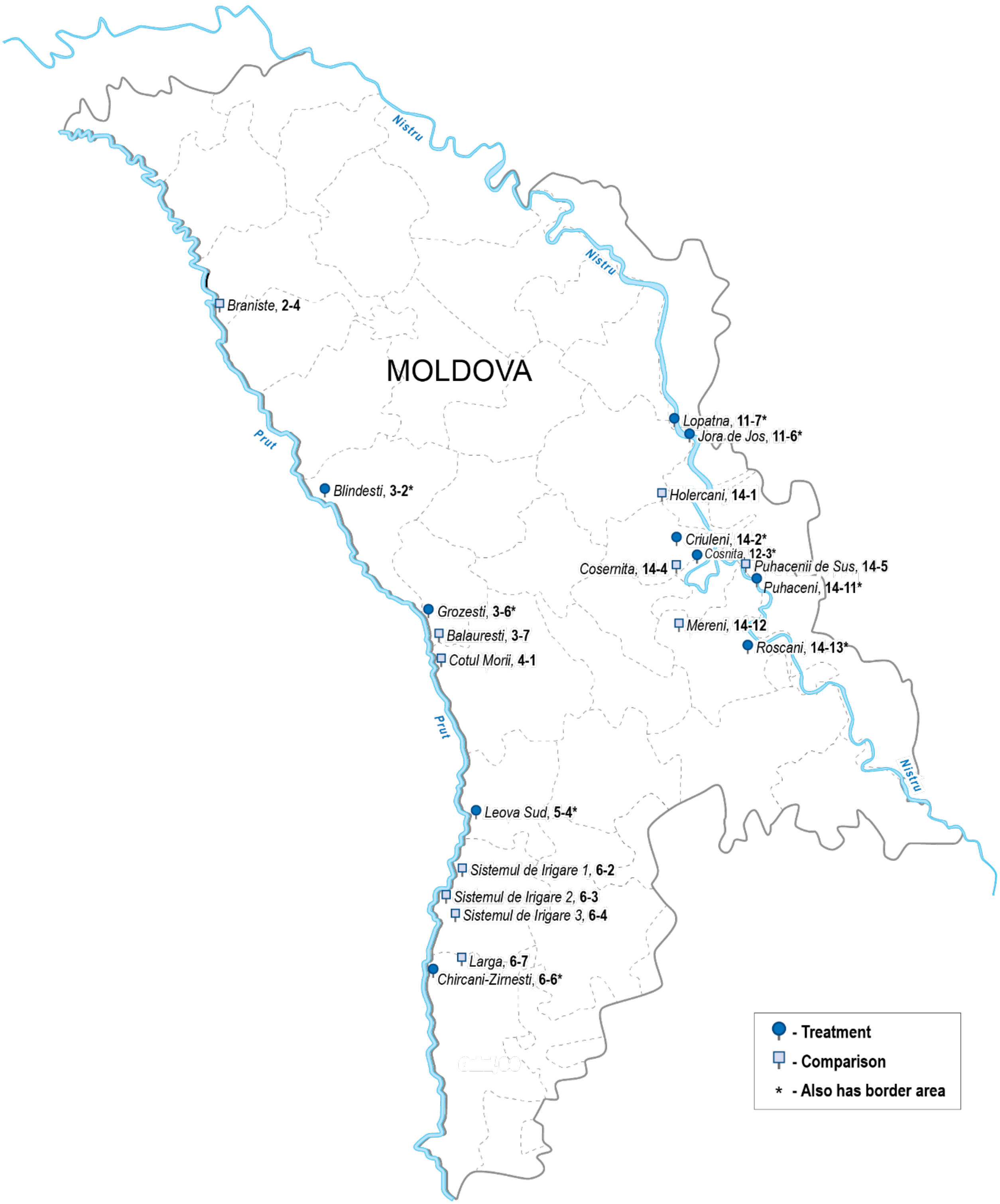
Stratum	Treatment CIS areas	Comparison CIS areas
1[a]	3-2 Blindesti	2-4 Braniste
2	3-6 Grozesti	3-7 Balauresti
3	5-4 Leova Sud	4-1 Cotul Morii 6-2 Sistemul de Irigare 1 6-3 Sistemul de Irigare 2 6-4 Sistemul de Irigare 3
4[b]	6-6 Chircani-Zirnesti	6-7 Larga
5	11-6 Jora de Jos 11-7 Lopatna 12-3 Cosnita 14-2 Criuleni 14-11 Puhaceni	14-1 Holercani 14-4 Cosernita 14-5 Puhacenii de Sus
6	14-13 Roscani	14-12 Mereni

[a]The comparison area in this stratum was originally 3-1 Sculeni. After the 2012-2013 Farm Operator Survey, we learned that this area overlaps significantly with the 3-2 Blindesti border area; therefore, many farmers in 3-1 Sculeni could benefit from ISRA-CISRA. We therefore replaced 3-1 Sculeni with 2-4 Braniste as the comparison area.

[b]This stratum originally included an additional treatment CIS area, 6-9 Cahul, which was also matched to comparison CIS 6-7 Larga. However, MCC no longer plans to fund the rehabilitation of the irrigation system in 6-9 Cahul, and it is therefore not included in the impact evaluation.

CIS = centralized irrigation system.

Figure I.1. Treatment and comparison CIS areas



Note: Locations are approximate.
CIS = centralized irrigation system.

As mentioned earlier, MCC also identified specific border areas adjacent to or near the command areas; farmers operating land in these areas may be able to connect to the CIS through connection points. These border areas were identified based on engineering constraints, interest from farmers, and the potential economic benefits of providing them access to irrigation. It was not possible to use a similar methodology to identify equivalent border areas for the comparison CIS areas because the engineering parameters that determined access are not known and it would not be possible to solicit interest from farmers in gaining access to (hypothetical) irrigation. However, given that the comparison system boundaries are based on historical CIS area boundaries (which may be more inclusive than the rehabilitated systems), there is a good chance that equivalent farmers are already encompassed by the comparison command areas.

The primary analysis approach for the impact evaluation will be to compare changes over time in the treatment areas to changes in the comparison areas; the analysis approach for the border areas will be to include them as part of the treatment group. Specifically, we will compare changes in the treatment plus border areas to changes in the comparison areas. These impacts are the most relevant for computing the ex post economic rate of return of the project because they capture overall project impacts. (We are not able to estimate results for the border areas alone, primarily because the border area sample size is relatively small and the estimates would have low statistical power).

3. Performance evaluation

The performance evaluation will complement the impact evaluation and will inform our answers to research questions that cannot be answered through the impact evaluation alone. It will rely on several data sources, including in-depth qualitative interviews and focus groups with stakeholders relevant to each activity, a quantitative survey of AAF borrowers, administrative data, and a document review. The analysis for the performance evaluation will involve triangulating data from these sources, identifying similarities and differences in perspectives in the qualitative data, and complementing this with descriptive information from the quantitative data, administrative data, and document review.

Qualitative data for the performance evaluation were collected through interviews and focus groups with key stakeholders in July–August 2013, April–May 2014, and February–March 2015. These data were intended to complement the quantitative data collection by providing additional context about the farmers and areas included in the impact evaluation, as well as to document implementation progress and initial experiences with the project activities (especially related to ISRA) in treatment areas. They also provided valuable information specifically related to the GHS activity. MCA-Moldova’s data collection contractor prepared a report summarizing the findings in each year (ACT Research 2013a, ACT Research 2013b, ACT Research 2014a, ACT Research 2014b, ACT Research 2015a, ACT Research 2015b).

We have proposed four additional rounds of qualitative data collection to inform the performance evaluation, taking place in 2015, 2017, 2019, and 2021. The upcoming 2015 round will include interviews with high-level stakeholders focused on implementation and will occur in the fourth quarter, after the compact has closed. The 2017 round will focus on initial experiences with the fully rehabilitated irrigation systems, which should all have been operational for at least one agricultural season. For example, it will examine whether water user associations are functioning well (in terms of membership, financial status, and management), the extent to which new investments in HVA are being made and some of the initial challenges, and whether the envisaged complementarities between the THVA activities are beginning to manifest. The 2019 and 2021 rounds will enable us to document whether and how change occurred in the longer-term, after several agricultural seasons with the rehabilitated systems.

D. Moldova Farm Operator Survey

The Farm Operator Survey is a survey of farm households or farms that operate inside treatment, comparison, or border areas. The 2013–2014 Farm Operator Survey relied on two questionnaires: one for small and medium farms, and another questionnaire for large farms, which are typically operated as businesses. The questionnaire (included as Appendices D and E) contained several modules (Table I.4), which were designed to address the key research questions, as well as other interests of MCC and MCA-Moldova. It collected data on basic household/farm characteristics, together with a range of outcome measures, including the main final program outcomes (such as farm profits and household income) and several intermediate outcomes (such as access to irrigation water, cultivation of HVA crops, and other agricultural investments) that can inform the research questions. For the most part, the small/medium and large questionnaires were the same, with differences reflecting the fact that large farms are not typically household farms. Most questions were asked only of a single respondent, but a handful of questions were asked of both the farm operator and his/her spouse (for small/medium farms only) to obtain different perspectives of gender dynamics within the household.

Table I.4. Farm Operator Survey modules 2013–2014

Module	Key topics covered
Household roster (small/medium only)	Identification of farm operator(s); demographic information on all members of the household, such as gender, age, and migration
Farm information (large only)	Respondent characteristics; legal and ownership status of farm; number of owners by gender; number of managers and other employees; and wages paid
Household, farm, and community characteristics	Farm decision making by household members (small/medium only, *); use of household labor and hired labor (small/medium only); asset ownership; cold storage access and use; participation in producer/agricultural organizations, cooperatives, and savings and credit associations (*)
Farm production, revenue, and costs	Livestock ownership and revenue (small/medium only); garden plot revenue (small/medium only); crops cultivated and harvested, intensive HVA, land rental price, and use of irrigation, separately for land in CIS, border, and other areas; use of cold storage; characteristics of sales, including volume, value, timing, destination, point of sale, and buyer; expenditures on agricultural inputs
Focal plot(s)	Plot size; ownership status and rental/purchase price; crops cultivated and crop harvest; irrigation use and cost; use of household labor (small/medium only), use of hired labor, and wages paid to laborers; reasons for not cultivating; future plans for production and financing
Other farming experience	Sources of different types of information, including agricultural practices and markets; cooperation with other farmers in sales; weather or pests that affected production; perceived level of rainfall; time use during agricultural season (small/medium only, *)
Irrigation management, satisfaction, and usage	Availability and utilization of irrigation; satisfaction with irrigation; affordability of irrigation service; awareness of WUAs; participation in WUAs (*) and payment of fees; satisfaction with WUAs
Agricultural trainings	Participation in agricultural training; for most recent training attended in the past year, details including month of training, topics covered, location, and training provider; reasons for not attending training
Crop and post-harvesting practices/equipment	Use of practices/equipment for apples, table grapes, tomatoes or tomato seedlings, or stone fruits; source of information on practices/equipment; reasons for not using practices
Credit	Loan applications; for loans approved in the past year, details including purpose of the loan, source of credit, loan size, collateral value, term, and interest rate; reasons for rejection; reasons for not applying for loans
Employment, income, and consumption (small/medium only)	Education and occupation of household members, nonagricultural income (for example, wages, self-employment income, pensions, remittances, rental payments received); household consumption/expenditure (excluding agricultural expenses); importance of agricultural income for household; interest in children becoming farmers

(*) = asked separately of the farm operator and his or her spouse in small/medium farm households.

Not starred = asked only of farm operator.

CIS = centralized irrigation system, HVA = high-value agriculture, WUA = water user association.

Farmers participating in the Farm Operator Survey often cultivate multiple plots of land, which could include land inside and outside the CIS command area. This is a legacy of the land privatization that took place in the 1990s: different types of land in a community (such as orchards and fields) were apportioned equally among community members, which often resulted in an individual owning noncontiguous plots (for example, if the orchards or fields were not contiguous). All plots of land operated by a farmer—including those inside and outside the CIS command area—are typically considered to be part of the same farm. Therefore, focusing on farm-level outcomes could potentially understate impacts of the program on land inside the CIS command area (which is most affected by the THVA project).

To address this issue, we measured outcomes specific to the land operated by each farmer inside the CIS command area using two different approaches. First, the 2013–2014 Farm Operator Survey gathered some information separately for land inside and outside the command area. For example, the survey gathered information on crops cultivated and amounts harvested separately for land inside and outside the CIS command area (and inside the border area, if applicable). Other measures that would be difficult to disaggregate by land type—such as sales and expenditures—were gathered for the farm as a whole. In our analysis, we used CIS command area measures where available, and attempted to rescale farm-level measures to approximate a command area measure (for example, to approximate sales from the CIS command area, we rescaled total sales by the proportion of the harvest that came from the CIS command area). We discuss the use and construction of specific CIS command area measures in Chapter III.

Second, we asked respondents to provide information on cultivation, irrigation, and other outcomes for a specific "focal" plot or plots that they operated within the CIS command area. Obtaining this plot-level information is important because ISRA-CISRA is expected to affect land productivity; therefore, the impact evaluation intends to follow farm plots over time to observe changes in land use, even if the farm operator changes.[5] Focal plots, identified by cadastral codes, were selected from among land plots cultivated by the farmer inside the CIS command area. Operators of small and medium farms were asked to provide information about one focal plot apiece; large-farm operators (who accounted for a large fraction of plots in these areas) were asked to provide information about up to three focal plots, as available.[6] We used plot-level measures directly in the analysis where relevant, as described in subsequent chapters.

The 2013–2014 Farm Operator Survey was administered to farm households or farms operating land inside the command areas in the 10 treatment and the 11 comparison CIS areas (it was also administered in treatment CIS 6-9 Cahul, which was omitted from the analysis once it was determined that it would not be rehabilitated). There were relatively few medium (between 10 and 100 hectares) and large (100 hectares or more) farms operating plots inside these command areas, though these farms accounted for more than one third of plots (Figure I.2 shows

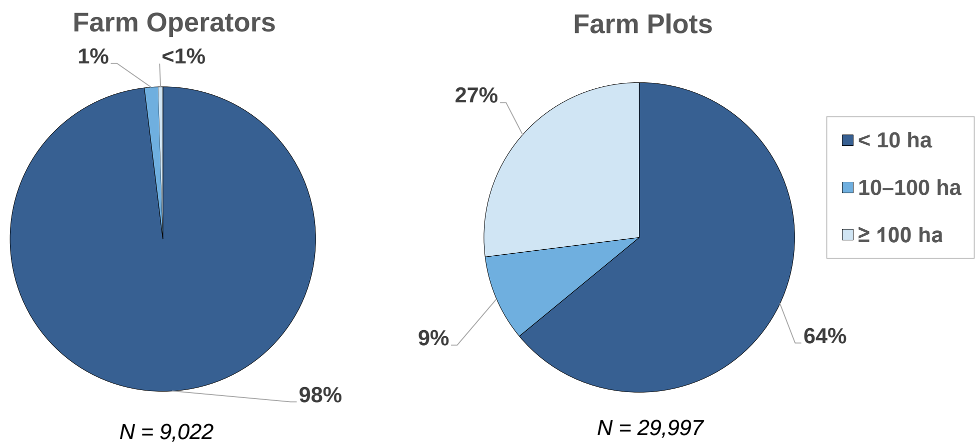
[5] Compact activities in the CIS areas might affect outcomes for the pre-rehabilitation owners of these plots, even if they sell or rent them (for example, owners might be able to sell their land for a higher price than they would have otherwise received). Therefore, if we observe very large changes in plot operation over time, we will also conduct a supplementary analysis to estimate changes for a sample of individuals who owned the sampled plots before rehabilitation (in the 2013 agricultural season).

[6] Some operators have plots in both the treatment command and border areas. Because the focus of the evaluation is primarily on the command area, we removed these small- and medium-farm operators (and their plots) from the border area sample frame before sampling. (These farmers were included in the treatment command area sample frame.) However, we were concerned that using a similar approach for large-farm operators could more substantively change the border area sample frame and lead us to omit large parts of the border area, because these large farms operate a substantial fraction of border area plots. We therefore sampled up to three plots in the treatment area and two plots in the border area for large-farm operators with plots in both areas.

the distribution of farms and plots in the treatment sample frame; these patterns were broadly similar in the comparison and border area sample frames). Therefore, all medium and large farms were asked to participate in the survey, but we collected information on more focal plots for large farms (three plots per large farm compared to one plot for medium farms). For small farms (less than 10 hectares), we selected a sample of operators and one focal plot per operator (Appendix B describes the sampling approach for farmers and plots in detail). By applying appropriate farmer or plot weights (for farm-level and plot-level variables respectively), we were able to ensure that our sample was representative of all farmers or plots in the CIS areas, as relevant (Appendix B describes these weights).

The 2013–2014 Farm Operator Survey was administered between February and April 2014, and the final analysis sample included 3,913 farmers: 2,393 in treatment areas, 992 in comparison areas, and 541 in border areas (Table I.5).[7] The overall response rate to the survey was 87 percent: 87 percent in treatment areas, 88 percent in comparison areas, and 86 percent in border areas. These 3,913 interviews provided information on 4,091 plots: 2,445 in treatment areas, 1,078 in comparison areas, and 568 in border areas.

Figure I.2. Farm size in treatment CIS areas (2013, percentage of operators or plots in each farm size group)



Source: 2013–2014 Moldova Farm Operator Survey and Sample Frame

Note: The farm sizes of farmers who were surveyed in the Farm Operator Survey were computed from their survey responses. The farm sizes for the remaining farmers were based on the sample frame. The size categories are small (<10 ha), medium (≥10 to <100 ha), and large (≥100 ha).

[7] Because some large farmers in the sample operated land in both treatment and border areas, 13 of the large farmers in the treatment area sample also appear in the border area sample (which is why the total number of interviews, 3,913, is less than the sum of the number of interviews by type). However, each sampled plot for these operators can be uniquely assigned to the treatment or border areas (as mentioned earlier, we sampled up to three plots in the treatment area and two plots in the border area for large-farm operators with plots in both areas).

Table I.5. Number of farm operators and plots in the analysis sample

CIS	Farm operators in 2013–2014 analysis sample			Plots in 2013–2014 analysis sample		
	Small	Medium	Large	Small	Medium	Large
Treatment command areas[a]						
3-2 Blindesti (upper)	74	1	3	74	1	9
3-2 Blindesti (lower)	21	0	0	21	0	0
3-6 Grozesti	272	0	1	272	0	3
5-4 Leova Sud	162	4	4	162	4	10
6-6 Chircani-Zirnesti (rehabilitated)[b]	209	12	3	209	12	9
6-6 Chircani-Zirnesti (nonrehabilitated)[b]	60	7	0	60	7	0
11-6 Jora de Jos	219	9	3	219	9	9
11-7 Lopatna	211	6	0	211	6	0
12-3 Cosnita	338	6	4	338	6	12
14-2 Criuleni	185	4	5	185	4	15
14-11 Puhaceni	347	5	2	347	5	6
14-13 Roscani	203	11	2	203	11	6
All treatment areas	2,301	65	27	2,301	65	79
Border areas[b]						
3-2 Blindesti	126	3	1	126	3	1
3-6 Grozesti	41	2	1	41	2	2
5-4 Leova Sud	105	2	4	105	2	10
6-6 Chircani-Zirnesti	15	3	1	15	3	3
11-6 Jora de Jos	17	0	4	17	0	10
11-7 Lopatna	19	1	1	19	1	3
12-3 Cosnita	17	0	0	17	0	0
14-2 Criuleni	18	2	4	18	2	9
14-11 Puhaceni	67	0	3	67	0	7
14-13 Roscani	79	4	1	79	4	2
All border areas	504	17	20	504	17	47
Comparison command areas						
2-4 Braniste	33	4	7	33	4	21
3-7 Balauresti	97	14	0	97	14	0
4-1 Cotul Morii	62	6	2	62	6	6
6-2 Sistemul de Irigare 1	1	1	2	1	1	6
6-3 Sistemul de Irigare 2	10	3	2	10	3	6
6-4 Sistemul de Irigare 3	16	1	2	16	1	6
6-7 Larga	109	10	2	109	10	6
14-1 Holercani	134	11	5	134	11	15
14-4 Cosernita	14	0	2	14	0	4
14-5 Puhacenii de Sus	322	30	16	322	30	46
14-12 Mereni	66	3	5	66	3	15
All comparison areas	864	83	45	864	83	131

Source: 2013–2014 Moldova Farm Operator Survey.

Note: The farm size categories shown here are: small (<10 ha), medium (≥10 to <100 ha), and large (≥100 ha).

[a]Thirteen large farms with plots in the treatment and border areas were included in both samples (we sampled up to three treatment area plots and two border area plots for these farms).

[b]The rehabilitated module sample only includes the modules that MCC planned to rehabilitate as of late 2013. However, (a) an additional module was later added and (b) some of the nonrehabilitated modules might be rehabilitated through other methods.

CIS = centralized irrigation system.

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II. HOUSEHOLD, FARM, AND PLOT CHARACTERISTICS

In this chapter, we examine the characteristics of the households, farms, and plots in treatment and comparison areas at baseline. This information provides important context for the evaluation and helps us understand the types of households and farms that may be affected by the THVA project. Because some of these characteristics might be related to the outcomes of interest, we would also like to determine the extent to which they are similar in treatment and comparison areas at baseline to help assess the validity of our comparison group design. Some of these characteristics will also serve as explanatory variables in the regression models we will ultimately use to estimate impacts.

The Farm Operator Survey captured information on household characteristics for small and medium farms through a roster of household members. The roster included household members who lived together for at least three months of the year and relied on the same budget. It also identified the head of household and the primary farm operators—defined as the members of the household who were most knowledgeable about farm operations—enabling us to examine and compare head of household and farm operator characteristics. The Farm Operator Survey did not include a household roster for large farms, which typically operate as businesses rather than household enterprises. Instead, the survey captured information on a large farm's characteristics from a knowledgeable respondent associated with the farm.

As mentioned in Chapter I, farms often cultivate land located in different areas, which could include land inside the CIS command area, inside the border area, and outside the CIS command and border areas. We therefore collected information on the area cultivated in each of these locations for all farms in our sample. We gathered similar information on the cultivated area for the plots in our sample, which by definition were inside the command area.[8] We also captured information on ownership status, purchase characteristics, and rent (if any) for these plots. Table II.1 summarizes the key household, farm, and plot characteristics included in the Farm Operator Survey questionnaire.

Table II.1. Measures of household and farm characteristics

Measures	Time frame
Household and operator characteristics—small and medium farms. List of all household members (including household head and primary farm operators); age; gender; education level; number of household members; number of farm operators; gender composition of farm operators; number of children in household; adult household members living abroad during the 2013 agricultural season.	As of survey date
Farm characteristics—large farms. Role of respondent; number of owners; gender composition of owners; years in existence; number of paid employees.	As of survey date
Farm characteristics—all farms. Available area and total area cultivated (entire farm and inside CIS command area); proportion of cultivated land inside CIS command area or border areas; ownership status of available land inside CIS command area; rent paid if land inside CIS command area rented.	2013 agricultural season
Plot characteristics. Plot cultivated; plot area cultivated; plot ownership status; purchase timing and price if plot purchased; rent paid if plot rented.	2013 agricultural season

[8] As described in Chapter I, our sample of plots also included plots inside the border areas. We focus our plot-level analyses in this and subsequent chapters on plots inside the command area; in Chapter VIII, we conduct analyses that include plots in the border areas.

A. Household and farm operator characteristics

The typical household head of small and medium farms was male, at least 50 years old, and had completed at least some secondary education (Table II.2). More than one-third of household heads in treatment areas were 60 or older, with a median age of 55, and only about one in four was female. The vast majority had some secondary education (37 percent) or had completed secondary education (37 percent), with a sizeable share (21 percent) completing some higher education. The head of household was often listed as a primary operator: about 92 percent of household heads in treatment areas were the sole primary operator on the farm and a further 4 percent were listed as a joint operator (not shown). Therefore, the characteristics of primary operators were very similar to the characteristics of household heads, except that a slightly larger percentage of operators were female (28 percent versus 23 percent in treatment CIS areas).

Households operating small and medium farms were relatively small on average: in treatment areas, only about a third had more than three members (Table II.3). Ninety-six percent of treatment households had only one primary farm operator, and more than 70 percent had farm operators that were all men. The typical small or medium farm was therefore operated by a sole male operator who, as noted above, was also the head of household. Consistent with having household heads in their fifties or older, only about one-third of households in treatment areas had any children under age 18. About 19 percent of households in treatment areas reported that a member of their household lived primarily abroad during the agricultural season, which is consistent with the findings from the qualitative study (ACT Research 2013a) that seasonal migration—largely for work—is common.

Households operating farms in treatment and comparison areas at baseline generally had similar basic characteristics. Although the differences between treatment and comparison areas are significant in a few cases (for example, households in the comparison areas tended to have slightly more educated household heads and fewer children), the magnitudes of these significant differences are modest.

Table II.2. Head of household and farm operator characteristics for small and medium farms (2013, percentage of household heads or farm operators unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Head of household						
Age	2,361	941				0.37[a]
Younger than 40			10.6	9.6	1.1	0.39
40–49			20.0	18.6	1.4	0.26
50–59			33.8	37.0	-3.2	0.00***
60 and older			35.6	34.9	0.7	0.67
Median (years)			55	56	--	--
Female	2,366	946	23.4	26.8	-3.4	0.18
Education	2,360	946				0.28[a]
Less than secondary			4.5	4.0	0.6	0.66
Some secondary			37.2	35.0	2.2	0.58
Completed secondary			37.2	32.1	5.1	0.30
Higher			21.1	29.0	-7.9	0.00***
Farm operator						
Age	2,537	1,009				0.25[a]
Younger than 40			11.6	10.5	1.1	0.43
40–49			20.5	18.1	2.4	0.02**
50–59			33.8	37.3	-3.5	0.00***
60 and older			34.1	34.0	0.1	0.95
Median (years)			55	55	--	--
Female	2,542	1,014	27.7	32.3	-4.6	0.09*
Education	2,536	1,014				0.24[a]
Less than secondary			4.5	3.4	1.0	0.26
Some secondary			38.2	34.9	2.9	0.48
Completed secondary			35.7	31.7	4.4	0.39
Higher			21.6	30.1	-8.4	0.00***

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Large farms (≥ 100 ha) are not included because large farms operate as businesses rather than household enterprises. To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a] *p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Table II.3. Household characteristics for small and medium farms (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Household members	2,366	947				0.60[a]
1			18.6	17.8	0.8	0.78
2			28.7	31.8	-3.1	0.46
3			16.4	18.6	-2.2	0.23
4			19.8	17.1	2.6	0.33
5 or more			16.5	14.6	1.8	0.57
Median			3	3	--	--
Number of farm operators	2,366	946				0.31[a]
1			96.2	92.8	3.4	0.15
2			3.5	6.8	-3.3	0.15
3 or more			0.3	0.4	-0.1	0.67
Median			1	1	--	--
Farm operated by:	2,365	946				0.21[a]
Man or men only			71.4	65.3	6.1	0.07*
Woman or women only			25.1	27.6	-2.5	0.28
Men and women together			3.5	7.0	-3.6	0.12
Children in household	2,363	946				0.06*[a]
0			67.2	74.4	-7.2	0.02**
1			17.7	14.0	3.7	0.08*
2 or more			15.1	11.6	3.5	0.00***
Median			0	0	--	--
Any adult household member abroad	2,363	947	18.6	19.0	-0.4	0.91

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Large farms (≥ 100 ha) are not included because large farms operate as businesses rather than household enterprises. Children are defined as less than 18 years of age. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

B. Large-farm characteristics

For large farms, the Farm Operator Survey asked a person knowledgeable about the farm's operations to respond to the questionnaire. In treatment areas, 70 percent of respondents to the large-farm survey were farm managers and almost half were one of the farm's owners or shareholders (Table II.4).[9] Large farms typically had few owners (only about 31 percent of farms in treatment areas had more than two) who were mostly male (only 27 percent had at least half female ownership). They tended to be well established, with about 72 percent of large farms in treatment areas having been in existence for more than 10 years, and only 3 percent for fewer

[9] Respondents to the large-farm survey could have cited multiple farm roles.

than 5 years. Large farms also tended to have many employees, with a median of 9 in treatment areas.

There are several large and significant differences in the characteristics of large farms in treatment and comparison areas. For example, large farms in treatment areas typically had been in existence for longer, had more employees, and were more likely to have at least half female ownership relative to those in comparison areas. These large differences are not unexpected given the small number of large farms in these areas (all of which were included in our sample). In the impact analysis we will combine large farms with other farm sizes to estimate impacts on key outcomes, and we assess the similarity between treatment and comparison areas for this combined sample (along characteristics that apply to all farms) below and in subsequent chapters. We therefore do not expect that these treatment-comparison differences in large farm characteristics alone will bias the impact estimates.

Table II.4. Large farm characteristics (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Farm role of respondent	27	45				
Owner/shareholder			49.1	56.9	-6.9	0.65
Manager			69.7	37.1	32.6	0.01**
Economist/accountant			0.0	17.4	-17.0	0.03**
Other			5.6	0.0	5.9	0.15
Number of owners	26	44				0.38[a]
1			51.0	67.2	-16.9	0.24
2			17.9	4.9	11.1	0.11
3			11.4	7.3	5.4	0.58
≥ 4			19.8	20.6	0.3	0.97
Median			1	1	--	--
At least half of farm's owners are female	25	44	27.0	3.7	23.9	0.00***
Years farm in existence	27	43				0.10[a]
< 5			2.8	15.7	-11.9	0.03**
5–10			24.8	42.1	-20.0	0.04**
> 10			72.5	42.2	32.0	0.00***
Median (years)			13	10	--	--
Total number of paid employees	27	45				0.43[a]
0			0.0	13.6	-14.4	0.04**
1–10			56.5	57.3	-2.2	0.85
11–20			18.1	14.2	5.2	0.39
> 20			25.5	14.9	11.4	0.34
Median			9	6	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Percentages of farm roles may not sum to 100 because respondents could select more than one response option. To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

C. Cultivated area and plot characteristics

Looking across all farms, farms in treatment areas generally cultivated most of their available land (about 90 percent, Table II.5). However, most farms were small: about 65 percent of farms in treatment areas cultivated less than 1 hectare, and another 32 percent cultivated between 1 and 5 hectares; the median farm cultivated 0.6 hectares. These area estimates include the land of the entire farm, which includes land inside the CIS command area, and may also include land inside border areas (for farms in treatment areas), as well as land outside the CIS command and border areas. By definition, all treatment area farms operated land inside the command area, but about 12 percent also operated land in border areas and 50 percent also operated land outside of these areas (not shown). However, for treatment area farms, most cultivated land was located inside the CIS command area (72 percent, on average), rather than in the border area (3 percent) or outside of these areas (the remaining 25 percent). Because the land inside the command area is a subset of the land of the entire farm, cultivated area within the command area was smaller than for the entire farm, with a median of only 0.3 hectares.

Most land inside the CIS command area was owner-operated. On average, farms in treatment areas owned 93 percent and rented about 1 percent of their land available for cultivation in the CIS command area (the remainder was available to them to use for free). Farms in treatment areas that rented land in the command area paid an average annual rent of 146 dollars per hectare, although the sample sizes for these estimates are low because relatively few farms rented land. Overall, comparison area farms are statistically similar to treatment area farms with respect to almost all of the farm-level cultivation characteristics that we examined.

Table II.5. Farm cultivation characteristics (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Entire farm area						
Percent of total available area cultivated per farm	2,393	992	90.4	88.0	2.3	0.22
Total area cultivated per farm	2,393	992				0.71
<1 ha			64.9	58.2	6.6	0.37
≥1 to <5 ha			32.3	38.8	-6.5	0.39
≥5 to <10 ha			1.8	2.0	-0.2	0.85
≥10 to <100 ha			0.7	0.7	0.0	0.70
≥100 ha			0.3	0.3	0.0	0.19
Median (ha)			0.6	0.8	--	--
Of total cultivated area, Percent:						
Inside CIS command area	2,301	951	72.4	76.8	-4.4	0.62
Inside border area	2,301	--	3.5	--	--	--
Farm area inside CIS command area						
Percent of total available area cultivated per farm	2,372	992	87.0	87.4	-0.3	0.93
Total area cultivated per farm	2,393	992				0.31
<1 ha			78.1	66.9	11.2	0.10*
≥1 to <5 ha			20.1	31.1	-11.1	0.10
≥5 to <10 ha			1.1	1.1	0.0	0.96
≥10 to <100 ha			0.5	0.6	-0.1	0.32
≥100 ha			0.2	0.2	-0.1	0.30
Median (ha)			0.3	0.4	--	--
Of available land inside CIS command area, percent:						
Owned	2,372	992	92.7	92.2	0.5	0.81
Rented	2,372	992	0.9	1.0	-0.1	0.60
Used for free	2,372	992	6.4	6.8	-0.4	0.84
Rent per hectare inside CIS, among farms renting in CIS command area (mean, dollars/ha)	64	81	146	96	48	0.24

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Entire farm area includes land in the CIS command area, land inside border areas, and land outside the CIS command and border areas. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares.

We also analyzed the characteristics of the plots in our sample. For some measures presented in this report, the sampled plot is the unit of analysis. About 87 percent of plots in treatment areas were cultivated (Table II.6). Plots tended to be small: almost half had a cultivated area of less than 0.25 hectares, and fewer than 8 percent had a cultivated area of 1 hectare or more. About 76 percent of plots in treatment areas were owner-operated; most of these were acquired through land privatization (56 percent of all treatment area plots), and less often through inheritance (12 percent) or purchase (7 percent).[10] Of the owned plots that were purchased, about half were purchased within the five years prior to the survey, with about 1 in 10 purchased within the two years prior to the survey, a pattern that does not suggest an acceleration of plot sales in anticipation of system rehabilitation. Plots purchased in the five years prior to the survey were purchased for an average price of $1,146 per hectare, more than double the average purchase price for plots purchased more than five years ago (an increase which could reflect price inflation).[11] About 18 percent of plots in treatment areas were rented by the farm, with a mean annual rent of $79 per hectare.[12] Despite a few statistically significant differences, the characteristics of plots in treatment and comparison areas were largely similar at baseline.

[10] The share of plots that is owner-operated (76 percent) is smaller than the average share of CIS command area land that is owner-operated (93 percent) because small farms are more likely to own the CIS command area land that they operate, and the typical farm is more likely to be operated by small operator than the typical plot.

[11] Because the sample size for the price of plots purchased within the past two years was small, we combined plots purchased within the previous two years with those purchased between two and five years ago for these price estimates.

[12] The percent of treatment command area plots that were rented (18 percent) is much higher than the percent of command area land that was rented by the average farm (1 percent). This is because large operators, who are much more likely to rent land than small operators, compose a much larger share of plots than of farms in the command area. Therefore, the typical plot is more likely to be operated by a large operator than the typical farm and, as a result, is more likely to involve rented land.

Table II.6. Plot characteristics (2013, percentage of plots unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Plot cultivated in 2013	2,445	1,078	87.1	89.6	-2.5	0.53
Plot area cultivated	2,445	1,078				0.44
<0.25 ha			49.0	38.7	9.6	0.23
≥0.25 to <0.5 ha			25.9	20.3	5.2	0.54
≥0.5 to <0.75 ha			11.3	13.7	-2.4	0.50
≥0.75 to <1 ha			6.4	8.0	-1.2	0.63
≥1 ha			7.4	19.3	-11.2	0.03**
Median (ha)			0.3	0.4	--	--
Plot ownership status:	2,444	1,078				0.70
Owned—purchase			6.8	5.9	1.1	0.49
Owned—inheritance			12.1	11.5	0.3	0.83
Owned—privatization			56.5	51.6	3.7	0.16
Owned—other			0.2	0.0	0.2	0.13
Rented			18.5	22.7	-2.9	0.10*
Used for free			6.0	8.3	-2.4	0.28
Timing of purchase, among purchased plots:	83	69				0.94
Purchased in the last 2 years			10.9	10.9	2.2	0.82
Purchased 2–5 years ago			40.7	36.7	6.0	0.76
Purchased more than 5 years ago			48.5	52.4	-8.2	0.55
Purchase price, among purchased plots (mean, dollars per ha):						
Purchased in the last 5 years	35	32	1,146	841	303	0.15
Purchased more than 5 years ago	35	21	502	641	-150	0.27
Rent per hectare, among plots rented (mean, dollars/ha)	71	140	79	86	-4	0.72

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2012, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares.

III. AGRICULTURAL PRODUCTION, FARM PROFITS, AND HOUSEHOLD INCOME

In this chapter, we describe agricultural production, farm profits, and household income in treatment and comparison CIS areas during the 2013 agricultural season. These measures are among the key outcomes that the THVA project is expected to affect. It is therefore important to both document the baseline levels of these measures as a benchmark for future changes and assess the degree of similarity between treatment and comparison areas. Large treatment-comparison differences in these measures at baseline could suggest important underlying differences in unobservable characteristics that would be a concern for the comparison group design (for example, if baseline crop patterns were very different, treatment and comparison areas might react differently to market shocks unrelated to the THVA project).

The package of THVA activities in the treatment CIS areas is expected to result in changes in crop production patterns—in particular, increased cultivation of HVA crops. The Farm Operator Survey therefore captured detailed information regarding the cultivation and harvest volumes of specific crops. It also collected information on other aspects of crop production and post-harvesting practices, including the use of household and formal labor in the production process and the use of cold storage.

The changes in crop production are expected to lead to increases in farm profits and overall household income in the treatment CIS areas. To enable us to measure these outcomes, the Farm Operator Survey captured detailed information on agricultural sales and expenditures, as well as non-agricultural household income. The survey also collected an alternative measure of well-being, household consumption, which is less susceptible to year-to-year variation than household income and might therefore be a better long-term measure of well-being (Deaton 1997). Table III.1 summarizes the key measures related to production, farm profits, and household income from the Farm Operator Survey; we will use similar measures in future rounds of the survey to assess changes over time in the treatment CIS areas relative to the comparison CIS areas.

Because only cultivation on land that can be irrigated by the rehabilitated CIS will be affected by the full package of THVA activities, we are primarily interested in measures related to production on CIS command area land. However, many farmers (about 39 percent in treatment areas and 48 percent in comparison areas, not shown) cultivated land both inside and outside the CIS command area. To facilitate an analysis focused on land inside the CIS command area, the Farm Operator Survey collected some measures separately for farmers’ land in the command area (for example, cultivation and harvest volumes of specific crops). The survey collected other measures for the farm as a whole (for example, sales of specific crops and agricultural expenditures) because it would have been difficult for farmers to report these separately for different parts of their farm. In our analysis, we attempted to rescale these farm-level measures where feasible to approximate a measure that is applicable to the CIS command area (for example, to approximate the amount sold from CIS command area production, we rescaled total sales for each crop by the proportion of the farm’s harvest that came from inside the command area). The survey also collected some information specific to the sampled plots, which we present at the end of this chapter. Because these plots are by definition located within the CIS command area, plot-level measures are expected to be directly affected by the project.

Table III.1. Measures of agricultural production, farm profits, and household income

Measures	Time frame
Agricultural production. Crops cultivated; cultivation of HVA crops; cultivation of intensive HVA (orchard crops only); area of HVA cultivated and percentage of cultivated area devoted to HVA; amount of specific crops harvested; value of specific crops harvested; weather and pests affecting production.	2013 agricultural season
Farm labor. Use of household labor; time spent on agricultural work by farm operator (small/medium farms only); use of hired labor; amount paid to hired labor.	2013 agricultural season
Cold storage. Use of cold storage facilities; distance from cold storage facilities.	2013 agricultural season
Agricultural sales. Crops sold; amount of specific crops sold; characteristics of crop sales (including to whom sold, where sold, product destination, and season of sales).	2013 agricultural season
Farmer cooperation and membership of organizations. Cooperation with other farmers in various agricultural activities; membership in farmer organizations.	2013 agricultural season
Revenue from agricultural production. Value of crops sold.	2013 agricultural season
Farm expenditures. Amount spent on specific farm expenditures.	2013 agricultural season
Farm profits. Revenues minus expenditures.	2013 agricultural season
Non-agricultural income. Income from the household head, spouse, and any grown children from all sources, besides work on the family farm (small/medium farms only); sources of non-agricultural income; whether agricultural activities are the main source of income.	2013 calendar year
Total household income. Farm profits plus non-agricultural income (small/medium farms only).	2013 calendar year
Household Consumption. Total household non-agricultural expenditures plus value of harvested crops consumed by the household and value of consumption from livestock and the garden plot (small/medium farms only).	2013 calendar year

Note: The Farm Operator Survey recorded each measure for production on the entire farm and/or on land inside the CIS command area and/or on the sampled CIS command area plot.

CIS = centralized irrigation system, HVA = high-value agriculture.

A. Agricultural production and sales

1. Crop cultivation

Farmers in the treatment areas cultivated a wide variety of crops in the CIS command area in 2013, but cultivation of HVA crops was limited (Table III.2). The most common crops cultivated in the treatment command areas were all non-HVA crops: corn (78 percent of farms), technical grapes (13 percent), and sunflowers (11 percent).[13] The most common HVA crop cultivated by treatment farms was apples (9 percent of farms), with other types of HVA crops each cultivated by less than 2 percent of the sample (potatoes, tree fruit seedlings, onions, and peaches were the most common after apples).[14] Overall, 90 percent of treatment area farmers cultivated crops in

[13] Technical grapes (grapes grown for wine) are generally not considered to be HVA in Moldova. Table grapes (grapes grown for direct consumption) are considered to be HVA, but were cultivated by a very small percentage of farmers and are therefore not shown in Table III.2.

[14] HVA crops include sweet corn, potatoes, cabbages, tomatoes, peppers, onions, cucumbers, carrots, watermelons, seed, vegetable seedlings, tree fruit seedlings, apples, pears, sweet cherries, plums, peaches, apricots, walnuts,

the CIS command area, but only 15 percent cultivated HVA crops. Less than 1 percent of treatment area farmers cultivated HVA crops intensively (defined as orchards with a tree density of more than 1,000 per hectare or cultivation of HVA crops in a greenhouse).

Table III.2. Crops cultivated in CIS command area (2013, percentage of farms, HVA crops in bold)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Corn	2,393	992	78.3	76.6	1.7	0.73
Technical grapes			12.8	9.4	3.3	0.55
Sunflowers			10.7	19.6	-8.9	0.35
Apples			9.4	4.9	4.6	0.47
Wheat			6.7	11.6	-4.8	0.12
Fodder plants/forage			5.9	7.4	-1.5	0.64
Barley			4.9	3.9	0.9	0.38
Potatoes			1.5	4.3	-2.8	0.50
Tree fruit seedlings			1.3	0.0	1.3	0.22
Onions			1.2	0.3	1.0	0.24
Peaches			1.2	0.6	0.5	0.48
Beans			1.1	5.5	-4.3	0.32
Any crops	2,393	992	89.6	91.8	-2.2	0.58
HVA crops	2,393	992	14.7	12.3	2.3	0.68
Intensive HVA crops	2,384	975	0.8	0.0	0.8	0.07*
Non-HVA crops	2,393	992	87.5	90.1	-2.6	0.52

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Crops that were reported by a small percentage of treatment and comparison farms are not shown. HVA crops are highlighted in bold. Intensive HVA cultivation is defined as an orchard with a tree density of at least 1,000 per hectare or cultivation in a greenhouse. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

The differences between the treatment and comparison areas in the prevalence of cultivation of specific crops in the CIS command area were generally small, and none of the differences for commonly cultivated crops is statistically significant. The largest difference was for the cultivation of sunflowers (9 percentage points higher in comparison areas); the differences for the cultivation of other crops were all less than 5 percentage points. HVA cultivation was uncommon in both the treatment and comparison areas (less than 15 percent of farms cultivated HVA) and the difference was not statistically significant, while intensive HVA cultivation was close to zero in both areas even though the difference was marginally statistically significant. Overall, the cultivation patterns in the treatment and comparison CIS command areas were

strawberries, table grapes, garlic, green beans, zucchini, sugar beets, radish, onion seeds, almonds, quince, grafted vines, eggplant, raspberries, lawn rolls, gooseberries, sour cherries, and blackberries.

similar in this pre-rehabilitation baseline year, lending confidence to the validity of our comparison group design.

To further explore HVA cultivation, we examined the average area of cultivated CIS command area land that farmers devoted to HVA crops. This analysis confirms that HVA cultivation in the treatment command areas was limited at baseline: the average treatment area farmer cultivated only about 0.1 hectares of HVA crops, composing about 8 percent of their total cultivated CIS command area land (Table III.3). These estimates include farmers who did not cultivate any HVA crops; the average HVA farmer in treatment areas devoted about 47 percent of cultivated CIS command area land to HVA crops. This suggests that typical farmers in the treatment areas devoted little if any of their cultivated CIS area land to HVA crops and that even HVA farmers tended to devote a substantial part of their land to non-HVA crops. Like the prevalence of HVA cultivation (discussed above), the area devoted to HVA was very similar in the comparison areas.

Table III.3. Area of HVA crops cultivated per farm in CIS command area (2013)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Mean hectares of HVA cultivated (ha)	2,393	992	0.1	0.1	0.0	0.76
Percentage of cultivated area devoted to HVA (Mean)	2,183	918	7.7	5.7	1.8	0.40

Source: 2013–2014 Moldova Farm Operator Survey.

Note: To account for outliers, hectares of HVA cultivated were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares, HVA = high-value agriculture.

2. Crop sales, harvests, and revenues

To understand how these cultivation patterns translated into agricultural income for farmers, we examined patterns of crop sales, harvests, and revenues in the CIS command area. Although the 2013–2014 Farm Operator Survey captured separate information about farmers' harvests from land inside the CIS command area, it only captured information about crop sales for the entire farm. Therefore, to estimate sales from CIS command area production, we rescaled total sales for each crop by the proportion of the harvest of that crop that came from inside the command area.

The pattern of crop sales suggests that that far fewer farmers sold a given crop from CIS area production than cultivated it, especially for non-HVA crops (Table III.4). For example, although 78 percent of treatment area farmers cultivated corn inside the CIS command area (as shown above), only 6 percent sold it. A similar discrepancy between cultivation and sales, albeit smaller in magnitude, is observed for other common non-HVA crops such as sunflowers and wheat. This is largely explained by the fact that, although almost all treatment area farmers who cultivated these non-HVA crops reported a nonzero harvest, they tended to sell only a small fraction (if any) of their harvests. Instead, they tended to consume a large proportion of their production and keep the rest (possibly for future consumption). Specifically, the average treatment area farm that harvested corn, sunflowers, or wheat consumed more than one-third of its harvest of these crops, while almost all the rest was kept (not shown). Overall, only about 10 percent of treatment area farmers sold any non-HVA crops from their production in the CIS command area, even though 88 percent reported cultivating non-HVA crops on command area land.

Table III.4. Crops sold from CIS command area (2013, percentage of farms, HVA crops in bold)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Corn	2,393	992	6.3	7.9	-1.6	0.14
Apples			5.0	3.8	1.2	0.77
Sunflowers			1.9	3.5	-1.6	0.05**
Wheat			1.4	5.3	-3.9	0.04**
Potatoes			1.3	4.2	-3.0	0.48
Fodder plants/forage			1.1	0.5	0.6	0.48
Tree fruit seedlings			1.0	0.0	1.0	0.24
Any crops	2,393	992	16.7	26.7	-9.9	0.09*
HVA crops	2,393	992	8.9	9.9	-1.0	0.79
Non-HVA crops	2,393	992	10.0	19.5	-9.5	0.03**

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Crops that were reported by a small percentage of treatment and comparison farms are not shown. HVA crops are highlighted in bold. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

In contrast, prevalence of cultivation and sales in the CIS command area were more closely aligned for the most common HVA crops, such as apples, potatoes, and tree fruit seedlings. The largest discrepancy was for apples (the most common HVA crop), which were cultivated by 9 percent of treatment area farmers but only sold by 5 percent. This was largely due to the zero reported harvests of apples (almost half of farmers who cultivated apples in the CIS command area reported a zero harvest of apples on that land, not shown), possibly reflecting young orchards that had yet to produce. Overall, about 9 percent of treatment area farmers sold any HVA crops from their production in the CIS command area, compared to about 15 percent cultivating HVA.

The overall percentage of farmers selling HVA crops was similar in the treatment and comparison areas, but the percentage of farmers selling non-HVA crops was significantly higher in comparison areas (by 10 percentage points). Crop production in treatment areas is unlikely to have been affected by the THVA project at the time of the 2013–2014 Farm Operator Survey; therefore, these differences in non-HVA crop sales likely reflect underlying preexisting differences between the treatment and comparison areas. However, because the THVA project focuses on HVA crops—for which the percentage selling crops at baseline is statistically similar—these baseline differences are not a major concern for our comparison group design.

To complement our analysis of the percentage of farmers cultivating and selling specific crops, we also examined the *amounts* of specific crops harvested and sold from CIS area production and the values of these harvests and sales (that is, revenues), focusing on the most prominent crops. We present the amounts harvested and sold both in metric tons and in metric tons per cultivated hectare, which is a better indication of productivity because it accounts for variation in cultivated area (Table III.5). However, amounts are difficult to compare across different crops; therefore, we focus our discussion on harvest value (amount harvested in tons multiplied by the value per ton) and revenue in dollars—monetary measures that are more directly comparable across different crops (Table III.6).

Table III.5. Agricultural harvest and sales from production in CIS command area (2013, HVA crops in bold)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Average amount harvested from CIS area land (mean, metric tons)						
Corn	2,393	992	2.1	3.0	-0.9	0.02**
Wheat			0.9	1.1	-0.3	0.35
Apples			0.5	0.2	0.3	0.26
Sunflowers			0.4	0.5	-0.2	0.02**
Fodder plants/forage			0.3	0.3	0.0	0.98
Potatoes			0.3	0.4	-0.1	0.86
Onions			0.3	0.0	0.3	0.12
Barley			0.2	0.3	-0.1	0.11
Technical grapes			0.1	0.1	0.0	0.45
Average amount harvested per hectare from CIS area land, among those cultivating (mean, metric tons per hectare)						
Corn	1,791	697	5.5	5.5	0.0	0.94
Wheat	233	177	2.9	3.1	-0.1	0.59
Apples	208	42	4.8	5.4	0.1	0.71
Sunflowers	396	242	1.8	1.7	0.1	0.67
Fodder plants/forage	227	71	4.4	6.9	-2.1	0.05**
Potatoes	35	30	20.5	18.1	2.6	0.41
Onions	51	5	15.0	-- [a]	-- [a]	-- [a]
Barley	185	82	2.3	2.5	0.0	0.90
Technical grapes	250	95	6.8	6.3	1.4	0.04**

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Average amount sold from CIS area land (mean, metric tons)						
Corn	2,393	992	0.3	0.6	-0.3	0.00***
Wheat			0.6	0.5	0.0	0.98
Apples			0.4	0.2	0.3	0.29
Sunflowers			0.2	0.4	-0.1	0.08*
Fodder plants/forage			0.1	0.0	0.0	0.55
Potatoes			0.3	0.3	0.0	0.98
Onions			0.3	0.0	0.3	0.13
Barley			0.1	0.2	-0.1	0.08*
Technical grapes			0.0	0.0	0.0	0.09*
Average amount per hectare sold per hectare from CIS area land, among those cultivating (mean, metric tons per hectare)						
Corn	1,791	697	0.2	0.3	-0.1	0.05**
Wheat	233	177	0.4	1.1	-0.6	0.00***
Apples	208	42	4.7	4.5	0.8	0.00***
Sunflowers	396	242	0.2	0.3	-0.2	0.06*
Fodder plants/forage	227	71	0.5	0.3	-0.1	0.50
Potatoes	35	30	17.1	13.9	3.1	0.45
Onions	51	5	12.4	-- [a]	-- [a]	-- [a]
Barley	185	82	0.4	0.5	0.0	0.84
Technical grapes	250	95	0.1	1.8	-0.7	0.00***

Source: 2013–2014 Moldova Farm Operator Survey.

Note: The total amounts harvested and sold are defined for the full sample of farmers and set to zero if a specific crop was not harvested or sold, respectively. The amounts harvested and sold per hectare are defined for farmers who reported a nonzero cultivated area of the specific crop in the CIS command area and are computed based on the crop-specific cultivated area. The table includes the most commonly cultivated crops (Table III.2) except for peaches and beans, which had very low average harvests, and fruit tree seedlings, which were measured in number of units rather than metric tons. HVA crops are highlighted in bold. To account for outliers, all measures were top- or bottom-coded at three standard deviations above and below the mean of nonzero values for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]The values for comparison areas are not shown because the sample sizes are too small (fewer than 15 observations) to provide reliable estimates.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

Our analysis of revenues from CIS area production suggests that, despite the limited cultivation of HVA crops, these crops made a large contribution to total average revenues (Table III.6).[15] In the treatment areas, average revenue from HVA crops was $262, compared to $210 for non-HVA crops. Because HVA crops are typically cultivated on a much smaller area of land than non-HVA crops, HVA crops provided substantially higher revenues on a per-hectare basis—$1,585 per hectare compared to $36 per hectare. Harvest values for non-HVA crops (both total and per hectare) were generally substantially higher than revenues because the amount of these crops that was sold was typically much less than the amount harvested.[16] In contrast, revenues and harvest values were more closely aligned for HVA crops, for which a larger fraction of the harvest was sold. The differences between the treatment and comparison areas in revenues and harvest values (both total and per hectare) were small and not statistically significant for HVA crops. Further, although there were some statistically significant treatment-comparison differences in revenues and harvest values for non-HVA crops, the differences in overall revenues and harvest values were also not statistically significant.

[15] Crops that were processed and sold (for example, technical grapes sold as wine) may have been erroneously recorded as on-farm consumption rather than sales—particularly for some large and medium farms. This could lead to inaccurate estimates of mean revenues. However, we only identified seven farms that cultivated at least 25 hectares and consumed at least 25 percent of their production of a crop that could potentially be processed, which are the farms for which misreported consumption could potentially have a large effect on mean revenues. Further, among these seven farms, the share of land devoted to these potentially processed crops was very small, so that misreporting is unlikely to have a large effect on farm revenues. Therefore, this misreporting is unlikely to be a potential source of bias in our estimates of mean farm revenues and profits.

[16] In measuring harvest values for farmers who reported that they harvested a given crop but had no sales, we could not compute a per-ton price to compute their harvest value. We therefore imputed missing farmer-level per-ton prices for each harvested crop using the CIS-level median price for that crop. Where fewer than five farmers in the CIS grew a particular crop and the imputed prices would thus have been imprecise, we imputed prices using the median in the entire sample (provided there were at least five farmers growing that crop). We also used these imputed prices to compute agricultural revenues in the handful of cases in which farmers sold a specific crop but did not report revenues for that crop.

Table III.6. Agricultural revenue and production value from production in CIS command area (2013)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Average agricultural revenue from CIS area land (mean, dollars)						
All crops	2,393	992	480	571	-109	0.53
HVA crops	2,393	992	262	191	65	0.69
Non-HVA crops	2,393	992	210	345	-147	0.00***
Average agricultural revenue per hectare from CIS area land, among those cultivating (mean, dollars per hectare)						
All crops	2,183	918	125	190	-64	0.21
HVA crops	385	120	1,585	1,703	50	0.97
Non-HVA crops	2,115	891	36	98	-61	0.00***
Average harvest value from CIS area land (mean, dollars)						
All crops	2,380	986	921	1,241	-370	0.23
HVA crops	2,389	992	311	271	32	0.89
Non-HVA crops	2,384	986	597	933	-369	0.00***
Average harvest value per hectare from CIS area land, among those cultivating (mean, dollars per hectare)						
All crops	2,170	912	798	919	-115	0.29
HVA crops	381	120	2,037	2,202	61	0.97
Non-HVA crops	2,106	885	735	848	-110	0.14

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Total revenues and harvest values in the CIS command area are defined for the full sample of farmers. Revenues and harvest values per hectare are only defined for farmers who reported a nonzero cultivated area of the given crop in the CIS command area. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

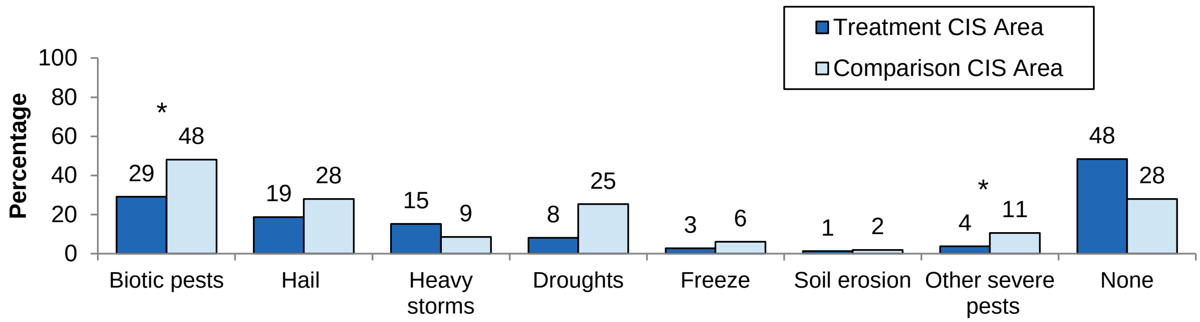
B. Other dimensions of agricultural production and sales

In addition to describing the overall pattern of crop production and sales, we also examined specific dimensions of the production and sales process that might be related to the outcomes of interest and are relevant to the key research questions.

1. Weather and pests

To understand other factors that might have affected agricultural production, the survey asked farmers about pests and weather conditions that they experienced in the 2013 agricultural season (Figure III.1). About half of treatment area farmers experienced at least some adverse conditions, of which the most common were biotic pests (29 percent of farms in the treatment area), hail (19 percent), and heavy rainstorms (15 percent). About 55 percent of treatment area farmers reported that their farm had received a typical amount of rainfall in the 2013 season, whereas about 36 percent reported that their farm had received more than the typical amount (Figure III.2). Because weather and pests can be quite localized, there were some differences in the experiences of farmers in the treatment and comparison areas despite the geographical proximity of the two types of areas. Although the differences were generally not statistically significant, they suggest that it may be important to control for some measures of external conditions—especially rainfall—when we conduct the impact analysis.[17]

Figure III.1. Weather and pests (2013, percentage of farms)



N = 3,343

Source: 2013–2014 Moldova Farm Operator Survey.

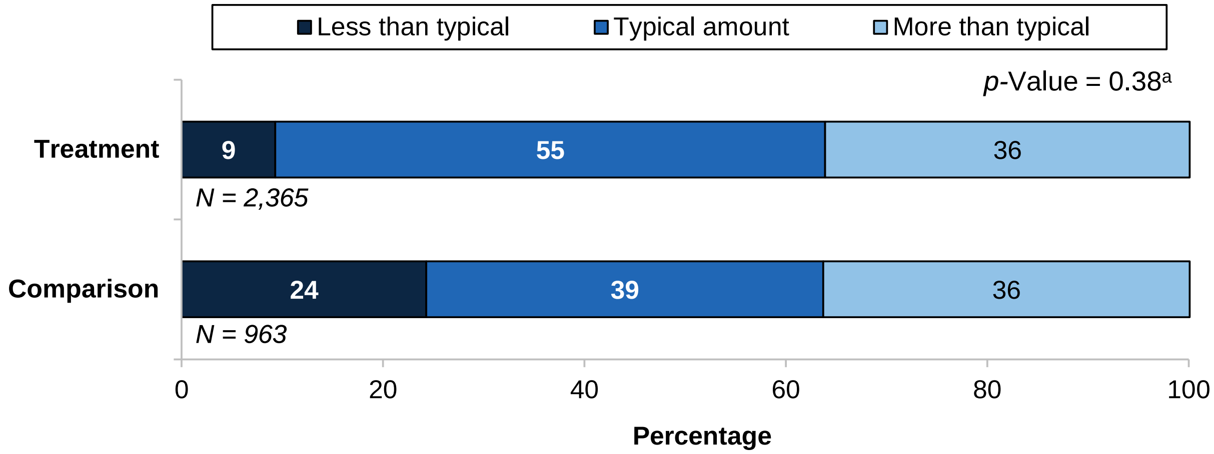
Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

[17] We will only control for measures for which farmers' reports are unlikely to be affected by the THVA project. For example, rainfall is likely to be reported objectively, but reports of adverse effects of drought could reflect differences in access to irrigation as a result of the project. Therefore, although it would be appropriate to control for reported rainfall, controlling for reported drought could bias the impact estimates downwards.

Figure III.2. Rainfall (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

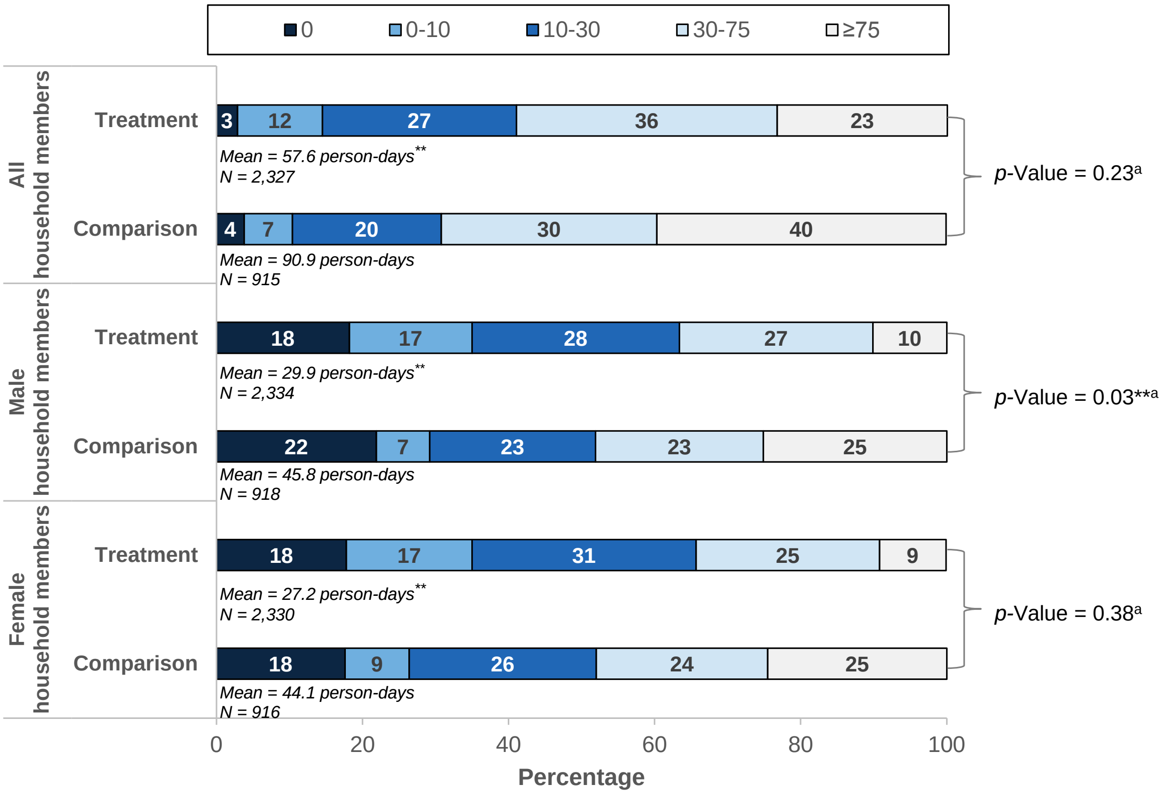
2. Farm labor

We also examined the use of farm labor, which is an important input into the production process and which can provide information on the distribution of project benefits. Our analysis in this section focuses on household and hired labor used on the farm as a whole, including land inside and outside the CIS command area. Later, we focus specifically on hired labor used on CIS area plots, which was recorded separately in the survey.

Because large farms tend to operate as businesses rather than household enterprises, we focus our analysis of household labor on small and medium farms. On average, small and medium farms in the treatment areas used 58 person-days of household labor in the 2013 season (Figure III.3). There was substantial variation across farms in the quantity of household labor used, although the distributions of labor by male and female household members were similar. There was also substantial variation in the respondent’s own on-farm usual daily labor hours during the agricultural season, with an average of about six hours (Figure III.4).

Average on-farm labor hours among respondents were similar in the treatment and comparison areas. However, average household labor on the farm was substantially and significantly higher in comparison areas (a difference of 33 person-days). If we observe subsequent changes in the quantity of household labor, we will be cautious in attributing those changes to the THVA project because the comparison group might not be as good of a counterfactual for this measure.

Figure III.3. Household labor used on the farm over agricultural season (2013, percentage of small and medium farm operators)



Source: 2013–2014 Moldova Farm Operator Survey.

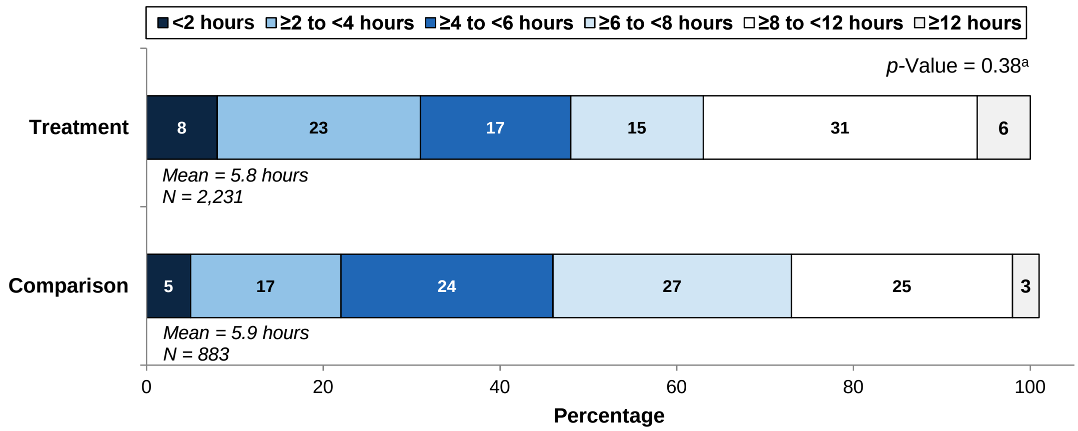
Note: To account for outliers, all measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small and medium). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

[a] *p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Figure III.4. Average daily hours spent on agricultural work during the agricultural season (2013, percentage of small and medium farm operators)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

We also analyzed the use of hired labor on the farms in our sample, including farms of all sizes. About 31 percent of farms in the treatment areas used hired labor in the 2013 agricultural season, although almost all of these farms relied exclusively on part-time laborers (Table III.7). On average, farms in the treatment areas used about 15 person-days of hired labor, composed of about nine days from male laborers and six days from female laborers. Use of hired labor at the farm level was higher in the treatment areas compared to the comparison areas (31 percent versus 23 percent), but the difference is not statistically significant. Further, the difference in average person-days of hired labor is small and statistically insignificant. Therefore, changes in hired labor that arise over time are likely to be attributable to the project.

Table III.7. Hired farm labor (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Use of hired labor:						
Any hired labor	2,390	981	31.4	23.4	7.9	0.34
Any hired full-time labor	2,393	992	0.5	0.7	-0.2	0.17
Any hired part-time labor	2,387	979	31.2	23.2	7.8	0.35
Number of person-days of hired labor (mean):						
All laborers	2,387	979	14.8	12.8	2.0	0.38
Male laborers	2,387	979	8.7	7.8	0.9	0.46
Female laborers	2,387	979	6.1	4.9	1.2	0.30

Source: 2013–2014 Moldova Farm Operator Survey.

Note: To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

3. Characteristics of sales

To further explore farm sales, the survey asked farmers where and to whom they sold their crops. Although the survey asked these questions separately for each crop sold, for conciseness we focus our analysis on sales of any of a farmer's crops (Table III.8). We also examined the season of sales because the THVA project seeks to enable farmers to sell part of their produce out of season—in particular, through the use of cold storage—when prices might be higher. Because we were not able to capture sales specifically for production from the CIS command area, our analysis applies to sales from the entire farm; however, we excluded from this analysis farmers who harvested crops *only* outside of the CIS command area.

Among those who sold crops in treatment areas, the vast majority sold some of their produce directly to the end consumer (70 percent), processors (25 percent), or traders/intermediaries (22 percent), whereas relatively few (9 percent) sold any of their produce to retailers. Most of these farmers sold some of their produce directly from the farm or roadside (87 percent) rather than at market, and few of them (2 percent) had any of their produce exported.[18] The vast majority of treatment area farmers sold crops in summer (25 percent) and/or autumn (88 percent); few sold crops out of season in winter (17 percent) or spring (1 percent).

[18] The survey inquired about the ultimate destination, so produce sold to an intermediary but destined for export would theoretically be reported as an exported product. Because some farmers might not be certain of the destination of their products, this measure could be subject to some reporting error.

There were some important differences in the patterns of sales for HVA crops relative to all crops. Sales to processors were more common for HVA crops (42 percent of those selling HVA crops in treatment areas, compared to 25 percent of those selling any crops), and sales in regional and raion markets were also more common, though the farm gate and roadside were by far the most common point of sale. Out-of-season sales were even lower for HVA crops than for all crops (only 4 percent sold these crops in winter, and none in spring), likely because HVA crops require more careful and costly storage. Some of the differences between the treatment and comparison areas in characteristics of sales are large in magnitude; however, only a handful of the treatment-comparison differences are statistically significant because the relatively small sample size of farmers selling crops leads to imprecisely estimated means.

Table III.8. Characteristics of agricultural sales (2013, percentage among farms selling from CIS area production)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
All crop sales						
Buyer	451	330				
End consumer (direct)			69.8	75.4	-6.8	0.55
Processor			24.8	1.5	23.3	0.10
Trader/intermediary			22.4	42.2	-20.1	0.02**
Retailer			8.6	2.0	6.5	0.20
Other			2.1	0.2	1.2	0.16
Point of sale	451	330				
Farm gate/roadside			86.6	92.1	-7.0	0.06*
Regional market			12.7	12.2	0.1	0.99
Raion market			11.4	6.3	5.1	0.20
Village market			6.3	3.7	2.1	0.11
Other market			0.9	2.4	-0.8	0.50
Product destination	386	310				
In-country market			99.4	96.9	0.4	0.66
Export			2.1	3.2	1.0	0.51
Season of sales	451	330				
Summer (Jun–Aug)			24.6	30.9	-9.4	0.47
Autumn (Sep–Nov)			88.0	83.0	6.0	0.28
Winter (Dec–Feb)			16.7	13.0	3.7	0.37
Spring (Mar–May)			1.4	1.0	0.2	0.87
HVA crop sales						
Buyer	200	87				
End consumer (direct)			49.7	61.4	-12.6	0.65
Processor			41.6	1.7	39.7	0.09*
Trader/intermediary			26.1	75.9	-50.9	0.00***
Retailer			15.4	5.0	10.0	0.38
Other			0.5	0.2	0.0	0.98
Point of sale	200	87				
Farm gate/roadside			80.6	91.9	-12.3	0.22
Regional market			19.9	29.9	-12.2	0.56
Raion market			19.2	11.3	8.4	0.28
Village market			5.3	5.2	0.0	1.00
Other market			0.4	0.0	0.4	0.18
Product destination	173	82				
In-country market			99.4	95.9	-0.6	0.40
Export			3.2	4.2	3.1	0.27
Season of sales	200	87				
Summer (Jun–Aug)			29.3	44.2	-16.0	0.59
Autumn (Sep–Nov)			92.7	83.5	9.5	0.33
Winter (Dec–Feb)			4.1	1.8	1.9	0.44
Spring (Mar–May)			0.0	0.1	-0.2	0.25

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Percentages may not sum to 100 because respondents could select more than one response option. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

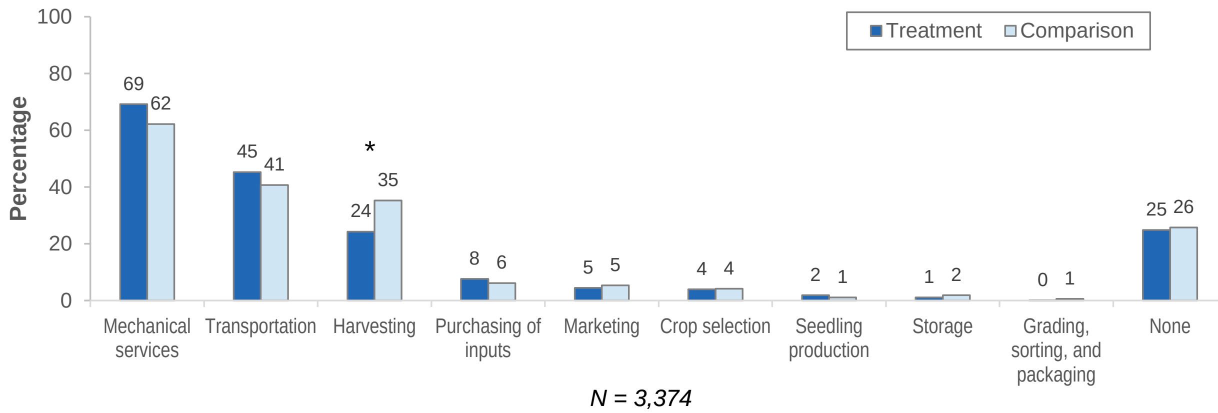
*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

4. Cooperation among farmers and membership in farmer organizations

We also examined cooperation among farmers and their membership in farmer organizations, which could play an important role in supporting changes in production and sales due to the THVA project. In the treatment areas, 75 percent of farmers reported cooperating with other farmers in the 2013 agricultural season (Figure III.5), most commonly in mechanical services (69 percent), transportation (45 percent), and harvesting (24 percent). Cooperation on these activities could reflect farmers seeking to take advantage of economies of scale and lower the costs of these services given that most farmers only cultivate a small area of land (for example, sharing the daily rental cost of mechanical equipment). The level of cooperation was generally similar in the treatment and comparison areas both overall and for specific topics.

Figure III.5. Cooperation with other farmers (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

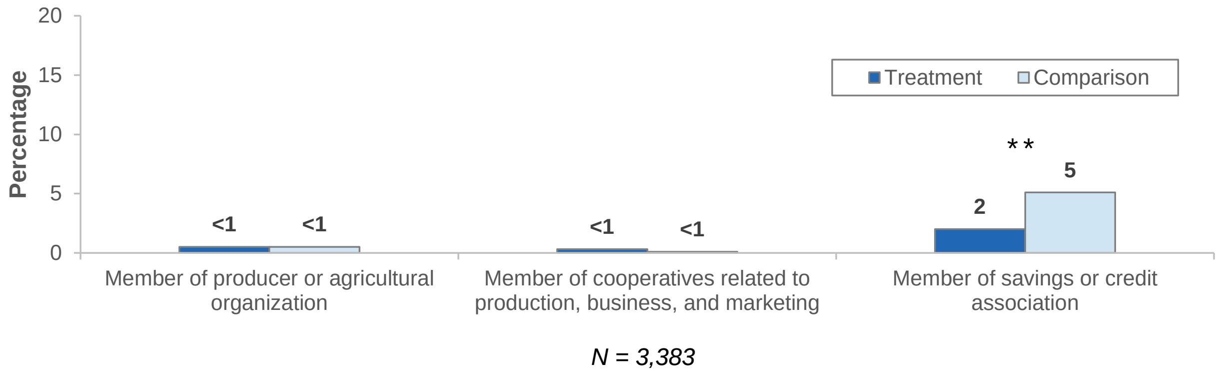
Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

However, despite high levels of reported cooperation, very few farmers were members of farmer organizations (Figure III.6). For example, less than 1 percent of treatment area farmers were members of functional producer organizations or farmer cooperatives, and only 2 percent were members of savings and credit associations. These membership rates were similarly low in comparison areas; although the membership rate for savings and credit associations was significantly higher in comparison areas, it was still only 5 percent.

Figure III.6. Membership in farmer organizations (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: Membership is restricted to organizations that were reported to be functional. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

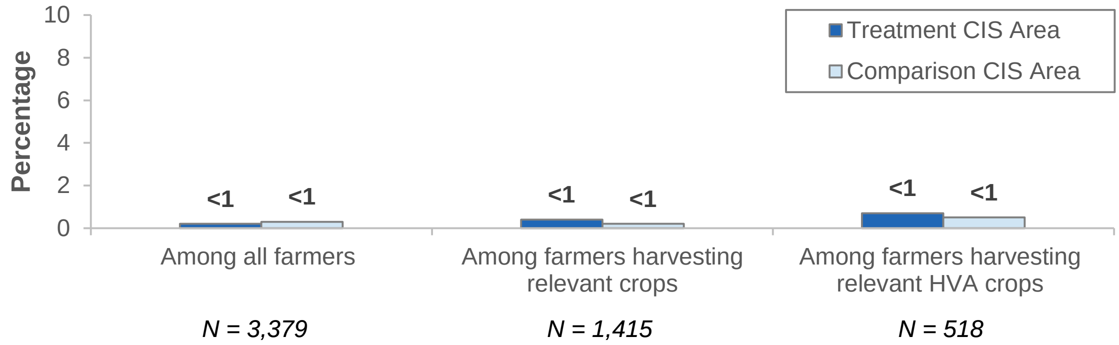
CIS = centralized irrigation system.

5. Use of cold storage

Using cold storage, farmers can potentially increase their revenues from sales of certain crops by selling them off-season, when the prices are typically higher. The AAF activity of the THVA project had a particular emphasis on funding investments in cold storage (both in the treatment CIS areas and more widely), although it also funded a range of other investments in post-harvest infrastructure. Because cold storage was potentially affected by the project and could complement other THVA activities, we describe the pattern of cold storage access and use in 2013.

Use of cold storage for crops harvested in the 2013 season was extremely limited. Less than 1 percent of farmers in the treatment and comparison CIS areas reported storing any of their crops in cold storage in the 2013 agricultural season (Figure III.7). Use of cold storage remains at less than 1 percent even after restricting to farmers who reported a nonzero harvest of crops relevant for cold storage (either any relevant crops or any relevant HVA crops). These low usage rates are despite the fact that more than half of treatment farmers reported that they knew of a cold storage facility within 5 kilometers of their farm (Figure III.8). Although we have limited ability to explore the reasons for the almost nonexistent use of cold storage using the Farm Operator Survey data, results from the qualitative study (ACT Research 2013a, ACT Research 2014a) suggest that this could be driven by factors such as small harvests of crops relevant for cold storage; high transport and storage costs; and uncertainty regarding future prices.

Figure III.7. Use of cold storage for harvested crops (2013, percentage of farms harvesting from CIS area production)



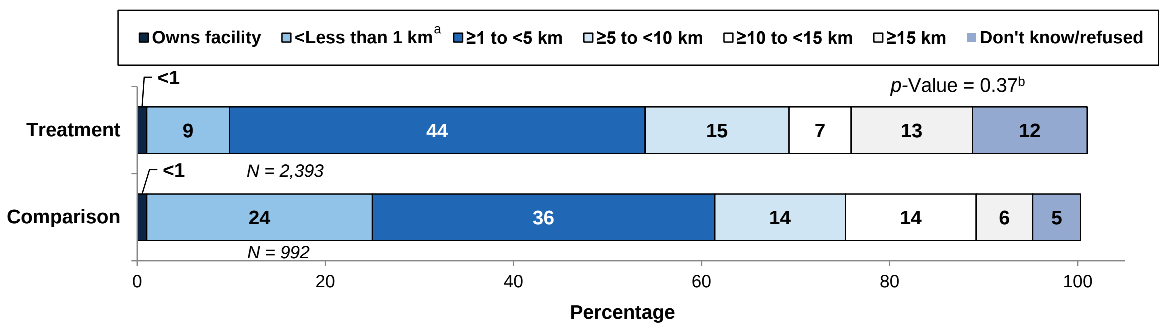
Source: 2013–2014 Moldova Farm Operator Survey.

Note: Crops that are relevant for cold storage include potatoes, cabbages, tomatoes, peppers, onions, cucumbers, carrots, watermelon, tree fruit seedlings, apples, pears, sweet cherries, plums, peaches, apricots, strawberries, table grapes, technical grapes, grafted vines, gooseberries, sour cherries, blackberries, garlic, green beans, zucchini, red beets, radish, onion seeds, quince, and eggplant. All these crops are HVA except for technical grapes. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

Figure III.8. Distance to cold storage (2013, percentage of farms)



Source: 2013-2014 Moldova Farm Operator Survey.

Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

[a]Distance categories reflect the response categories available to respondents in the survey.

[b]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, km = kilometer(s).

C. Agricultural profits and household income

To measure agricultural profits, we combined information on agricultural revenues with estimated agricultural expenditures on various agricultural inputs, which were recorded at the farm level. Mean expenditures on agricultural inputs in treatment areas (Table III.9) were highest for mechanized services (a mean of $220 per farm), seeds and seedlings ($151), and chemicals ($74). Total mean expenditures on agricultural inputs in 2013 were about $1,109 in the treatment CIS areas and were similar in the comparison areas. Median expenditures in both treatment and comparison areas were much lower, about $279 and $257, respectively.

We used the information on expenditures to estimate farm profits, both for the entire farm and for land inside the CIS command area. To estimate profits for the entire farm, we computed total revenues and subtracted total farm-level expenditures. For all farms, revenues included income from crop sales; for small and medium farms, it also included income from livestock and the garden plot (a small plot of land adjacent to the family home). To estimate profits for the land inside the CIS command area, we first scaled farm-level expenditures based on the proportion of the farm's cultivated land that was located in the command area. We then subtracted these estimates of CIS command area expenditures from the estimates of revenues from CIS command area production (which we presented in Table III.6). We did not include livestock and garden plot revenues in our estimates of CIS command area profits, because livestock and garden plots are likely to be adjacent to the family home, which is typically located outside the CIS command area.

We also extended our basic estimates of profits (both for the entire farm and for land inside the CIS command area) in two ways. First, because farm profits are likely to be highly variable due to variation in cultivated area across farms, we also estimated farm profits per cultivated hectare. Our impact analysis of farm profits will focus on this less variable per-hectare estimate, for which we expect to have greater statistical power to detect impacts. Second, our basic measure of farm expenses includes both operating expenses (such as seeds and fertilizer) as well as longer-term investments (such as equipment purchases or cold storage construction). Although these longer-term investments should average out across farmers at a given point in time, they may provide a misleading view of profits if long-term investments are being affected by the THVA project. We therefore computed an alternative measure of farm profits that is defined as revenues minus operating expenses.

Our basic estimate of mean annual farm-level profits in the treatment areas—including all expenditures—was *negative* $156 (Table III.10). The distribution of profits suggests that more than three-quarters of treatment area farmers had zero or negative profits, which is likely related to the fact that relatively few farmers in our sample sold any of their produce.[19] Mean farm-level profits per cultivated hectare were negative $116 per hectare, whereas mean profits estimated using only operating expenses became positive but were still close to zero ($51 in total, and $8 per hectare).

[19] To explore the contribution of livestock and garden plot revenues to total revenues, we re-estimated total farm revenues using only crop revenues. Mean revenues decreased substantially to negative $378, suggesting that livestock and garden plot revenues made an important contribution to total farm revenues.

Table III.9. Agricultural expenditures per farm (2013, in dollars unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Agricultural expenditures by category (mean, dollars)						
Mechanized services	2,357	986	220	223	-4	0.90
Seeds or seedlings	2,376	984	151	152	-2	0.94
Chemicals[a]	2,382	987	74	67	5	0.74
Part-time labor	2,381	979	67	48	20	0.06*
Other farm consumables[b]	2,383	987	64	97	-35	0.18
Agricultural loan principal and interest repayments	2,384	990	54	32	21	0.31
Fertilizers	2,385	987	50	46	2	0.80
Other labor, including full -time	2,386	988	49	57	-11	0.55
Rental payments to landowners for agricultural land	2,385	987	49	75	-28	0.16
Transportation costs	2,380	980	45	41	4	0.50
Livestock purchase expenses	2,382	989	31	21	10	0.22
Agricultural land taxes	2,284	962	19	23	-4	0.04**
Livestock care expenses	2,377	988	18	31	-14	0.05**
Greenhouse construction and maintenance	2,385	990	13	9	4	0.39
Irrigation water	2,383	990	12	14	-2	0.59
Marketing costs	2,382	987	10	10	1	0.85
Agricultural equipment purchases	2,386	990	10	41	-31	0.05*
Other major farming expenditures	2,289	970	84	26	56	0.01**
Total agricultural expenditures						
Mean (dollars)	2,194	944	1,109	1,079	78	0.55
Median (dollars)			279	257	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Categories with small expenditures were combined into the “other” category. These include drainage services, cold storage rental payments, post-harvest activities, other taxes related to agricultural production or sales, equipment for drip irrigation, equipment for sprinklers, expenses associated with connecting to irrigation sources, cold storage construction and maintenance, other storage and physical/infrastructure improvements for the farm, agricultural land purchases, and other farming expenditures. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, all measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]Includes herbicides, fungicides, insecticides, and other chemicals.

[b]Includes tools, spare parts, and fuel.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Profits were similar in the treatment and comparison areas for the different measures of farm-level profits that we considered. There were some statistically significant differences in the distribution of total profits (including all expenditures), but the magnitudes of these differences were generally small (less than 9 percentage points for each category in the distribution), and the difference in mean profits was not statistically significant. Further, although there was a marginally significant difference in mean profits per hectare, the magnitude of the difference was small and the difference was no longer significant when accounting for only operating expenses.[20]

The pattern of profits was broadly similar when estimated for land inside the CIS command area. For the profits measure that included all expenditures, the percentage of farmers in treatment areas with zero or negative profits was even higher than for the farm as a whole (92 percent in treatment areas) and mean profits were even more negative (negative $275 in total, and negative $435 per hectare). Again, using only operating expenditures increased the estimated means only slightly, and the treatment-comparison differences were small in magnitude and/or not statistically significant for all of the measures we considered. Overall, the absence of large differences in profits between treatment and comparison areas at baseline across the various measures that we examined supports the validity of the comparison group design.

The high prevalence of zero or negative profits does not necessarily imply that farmers are receiving no benefits from farming—in particular, they may have been consuming a large fraction of their production. We explored this possibility by computing an alternative measure of net benefits from production on CIS command area land that subtracts expenditures from harvest values rather than from revenues. Only about 18 percent on treatment area farmers had negative benefits in 2013 by this measure, and mean and median net benefits were positive ($161 and $78 respectively, not shown). In addition, as we show below, most small and medium farmers (the vast majority of farmers in these areas) reported that farming was not their primary source of income. This suggests that most of the farmers in the treatment areas were not farming commercially at baseline—rather, they primarily relied on income from non-agricultural sources, and their agricultural activities were primarily intended to supplement their consumption.

[20] We consider the difference in mean profits per hectare of $130 to be small because most farms cultivate only a small area of land (as described in Chapter II, almost two thirds of treatment area farms cultivated less than 1 hectare, and very few cultivated more than 5 hectares) and average household income is more than $2,500 (reported below). Therefore, this difference in mean profits per hectare is unlikely to result in substantial differences in household income.

Table III.10. Agricultural profits per farm (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Average agricultural profits, entire farm						
Agricultural profits, revenues minus all expenses	2,194	944				0.01[a]**
≤$0			76.1	67.2	8.9	0.01***
>$0 to <$250			6.5	13.3	-6.7	0.00***
≥$250 to <$500			5.9	4.4	1.5	0.39
≥$500 to <$1,000			4.5	5.9	-1.4	0.09*
≥$1,000 to <$2,500			5.5	5.6	-0.1	0.94
≥$2,500			1.5	3.6	-2.1	0.02**
Mean (dollars)			-156	-41	-131	0.18
Median (dollars)			-125	-59	--	--
Agricultural profits, revenues minus operating expenses	2,316	957				
Mean (dollars)			51	119	-66	0.55
Median (dollars)			-94	-45	--	--
Average agricultural profits per hectare, entire farm						
Agricultural profits, Revenues minus all expenses	2,108	908				
Mean (dollars/ha)			-116	14	-130	0.08*
Median (dollars/ha)			-276	-178	--	--
Agricultural profits, revenues minus operating expenses	2,224	918				
Mean (dollars/ha)			8	108	-97	0.18
Median (dollars/ha)			-241	-143	--	--
Average agricultural profits, land inside CIS command area						
Agricultural profits, revenues minus all expenses	2,108	908				0.03[a]**
≤$0			91.9	83.0	8.9	0.01***
>$0 to <$250			3.2	9.2	-5.9	0.00***
≥$250 to <$500			1.7	3.0	-1.3	0.02**
≥$500 to <$1,000			1.4	3.0	-1.7	0.07*
≥$1,000 to <$2,500			0.9	1.2	-0.3	0.80
≥$2,500			1.0	0.6	0.3	0.21
Mean (dollars)			-275	-213	-72	0.56
Median (dollars)			-134	-89	--	--
Agricultural profits, revenues minus operating expenses	2,224	918				
Mean (dollars)			-132	-97	-40	0.73
Median (dollars)			-109	-74	--	--

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Average agricultural profits per hectare, land inside CIS command area						
Agricultural profits, revenues minus all expenses	1,992	876				
Mean (dollars/ha)			-435	-338	-95	0.40
Median (dollars/ha)			-368	-276	--	--
Agricultural profits, revenues minus operating expenses	2,106	886				
Mean (dollars/ha)			-330	-256	-72	0.45
Median (dollars/ha)			-317	-253	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Operating expenses exclude expenses for: livestock purchases, repayments of loan principal and interest for agricultural loans, agricultural land taxes, other taxes related to agricultural production or sales, equipment for drip irrigation, equipment for sprinklers, costs of connecting to irrigation sources, greenhouse construction and maintenance, cold storage construction and maintenance, other storage and physical/infrastructure improvements for farm, and agricultural land purchases. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectare.

The ultimate goal of the THVA project is to increase household income in the treatment CIS areas. If agricultural income increases due to the project, it will be important to determine whether the net income of the household is increasing or if households are substituting agriculture for other income sources. Therefore, we combined agricultural profits with employment income and other non-agricultural sources of income to compute overall household income. Because large farms are usually operated as businesses rather than household enterprises, these measures are applicable only to small and medium farms.

Non-agricultural income was the dominant source of income for most households in the sample, with only 28 percent of households in treatment areas reporting that agricultural activities were their main source of income. The highest mean sources of non-agricultural income in treatment areas were wages ($893) and pensions and social payments ($639), with a total mean non-agricultural income of $2,570 (Table III.11).[21] Combined with agricultural

[21] The survey asked respondents to report income for various categories of non-agricultural income for each household member 16 years or older. If the respondent could not provide this information by category for a given household member, he or she was asked about total non-agricultural income for that member. Therefore, the total non-agricultural income for each household member was computed as the sum of all the categories if reported, or

profits (a mean of negative $61 for small and medium farms), this resulted in a mean household income of $2,553 in the treatment CIS areas. This was significantly lower than mean household income in the comparison areas (an adjusted difference of $609), driven mainly by significantly lower mean non-agricultural income (an adjusted difference of $473). Because the significant differences in mean household income were primarily driven by large differences in non-agricultural income rather than farm profits—the component of household income that the THVA project seeks to affect—they are unlikely to compromise the validity of the design. Nevertheless, we still intend to control for baseline household income in the impact analysis.

Finally, we examined reported household consumption as an alternate measure of household well-being, again restricting to small and medium farms, for which these measures were relevant (Table III.12). Total consumption consisted of the estimated value of consumption expenditure (mean of $2,159 in the treatment areas) and consumption out of agricultural production (mean of $607 in the treatment areas), which included consumption of crops, livestock, and garden plot production.[22] Mean total consumption was $2,790 in the treatment areas, comparable to total household income. However, it was much higher in the comparison areas (about $3,345), a statistically significant difference that reflects the difference in household income discussed above. Again, although we do not believe that this baseline difference will compromise the validity of the design, we intend to control for baseline consumption in the impact analysis.

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else as the direct reported total; these totals were summed across all household members to obtain a farm-level total for the analysis.

[22] There were a large number of missing values for garden plot and livestock consumption, which would have resulted in a large number of missing values for overall consumption. For garden plot consumption, we therefore imputed missing values as follows. First, we estimated the value of garden plot production per hectare for each respondent by dividing the value of garden plot sales and consumption by the area of the garden plot. Second, we computed the median per hectare value of garden plot production by farm size group (small or medium) in each CIS area, provided there were at least five observations (if not, we used the overall median for each farm size). Third, we multiplied this median per hectare value by the area of the garden plot for the missing cases to obtain the total value, and subtracted the reported value of sales (if any). This yielded an imputed estimate of the value of garden plot consumption. We used a similar approach to impute the value of livestock consumption, using median estimates of the value obtained from each head of livestock to estimate total value, and then subtracting the value of sales.

Table III.11. Household income per farm for small and medium farms (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Agricultural activities are main source of income	2,256	922	28.4	36.5	-8.0	0.24
Non-agricultural Income (mean, dollars)						
Wages	1,845	808	893	1,320	-444	0.02**
Pensions and social payments	1,859	809	639	567	72	0.18
Support and remittances	1,860	809	49	112	-65	0.12
Rental income	1,860	809	28	11	17	0.36
Self-employment income	1,856	809	19	15	4	0.28
Other source of income	1,844	806	383	561	-187	0.07*
Total non-agricultural Income	1,935	819				0.13[a]
$0 to <$1,000			20.8	22.5	-1.7	0.55
≥$1,000 to <$2,500			38.7	29.5	9.3	0.00***
≥$2,500 to <$5,000			27.0	28.3	-1.3	0.59
≥$5,000			13.5	19.7	-6.4	0.02**
Mean (dollars)			2,570	3,032	-473	0.01***
Median (dollars)			2,007	2,391	--	--
Farm profits, all expenses	2,171	902				0.04[a]***
≤$0			76.2	67.2	8.9	0.01***
$0 to <$1,000			16.9	23.7	-6.7	0.01**
≥$1,000 to <$2,500			5.5	5.6	-0.1	0.96
≥$2,500 to <$5,000			0.9	2.7	-1.9	0.00***
≥$5,000			0.5	0.8	-0.3	0.32
Mean (dollars)			-61	53	-117	0.16
Median (dollars)			-124	-58	--	--
Total household Income	1,852	795				0.20[a]
≤$0			5.5	5.3	0.2	0.90
>$0 to <$1000			20.1	16.0	4.2	0.13
≥$1,000 to <$2,500			34.4	27.1	7.4	0.00***
≥$2,500 to <$5,000			25.1	29.5	-4.5	0.04**
≥$5,000			14.9	22.1	-7.3	0.05*
Mean (dollars)			2,553	3,151	-609	0.01***
Median (dollars)			1,984	2,606	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Table III.12. Annual household consumption per farm for small and medium farms (2013, percentage of farms unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Annual consumption expenditure (dollars)						
Mean	1,787	703	2,159	2,598	-436	0.24
Median			1,725	2,250	--	--
Annual value of consumption out of agricultural production (dollars)						
Mean	2,294	910	607	700	-97	0.47
Median			486	549	--	--
Total annual consumption	1,753	695				0.13[a]
<$1,000			8.0	6.3	1.6	0.18
≥$1,000 to <$2,500			43.8	33.8	10.2	0.04**
≥$2,500 to <$5,000			37.7	41.3	-3.7	0.24
≥$5,000			10.5	18.6	-8.1	0.11
Mean (dollars)			2,790	3,345	-557	0.04**
Median (dollars)			2,438	2,898	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Annual value of consumption out of production includes the value of consumption of crops, livestock, and production from the garden plot. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Our findings on household income and consumption are broadly consistent with data from Moldova's National Bureau of Statistics, although possible differences in samples and methodology suggest that these data might not be directly comparable to the Farm Operator Survey data. Specifically, the National Bureau of Statistics data show that farming households in rural areas of Moldova (the available data are not restricted to the areas in which farmers in the THVA evaluation sample are located) had a mean disposable income of $2,646 and mean consumption of $3,731 in 2013—which are similar in magnitude to our findings.[23] Additional

[23] Income and consumption were estimated using data on average per-capita disposable income, per-capita consumption, and household size for farm households across rural Moldova from the National Bureau of Statistics' StatBank website (http://statbank.statistica.md/) (accessed June 29, 2015). Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com).

data from the National Bureau of Statistics confirm that non-agricultural income is an important component of total income, contributing almost 60 percent of disposable income for rural farming households in 2013.

D. Plot-level production and revenues

As mentioned in Chapter I, because the THVA project has the potential to affect the productivity of land through improved irrigation, the impact evaluation will follow specific CIS command area plots over time. Therefore, the ideal measures for the evaluation are at the plot level. The Farm Operator Survey directly collected plot-level information where feasible (for example, crop harvests and use of hired labor); for other measures (such as revenues) we were able to approximate plot-level measures by rescaling the farm-level estimates appropriately. Below, we describe the plot-level findings related to cultivation, hired labor, and revenues and profits.

The plot-level pattern of crop cultivation 2013 (Table III.13) was broadly similar to the farm-level pattern in the CIS command area. Corn was by far the most common crop cultivated (51 percent of plots in treatment areas); the other common crops were typically non-HVA crops, except for apples (9 percent). Overall, HVA crops were only cultivated on about 14 percent of treatment area plots, and cultivation of intensive HVA crops was very limited (only 2 percent of treatment plots). Cultivation patterns were broadly similar for plots in treatment and comparison areas, although there were significant differences in cultivation for some non-HVA crops (specifically, corn was more common in treatment areas and wheat was more common in comparison areas; non-HVA crops overall were more common in comparison areas). However, because cultivation of HVA crops—the focus of the project activities—was similar for the treatment and comparison area plots, the baseline differences in non-HVA cultivation are unlikely to affect the results of the impact evaluation.

Table III.13. Crops cultivated on CIS area plots (2013, percentage of plots, HVA crops in bold)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Corn	2,445	1,078	50.7	41.2	8.7	0.02**
Sunflowers			8.7	12.2	-3.0	0.37
Apples			8.0	2.9	5.0	0.20
Wheat			6.5	17.8	-10.7	0.00***
Fodder plants/forage			3.5	2.8	0.7	0.75
Technical grapes			3.2	3.7	-0.6	0.74
Barley			2.9	3.1	-0.1	0.91
Potatoes			2.0	2.2	-0.2	0.91
Tree fruit seedlings			1.1	0.0	1.1	0.19
Any crops	2,445	1,078	87.1	89.6	-2.5	0.53
HVA crops	2,445	1,078	13.7	10.3	3.2	0.40
Intensive HVA crops	2,444	1,077	2.2	0.2	2.0	0.33
Non-HVA crops	2,445	1,078	74.0	79.6	-5.5	0.01**

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Crops that were reported by a small percentage of treatment and comparison farms are not shown. HVA crops are highlighted in bold. Intensive HVA cultivation is defined as an orchard with a tree density of at least 1,000 per hectare or cultivation in a greenhouse. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

Although most of the characteristics of agricultural production and sales were recorded at the farm level, the Farm Operator Survey did capture information on hired labor at the plot level (Table III.14). Hired labor was used on about 33 percent of treatment area plots, similar to the percentage of farms in the treatment areas that used hired labor. Although part-time labor was still the most common type of labor (used on about 23 percent of treatment area plots), full-time labor was more prevalent than for the farm as a whole (14 percent of plots).[24] On average, treatment plots used almost three person-days of hired labor in 2013, composed of slightly more person-days by male than female laborers. The survey also measured payments to hired labor at the plot level, which were about $10 per person-day in treatment areas, and slightly less for females ($8 per person-day) than for males ($11 per person-day). The plot-level measures of hired labor were mostly similar in treatment and comparison areas, except for small, marginally significant differences in the payments to hired labor.

[24] Large operators are more likely to use hired (and full-time) labor than small or medium operators, and large operators compose a much larger fraction of plots than farms. Therefore, the average plot is more likely to have hired (and full-time) labor than the average farm. Reports of use of hired labor at the plot and farm levels were almost all internally consistent in that use of hired labor at the plot level was reflected in farm level use (but not necessarily vice versa).

Table III.14. Hired labor on CIS area plots (2013, percentage of plots unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Use of hired labor:						
Any hired labor	2,420	1,041	32.8	34.2	-1.4	0.81
Any hired full-time labor	2,421	1,059	13.6	12.8	0.2	0.88
Any hired part-time labor	2,430	1,054	22.6	21.0	2.1	0.77
Number of person-days (mean):						
All laborers	2,420	1,041	2.7	2.4	0.2	0.66
Male laborers	2,421	1,041	1.5	1.5	0.0	0.83
Female laborers	2,420	1,048	1.1	0.8	0.2	0.50
Payment per person-day (dollars, mean):						
All laborers	713	313	10	9	2	0.06*
Male laborers	619	264	11	9	2	0.06*
Female laborers	465	190	8	8	0	0.23

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Finally, we estimated agricultural revenues and profits from production on CIS area plots (Table III.15). To compute revenues at the plot level, we scaled total revenues for each crop by the proportion of the farm's harvest that came from the sampled plot. To compute profits at the plot level, we first scaled total farm expenditures by the fraction of the farm's cultivated area that came from the sampled plot, and subtracted this from the estimated plot-level revenues.

Similar to the pattern for revenues from the CIS command area, HVA crops made an important contribution to mean plot-level revenues. In treatment areas, mean revenues from HVA crops were $87 compared to $52 for non-HVA crops. Again, on a per hectare basis, HVA crops yielded substantially higher revenues than non-HVA crops (on treatment plots, $2,136 compared to $113 for non-HVA crops). The differences in mean plot-level revenues (total and per hectare) between treatment and comparison areas were statistically significant for non-HVA crops. However, these differences were only marginally significant or insignificant for HVA crops, and the overall differences were small and not statistically significant.

Table III.15. Agricultural revenue and profits from production on CIS area plots (2013)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Average agricultural revenue from plot (mean, dollars)						
Any crops	2,442	1,077	161	171	-4	0.87
HVA crops	2,445	1,078	87	39	48	0.10*
Non-HVA crops	2,442	1,077	52	124	-66	0.00***
Average agricultural revenue per hectare from plot (mean, dollars per hectare)						
Any crops	2,088	939	333	297	45	0.30
HVA crops	160	68	2,136	1,155	788	0.23
Non-HVA crops	1,954	875	113	190	-49	0.00***
Average agricultural profits from plot (dollars)						
Agricultural profits, revenues minus all expenses	2,152	979				0.34[a]
≤$0			82.4	76.9	5.1	0.09*
>$0 to <$250			11.5	13.4	-1.8	0.60
≥$250 to <$500			2.8	6.3	-3.2	0.16
≥$500 to <$1,000			0.9	1.9	-1.1	0.06*
≥$1,000 to <$2,500			1.3	1.2	0.0	0.98
≥$2,500			1.1	0.2	0.9	0.17
Mean (dollars)			-36	-87	53	0.05**
Median (dollars)			-59	-61	--	--
Agricultural profits, revenues minus operating expenses	2,268	989				
Mean (dollars)			-4	-51	52	0.02**
Median (dollars)			-48	-53	--	--
Average agricultural profits per hectare from plot (dollars per hectare)						
Agricultural profits, revenues minus all expenses	1,963	891				
Mean (dollars/ha)			-264	-218	-33	0.71
Median (dollars/ha)			-301	-252	--	--
Agricultural profits, revenues minus operating expenses	2,021	901				
Mean (dollars/ha)			-150	-143	6	0.93
Median (dollars/ha)			-259	-221	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectare, HVA = high-value agriculture.

Again, similar to estimates of profits from CIS command area production, the vast majority of treatment area plots (82 percent) yielded zero or negative profits in 2013, and mean profits were negative (negative $36 for total profits, and negative $264 for profits per hectare). Using operating expenses rather than all expenses increases mean profits slightly, but they remain negative. Although some of the treatment-comparison differences in profits were statistically significant, they were small in magnitude and are not a major concern for the validity of the plot-level impact estimates.[25] Further, our estimates will focus primarily on the measures of per hectare plot-level profits, which were not significantly different between the treatment and comparison areas.

[25] Again, we consider these differences in profits to be small relative to average household income.

IV. IRRIGATION PRACTICES AND EXPERIENCE WITH WATER USER ASSOCIATIONS

The THVA project is expected to ultimately increase farm profits and household income through improved irrigation in treatment CIS areas. In this chapter, we examine the irrigation experiences of farmers in 2013—after water user associations had been established in all treatment CIS areas but prior to the completion of rehabilitation—to verify that the pre-rehabilitation irrigation situation was similar in treatment and comparison areas. We also analyze satisfaction with pre-rehabilitation CIS irrigation and initial interactions with and perceptions toward the water user associations that were established under ISRA. Table IV.1 presents the key measures of irrigation practices and experiences with water user associations included in the Farm Operator Survey.

Table IV.1. Measures of irrigation practices and water user association experiences

Measures	Time frame
Irrigation practices—farm level. Whether farm was irrigated; source of irrigation water; quality of water delivery; whether land inside CIS command area was irrigated; area irrigated and volume of irrigation water used in CIS command area; satisfaction with cost and delivery of CIS irrigation water.	2013 agricultural season
Irrigation practices—plot level. Whether plot was irrigated; area irrigated; source of irrigation water; volume of irrigation water used; cost of irrigation water used.	2013 agricultural season
WUA experiences. Awareness of WUA; membership in WUA; involvement in leadership; attendance at WUA meetings; whether fees paid; perceptions of WUA.	2013 agricultural season

CIS = centralized irrigation system, WUA = water user association.

A. Irrigation practices

Irrigation was not a common practice in the 2013 agricultural season, with only 2 percent of farms in treatment areas irrigating any of their land (Table IV.2). When summarizing irrigation for the entire farm, we excluded irrigation from farms' own water sources—such as water from wells, lakes, and pools—because the THVA project is not intended to impact own-source irrigation and because reports of own-source irrigation at the farm level are not aligned with crop-level estimates of irrigation, which raises questions about their accuracy.[26] Most of the very limited irrigation from external sources was obtained from the partially functioning CISs operated by water user associations.[27]

Table IV.2. Irrigation practices: use, source, area irrigated, volume, and price (2013, percentage of farms or plots unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Entire farm area						
Percentage of farms irrigating	2,211	975	1.7	5.7	-4.1	0.00***
Used irrigation sources, entire farm						
CIS/Apele Moldovei	2,327	985	0.3	1.2	-0.9	0.46
CIS/WUA	2,276	985	1.3	0.0	1.2	0.00***
Private provider	2,290	978	0.0	4.1	-4.1	0.06*
Other	2,257	980	0.1	0.5	-0.3	0.33
Water delivery in 2013 versus 2012, among those irrigating	41	44				0.84[a]
Better			20.2	7.7	4.3	0.69
Same			79.8	77.4	11.1	0.55
Worse			0.0	14.9	-15.4	0.41
Farm area inside CIS command area						
Percentage of farms irrigating, inside CIS	2,393	992	2.0	1.8	0.2	0.90
Hectares irrigated, inside CIS (mean, ha)	2,393	992	0.0	0.0	0.0	0.20
Irrigation water used per hectare irrigated (m^3/ha)						
Mean	42	17	1,046	664	328	0.07*
Median			714	556	--	--

[26] In addition to measuring irrigation at the farm level, the Farm Operator Survey also captured information on irrigation of specific crops. Based on this crop-level information, about 3 percent of farms in treatment areas applied irrigation to at least one of their cultivated crops (not shown), which is nearly equivalent to the percentage of farms who reported irrigating from external sources. In contrast, about 21 percent of farms in treatment areas reported using own-source irrigation (not shown). The difference between these reports suggests that own-source irrigation was likely very limited in volume and area applied, and therefore the percentage of farms who reported irrigating any of their land using external sources more accurately describes the irrigation situation at baseline.

[27] In contrast to the very small share of farms using irrigation, more than 90 percent of treatment area farms reported that irrigation was available from water user association-operated CISs (not shown). Though the treatment CISs had not yet been rehabilitated in 2013, respondents may have reported access to the CIS because they could connect and the system was partially functional, even though irrigation service was very limited.

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Plot						
Percentage of plots irrigated	2,445	1,078	2.9	1.3	1.6	0.26
Hectares irrigated (mean, ha)	2,445	1,078	0.0	0.0	0.0	0.10
Used irrigation water from:	2,445	1,078				
CIS/Apele Moldovei			0.2	1.3	-1.1	0.38
CIS/WUA			2.6	0.0	2.7	0.01**
Private provider			0.0	0.0	0.0	0.37
Other			0.0	0.0	0.0	--
Irrigation water used per hectare irrigated (m^3/ha)						
Mean	20	7	1,918	--[b]	--[b]	--[b]
Median			2,000	--[b]	--	--
Price paid for irrigation water (U.S. cents/m^3)						
Mean	20	7	23	--[b]	--[b]	--[b]
Median			24	--[b]	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Farm-level irrigation measures are restricted to external irrigation sources. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-Value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

[b]The values for comparison areas are not shown because the sample sizes are too small (fewer than 15 observations) to provide reliable estimates.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares, WUA = water user association.

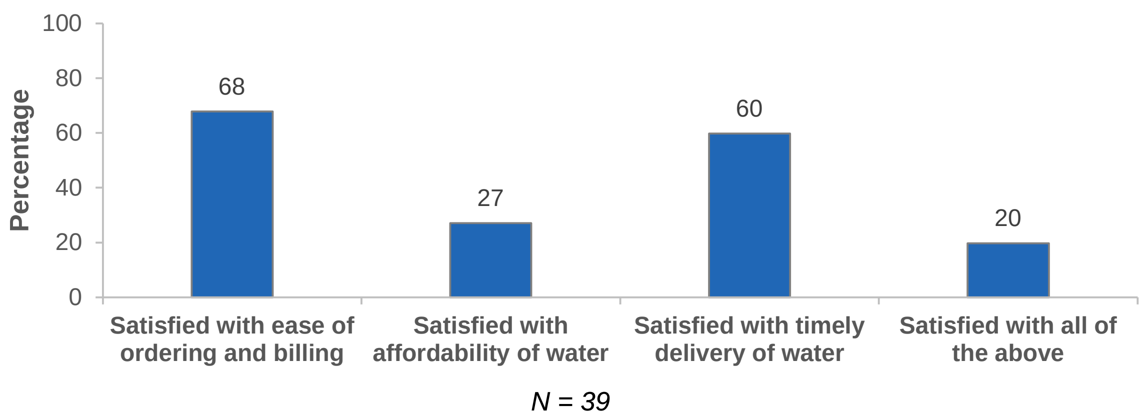
Because satisfaction with irrigation sources is an important monitoring indicator for the TVHA project, the Farm Operator Survey also captured the baseline levels of respondent satisfaction with irrigation. Among the few farms (less than 2 percent) in treatment areas that were irrigating, all reported that the quality of the water delivery was either the same (80 percent) or better (20 percent) in 2013 compared to 2012. Of those treatment farms using irrigation from CISs (almost all of those irrigating), most were satisfied with the ordering and billing process (68 percent) and timeliness of delivery (60 percent), but were not generally satisfied with affordability (only 27 percent reported being satisfied) (Figure IV.1).

In comparison areas, about 6 percent of farms used irrigation (mainly from private providers) compared to roughly 2 percent of treatment farms (mainly from the CIS). Even though the difference is statistically significant, the overall irrigation situation at baseline was the same in both areas—very few farms used irrigation during the 2013 agricultural season.

Because the THVA project focuses on improving irrigation for land inside the CIS command area, we focus the remainder of our analysis of irrigation practices on land in this area rather than for the entire farm. The Farm Operator Survey captured information on irrigation in the command area in two ways. First, the survey gathered information on each farm's irrigated area inside the command area, by crop—by combining this information across all crops, we can determine the extent of irrigation in the command area. Second, the survey measured the area irrigated (and the source of that irrigation) for each sampled command area plot.

Consistent with the pattern in irrigation use across the entire farm area, irrigation use in command area land is low. Only about 2 percent of treatment farms irrigated any command area crops, and the average area irrigated by treatment area farms within the command area was less than a tenth of a hectare (compared to the average cultivated area of 1.3 hectares, not shown). Similarly, only about 3 percent of the treatment CIS command area plots were irrigated. The most common source of plot irrigation was the (partially functioning) CISs managed by water user associations. The average volume of water applied by treatment area farms irrigating within the command area was 1,046 m^3 per hectare and the typical treatment area plot that was irrigated received 1,918 m^3 of water per hectare, at a cost of 23 cents per m^3 (however, because so few farmers were irrigating, the sample sizes for these volume and cost measures are very small and the estimates are imprecise). The percentage of farmers irrigating land in the command area and the percentage of plots irrigated were similarly low in the comparison CIS areas.

Figure IV.1. Satisfaction with irrigation, among treatment farms irrigating from CIS (2013, unless otherwise indicated)



Source: 2013–2014 Moldova Farm Operator Survey.
Note: Comparison farms are omitted because so few farmers were irrigating that the estimates are imprecise. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse.

CIS = centralized irrigation system.

B. Experiences with water user associations

Because water user association membership is largely concentrated in treatment areas, we focus on treatment areas only for our analysis of experiences with water user associations.[28] More than 90 percent of farms in treatment areas were aware of a water user association in their communities, and about 56 percent of treatment area farms were members of the water user association (Table IV.3); the remainder of our analysis of water user association experiences focuses on these members. General involvement with the water user association was limited—only 3 percent of members held a leadership position in the organization, and only about 16 percent of members attended more than half of the last five meetings. Participation in 2013 may have been limited because the water user associations will not assume their full operational role until irrigation water is available. The large majority of members (76 percent) had paid their membership fees for the 2013 agricultural season, but only 48 percent of members who irrigated had paid their irrigation fees (however, because so few members were irrigating, the sample size for this measure is very small).

Table IV.3. Experiences with water user associations in treatment CIS areas (2013, percentage of farm operators or farms unless otherwise indicated)

	Treatment sample size	Treatment mean
Aware of WUA	2,392	92.1
Member of WUA	2,346	56.3
Of WUA members:		
Has leadership position in WUA	1,129	3.2
Number of WUA general meetings attended, of past five	1,052	
0		22.5
1		43.6
2		18.0
3		7.6
4		3.9
5		4.4
Mean (number of meetings attended)		1.4
Paid WUA membership fees	1,267	76.0
Paid irrigation fees, among members irrigating from CIS	34	48.0

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Comparison CIS areas are not included because very few farmers in comparison areas were members of WUAs. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse.

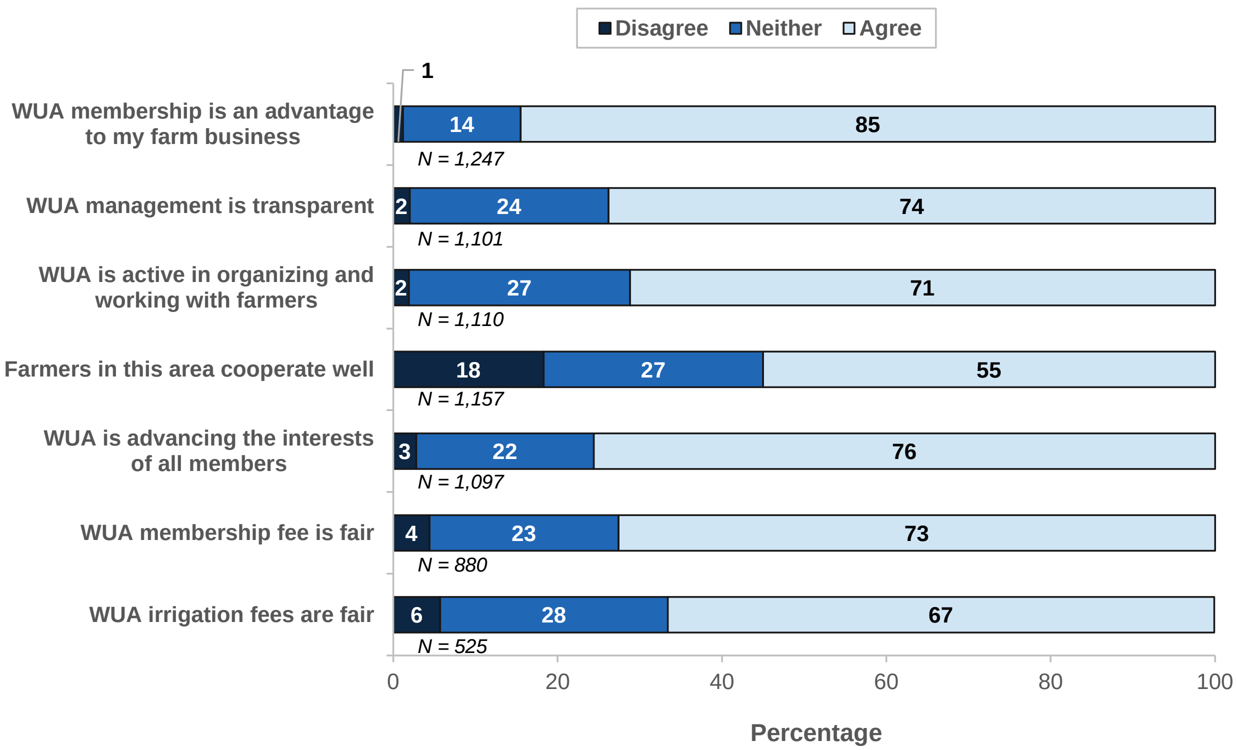
CIS = centralized irrigation system, WUA = water user association.

Despite limited involvement by members, perceptions toward water user associations were generally positive (Figure IV.2). Specifically, the majority of members agreed with a series of positive statements about water user associations. Most members agreed that membership is beneficial (85 percent of members agreed), that the water user association advances the interests

[28] In the comparison CIS areas, only 23 respondents reported being members of a water user association—16 in Balauresti (15 small farms and 1 medium farm), 4 in Holercani (all small farms), 2 in Puhacenii de Sus (1 medium and 1 large farm), and 1 in Cotul Morii (a large farm). We understand that a water user association existed in Balauresti in 2013, so the positive responses there are not entirely unexpected.

of members (76 percent), that management is transparent (74 percent), and that the membership fee is fair (73 percent). Most of the members who did not agree with these statements were ambivalent about them, rather than disagreeing (the highest level of disagreement was for farmer cooperation, with 18 percent of respondents disagreeing that farmers in their area cooperate well). It will be important to examine how these perceptions evolve in the future once water user associations are fully operational.

Figure IV.2. Perceptions of water user associations in treatment CIS areas (2013, percentage of WUA members)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: In the survey, WUA members were asked their opinion on a five point scale (1, strongly disagree; 2, somewhat disagree; 3, neither agree nor disagree; 4, somewhat agree; and 5, strongly agree). In the figure, the somewhat disagree and strongly disagree categories were combined, as were the somewhat agree and strongly agree categories. Comparison CIS areas are not included because very few farmers in these areas were members of WUAs. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse.

CIS = centralized irrigation system, WUA = water user association.

V. TRAINING PARTICIPATION

In this chapter, we examine pre-rehabilitation participation in agricultural training by farms in the treatment and comparison areas. Trainings can potentially provide participants with information on farming or marketing practices that can contribute to greater farm profits and household income. Training may enhance the effectiveness of other activities of the THVA project; the other THVA activities may also induce farmers to seek training.

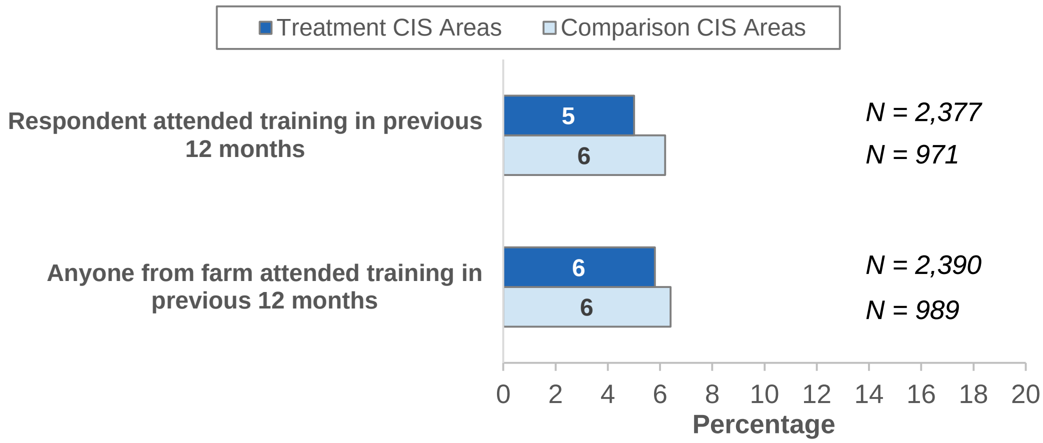
Two specific types of trainings are being provided under the GHS activity of the THVA project: value chain and CIS-area trainings. Value chain trainings, which began in 2011, targeted HVA farmers in selected communities and focused on cultivation and post-harvest practices in specific value chains. Some of the selected communities were located in the CIS areas included in the evaluation: 8 of the 22 communities in treatment CIS areas were identified as sites for GHS value chain trainings, as well as 3 of the 34 communities in comparison CIS areas. (Farmers outside these communities could participate in training, although farmers in these communities were much more likely to participate.) In the year prior to the Farm Operator Survey—the time period over which the survey captured training participation—5 of the 22 communities in treatment CIS areas received at least one GHS value chain training (a total of 15 trainings), and 2 of the 34 communities in comparison CIS areas received at least one training (a total of 5 trainings). However, because overlap with the CIS communities was limited, the trainings were targeted at farmers working in specific HVA value chains, and not all the farmers in the targeted communities and value chains attended, we would expect only a small share of farmers in our sample to have participated in GHS value chain trainings. In contrast, CIS-area trainings were designed to support the transition to HVA and irrigation use in the CIS treatment areas specifically. CIS-area trainings started in mid-2014, after the 2013–2014 Farm Operator Survey data were collected, and are therefore not captured in the baseline data; however, we will be able to capture participation in CIS-area trainings in future rounds of data collection. Table V.1 summarizes the key measures from the Farm Operator Survey that are related to agricultural trainings.

Table V.1. Measures of agricultural training participation

Measures	Time frame
Training participation. Participation of household or farm members in training; number of training participants per farm; reasons for nonparticipation by respondents.	Previous 12 months
Training characteristics. Focus and provider of most recent training.	Previous 12 months

The Farm Operator Survey captured information on participation in agricultural trainings by collecting information on trainings attended by household members (small and medium farms) or farm members (large farms) during the 12 months prior to the survey. Participation in trainings was not common—only about 6 percent of farms in treatment areas had any member participate in an agricultural training in the previous 12 months (Figure V.1). Among farms that participated in trainings, the mean number of participants was about 1 per farm (the mean for large farms was 2, not shown), and the respondent was often the sole participant (79 percent of treatment area farms with anyone participating in agricultural training, not shown). Training participation was similarly limited for farms in the comparison areas—as in the treatment areas, only 6 percent had any member participating in training in the previous 12 months.

Figure V.1. Participation in agricultural trainings (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

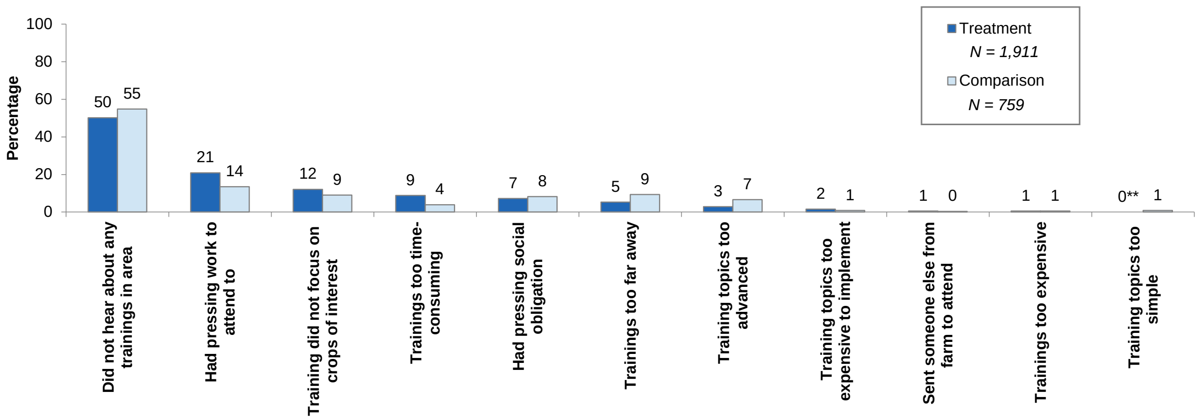
Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between the treatment and comparison samples are estimated using an ordinary-least-squares regression that controls for stratum fixed effects. Reported *p*-values are adjusted for clustering at the CIS level. Statistical significance of differences is based on p-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

If the respondent did not attend a training in the previous 12 months (even if someone else from his or her farm did), we collected information on the reasons for nonparticipation, allowing for multiple responses (Figure V.2). Just over half of the nonparticipating respondents in treatment areas did not participate in agricultural training in the past year because they did not hear about any trainings in their area. Other common reasons for not participating included conflicting work obligations (21 percent in treatment areas) and trainings not focused on crops of interest (12 percent).

Figure V.2. Reasons for nonparticipation in agricultural trainings (2012–2013, percentage of respondents that did not participate in training)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between the treatment and comparison samples are estimated using an ordinary-least-squares regression that controls for stratum fixed effects. Reported *p*-values are adjusted for clustering at the CIS level. Statistical significance of differences is based on p-values that are adjusted for clustering at the CIS level.

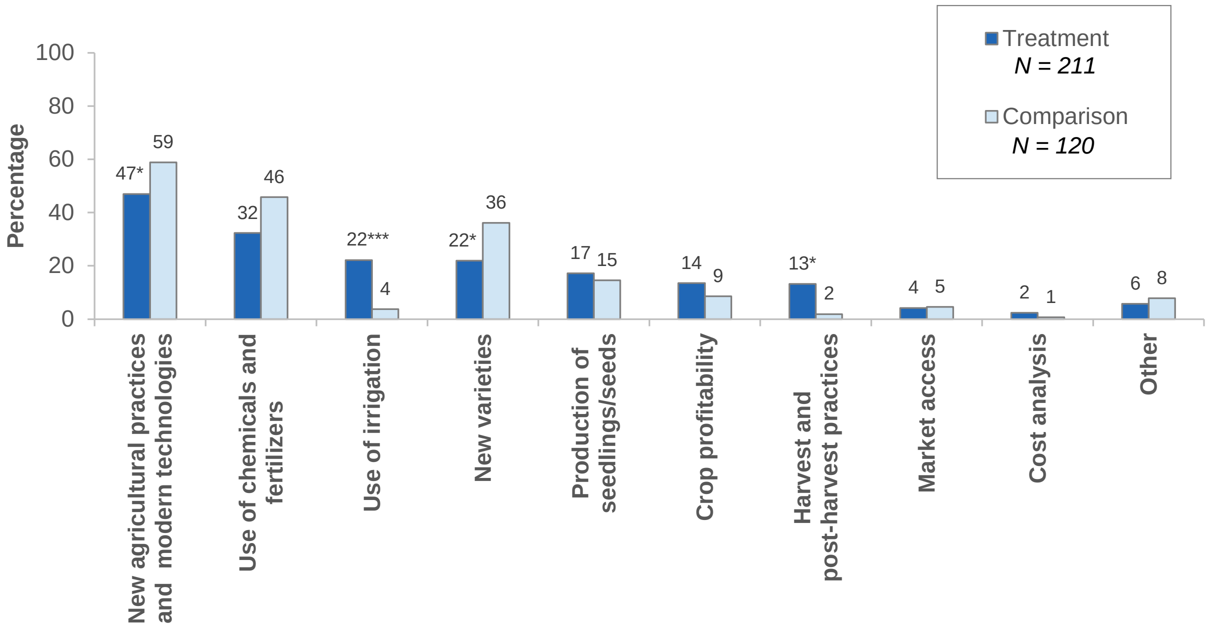
*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

For farms that participated in an agricultural training in the previous 12 months, we collected information on the most recent training from the household or farm member who attended.[29] Trainings covered a wide variety of topics, and participants could have cited more than one topic as the focus of each training (Figure V.3). About half of training participants in treatment areas attended a training that focused on new practices and technology, and about a third attended a training on the use of chemicals and fertilizers. There was also some variation in training providers (Figure V.4). About 55 percent of participants in treatment areas attended trainings from extension service providers, with trainings from other providers, such as the Agricultural Competitiveness and Enterprise Development (ACED) project (36 percent) and the raion department for agriculture and food (15 percent), also common. The percentage of trainings provided by the ACED project, the implementing project for GHS, seems large given that participation in GHS value chain trainings by farmers in our sample was likely limited and the GHS CIS-area trainings did not begin until after data collection. However, the overall participation rate in trainings provided by the ACED project is still very low given the small percentage of farmers who participated in any training.

[29] The survey collected information on trainings from respondents who participated in any agricultural training over the previous 12 months. If a respondent did not participate but identified another household or farm member who participated, the survey collected information from the most recent participant. If the most recent participant was not available, the survey collected no further training information for the farm.

Figure V.3. Agricultural training topics in most recent agricultural training (2013, percentage of farms that participated in training)



Source: 2013–2014 Moldova Farm Operator Survey.

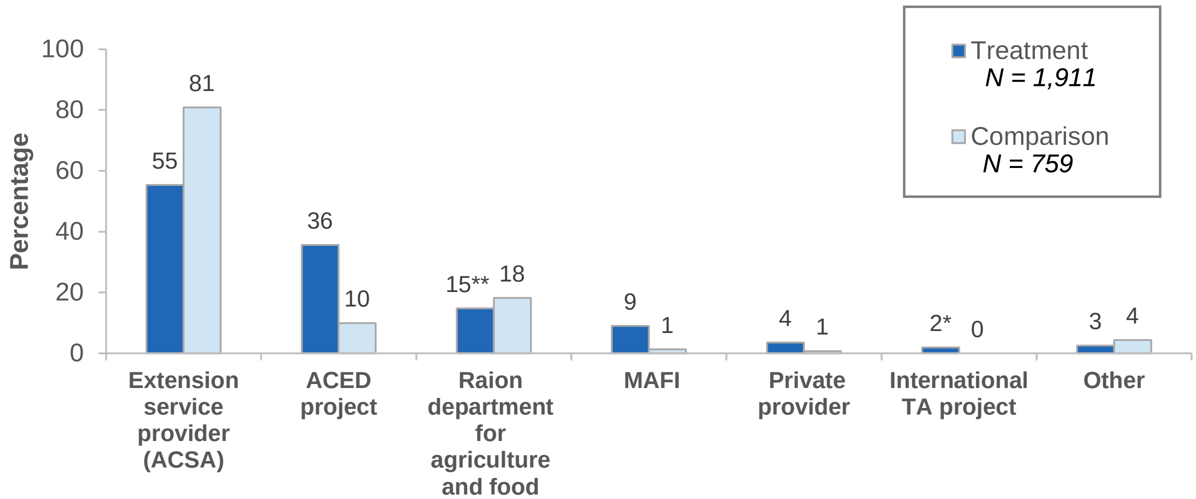
Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between the treatment and comparison samples are estimated using an ordinary-least-squares regression that controls for stratum fixed effects. Reported *p*-values are adjusted for clustering at the CIS level. Statistical significance of differences is based on p-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

There were a few substantial differences between treatment and comparison areas in the topics and providers of trainings. For example, only 4 percent of trainings attended by members of comparison area farms covered irrigation use (compared to 22 percent attended by treatment, a statistically significant difference). In comparison areas, over 80 percent of trainings were provided by extension service providers (compared to 55 percent in treatment areas), and only 10 percent were provided by the ACED project (compared to 36 percent), though both differences are not statistically significant. The fact that trainings provided by the ACED project were more common (though not significantly so) in the treatment areas relative to comparison areas likely reflects the greater overlap between GHS value chain training communities and the treatment CIS communities. The lack of statistical significance of some of the large differences between the treatment and comparison areas is likely due to the relatively small number of farms that had a member participate in agricultural training. Regardless, because so few household or farm members attended training overall, even these large differences should not significantly affect the baseline outcomes that apply to the full sample, such as irrigation use.

Figure V.4. Provider of most recent agricultural training (2013, percentage of farms that participated in training)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between the treatment and comparison samples are estimated using an ordinary-least-squares regression that controls for stratum fixed effects. Reported *p*-values are adjusted for clustering at the CIS level. Statistical significance of differences is based on *p*-values that are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

ACED = Agricultural Competitiveness and Enterprise Development, CIS = centralized irrigation system, MAFI = Ministry of Agriculture and Food Industry, TA = technical assistance.

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VI. PRACTICE USE

In this chapter, we examine the extent to which specific agricultural practices related to the cultivation and processing of HVA crops were used by farms in the treatment and comparison CIS areas. We also describe the sources of information about these practices (when used). Because these practices could help increase and maximize the benefits from HVA cultivation, it is important to assess how common they were among existing HVA producers prior to rehabilitation.

We focus on practices covered in the value chain trainings that are being conducted as part of the GHS activity. As described in Chapter V, these trainings, which began in 2011, target existing HVA producers in selected communities and focus on specific cultivation and post-harvest practices in specific value chains. These trainings have taken place throughout Moldova; some of the communities identified for training are located in treatment and comparison CIS areas, but the degree of overlap is limited. However, these practices are important to HVA cultivation and processing (consistent with the fact that they were identified as key training topics by the GHS implementer) and many of these same practices were selected as topics for GHS CIS-area trainings. Therefore, documenting their use at baseline is of interest to the evaluation. Table VI.1 summarizes the key measures of practice use captured in the 2013–2014 Farm Operator Survey. We expect future rounds of the survey to measure practice use using a list of practices that is well-aligned with the CIS area training topics.

Table VI.1. Measures of practice use by farms cultivating specific HVA crops

Measures	Time frame
Practice use. *Number of practices used; area on which practices used; percentage of cultivated crop area on which practices used; reasons for not using practices.*	2013 agricultural season
Sources of information. *Sources of information about practices used.*	2013 agricultural season

To examine how frequently specific practices were used, the Farm Operator Survey asked respondents cultivating specific HVA crops if they used the relevant practices for those crops in the 2013 agricultural season. Consistent with the value chains targeted for GHS value chain trainings, the survey asked about the use of 27 stone fruit practices (stone fruits include peaches, plums, sweet cherries, and apricots), 27 apple practices, 24 table grape practices, and 29 tomato or tomato seedling practices.

Overall, the farms cultivating these HVA crops used very few of the specified practices during the 2013 agricultural season (Table VI.2). Farms in treatment areas cultivating stone fruits, apples, and table grapes, on average, used only about one relevant practice for each crop. (These outcomes for farms cultivating tomato and tomato seedlings have been omitted from the tables because there were too few farms cultivating tomatoes to provide reliable estimates.) The average area on which these practices were applied was also generally small. Farms in treatment areas cultivating stone fruits or apples applied relevant practices to 0.6 hectares, on average; table grape farms applied relevant practices to 0.3 hectares, on average. Because these small areas may partly reflect the small overall area on which these crops were cultivated, we also examined the *percentage* of cultivated crop area on which these practices were applied. Treatment area farms cultivating stone fruits applied at least one practice to about a third of the stone fruit cultivation area, on average. Apple and table grape farms on average applied at least one relevant practice to 54 and 59 percent, respectively, of the farm area dedicated to the cultivation of those crops.

Farms cultivating these HVA crops in comparison areas used more relevant practices than farms in treatment areas, on average, although the typical comparison area farm still only applied a few practices in the cultivation of these crops. Apple and table grape farms in comparison areas each applied practices to a significantly greater share of land relative to treatment areas, whereas comparison area stone fruit farms (after controlling for stratum and farm size) applied practices to a significantly smaller share of land relative to treatment areas. However, the number of farms growing these specific HVA crops and using relevant practices is only a small fraction of our overall sample, so these treatment-comparison differences do not indicate an imbalance in the overall sample.

Table VI.2. Use of practices, among farms cultivating relevant crops (2013)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Number of practices used, mean:						
Stone fruits	247	56	0.9	1.9	0.1	0.87
Apples	255	56	1.2	1.8	-0.5	0.00***
Table grapes	65	75	1.3	3.1	-4.2	0.00***
Area on which practices used, mean (ha):						
Stone fruits	265	56	0.6	1.3	0.3	0.62
Apples	259	58	0.6	0.5	0.3	0.19
Table grapes	70	76	0.3	0.7	-0.6	0.00***
Percentage of cultivated crop area on which practices used, mean:						
Stone fruits	265	56	33.1	48.9	16.1	0.00***
Apples	259	58	54.1	73.1	-14.7	0.02**
Table grapes	70	76	59.3	88.8	-20.7	0.00***

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Stone fruits include peaches, plums, sweet cherries, and apricots. The values for tomatoes and tomato seedlings are not shown because the sample sizes are too small (fewer than 15 observations) to provide reliable estimates. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

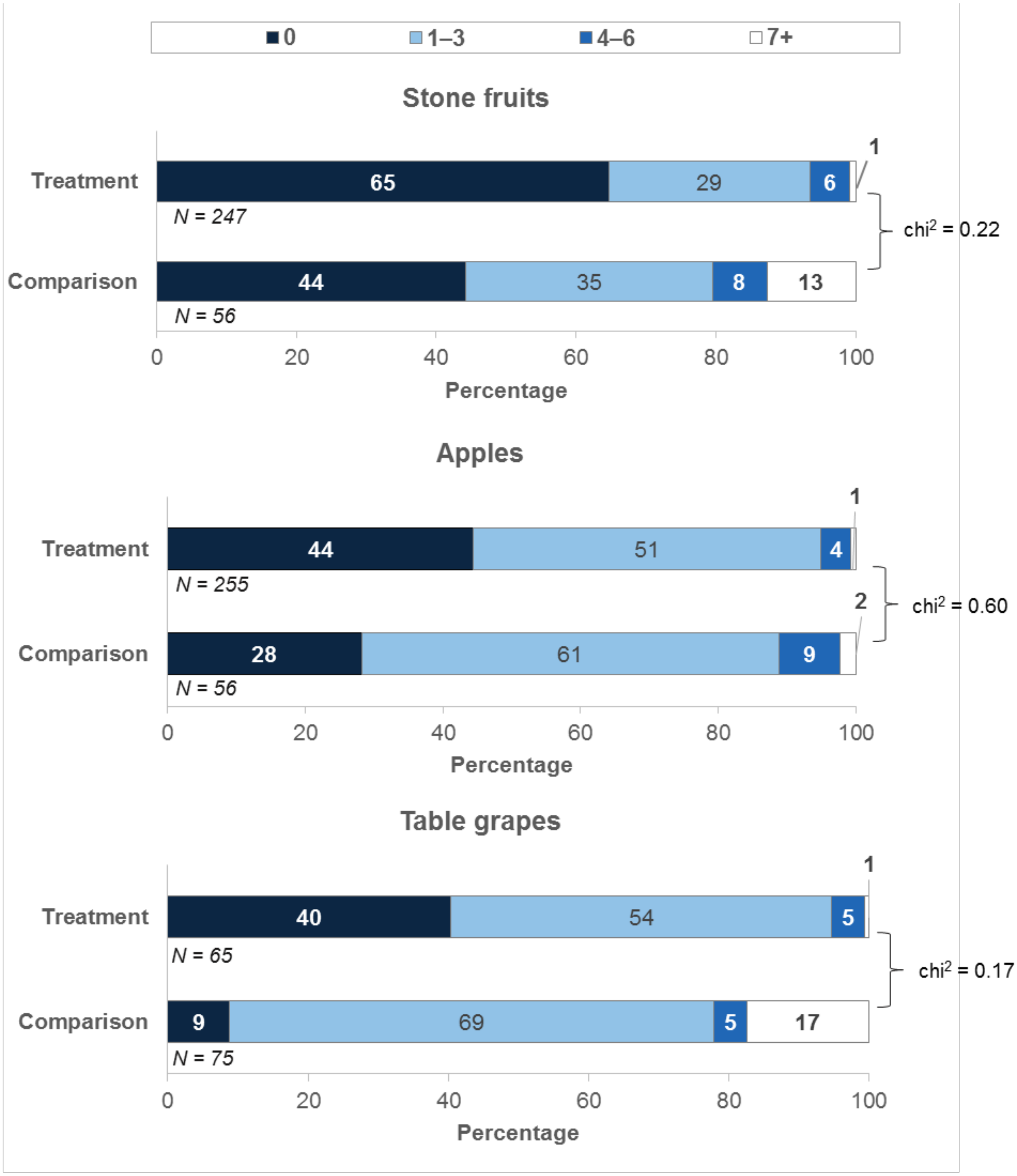
*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system

To complement our analysis of the mean number of practices used, we also looked at the distributions of the number of practices used during the 2013 agricultural season (Figure VI.1). The distribution of stone fruit practices shows that most farms cultivating stone fruits in treatment areas did not use any practices related to growing stone fruits (65 percent) and that almost all of the remaining farms (29 percent) only used one to three practices. The distributions for apple and table grape practices are broadly similar—44 percent of treatment area farms growing apples and 40 percent of those growing table grapes did not use any relevant practice, and 51 percent of apple growers and 54 percent of those cultivating table grapes used one to three practices.

The patterns at the lower end of the treatment area distributions are similar to those of the comparison area distributions: most comparison area farms cultivating these HVA crops used no or few practices. There are some larger treatment-comparison differences at the upper end of the distribution, with about 13 percent of stone fruit and about 17 percent of table grape farms in comparison areas reporting that they used seven or more relevant practices, compared to only 1 percent of farms cultivating those crops in treatment areas. However, the overall treatment-comparison difference in the distributions is not significant for any of the value chains that we examined.

Figure VI.1. Distribution of number of practices used, among farms cultivating relevant crops (2013, percentage of farms)



Note: Stone fruits include peaches, plums, sweet cherries, and apricots. The values for tomatoes and tomato seedlings are not shown because the sample sizes are too small (fewer than 15 observations) to provide reliable estimates. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

For farms using at least one practice related to their cultivation of these HVA crops, the survey captured the two main sources of information for practices used (separately by crop, though we aggregate across crops when summarizing responses). For these farms in treatment areas, the most common sources of information for practices used were a neighbor or other farmer (63 percent), other family member (46 percent), and an expert consultant (19 percent) (Table VI.3). (Because we aggregate across crops when summarizing responses, we were able to include the sample of farms who used relevant tomato and tomato seedling practices in this analysis.) For these farms in comparison areas, the sources of information for practices used were largely similar to those in treatment areas, except that a neighbor or other farmer was a less frequent source of information for practices in comparison areas (30 percent compared to 63 percent of analogous farms in treatment areas, a statistically significant difference).

Table VI.3. Sources of information about used practices (2013, percentage of farms that used at least one practice)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Neighbor or other farmer	211	118	63.1	30.5	32.1	0.00***
Family member			46.2	41.6	6.3	0.39
Expert consultant			18.6	27.6	-8.8	0.44
Mass media			10.3	16.7	-7.7	0.19
Training session			7.9	15.8	-9.7	0.19
Education			7.2	12.9	-5.0	0.45
Other			4.1	4.1	-0.4	0.78

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Sample only includes farms that grew stone fruits, apples, table grapes, or tomatoes or tomato seedlings during the 2013 agricultural season and used at least one relevant practice. Percentages may not sum to 100 because respondents could select up to two response options and could have responded to the question for more than one crop. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system

The survey also collected data on the two main reasons why farms cultivating specific HVA crops did not use all of the relevant practices (Table VI.4).[30] (As with the sources of information above, we aggregate across crops when summarizing responses; tomato and tomato seedling farms were therefore included.) Among treatment area farms cultivating these crops, the most frequently reported reason for not using the specified practices was that the practices were too costly to implement (43 percent). Other common reasons were that the practices were not useful (38 percent), farmers did not know about the relevant practices or equipment (22 percent), and the practices were too advanced (12 percent). Very few of these farms reported not using practices because they were used in the previous season (about 4 percent in treatment areas) or

[30] No farms growing any of these crops used all relevant practices.

take too much time to implement (3 percent). The reasons for not using practices provided by farms in comparison areas were quite different. The most frequently reported reasons for non-use among comparison area farms were that practices were too costly to implement (65 percent compared to 43 percent in treatment areas), the practices were too advanced (51 percent compared to 12 percent), and the practices were not useful (24 percent compared to 38 percent), with all the differences being statistically significant.

Table VI.4. Reasons for not using unused practices (2013, percentage of farms cultivating relevant crops)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Costly	417	143	42.5	64.5	-16.2	0.05*
Not useful	417	142	37.8	23.6	13.3	0.00***
Did not know about practice/equipment	420	142	22.3	10.7	14.3	0.01**
Too advanced	418	142	12.2	51.1	-42.8	0.00***
Already used in previous season	417	143	3.6	0.9	2.3	0.02**
Takes too much time	417	143	3.2	18.2	-14.9	0.00***
Other	425	143	17.0	4.4	8.6	0.00***

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Sample only includes farms that grew stone fruits, apples, table grapes, or tomatoes or tomato seedlings during the 2013 agricultural season and did not use all of the practices related to the cultivation of those crops listed in the Farm Operator Survey. Percentages may not sum to 100 because respondents could select up to two response options and could have responded to the question for more than one crop. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system

VII. AGRICULTURAL CREDIT

In this chapter, we examine the use of agricultural credit by farms in our sample and the characteristics of credit received. It is important to understand the agricultural credit environment because access to credit could affect the impacts of the THVA project. For example, a lack of long-term financing for investments in irrigation equipment and post-harvest infrastructure may preclude significant increases in cultivation and sales of HVA crops despite the rehabilitation of irrigation systems. To increase access to agricultural credit in the treatment areas and other parts of Moldova, the THVA project is providing financing for HVA- and irrigation-related investments by farmers and rural entrepreneurs through the AAF activity.

The 2013–2014 Farm Operator Survey collected detailed baseline information on the prevalence and characteristics of existing agricultural loans of all farms in the sample, focusing on loans in the year prior to the survey. Table VII.1 summarizes the key loan measures captured by the Farm Operator Survey.

Table VII.1. Measures of agricultural loan applications and characteristics

Measures	Time frame
Loan applications. Loan application; loan approval; reasons for not applying	Previous 12 months
Loan characteristics (of approved loans). Purpose; source; size; term; collateral-to-loan ratio; interest rate	Previous 12 months

A. Loan applications

In the 12 months prior to the survey, about 2 percent of treatment area farms applied for any type of agricultural loan; almost all of those applications were approved (Table VII.2).[31] This indicates that although nearly all of the farms (more than 99 percent) that applied for loans were able to obtain at least one, few farms accessed agricultural credit markets in the first place. The two principal reasons for not applying for a loan were not needing one (71 percent of treatment area farms not applying) and not wanting to incur debt (21 percent).[32] Very few farms were discouraged from applying because they thought they would not qualify (due to insufficient collateral or other reasons), the terms were unfavorable, or they were unaware of the availability of loans. Although a significantly higher percentage of farms in comparison areas applied for loans (4 percent) and received at least one (4 percent) compared to treatment areas, loan application and receipt were similarly rare in both types of area, and the main reasons for not applying were broadly equivalent.

[31] The Farm Operator Survey asked about agricultural loans from a variety of sources. Specifically, it asked about “loan[s] to finance the farm’s operations from a bank, a micro-credit organization, a savings and credit association, or a government or donor sponsored credit program.”

[32] The survey asked respondents whose farms did not apply for a loan to report one main reason that they did not apply, even if there were multiple reasons.

Table VII.2. Loan application decisions (2013, percentage of farms)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Applied for an agricultural loan in past year	2,391	992	2.0	3.6	-1.6	0.05**
Approved for an agricultural loan in past year	2,391	992	1.9	3.6	-1.6	0.04**
Main reason for not applying:	2,285	933				0.09*
Did not need loan			70.7	60.3	10.4	0.25
Did not want debt			21.4	19.3	2.1	0.80
Borrowed from friends or family			3.8	6.9	-3.1	0.05*
Thought he/she would not qualify due to insufficient collateral			1.5	4.7	-3.2	0.08*
Thought he/she would not qualify due to other reasons			1.3	1.2	0.1	0.95
Unfavorable terms of loan			1.2	1.3	-0.1	0.91
Unaware of loans/application process			0.1	0.7	-0.6	0.09*
Thought he/she would not qualify due to credit history			0.0	0.3	-0.3	0.13
Other			0.0	5.3	-5.3	0.32

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these treatment-comparison differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

B. Loan characteristics

To understand the characteristics of the few agricultural loans received in the 12 months prior to the Farm Operator Survey, the survey asked recipients about the purpose, source, size, and conditions of their loan(s).[33] The most common purposes in the treatment areas were purchasing inputs (65 percent of loans) and constructing greenhouses (23 percent), followed by purchasing irrigation equipment (21 percent) and introducing new crops (11 percent) (Table VII.3). Loans received in treatment areas were most frequently obtained from donor credit lines outside the AAF activity (45 percent of loans), micro-credit organizations (34 percent of loans), and banks (14 percent).[34] Loans were typically small—about three-quarters of all loans received by treatment area farms were less than $5,000—and generally short term, with about 71 percent of these loans having a term of two years or less. About 47 percent of all loans received by treatment area farms required no collateral, but about half required collateral that was greater than the loan value (the median collateral-to-loan ratio in treatment areas was 0.8). Interest rates were generally high, with more than half of all loans received by treatment area farms having interest rates between 10 and 20 percent, and roughly 43 percent with interest rates over 20 percent.

There were a handful of statistically significant differences in loan characteristics between treatment and comparison areas. For example, loans in comparison areas were generally smaller in size (61 percent were less than $1000 compared to 31 percent in treatment areas), though the difference in mean loan amounts is not statistically significant. There are also some large differences that are not statistically significant because the small number of loans likely does not provide enough statistical power to detect them (for example, 67 percent of loans in treatment areas were obtained from micro-credit organizations compared to 34 percent in comparison areas). Loans in comparison areas were therefore largely statistically similar in characteristics to those in treatment areas, although our ability to compare these loans is limited by the small sample size.

[33] We asked respondents for information on up to the three most recent loans received in the 12 months prior to the survey. In total, we obtained information on 84 loans received by 81 treatment area farms and 51 loans received by 49 comparison area farms during this period.

[34] One loan in treatment CIS areas was reported to be from the MCA credit line/AAF. Although AAF loans were approved over this period, we would expect very few (if any) farms in our treatment area sample to have received them, for the following reasons: (1) the total number of loans was small (only about 60 were awarded in the period from early 2012 through mid-2015; (2) AAF loans were also available outside the treatment CIS areas (though there were geographic restrictions at some points in time); and (3) some of these loans were given to other entities besides farms (such as processors). Because of the limited number of direct AAF loan beneficiaries in the treatment areas (even in the future), we plan to conduct a separate data collection effort for these beneficiaries as part of the THVA evaluation rather than relying on the Farm Operator Survey.

Table VII.3. Agricultural loan characteristics (2013, percentage of loans unless otherwise indicated)

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Purpose of loan	84	50				
Purchasing inputs			65.3	75.1	-6.8	0.59
Constructing greenhouse			23.0	32.9	4.1	0.75
Purchasing irrigation equipment			21.3	4.7	27.1	0.11
Introducing new crops			10.9	0.9	12.3	0.03**
Purchasing other farm equipment			8.6	13.4	-5.5	0.49
Constructing new buildings/infrastructure for post-harvest activities			4.1	0.0	0.7	0.17
Improvements to buildings/ infrastructure			3.2	0.0	1.0	0.19
Paying for irrigation water			2.2	0.1	2.2	0.08*
Refinancing/covering other loans/debt			2.1	1.9	1.1	0.70
Constructing new buildings/ infrastructure for other purposes			1.7	0.0	0.1	0.36
Purchasing livestock			1.0	0.0	1.5	0.26
Purchasing land			0.0	4.8	-4.7	0.01***
Other			13.8	14.6	-8.6	0.41
Source of loan	83	51				0.16 [a]
Other donor credit line			45.3	12.0	25.1	0.16
Micro-credit organization			33.7	67.4	-32.7	0.12
Private or commercial bank			13.7	18.7	2.4	0.86
MCA credit line/AAF activity			4.8	0.7	5.7	0.40
IFAD credit line			1.9	0.0	1.6	0.10*
RISP			0.6	0.5	-1.0	0.42
Savings and credit association			0.0	0.6	-1.1	0.10*
Other			0.0	0.0	0.0	--
Size of loan (USD)	77	48				0.08* [a]
<$1000			31.2	61.5	-27.9	0.03**
≥$1,000 to <$5,000			45.5	31.7	17.8	0.15
≥$5,000 to <$10,000			8.7	1.2	8.2	0.24
≥$10,000 to <$50,000			11.8	4.8	1.8	0.36
≥$50,000			2.9	0.8	0.2	0.89
Mean			7,629	2,862	1,130	0.60
Median			2,352	784	--	--

	Treatment sample size	Comparison sample size	Treatment	Comparison	Adjusted difference	*p*-value
Term of loan (months)	80	49				0.54 [a]
<6			6.3	9.0	1.0	0.89
≥6 to <12			26.7	30.6	-6.6	0.67
≥12 to <24			37.8	50.4	-6.5	0.73
≥24 to <36			18.5	7.9	6.0	0.46
≥36 to <60			9.3	2.1	5.0	0.48
≥60			1.3	0.0	1.2	0.26
Collateral-to-loan ratio	70	40				0.14 [a]
0			47.3	38.2	16.1	0.21
≥1 to <1.5			32.1	36.1	-5.5	0.52
≥1.5 to <2			12.3	11.7	-5.3	0.16
≥2 to <2.5			2.5	0.2	2.0	0.51
≥2.5			1.9	13.8	-11.5	0.02**
Mean			0.7	1.1	-0.5	0.04**
Median			0.8	1.4	--	--
Interest rate (percent)	76	48				0.39[a]
<5			0.0	0.0	0.0	--
≥5 to <10			2.4	0.1	1.9	0.07*
≥10 to <15			35.1	18.2	12.1	0.43
≥15 to <20			19.8	23.0	-1.1	0.93
≥20 to <25			34.8	29.5	2.9	0.90
≥25			7.9	29.1	-15.8	0.50

Source: 2013–2014 Moldova Farm Operator Survey.

Notes: Each farm could have reported up to three loans. Percentages for purpose of loan may sum to greater than 100 percent because respondents could select more than one response option. Monetary amounts were converted from Moldovan lei and Euros to U.S. dollars using the average exchange rates in 2013, which were 0.0784 dollars per lei and 1.3279 dollars per Euro (www.oanda.com). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. These treatment-comparison differences may not be equal to the raw differences as a result of the regression adjustment. Reported *p*-values are adjusted for clustering at the CIS level.

[a] *p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, MCA = Millennium Challenge Account, AAF = Access to Agricultural Finance, IFAD = International Fund for Agricultural Development, RISP = Rural Investment and Services Project.

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VIII. BORDER AREA ANALYSIS

The previous chapters focused on describing and comparing treatment and comparison areas; in this chapter, we extend the analysis to include border areas. As described in Chapter I, the impact evaluation primarily focuses on estimating impacts for farmers in the treatment areas (by comparing them to farmers in the comparison areas), because these farmers are the primary expected beneficiaries of the full package of THVA activities. However, some farmers operating land in border areas—which are located adjacent to or near the treatment command areas—will be able to connect to the rehabilitated CIS. Farmers operating land in border areas are therefore also potential beneficiaries of the full package of THVA activities, and it is important to determine how including them in the evaluation affects our estimates of project impacts.[35]

In the impact evaluation, we will therefore produce two sets of impact estimates—the first will exclude the border areas, and the second will include them together with the treatment group. In the latter case, we will compare changes over time in the combined treatment and border areas to changes in the comparison areas. (As mentioned earlier, it is not feasible to estimate impacts for the border areas alone, primarily because the small border area sample size means that that those estimates would have low statistical power.) For these impact estimates to be valid, it is important to verify that the combined treatment and border areas were similar to the comparison areas before rehabilitation.

To do this, we compare farms and plots in the treatment plus border areas to the comparison areas using the 2013–2014 Farm Operator Survey data. For conciseness, we focus this analysis on basic farm and plot characteristics and key outcomes for the impact evaluation, including cultivation, use of labor, profits, and irrigation. The border areas contain substantially fewer farmers and plots than the treatment areas; therefore, we would not expect the addition of the border area sample to substantially change our assessment of differences with comparison areas for most measures relative to the treatment-only analysis in the previous chapters.[36] Nevertheless, it is still important to confirm that this is the case.

A. Farm and plot characteristics

Similar to the pattern for the treatment areas alone that we reported in Chapter II, farms in the combined treatment and border areas tended to cultivate a small area of land (top panel of Table VIII.1). Almost two-thirds of farms in these areas cultivated an area of less than 1 hectare, and almost all of the rest cultivated an area of between 1 and 5 hectares; this distribution was

[35] As we describe in our design report (Borkum et al. 2015), the effects of including the border areas on the impact estimates is ambiguous. On the one hand, only some border area farmers will benefit from improved irrigation, because the system has limited capacity, and those who do want to connect to the system will have to make additional investments. Therefore, including border area farmers in the analysis could dilute the impact estimates. On the other hand, the border areas were specifically added because they were expected to experience large impacts; including these areas in the analysis might therefore increase the estimated impacts.

[36] Our sample weights are normalized so that the weighted sample reflects the relative proportions of farmers or plots in each area in the sample frame. Therefore, although the border area sample is substantially smaller than the treatment area sample, it is the small number of farmers and plots in the border area sample *frame* that leads us to expect the addition of the border areas to make little difference to the estimates.

very similar to that in the comparison areas.[37] On average, about 76 percent of the cultivated land of these farmers was potentially affected by the full package of THVA activities because it was cultivated in the treatment command area (62 percent) or border areas (14 percent).[38] In contrast, the average comparison area farmer cultivated 78 percent of their land in the comparison command area.

The characteristics of plots in the treatment and border areas (bottom panel of Table VIII.1) were also similar to those described in the treatment-only analysis. As before, almost three-quarters of plots in these areas were owner operated, and most of them (53 percent of the total) were acquired through privatization. For the 19 percent of plots that were rented, the average annual rent was $80 per hectare. These plot characteristics were generally similar in comparison areas, although there was a significant difference in the percentage of plots that were rented (6 percentage points higher in comparison areas, driven in part by a marginally significant difference of 3 percentage points in the treatment-only analysis described in Chapter II).

[37] All of the numbers for comparison areas presented in this chapter differ slightly from those in previous chapters because we used slightly different weights for this analysis compared to the treatment-only analyses (see Appendix A for details).

[38] Because the treatment and border areas are adjacent or nearby to each other, some farms in the combined sample cultivate land in both areas. About 65 percent of these farms cultivated land in the treatment but not border areas, 13 percent cultivated land in the border but not treatment areas, 12 percent cultivated land in both areas, and the remainder did not cultivate any land (not shown).

Table VIII.1. Farm and plot characteristics (percentage of farms or plots unless otherwise indicated)

	Treatment and border sample size	Comparison sample size	Treatment and border	Comparison	Adjusted difference	*p*-value
Entire farm area						
Total area cultivated per farm	2,921	992				0.87[a]
<1 ha			64.2	61.0	3.2	0.63
≥1 to <5 ha			33.0	36.2	-3.1	0.64
≥5 to <10 ha			1.7	1.8	-0.1	0.90
≥10 to <100 ha			0.8	0.8	0.0	0.85
≥100 ha			0.3	0.3	0.0	0.12
Median (ha)			0.6	0.7		
Of total cultivated area, percent:						
Inside CIS command area	2,770	951	62.1	77.6	-15.8	0.08*
Inside border area	2,770	--	13.8	--	--	--
Sampled plots						
Plot cultivated in 2013	3,013	1,078	85.8	90.1	-4.4	0.25
Plot ownership status:	3,012	1,078				0.45[a]
Owned—purchase			9.5	5.5	4.0	0.09*
Owned—inheritance			12.0	10.4	1.5	0.31
Owned—privatization			52.7	51.1	1.1	0.71
Owned—other			0.2	0.0	0.2	0.08*
Rented			19.5	25.7	-5.6	0.03**
Used for free			6.1	7.2	-1.1	0.60
Rent per hectare, among plots rented (mean, dollars/ha)	99	140	80	85	-2	0.80

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Entire farm area includes land in the CIS command area, land inside border areas, and land outside the CIS command and border areas. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment plus border areas and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares.

B. Cultivation, farm labor, and agricultural profits

Cultivation of HVA crops in the treatment plus border areas was limited in 2013—as it was for the treatment-only analysis. Specifically, HVA crops were only cultivated on 12 percent of plots and HVA was only cultivated intensively on 2 percent of plots (Table VIII.2). Although the percentage of plots cultivating non-HVA crops was significantly higher in comparison areas, the percentage cultivating HVA crops—which is the dimension of cultivation expected to be affected by the project—was statistically similar.

We also examined the plot-level use of hired labor in 2013 in the combined treatment and border area sample, which was again similar to the pattern previously reported for the treatment areas alone. About 38 percent of the plots in treatment and border areas used hired labor in 2013, they used an average of almost three person-days, and the average payment to hired labor was $11 per person-day. The average payment was significantly lower for plots in comparison areas, but this difference was small ($2 per person-day), and there were no significant differences in the measures of use of hired labor (the percentage using hired labor and the number of person-days used).

Table VIII.2. Crop cultivation and use of hired labor on CIS or border area plots (2013, percentage of plots unless otherwise indicated)

	Treatment and border sample size	Comparison sample size	Treatment and border	Comparison	Adjusted difference	*p*-value
Crop cultivation						
Any crops	3,013	1,078	85.8	90.1	-4.4	0.25
HVA crops	3,013	1,078	12.3	9.3	2.9	0.41
Intensive HVA crops	3,012	1,077	1.8	0.2	1.5	0.33
Non-HVA crops	3,013	1,078	74.1	81.2	-7.0	0.01***
Use of hired labor						
Used any hired labor	2,979	1,041	38.1	35.2	1.4	0.77
Number of person-days (number, mean)	2,979	1,041	2.7	2.4	0.1	0.75
Payment per person-day (dollars, mean)	918	313	11	9	2	0.04**

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Intensive HVA cultivation is defined as an orchard with a tree density of at least 1,000 per ha, or cultivation in a greenhouse. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment plus border areas and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, HVA = high-value agriculture.

Our analysis of agricultural profits—a key ultimate outcome for the evaluation—in the treatment and border areas focuses on per hectare profit measures, for which we will have the greatest statistical power to detect impacts. As in the treatment-only analysis in Chapter III, we present estimates that account for all expenditures and estimates that account for operating expenditures only. We also present separate estimates of agricultural profits for the entire farm, land inside the command area (or border area), and at the plot level, using assumptions analogous to those described in Chapter III to scale farm-level revenues and expenditures appropriately.

Similar to the treatment-only analysis, profits per hectare in the treatment and border areas were generally negative across all the measures that we considered (Table VIII.3). Mean profits per hectare including all expenses were negative $129 at the farm level, negative $417 for land inside the command area (or border area), and negative $284 at the plot level. These profits were slightly higher when only operating expenses were included and were slightly different for median profits instead of means, but the overall pattern was similar. Farm-level profits per hectare were significantly higher in the comparison group, but the difference was small in absolute terms ($226), and the command area and plot-level measures were not significantly different.[39]

[39] As mentioned in Chapter III, we consider a difference in profits per hectare of this magnitude to be small because most farms cultivate only a small area of land and the resulting difference in profits is therefore only a small fraction of typical household income.

Table VIII.3. Agricultural profits per farm or plot (2013, dollars per ha)

	Treatment and border sample size	Comparison sample size	Treatment and border	Comparison	Adjusted difference	*p*-value
Average agricultural profits per hectare, entire farm						
Agricultural profits, Revenues minus all expenses	2,501	908				
Mean			-129	102	-226	0.03**
Median			-274	-160	--	--
Agricultural profits, revenues minus operating expenses	2,655	918				
Mean			-14	198	-202	0.07*
Median			-237	-120	--	--
Average agricultural profits per hectare, land inside CIS command area and border area						
Agricultural profits, revenues minus all expenses	2,402	876				
Mean			-417	-296	-116	0.23
Median			-365	-270	--	--
Agricultural profits, revenues minus operating expenses	2,554	886				
Mean			-321	-214	-100	0.24
Median			-316	-243	--	--
Average agricultural profits per hectare from plot						
Agricultural profits, revenues minus all expenses	2,333	891				
Mean			-284	-187	-80	0.23
Median			-307	-249	--	--
Agricultural profits, revenues minus operating expenses	2,409	901				
Mean			-173	-106	-50	0.38
Median			-258	-211	--	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Operating expenses exclude expenses for: livestock purchases, repayments of loan principal and interest for agricultural loans, agricultural land taxes, other taxes related to agricultural production or sales, equipment for drip irrigation, equipment for sprinklers, costs of connecting to irrigation sources, greenhouse construction and maintenance, cold storage construction and maintenance, other storage and physical/infrastructure improvements for farm, and agricultural land purchases. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment plus border and comparison areas are estimated using an ordinary-least-squares regression that controls for stratum and farm size fixed effects. Because of the regression adjustment, these differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares.

C. Irrigation use

Irrigation was limited in the treatment and border areas in 2013, with only about 2 percent of farms irrigating any of their land (Table VIII.4).[40] Among the few farms that reported irrigating (mostly using partially functioning CIS systems), the vast majority reported no change in water delivery between 2012 and 2013. Consistent with the limited farm-level use of irrigation, the percentage of farmers irrigating land in the command and border areas (based on reported irrigation of specific crops cultivated in these areas) and the percentage of plots that were irrigated in these areas were also very low (each about 3 percent). As a result, the average area irrigated was less than one-tenth of a hectare for both the command area and plot-level measures.

Although some of the differences in these irrigation measures are statistically significant, these differences are small and do not suggest substantive differences in irrigation practices in 2013. For example, the percentage of farms irrigating is significantly higher in comparison areas but the difference is only 3 percentage points. The combined treatment and border areas were therefore similar to the comparison areas in that irrigation was very limited in 2013.

[40] As mentioned in Chapter IV, we excluded irrigation from farms' own water sources in this measure because the THVA project is not intended to impact own-source irrigation and because reports of own-source irrigation at the farm level are not aligned with crop-level estimates of irrigation, which raises questions about their accuracy.

Table VIII.4. Irrigation use (2013, percentage of farms or plots unless otherwise indicated)

	Treatment and border sample size	Comparison sample size	Treatment and border	Comparison	Adjusted difference	p-value
Entire farm area						
Percentage of farms irrigating	2,705	975	2.1	5.0	-3.0	0.01***
Used irrigation sources, entire farm						
CIS/Apele Moldovei	2,843	985	0.3	1.0	-0.7	0.50
CIS/WUA	2,781	985	1.6	0.0	1.6	0.03**
Private provider	2,802	978	0.0	3.6	-3.6	0.07*
Other	2,764	980	0.1	0.4	-0.3	0.36
Water delivery in 2013 versus 2012, among those irrigating	57	44				0.86[a]
Better			13.3	7.9	0.5	0.95
Same			86.7	77.2	14.9	0.39
Worse			0.0	14.9	-15.4	0.41
Farm area inside CIS command area and border area						
Percentage of farms irrigating, inside CIS or border area	2,921	992	2.5	1.6	1.0	0.57
Hectares irrigated, inside CIS or border area	2,921	992	0.0	0.0	0.0	0.05*
Irrigation water used per hectare irrigated (m^3/ha)						
Mean	64	17	980	671	296	0.06*
Median			676	556		
Plot						
Percentage of plots irrigated	3,013	1,078	2.7	1.1	1.6	0.18
Hectares irrigated (mean, ha)	3,013	1,078	0.01	0.00	0.01	0.09*
Used irrigation water from:						
CIS/Apele Moldovei	3,013	1,078	0.3	1.1	-0.8	0.42
CIS/WUA	3,013	1,078	2.4	0.0	2.4	0.00***
Private provider	3,013	1,078	0.0	0.0	0.0	0.36
Other	3,013	1,078	0.0	0.0	0.0	--

Source: 2013–2014 Moldova Farm Operator Survey.

Note: Farm-level irrigation measures are restricted to external irrigation sources. To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment plus border areas and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Because of the regression adjustment, these differences may not be equal to the raw differences. Reported *p*-values are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares, WUA = water user association.

D. Summary of border area analysis

Overall, including border areas with treatment areas in this analysis had only small effects on estimated means relative to estimates based on treatment areas alone. This is due at least in part to the (relatively) small number of farmers and plots in border areas. As a result, our assessment of differences with the comparison areas is very similar to that for the treatment areas alone, which we described in previous chapters. This assessment suggests that the treatment and border areas combined were sufficiently similar to the comparison areas at baseline for the comparison group design to be valid.

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IX. GENDER ANALYSIS

In this chapter, we investigate gender roles in farm operations, compare key characteristics and outcomes by the gender of the farm operator, and examine the differences in intra-household responses of farm operators and their spouses to the same survey questions regarding gender roles, work on the farm, and membership in water user associations and farmer organizations. These gender analyses are relevant to the THVA evaluation for several reasons. First, the ISRA component of the THVA project explicitly seeks to involve women in water user association activities (for example, it has a target of 20 percent female representation in water user association leadership), which could affect female empowerment more generally in the treatment areas. Therefore, our investigation of gender roles in farm operations will serve as a gauge of female engagement early after water user association establishment. Second, MCC is interested in how its programs affect different types of beneficiaries, including women. Our analysis of differences in key outcomes prior to system rehabilitation by the gender of the farm operators will therefore inform future subgroup analyses of impacts by gender. Third, the comparison of spouses' responses will test whether measures of gender roles depend on the gender of the respondent within the household. If spouses' reports are similar, it will enhance our confidence in measures that are collected from only the primary respondent.

Table IX.1 summarizes the key measures included in the Farm Operator Survey instrument that we discuss in this chapter. Most of the data for these measures were collected only from small and medium farms. Because households do not typically operate large farms, the large farm questionnaire did not collect information about gender roles, nor did it include an interview with the respondent's spouse.

Table IX.1. Measures of gender roles, farm characteristics by gender of the operator, and intra-household responses by gender of the respondent

Measures	Time frame
Gender roles by treatment status. Involvement in cultivation, crop sales, and irrigation decisions (small and medium farms); gender composition of ownership (large farms).	As of survey date
***Farm characteristics by gender of operator—small and medium farms*.**	
Household characteristics. Number of farm operators; number of household members.	As of survey date
Cultivation. Cultivated area inside the CIS command area.	2013 agricultural season
Farm profits. Revenues minus farm expenditures.	2013 agricultural season
Household consumption. Total household non-agricultural expenditures plus value of garden plot, livestock, and crop consumption by the household.	2013 calendar year
Plot characteristics. Whether plot was irrigated; cultivation of HVA crops; whether hired labor was used; plot ownership status.	2013 agricultural season
Participation in WUAs and farmer organizations. Membership in WUAs and farmer organizations.	2013 agricultural season
Other characteristics. Participation in agricultural training; loan approval.	Previous year
Intra-household responses by gender of respondent—small and medium farms.	
Gender roles. Involvement in cultivation, crop sales, and irrigation decisions.	As of survey date
Farm labor and participation in WUAs and farmer organizations. Hours of agricultural work; membership in WUAs and farmer organizations.	2013 agricultural season

CIS = centralized irrigation system, HVA = high-value agriculture, WUA = water user association.

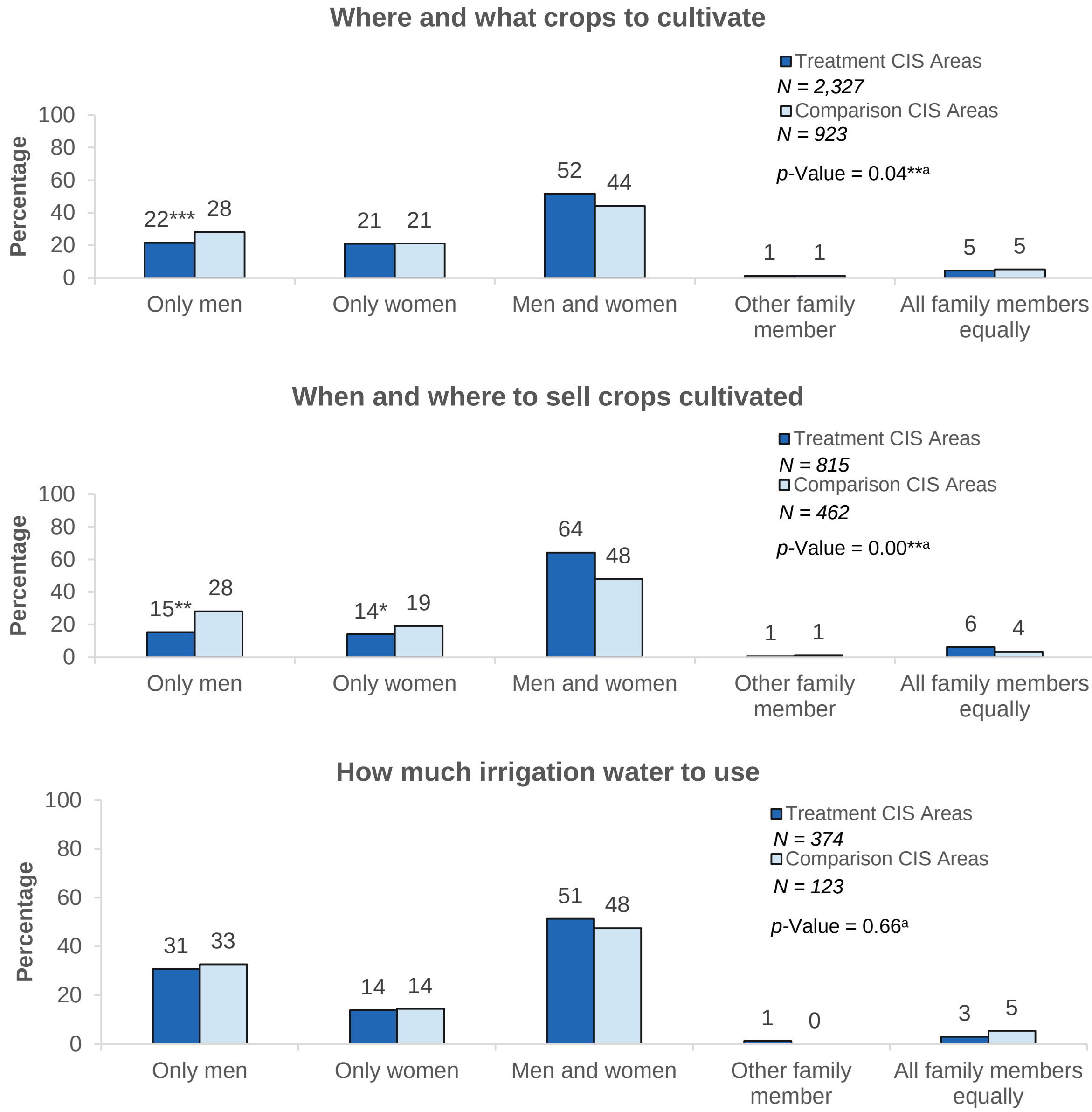
A. Gender roles

To investigate gender roles in farm operations on small and medium farms, we asked respondents to identify who in the household was primarily responsible for making cultivation, crop sales, and irrigation decisions: the respondent, the respondent's spouse, both the respondent and spouse, another family member, or all family members equally. If the respondent or the respondent's spouse was exclusively responsible for a given type of decision, we identified the gender of that individual and categorized the farm as one where a man or woman had exclusive control of the decision. If the respondent and spouse were jointly responsible for farming decisions, we categorized the farm as one where men and women made the decision jointly. The other two options—having another family member or all family members equally in charge of the decision—were treated as separate categories, since we could not always be certain about the gender of the individuals in charge of the decision in these cases.

In the majority of treatment area farms, decisions regarding cultivation, crop sales, and irrigation were made jointly by men and women (52 percent, 64 percent, and 51 percent, respectively; Figure IX.1). Crop cultivation and sales decisions in the remainder of the treatment sample were equally likely to be made exclusively by men or by women. However, irrigation decisions in the remainder of the treatment sample were more likely to be made exclusively by men (31 percent) than by women (14 percent). The percentage of farms in which decisions were made by other family members or by all family members equally was low for all types of decisions. In comparison areas, the pattern of control of irrigation decisions was similar to treatment areas, but cultivation and sales decisions were more likely to be made exclusively by men compared to treatment areas.

To examine gender roles on large farms, we analyzed the breakdown of farm ownership. As shown in Chapter II, about half of large farms in treatment areas had multiple owners. About 67 percent of large farms in treatment areas were owned by men only, with the rest being jointly owned by men and women (not shown). The pattern of large farm ownership in comparison areas was statistically similar.

Figure IX.I. Roles of men and women in farming reported by farm operator, small and medium farms (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: Large farms (≥100 ha) are not included, because large farms operate as businesses rather than household enterprises. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between treatment and comparison areas are estimated using an ordinary-least-squares regression that controls for farm size and stratum fixed effects. Statistical significance of differences is based on p-values that are adjusted for clustering at the CIS level.

[a]*p*-value from a Pearson chi-squared test for equivalence of the treatment and comparison distributions, adjusting for clustering at the CIS level.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

B. Farm characteristics by gender of farm operator

To compare farm characteristics by farm operator gender, we focused on differences for small and medium farms in treatment areas. As described in Chapter II, farms could have had multiple farm operators, who could have been all the same gender or a mix of both genders. We therefore examined key farm characteristics separately for male-operated farms (68 percent of treatment area farms), female-operated farms (26 percent of treatment area farms), and farms with both male and female operators (5 percent of treatment area farms). We present outcomes for all three types of farms in Table IX.2. However, we focus on the differences between male-operated farms and female-operated farms in the discussion below, both because these baseline differences are the most informative with respect to future subgroup analyses on program impacts by gender and because only a small percentage of farms had operators of both genders. Our main findings are as follows:

- Households were generally small irrespective of operator gender, though the difference in the average number of household members of male-operated farms and female-operated farms is statistically significant (male-operated farms had an additional 0.8 members, on average).
- Farms typically cultivated a small area of land—one hectare or less on average—regardless of operator gender, although female-operated farms were significantly smaller, on average.
- Compared to male-operated farms, female-operated farms had lower mean profits (a difference of $84) and lower mean household consumption (a difference of $821); both differences are statistically significant, although the difference in profits is small in magnitude.
- Only a very small percentage of plots was irrigated, regardless of the gender of the operator.
- HVA crops were cultivated on a larger percentage of male-operated plots compared to female-operated plots, though the difference is not statistically significant; there is also no significant difference in the percentage of plots using hired labor.
- Most plots, regardless of operator gender, were owned and acquired through privatization. The ownership status of male-operated plots and female-operated plots was largely similar.
- Male-operated farms are significantly more likely to have a water user association member in the household compared to female-operated farms (58 percent versus 49 percent). However, membership in other farmer organizations was rare regardless of operator gender.
- The percentages of farms participating in agricultural trainings and receiving a loan in the 12 months prior to the survey were small for both male-operated farms and female-operated farms, although male-operated farms were significantly more likely to participate in training and receive a loan.

Table IX.2. Differences in farm characteristics by gender of farm operator, small and medium farms in treatment CIS areas (2013, percentage of farmers unless otherwise indicated)

	Sample sizes			Characteristics			Differences between male- and female-operated farms	
	Male-operated farm	Female-operated farm	Jointly operated farms	Male-operated farm	Female-operated farm	Jointly operated farms	Adjusted difference	*p*-value
Number of household members (mean)	1,645	566	154	3.1	2.3	3.5	0.8	0.00***
Total area cultivated per farm, inside CIS command area:	1,645	566	154					0.03**[a]
<1 ha				76.6	85.9	60.2	-9.2	0.00***
≥1 to <5 ha				21.6	13.3	37.3	8.6	0.00***
≥5 to <10 ha				1.3	0.5	2.1	0.7	0.03**
≥10 to <100 ha				0.4	0.3	0.4	-0.1	0.39
≥100 ha				0.0	0.0	0.0	0.0	--
Mean (ha)				0.8	0.6	1.1	0.2	0.00***
Median (ha)				0.4	0.3	0.6	--	--
Agricultural profits, revenues minus all expenses, farm level	1,532	540	98					0.04**[a]
≤$0				73.8	83.8	65.8	-9.4	0.00***
>$0 to <$250				7.0	5.7	3.1	1.3	0.38
≥$250 to <$500				6.1	5.0	9.6	1.0	0.49
≥$500 to <$1,000				4.9	2.9	9.3	1.9	0.10*
≥$1,000 to <$2,500				6.7	2.2	6.9	4.4	0.00***
≥$2,500				1.5	0.6	5.3	0.8	0.04**
Mean (dollars)				-39	-129	1	84	0.02**
Median (dollars)				-125	-116	-178	--	--
Total annual household consumption	1,206	432	114					0.00***[a]
<$1,000				6.3	13.0	4.9	-6.5	0.00***
≥$1,000 to <$2,500				39.0	56.4	46.6	-16.9	0.00***
≥$2,500 to <$5,000				42.3	25.0	39.8	17.2	0.00***
≥$5,000				12.4	5.6	8.6	6.2	0.00***
Mean (dollars)				3,022	2,160	2,811	821	0.00***
Median (dollars)				2,700	1,733	2,472	--	--
Percentage of plots irrigated	1,645	566	154	3.1	2.6	0.0	0.0	0.98
Percentage of plots cultivating any HVA crop	1,645	566	154	11.9	7.7	5.6	2.4	0.38
Percentage of plots on which hired labor was used	1,643	566	154	24.2	27.2	28.0	-2.0	0.44
Plot ownership status, percentage of plots:	1,644	566	154					0.74[a]
Owned—purchase				5.8	5.8	3.8	-0.3	0.89
Owned—inheritance				14.6	17.1	11.5	-2.3	0.34
Owned—privatization				68.9	65.5	67.4	2.2	0.47
Owned—other				0.3	0.0	0.0	0.3	0.08*
Rented				4.5	3.1	2.0	2.2	0.16
Used for free				5.9	8.5	15.2	-2.1	0.28
Member of WUA	1,618	550	150	58.5	49.4	59.4	10.0	0.00***

	Sample sizes			Characteristics			Differences between male- and female-operated farms	
	Male-operated farm	Female-operated farm	Jointly operated farms	Male-operated farm	Female-operated farm	Jointly operated farms	Adjusted difference	*p*-value
Member of producer or agricultural organization	1,645	564	154	0.4	0.2	0.0	0.2	0.29
Member of cooperative related to production, business, and marketing	1,644	566	154	0.3	0.2	0.0	0.1	0.64
Member of savings and credit association	1,645	566	153	1.7	1.4	12.4	0.5	0.40
Any household member participated in agricultural training in past 12 months	1,631	565	153	5.9	3.5	12.1	2.0	0.04**
Approved for an agricultural loan in past year	1,644	566	154	2.0	0.2	9.5	1.7	0.00***

Source: 2013–2014 Moldova Farm Operator Survey.

Note: For producer or agricultural organizations, cooperatives, and savings and credit associations, membership is restricted to organizations that were reported to be functional. The analysis is restricted to small and medium farms in treatment CIS areas. Large farms (≥100 ha) are not included, because large farms operate as businesses rather than household enterprises. To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between genders are estimated using an ordinary-least-squares regression that controls for CIS fixed effects. Because of the regression adjustment, these male-female differences may not be equal to the raw differences.

[a]*p*-value from a Pearson chi-squared test for equivalence of the male and female distributions.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, ha = hectares, WUA = water user association.

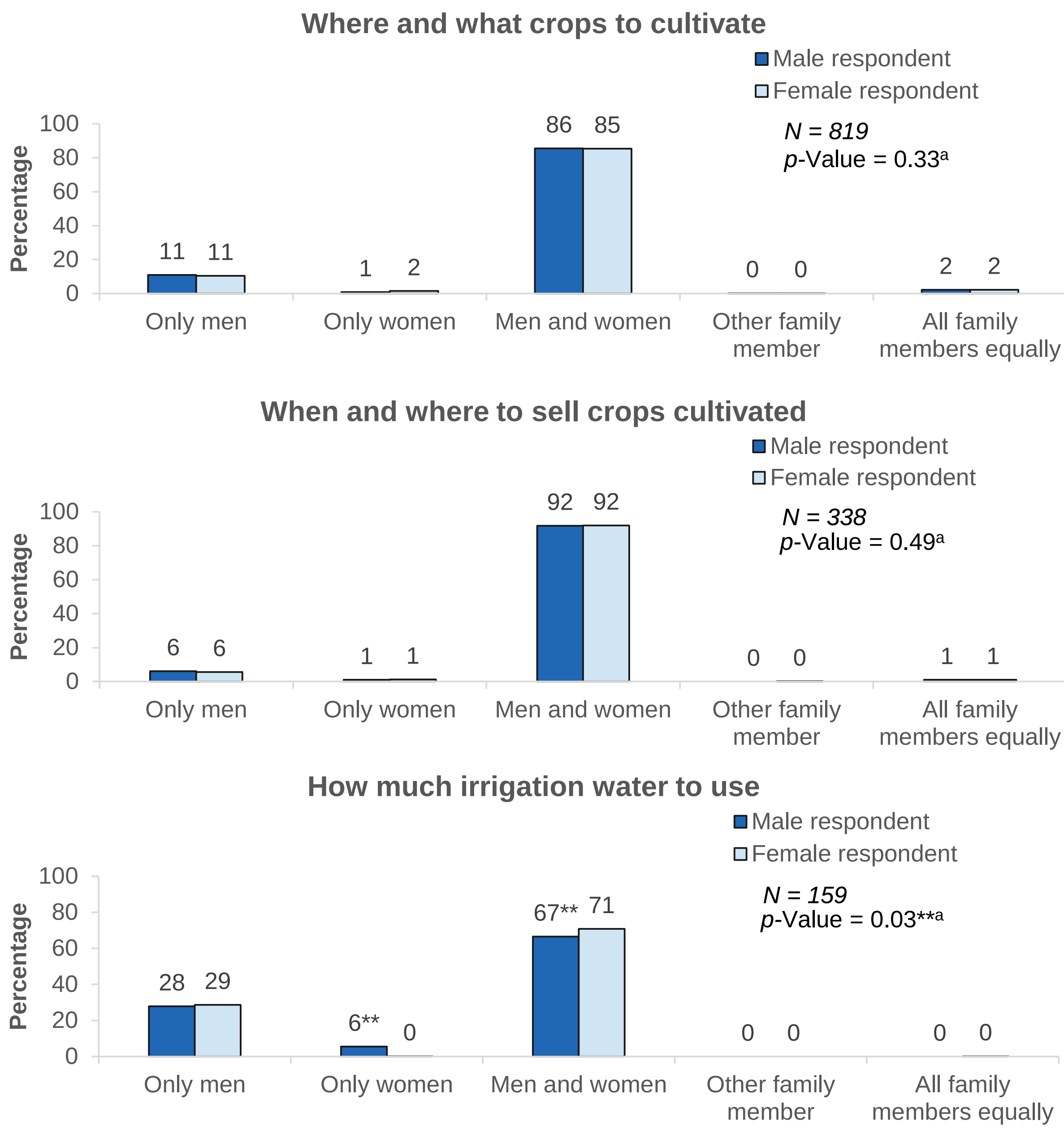
C. Differences between same-farm male and female respondents

To examine whether the perception of gender roles, as well as actual farm-related behavior, depends on the gender of the respondent, we compared how farm operators and their spouses responded to the same survey questions regarding these topics.[41] Our analysis is restricted to small and medium farms in treatment areas and households in which both the operator and his or her spouse responded.

Overall, we find that reported gender roles are consistent with the trends exhibited in the gender role analysis above, which was based on the perceptions of the primary respondent. For example, regardless of the gender of the respondent within the household, most cultivation, crop sales, and irrigation decisions were reported as made collectively by males and females in the household (Figure IX.2). Also consistent with the results above, both male and female respondents within the same household typically agree that males were more often exclusively in control of irrigation decisions for farms on which irrigation decisions were not jointly shared by men and women.

[41] Due to practical considerations during the administration of the survey, both husband and wife were sometimes present for each others' interviews. As such, some responses are likely to be similar. Any differences between the responses are therefore likely to be a lower bound for the true differences.

Figure IX.2. Differences between same-farm male and female respondents on roles of men and women in farming, small and medium farms in treatment CIS areas (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: The analysis is restricted to small and medium farms in treatment CIS areas in which the primary respondent and spouse responded to the survey. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between genders are estimated using an ordinary-least-squares regression that controls for household fixed effects.

[a] *p*-value from a Pearson chi-squared test for equivalence of the male and female distributions.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

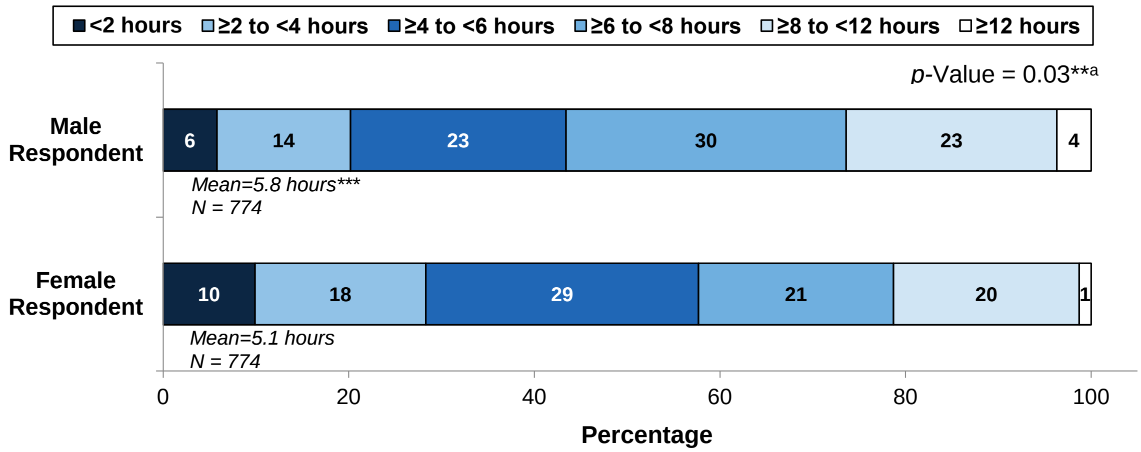
CIS = centralized irrigation system.

However, despite the similarities with the analysis by gender of the operator, there are a few notable differences in the findings of the two analyses. First, many more households in the spouse analysis reported joint male and female decisions on cultivation (about 85 percent), crop sales (92 percent), and irrigation decisions (about 70 percent) compared to the analysis by gender of the operator above (about half of all farms for each type of decision). This is likely due to the restriction of the sample in this section to households with spouses, in which respondents have more opportunities to make decisions collectively with someone of the opposite gender than unmarried respondents. Respondents may also have been reluctant to claim sole control of decisions if their spouses were present at the time of the interview. Second, on farms for which cultivation and sales decisions were not made jointly, both male and female respondents within the same household reported that men were more likely responsible for both of these farm decisions whereas, in the analysis by gender of the operator above, respondents reported that these decisions were fairly evenly split between exclusive male and exclusive female control.

Focusing on the spouse analysis, the intra-household perceptions of gender roles were nearly identical for male and female respondents within the same household. Specifically, for each type of decision, roughly the same percentage of male and female respondents reported that men and women shared the responsibility (the most common response of both genders for each decision). When not made jointly, roughly the same percentage of male and female respondents also agreed men more often had exclusive control of each decision, the second most common response of both genders for each decision.

To compare intra-household farm-related behavior by gender, we examined work on the farm and membership in water user associations and farmer organizations as reported by respondents and their spouses within the same treatment area households. Males, on average, worked almost an hour more per day in agricultural activities at the peak of the agricultural season compared to their female spouses (about 5.8 hours per day for males, compared to about 5.1 for females), a statistically significant difference (Figure IX.3). With respect to water user association participation, a significantly larger percentage of male than female spouses reported being water user association members (59 percent versus 24 percent) (Table IX.3). Because water user association membership is at the farm level—so that one would expect identical responses—this could suggest that some female spouses were unaware of their farm's membership in the water user association, that men were overstating water user association membership, or that the question was misinterpreted. Membership in various other types of farmer organizations was consistently reported as very low by both spouses within the household.

Figure IX.3. Differences between same-farm male and female respondents in agricultural work during the agricultural season, small and medium farms in treatment CIS areas (2013, percentage of farms)



Source: 2013–2014 Moldova Farm Operator Survey.

Note: The analysis is restricted to small and medium farms in treatment CIS areas in which the primary respondent and spouse responded to the survey. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between genders are estimated using an ordinary-least-squares regression that controls for household fixed effects.

[a]*p*-value from a Pearson chi-squared test for equivalence of the male and female distributions.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system.

Table IX.3. Differences between same-farm male and female respondents in membership in WUAs and farmer organizations, small and medium farms in treatment CIS areas (2013, percentage of farms)

	Male respondent sample size	Female respondent sample size	Male respondent	Female respondent	Difference	*p*-value
Member of WUA	804	804	59.4	23.7	35.7	0.00***
Member of producer or agricultural organization	823	823	0.4	0.2	0.2	0.25
Member of cooperative related to production, business, and marketing	823	823	0.3	0.0	0.3	0.21
Member of savings and credit association	821	821	2.4	1.7	0.7	0.24

Source: 2013–2014 Moldova Farm Operator Survey.

Note: For producer or agricultural organizations, cooperatives, and savings and credit associations, membership is restricted to organizations that were reported to be functional. The analysis is restricted to small and medium farms in treatment CIS areas in which the primary respondent and spouse responded to the survey. Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse. Differences between genders are estimated using an ordinary-least-squares regression that controls for household fixed effects. Because of the regression adjustment, these male-female differences may not be equal to the raw differences.

*/**/***Significantly different at the 0.10/0.05/0.01 level.

CIS = centralized irrigation system, WUA = water user association.

X. CONCLUSION

In this chapter, we summarize the key findings from our analysis of the 2013–2014 Farm Operator Survey data. This includes a description of the characteristics of farms in the treatment CIS areas and an assessment of the degree of similarity between the treatment and comparison areas—which is important for the validity of our comparison group design. We also recompute the minimum detectable impacts (MDIs)—the smallest impacts on key outcomes that our design will be able to statistically distinguish from zero—based on updated parameters from the data. Finally, we outline our future plans for data collection for the THVA evaluation.

A. Summary of findings

1. Characteristics of farms in treatment areas prior to rehabilitation

The analysis presented in this report has provided important context on the pre-rehabilitation situation in the treatment CIS areas, especially related to some of the key outcomes for the THVA impact evaluation such as HVA cultivation, irrigation, farm profits, and household income. Our analysis shows that most of the farms in the treatment areas cultivated a small area of land in the CIS command area (less than 1 hectare, on average) that they owned themselves. On average, only a small percentage of cultivated land in the command area was devoted to the cultivation of HVA crops. Average farm profits were consistently negative in the 2013 agricultural season across several measures of profits that we examine, largely because most farms had no revenue. Revenues were low because farmers often did not sell harvested non-HVA crops (rather, these harvests were consumed or kept by the farm) and because farmers that cultivated apples, the most common HVA crop, often had no harvest (likely because of young orchards that had yet to produce).

Access to and use of irrigation water, a key constraint to agricultural production being addressed by the THVA project, was very low in 2013. Specifically, only 2 percent of farms in treatment areas irrigated any crops within the command area, and only 3 percent of all plots in this area were irrigated. Membership of and interactions with the water user associations set up under ISRA were also still limited, likely because water user associations had not begun full operations prior to system rehabilitation; until water user associations begin to actually manage irrigation water in the rehabilitated systems, community members might not see the need to interact with them. Nevertheless, perceptions of water user associations were generally positive.

We also analyzed several other dimensions of farm operations that reflect various components of the THVA project. In particular, we analyzed the use of cold storage and use of agricultural credit (relevant to the AAF activity), as well as participation in agricultural training and practice use (relevant to the GHS activity). We found that use of cold storage was extremely limited—even for HVA farmers, for whom it was more likely to be relevant. Participation in agricultural trainings was also relatively uncommon, with only about 6 percent of farms in treatment CIS areas participating in the previous calendar year. Farms cultivating specific HVA crops used very few key agricultural practices related to cultivation and processing (that is, the practices covered by the GHS value chain training). In addition, few farms (only about 2 percent) received agricultural credit in the year prior to the survey; those that did typically received small, short-term loans with high interest rates.

2. Treatment and comparison differences

We now turn to the implications of our analysis for the validity of the comparison group design that we intend to use to estimate the impacts of the THVA project. As described in Chapter I, this design will compare the changes in outcomes in treatment CIS areas, which receive the full package of THVA activities, with changes in outcomes in geographically proximate matched comparison CIS areas, which do not. It will attribute any difference in outcome changes between the treatment and comparison groups to the impacts of the THVA project. The key assumption for unbiased impact estimates in this design is that any changes in outcomes that are unrelated to THVA project activities (for example, due to changes in weather or market conditions) are not systematically different between the treatment and comparison areas. These unrelated changes in outcomes are unobservable, so the validity of this assumption cannot be tested directly. However, if the treatment and comparison areas are similar in characteristics related to the outcomes of interest prior to rehabilitation, we would be more confident that this assumption holds, because they would be more likely to experience and react similarly to external events unrelated to the THVA project. For example, if similar crops are cultivated in treatment and comparison areas, profits are more likely to react in a similar way to external changes in market conditions.

Therefore, in the previous chapters, we conducted statistical tests for differences between treatment and comparison areas in characteristics related to key outcomes. Overall, these comparisons indicate that, although the treatment and comparison areas were not identical before rehabilitation, they were broadly similar in the characteristics that are most directly related to key outcomes. Specifically, the patterns of crop cultivation were similar in treatment and comparison areas, and cultivation of HVA crops was similarly low in both of these areas. Similarly, few farmers in either type of area used irrigation at baseline. Farm profits, a key long-term outcome of the THVA project, were also similar (and typically negative), although household income and consumption were significantly higher in the comparison areas (driven by higher non-agricultural income). Although it will be important to control for the pre-rehabilitation differences that we did observe in a regression analysis when estimating final impacts,[42] these differences are not large enough to suggest that comparison areas would likely experience vastly different changes in outcomes unrelated to the THVA project.

We also examined the similarity between the combined treatment and border areas (areas near to the treatment areas in which some farmers will be able to connect to the rehabilitated CISs) and the comparison areas. Because some farmers in border areas are expected to benefit from system rehabilitation (and hence the full package of THVA activities), the evaluation will compare these combined treatment and border areas to the comparison areas to estimate project impacts that account for border area beneficiaries. Our assessment of differences between the combined treatment and border areas and the comparison areas was very similar to that for the treatment areas alone, and suggested that most of these differences were small. Therefore, based

[42] The significant differences between certain weather conditions in treatment and comparison areas also suggest that it will be important to control for these external events in the year of the survey, despite the geographic proximity of the treatment and comparison areas.

on this evidence, the comparison group design seems to be plausible—both for the treatment areas alone and for the combined treatment and border areas.

B. Updated minimum detectable impacts

In our report of the findings from the 2012–2013 Farm Operator Survey (Borkum et al. 2015a), we computed MDIs for our comparison group design based on parameters from that survey. Using the 2013–2014 survey, we were able to revise our MDI calculations based on more up-to-date parameters. The revised calculations (Table X.1) focus on the outcomes of greatest interest to MCC.[43,44]

Although the THVA project ultimately seeks to improve household well-being, measured by outcomes such as income, we are also interested in detecting impacts on intermediate outcomes that might reflect improvements in irrigation before final impacts materialize. Our MDI calculations focus on three key intermediate outcomes: the average area per plot that is irrigated, the average area per plot that is devoted to HVA crops, and the average area per plot that is devoted to irrigated HVA crops (all measured in hectares). By multiplying these plot-level MDIs by the total number of plots in the treatment CIS areas, we can obtain an estimated MDI for the change in the total number of hectares for these outcomes.

We estimate that an average of 0.01 hectares per plot in the 10 treatment CIS areas are irrigated at baseline, and that we will be able to detect a change of about 0.01 hectares per plot (128 percent) in this outcome. This is equivalent to an increase in total irrigated hectares (across the 10 systems) of 307 hectares, from a baseline of 241 hectares. We also estimate that an average of 0.05 hectares per plot in the treatment CIS areas are devoted to HVA at baseline, and that we will be able to detect a change of about 0.06 hectares per plot (125 percent) in this outcome. This is equivalent to an increase in total hectares devoted to HVA of 1,672 hectares, from a baseline of 1,340 hectares. The MDIs for the area of irrigated HVA are almost identical to those for the irrigated area (0.01 hectares per plot or 309 hectares overall), because almost all irrigated plots in the sample were used to cultivate HVA. (Based on results from the 2014–2015 Farm Operator Survey, many farmers plan to use irrigation to cultivate non-HVA crops; if those plans materialize, the impacts on area irrigated are likely to be larger than the impacts on irrigated HVA.)

It is plausible that we would observe impacts of this magnitude. For example, based on the March 2015 Economic Rate of Return (ERR) model, irrigated area in the treatment areas is expected to increase by 3,815 hectares by 2018 and 4,753 hectares by 2020. Similarly, the area of irrigated HVA is expected to increase by 2,979 hectares by 2018 and 3,700 hectares by 2020. We should therefore be able to detect changes that are substantially more modest than those expected for these outcomes.[45]

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[43] These estimates are identical to those in the design report for the overall THVA evaluation (Borkum et al. 2015b)

[44] As discussed above, we will estimate impacts with and without the border areas. The MDI calculations in Table X.1 apply to the estimates without border areas; including this relatively small sample does not substantively affect the MDI calculations.

[45] The ERR model does not readily enable us to compare the overall expected changes in other outcomes such as area of HVA cultivated, farm profits, or household income.

Table X.1. Updated minimum detectable impacts for the matched comparison group design

	Area irrigated per plot (hectares)	Area of HVA cultivated per plot (hectares)[a]	Area of irrigated HVA cultivated per plot (hectares)[b]	Annual wage bill per hectare (dollars)	Annual rent per hectare (dollars)	Annual agricultural profits per hectare (dollars)	Annual household income (dollars)[c]
Estimated baseline treatment mean	0.01	0.05	0.01	75	79	-116	2,331
Standard deviation	0.09	0.35	0.09	402	47	1,197	3,154
Minimum detectable impact (MDI)	0.01	0.06	0.01	88	22	304	748
MDI as percentage of baseline mean	128	125	130	117	28	--	32
MDI as total hectares in treatment CIS (hectares)[d]	307	1,672	309	--	--	--	--

Sources: Authors' calculations using data from the 2013–2014 Moldova Farm Operator Survey.

Note: MDIs are for a two-tailed test with 80 percent power and a 95 percent level of significance. The table presents rounded values for all parameters, but unrounded values were used in the MDI calculations. We assume an 85 percent follow-up response rate for the baseline sample, yielding sample sizes of 2,038 for the 10 treatment CIS areas (including 37 large farms) and 851 for the 11 comparison CIS areas (including 48 large farms). Sample sizes for rent per hectare were assumed to be 60 in treatment CIS areas and 119 in comparison CIS areas based on the number of valid responses for rented plots in the baseline sample and the assumed 85 percent follow-up response rate. The calculations use standard deviation and intraclass correlations estimated from the combined treatment and control samples in the 2013–2014 Farm Operator Survey. The estimated intraclass correlations are as follows: 0.012 for area irrigated, 0.029 for area of HVA cultivated, 0.012 for area of irrigated HVA cultivated, 0.045 for wage bill per hectare, 0.140 for rent per hectare, 0.063 for profits per hectare, and 0.054 for household income. The calculations assume a regression R-squared of 0.4. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (http://www.oanda.com/currency/converter/).

[a]Calculations assume that if HVA is cultivated on the plot, the entire cultivated area of the plot is HVA. In future rounds of the survey, we will have a more precise measure of the area of HVA cultivated on the plot.

[b]Calculations assume that if HVA is cultivated on the plot, the entire irrigated area of the plot is HVA.

[c]Restricted to small and medium farms only. Annual household income was not reported for large farms because these farms are not operated by households.

[d]Obtained by multiplying the plot-level MDI by the total number of plots (26,069) in the treatment CIS areas based on the 2013–2014 Farm Operator Survey sample frame, which reflects the most up-to-date CIS area boundaries.

CIS = centralized irrigation system; HVA = high-value agriculture; THVA = Transition to High-Value Agriculture.

We will also estimate impacts on wages and rent. For wages, we will be able to detect a change in the wage bill of $88 per hectare, or about 117 percent of the estimated baseline mean. Our estimates of impacts on rent per hectare will only be available for those who rent. Estimated impacts on this outcome will therefore rely on a smaller sample size and will have to be interpreted with caution because they could reflect differential changes in the type of land that is rented in treatment versus comparison areas. Based on our estimates of the percentage of plots that are rented, we estimated that we will be able to detect a change of $22 per hectare, or about 28 percent of the baseline mean.

The MDI for farm profits per hectare is $304 per hectare, from a baseline mean of negative $116 per hectare. (We focus on farm profits per hectare to account for variability in farm size; farm profits are much more variable, which results in MDIs that are an order of magnitude higher.) The MDI for household income for small and medium farms—which includes other sources of income in addition to agricultural profits—is $748 (32 percent of the estimated baseline mean in the treatment CIS areas). These MDIs suggest that we will be able to detect only relatively large impacts on farm profits per hectare and household income, which might take longer to materialize.

C. Plans for future data collection and reporting

Figure X.1 shows our plans for quantitative and qualitative data collection and reporting for the remainder of the THVA evaluation. We intend to conduct up to two follow-up rounds of the Farm Operator Survey; combined with the 2013–2014 pre-rehabilitation baseline data, these will be the primary inputs for the THVA impact evaluation.[46] To allow sufficient time for impacts on key outcomes to materialize, we intend to conduct the first follow-up in 2018–2019 (three full seasons after rehabilitation of all systems), focusing mainly on intermediate outcomes such as HVA cultivation and irrigation, and the second follow-up in 2020–2021 (five full seasons after rehabilitation of all systems), including longer-term outcomes such as profits. The appropriate number, timing, and nature of the follow-up rounds will be finalized based on updated information available at the time, to optimize their value for the evaluation (for further detail, see the evaluation design report, Borkum et al. 2015b).

The impact evaluation will be complemented by a performance evaluation, which will draw on qualitative data from a variety of stakeholders (collected in several rounds between 2013 and 2022) and a quantitative survey of AAF loan recipients conducted in 2015, as well as administrative data and document review (not shown in Figure X.1). Qualitative data were collected through interviews and focus groups with key stakeholders in 2013, 2014, and early 2015. These data were intended to provide additional context about the farmers and areas included in the impact evaluation, as well as to document implementation progress and initial experiences with the project activities in treatment areas. Four additional rounds of qualitative data collection are planned, taking place in late 2015, 2017, 2020, and 2022. The upcoming 2015 round will include interviews with high-level stakeholders focused on implementation and will occur in the fourth quarter, after the compact has closed. The 2017 round will focus on initial experiences with the fully rehabilitated irrigation systems, which should all have been operational for at least one agricultural season. The 2020 and 2022 rounds will enable us to document whether and how change occurred in the longer-term, after several agricultural seasons with the rehabilitated systems. The timing of these last two rounds is designed to follow the quantitative data collection through the Farm Operator Survey, and will therefore complement the impact analysis.

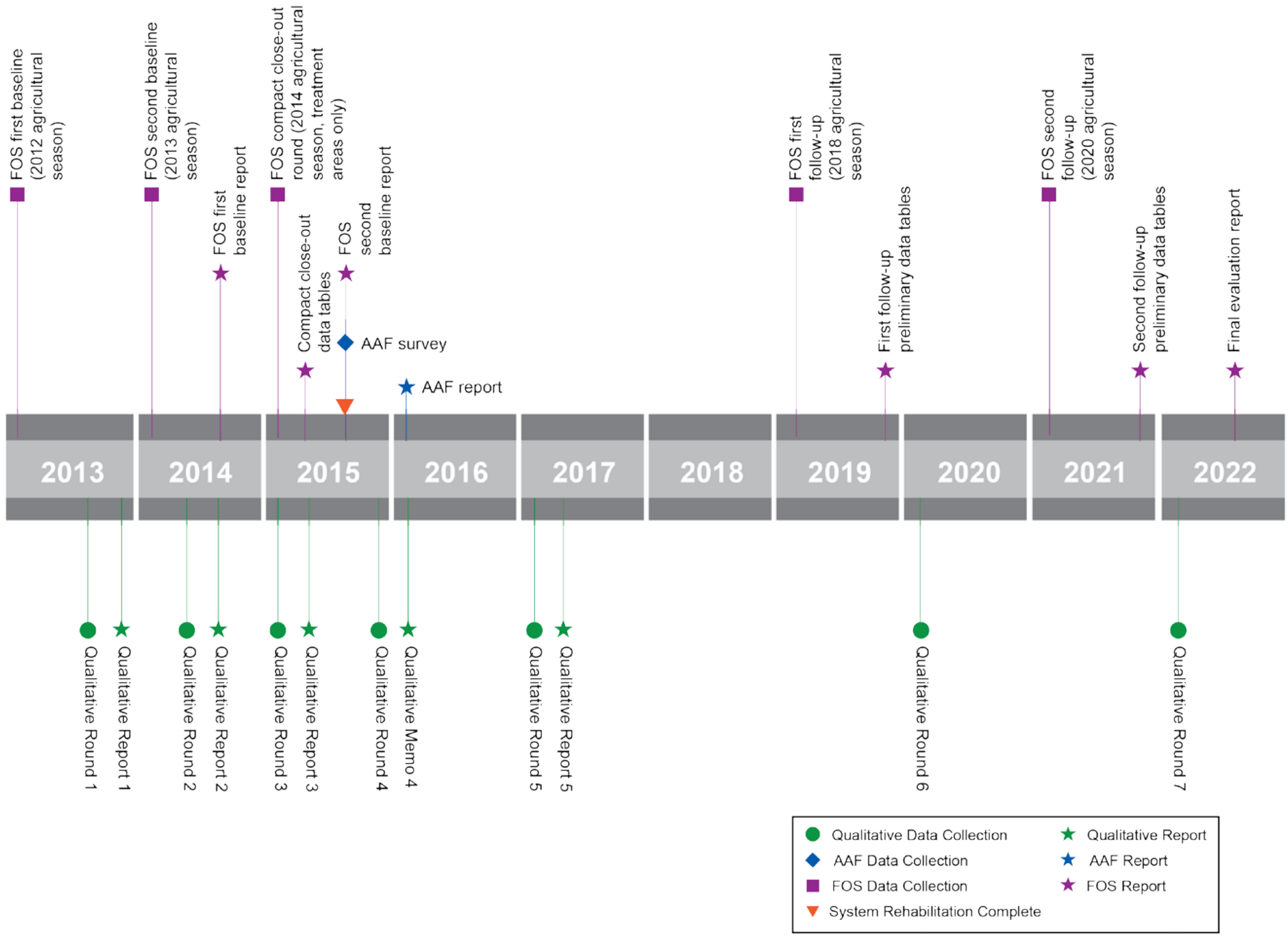
Given the large scale and long duration of the proposed data collection activities, we intend to produce a series of intermediate products that summarize relevant findings based on specific data. These products will be closely aligned with the data collection schedule (Figure X.1), and

[46] Figure X.1 shows that there was an additional round in 2014–2015 to inform compact close-out; however, because this was conducted in treatment areas only, it will not play a significant role in the impact evaluation.

will inform the final evaluation findings. Intermediate products that have already been produced or are in process include qualitative reports based on the 2013, 2014, and early 2015 qualitative data collection, as well as baseline quantitative reports based on the 2012–2013 Farm Operator Survey (Borkum et al. 2015a) and the 2013–2014 Farm Operator Survey (this report). Future intermediate products will include a memo summarizing the key findings from stakeholder interviews conducted in late 2015, a report of the findings related to the AAF activity based on the survey with AAF recipients and related qualitative data from non-recipients and banks collected in 2015, and a report based on the qualitative data collection in 2017. We also plan to produce intermediate data tables based on the two follow-up rounds of the Farm Operator Survey in 2019 and 2021. This will help inform the design of the final two rounds of qualitative data collection, ensuring that these rounds can be used effectively to interpret the quantitative results.

These intermediate products, together with the two final rounds of qualitative data in 2020 and 2022, administrative data, and document review, will be the key inputs into the final evaluation report. This report, which will be produced in 2022, will address the key research questions for the evaluation in a comprehensive manner by applying both the impact evaluation and process evaluation components of the evaluation design.

Figure X.1. Evaluation and reporting timeline for the THVA evaluation



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APPENDIX A

PROGRAM LOGIC

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Figure A.1. Logic model for the THVA project

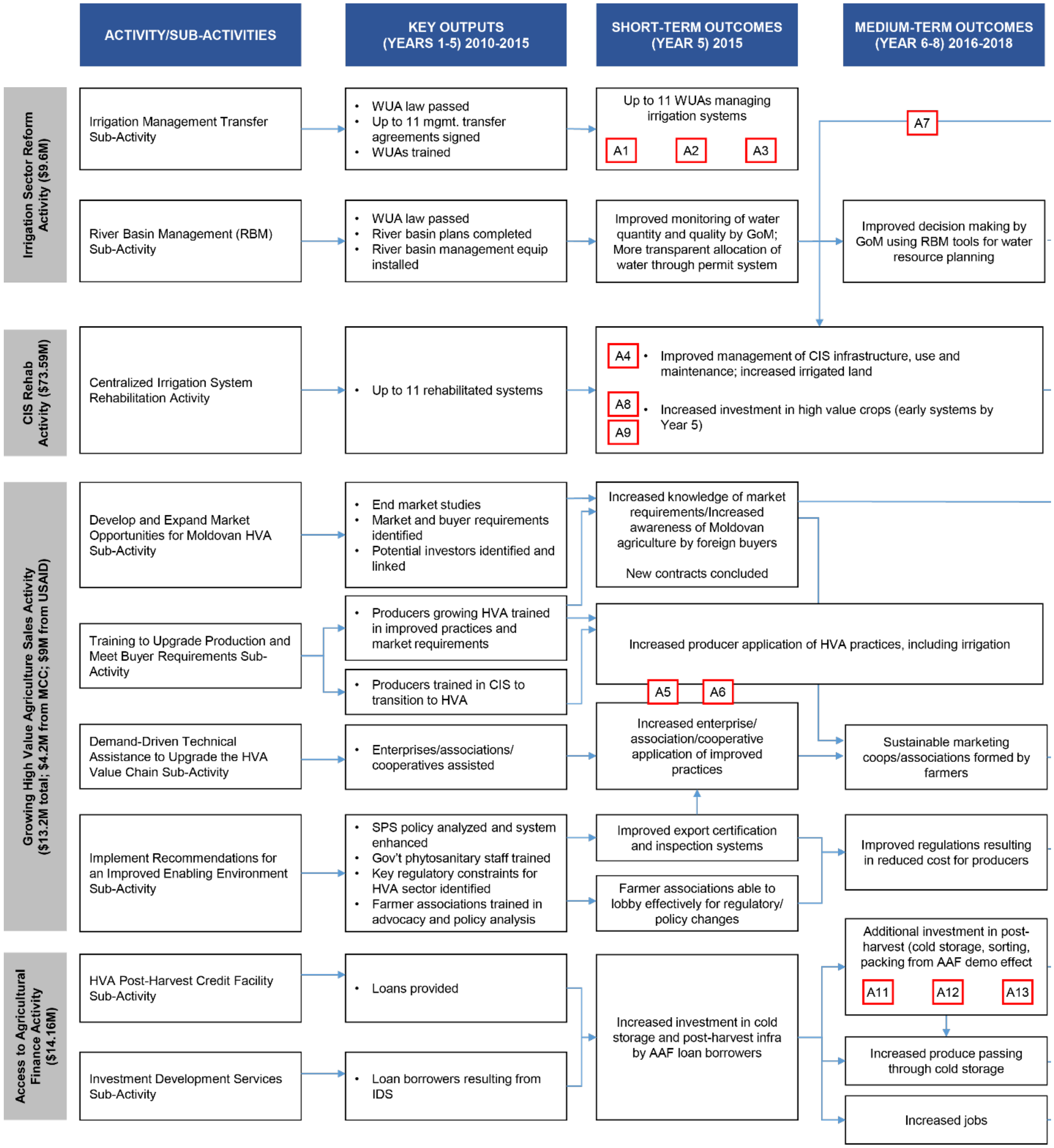
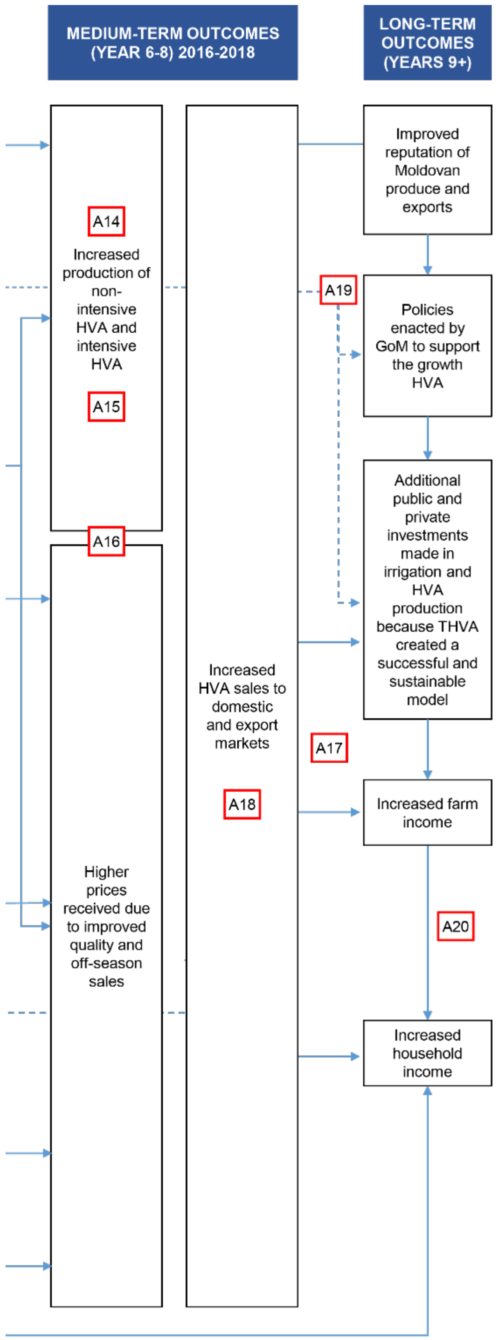


Figure A.1. Logic model for the THVA project (continued)



THVA project logic model assumptions:

ISRA		
A1	-	Apele Moldovei fulfills agreement to transfer the management of systems to WUAs. Water User Associations are expected to be the most efficient organizational structure for management of CIS infrastructure
A2	-	All WUAs with rehabilitated systems will have the capacity to manage irrigation systems and provide maintenance on the systems by the end of the compact
A3	-	The price for water is affordable (and covers the cost) and farmers pay regularly for water
A7	-	WUA members are engaged through rehabilitation and beyond
A9	-	WUAs are well-functioning and well-managed
A17	-	WUAs will have sufficient resources and devote them to repairing and replacing systems in the long-term (i.e. not just maintenance, but repair/replacement)
A19	-	GoM will created an integrated water report management structure which will strengthen water security
CISRA		
A4	-	2 systems (Lopatna and Criuleni) in use for at least part of the 2015 agricultural season
A8	-	There is sufficient financing available for on-farm investments for HVA production and some intensive HVA production. Improved irrigation will mitigate weather-related risks for farmers so that they can more reliably produce a consistent quality and quantity of HVA. This risk reduction will translate into lower collateral from banks that recognize the increased likelihood of loan repayment. Over the medium to long-term, collateral rates will continue to decrease for irrigation beneficiaries as they demonstrate their long term capacity to repay their loans
A14	-	Irrigation area will be extended by farmers in border areas
A15	-	New market opportunities for HVA products are developed, thus farmers will be interested in increasing irrigated areas with HVA crop
GHS		
A5	-	Training and technical assistance duration and content are sufficient to lead to use of new practices (i.e. farmers will adopt)
A6	-	Participants who attend trainings/receive technical assistance are appropriate (i.e. farmers, interested in HVA, etc.)
A10	-	Farmers will learn from neighbors who have attended training
A16	-	To the extent necessary, agricultural extension services will be available to support farmers after the compact (potentially take over the training programs)
A18	-	Produce competitively meets market quality standards for high value agriculture and market demand remains constant or increases
AAF		
A11	-	Financing for post-harvest investments will be available after AAF for demonstration effect to work (banks will be more knowledgeable about lending for post-harvest and/or the project will result in lower risk which would reduce collateral requirements and/or banks will use their own funds if donor money is not available)
A12	-	Enterprises will have the capacity to invest in post-harvest infrastructure (knowledge, business plans, collateral, etc.)
A13	-	Improved access to finance resulting in more stable and better forecasted cash flow and increased collateralization capacity of AAF borrowers
Overall		
A20	-	Increases in farm operator income will lead to increases in household income for both large farm enterprises and medium-small farm enterprises

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APPENDIX B

TECHNICAL APPENDIX

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A. Sampling approach

As described in Chapter I, the Farm Operator Survey sampling approach involved drawing a sample of farm operators with plots in the CIS command and border areas, and then a CIS command or border area plot (or plots, in the case of large farms) for each operator. Below, we describe the construction of the sample frame, the steps we used to draw the sample for farms of different sizes, and how replacements were selected when sampled farmers were not available for interviews.

1. Sample frame

To construct the sample frame, the survey contractor developed a complete list of all farm plots and their operators in the 11 treatment CIS command and border areas, and in the 11 comparison CIS command areas.[47,48] In treatment areas, the command area was defined as the area identified for rehabilitation as part of the detailed rehabilitation design. The border area for each treatment CIS area was identified jointly by MCC and MCA-Moldova. In the comparison areas, the command area was defined as the historical command area.

In addition to listing farm plots and their operators in these areas, the survey contractor identified the total size of the farm to which each plot belonged. The farm could include other plots in the CIS command or border areas, as well as plots outside these areas. Information on total farm size was used to draw separate samples for farms of different sizes and to determine which questionnaire to administer.

2. Drawing the sample

To balance statistical power with practical data collection limitations, we determined that the optimal total sample size for the Farm Operator Survey was 4,000 farmers. The majority of the sample—about 2,500 farmers—was allocated to treatment areas, so that we would have a sufficiently large sample to calculate precise CIS-level estimates of key characteristics for these areas. Since the focus of the evaluation is primarily on comparing the treatment and comparison areas, the remainder of the sample was mostly allocated to the comparison areas—about 1,000 farmers—with the balance of about 500 farmers allocated to the border areas. The approach used to draw the sample of farmers and plots within treatment, comparison, and border areas depended on farm size.

For **small farms** (less than 10 hectares), we drew a random sample of farmers and then randomly selected one focal plot from the CIS command or border area plots operated by each farmer (if the farmer cultivated multiple plots in the command or border area). To determine the number of farmers to select in each community, we implemented the following approach in each type of area:

[47] Although the sample frame and our sample included 11 treatment CIS command areas, treatment CIS 6-9 Cahul was ultimately omitted from the analysis once it was determined that it would not be rehabilitated, leaving 10 treatment and the 11 comparison CIS areas in our final analysis sample.

[48] Operators that cultivate only "garden/*intravilan*" plots were excluded from the listing.

- *Treatment CIS areas*. The size of the small-farm sample allocated to each treatment CIS area was selected to ensure similar levels of statistical precision for CIS-level estimates in each area.[49] We then allocated the small-farm sample in each CIS area across communities in proportion to the number of small farms in each community. For example, if one community had twice as many small-farm operators as another in the same treatment CIS, we allocated twice as many small-farm operators to that community. Allocating the sample in this way ensured that, with appropriate weights, the estimates would be representative of operators and plots in the treatment CIS areas.
- *Comparison CIS areas*. We allocated the total comparison small-farm sample across the six treatment-comparison strata in proportion to the treatment small-farm sample in each stratum. For example, if one stratum had 10 percent of the total small-farm treatment sample, we allocated 10 percent of the total small-farm comparison sample to that stratum. This ensured that the ratio of treatment operators to comparison operators (and plots) in the sample was the same across strata so that then treatment status was uncorrelated with the stratum, limiting the need for additional reweighting to ensure unbiased results. Because some strata consist of several comparison CIS areas, we allocated the comparison sample in each stratum across comparison CIS areas in proportion to the number of small-farm operators in each CIS area to ensure balance across these areas. To guarantee that smaller command areas were adequately represented using this allocation method, a CIS-level minimum of 15 operators was enforced.[50] To ensure balance across communities, we then allocated the sample in each comparison CIS area across communities in proportion to the number of small-farm operators in each community.
- *Treatment border areas.* We allocated the small-farm border area sample across border areas in proportion to the number of small-farm operators in each area, and then across communities in proportion to the number of small-farm operators in each community. This approach ensured that the sample of farm operators would be representative of each border area and the border areas as a whole with minimal weighting. To guarantee that all border areas were adequately represented using this allocation method, a CIS-level minimum of 15 small-farm operators was enforced if the allocation to the border area was less than 15.[51]

Once the allocations were determined, we randomly selected the designated number of small-farm operators in each community to obtain a representative sample of such operators. The final sampling units were the plots of the selected operators. If a selected farmer operated on more than one plot, we therefore randomly selected one of the plots as the final sampling unit to obtain a representative sample of small-farm plots. Some small-farm operators have plots in both the treatment command area and the border area. Because the focus of the evaluation is primarily

[49] In treatment CIS 3-2 Blindesti, MCC is interested in obtaining separate estimates of levels of key outcomes for two geographic areas within the CIS, namely upper and lower Blindesti. We therefore distinguished between these two geographic areas and treated each as a pseudo-CIS for sampling purposes. Similarly, we distinguished between two geographic areas in treatment CIS 6-6 Chircani-Zirnesti (defined by likelihood of rehabilitation), treating each as a pseudo-CIS for sampling purposes.

[50] This minimum was enforced in four CIS areas. In two of these, we could not meet the minimum because there were too few farmers in each area. We therefore sampled all the small farmers in these areas.

[51] This minimum was enforced in one CIS area.

on the command area—and the command area plots are more likely to drive changes in key outcomes for these operators—we removed these operators (and their plots) from the border area sample frame before sampling. (These farmers were included in the treatment command area sample frame, however.)

For **medium** (between 10 and 100 hectares**)** and **large** (100 hectares or larger) farms, we attempted to interview all operators of these farms so that we would have precise estimates for these groups given that there were relatively few medium and large farms in the sample frame (292 and 117, respectively). To enable us to capture plot-specific information and to track specific plots in subsequent survey rounds, we selected a random sample of focal plots from the plots farmed by each medium and large farm operator (1 plot per medium-farm operator and 3 per large-farm operator). As in the case of small-farm operators, some medium- and large-farm operators operated plots in both the treatment and border areas. For medium-farm operators, we followed the same approach as for small-farm operators by removing these plots from the border area sample frame. However, because using a similar approach for large-farm operators could lead us to omit large parts of the border area, we sampled 3 plots in the treatment area and 2 plots in the border area for large-farm operators with plots in both areas.

3. Use of replacements

In some cases, the survey contractor was unable to conduct an interview with a selected farm operator (or about a selected plot). This occurred for various reasons, such as refusal to participate or ineligibility for the survey (if it was determined that the operator did not operate the selected plot). To account for this, we developed an ex ante list of replacement farmers and plots. For small farmers, we replaced the original farmer with a different randomly selected farmer (and an associated randomly selected focal plot) as necessary. Medium and large farmers could not be replaced because all medium and large farmers were selected for the sample; the replacement list therefore included only small farmers. However, replacements were used for large farmers at the plot level if a large farmer did not operate a selected focal plot. In these cases, we attempted to replace any such large plot with another taken from a randomly ordered list of the same operator’s plots in the same treatment, comparison, or border area (if additional plots were available). These procedures were designed to help ensure that we reached our target sample sizes for the analysis while maintaining the representativeness of the sample and keeping the replacement procedure as straightforward as possible.

B. Analysis weights

The aim of the weighting scheme for the baseline analysis was to enable us to conduct a valid comparison of average outcomes of farmers and plots in the treatment and comparison CIS command areas—this analysis is the focus of the evaluation. However, the evaluation also includes border areas; as described in Chapter I, the analysis approach for the border areas will be to include them as part of the treatment group. Therefore, we created two sets of weights: one for the analysis that excludes border areas, and a second for the analysis that includes them as part of the treatment group. Each set of weights accounts for the following:

- **Differences in sampling probabilities across farmers.** We drew the sample of small farmers by taking a simple random sample of eligible farmers in each community. The sampling probability for small farmers in a given community was therefore determined by the fraction of small farmers sampled in that community. Because the community allocations were roughly proportional to the number of farmers in each community (except for small deviations due to the minima we imposed), this sampling probability was similar for most small farmers. We surveyed all medium and large farmers; therefore, their sampling probability was one. The inverse of the sampling probability was used to obtain a farm-level sampling weight for each farmer.

- **Possible differential nonresponse across different types of farmers.** To adjust for possible systematic nonresponse among certain types of farmers, we computed response rates within cells that we defined by CIS area, treatment status (treatment, comparison, or border), and farm size (small, medium, or large).[52] We used the inverse of the response rates to obtain a nonresponse weight for all farmers in a given cell.
- **Differences in sampling probabilities across plots.** Because we also randomly selected a plot (or plots, for large farmers) when a sampled farmer cultivated multiple plots, we also computed a plot-level sampling probability. This was given simply by the number of plots sampled (one for small and medium farmers, up to three for large farmers who operated only in command or border areas, and up to five for large farmers who operated in both areas) divided by the number of plots operated by the farmer. The inverse of this probability yielded the plot sampling weights.

For each set of weights (excluding or including border areas), we then combined these various weights by multiplication to yield preliminary farm-level and plot-level weights. Both farm-level and plot-level weights included the farmer sampling weights and nonresponse weights; the plot-level weights also included the plot sampling weights. In addition, to ensure that treatment status was not correlated with stratum, we reweighted the comparison farms in each stratum so that their weighted sum was equal to the weighted sum of treatment observations (or, for the set of weights that included border areas, the weighted sum of treatment and border observations) in that stratum.[53] We conducted a similar within-stratum reweighting for plot-level observations.

Finally, we normalized these adjusted weights so that their sum was equal to the number of observations for each farm size group (small, medium, and large). We conducted this normalization separately for farm-level observations and plot-level observations for each set of weights. This yielded four final sets of normalized weights: a set of farm-level and plot-level weights for the analyses excluding border areas, and another set for the analyses including border areas.

C. Analysis approach

For the baseline analysis to meet the goals described in Chapter I, it was necessary to estimate levels of key characteristics and outcomes in the treatment CIS areas and to compare them to the levels in the comparison areas. To estimate levels in the treatment areas, we simply

[52] To implement a nonresponse adjustment, we had to rely on information from our sample frame; CIS area, treatment status, and farm size were the only characteristics available for this adjustment.

[53] Our analysis controlled for stratum, so this was not strictly necessary. However, this makes it simpler for us—and future data users—to compute descriptive statistics.

applied the weights described above.[54] To compare levels between treatment and comparison areas, we estimated the differences between the two types of areas using the following ordinary-least-squares regression model, applying the weights described above:

$$(1) \quad Y_{ij} = \alpha + \beta T_j + \delta_k + \upsilon_j + \varepsilon_{ij} \,,$$

where Y_{ij} is the outcome for farm operator (or plot) *i* in CIS area *j*; T_j is an binary indicator that is one for treatment CIS areas and zero for comparison CIS areas; δ_k is a set of binary indicators, one for each treatment-comparison stratum, *k;* and v_j and ε_{ij} are random error terms at the CIS and individual levels respectively.[55] The coefficient β gives the average difference in the outcome between the treatment and comparison areas.

This regression model enabled us to account for features of the evaluation design—specifically the allocation of the sample by treatment-comparison strata, through the inclusion of δ_k. In addition, because the unit of intervention is the CIS area, to obtain the correct standard error for the difference β we had to account for the fact that outcomes in the same CIS areas are likely correlated. (This correlation is reflected in the CIS-level error term, v_j.) The regression model enabled us to account for this using the "cluster" correction in Stata, with the CIS area as the level of clustering.[56]

Because we adjusted for the correlation in outcomes within CIS and the number of CIS areas is small (10 treatment and 11 comparison), only very large differences in baseline characteristics were identified as statistically significant. However, this adjustment is necessary given the research design, and we will apply it consistently at all stages of the evaluation, including when we assess final impacts.

Some of the gender analyses in Chapter IX were different in nature from the other analyses in this report in that they did not involve testing for differences between treatment and

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[54] As mentioned above, the main analysis focuses on comparing treatment and comparison CIS areas; for this analysis, we applied the set of weights that excludes border areas. For the analysis that includes border areas with the treatment CIS command areas, we applied the alternate set of weights that includes the border areas.

[55] In the case of a binary outcome (for example, whether a farmer has access to irrigation), equation (1) is termed a linear probability model. Although probit or logit models are often used for binary outcomes, we prefer a linear probability model because it is easier to interpret and relies on weaker parametric assumptions. In practice, probit or logit and linear probability models generally yield similar results for the types of marginal effects that we are estimating here (Angrist and Pischke 2008; Wooldridge 2010).

[56] Because the total number of CIS areas is relatively small (21 in total—10 treatment and 11 comparison areas), there may be a concern that the standard clustering correction is not appropriate (Donald and Lang 2007; Cameron et al. 2008, 2013; Angrist and Pischke 2008). Several methods have been proposed to account for this and estimate correct standard errors. However, the most straightforward approach is to use a conservative number of degrees of freedom for hypothesis testing, based on the number of clusters rather than the number of observations (Donald and Lang 2007; Cameron et al. 2008, 2013; Angrist and Pischke 2008). We use the Stata default of a t-distribution with 20 degrees of freedom (21 clusters minus 1) for hypothesis testing, which results in *p*-values that are substantially more conservative relative to the typical clustering correction (Hedges 2007). Because this approach may be overly conservative, we have paid attention to both the statistical significance and magnitude of pre-rehabilitation differences.

comparison areas. Rather, they involved testing for differences between male- and female-operated farms, or between spouse responses for the same farm, restricted to treatment areas. To test for differences between male- and female-operated farms, we estimated versions of equation (1) where T_j is an indicator for a female-operated farm and δ_k is a set of binary indicators, one for each CIS area. To test for differences between spouse responses, we restricted the analysis for each variable to farms in which both spouses responded to the relevant question, and estimated versions of equation (1) where T_j was an indicator for the gender of the respondent or spouse. We included farm fixed effects as δ_k in these spouse analyses to make the comparison explicitly between spouses in the same farm.[57]

Finally, we were concerned that the reported means of some continuous variables could be misleading if they included "outlier" values. These outliers could reflect errors in data collection, or just specific atypical cases. To a large extent, we have addressed this concern by also reporting other features of the distribution of these continuous variables (for example, the median and/or specific categories of continuous values). However, because MCC is still interested in the means of these variables, we also sought to address the problem of outliers directly. Specifically, when reporting means of continuous variables, we top- or bottom-coded all values that were more than three standard deviations above or below the mean, respectively.[58] We implemented this correction separately by farm size—small, medium, and large—to avoid erroneously identifying values for larger farms as outliers.

[57] Because the operator gender and spouse analyses were restricted to the universe of treatment areas, there was no sampling variation at the CIS level; therefore, it was not necessary to adjust for correlations within CIS areas through a clustering correction.

[58] We considered other approaches to accounting for outliers, such as using a multiple of the inter-quartile range or the upper or lower percentiles as cutoff points. However, using standard deviations appeared to work best in providing a consistent approach that successfully identified outliers that were apparent by visual inspection, while leaving the rest of the distribution intact.

APPENDIX C

MONITORING AND EVALUATION INDICATORS

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MCC has requested baseline estimates from the 2013–2014 Farm Operator Survey for several indicators featured in MCA-Moldova's monitoring and evaluation plan. These baseline estimates, which focus on the treatment CIS areas, will enable MCC to track progress in key indicators over time. Below, we present the estimates for each requested indicator based on the 2013–2014 Farm Operator Survey (Table C.1); we also present a 95 percent confidence interval to illustrate the precision of these estimates.

Table C.1. Indicators from monitoring and evaluation plan, treatment CIS areas (2013, percentages unless otherwise indicated)

	Sample size	Estimate	95% confidence interval lower bound	95% confidence interval upper bound
Agricultural profits from crop production (dollars/ha)	2,108	-442	-473	-411
Rent paid to lessors in CIS (dollars/ha)	71	79	68	90
Agricultural wages paid in CIS (dollars/ha)	2,420	64	47	81
Total area irrigated in CIS (ha)	2,445	241	103	379
Total area of HVA cultivated in CIS (ha)	2,445	1,340	935	1,744
Percentage satisfied with irrigation, among those irrigating:[a]	39			
Satisfied with cost		27.1	9.5	44.7
Satisfied with timeliness		59.8	37.6	81.9
Satisfied with ease of ordering and billing		67.8	46.8	88.9
Satisfied with all of the above		19.7	3.4	36.1
Percentage aware of WUA, among farms operated by:				
Any gender (all farms)	2,392	92.1	90.9	93.3
Man or men only	566	88.8	85.7	91.8
Woman or women only	1,644	93.5	92.2	94.8
Men and women together	154	87.5	80.4	94.7

Source: 2013-2014 Moldova Farm Operator Survey.

Note: See text for indicator definitions. Monetary amounts were converted from Moldovan lei to U.S. dollars using the average exchange rate in 2013, which was 0.0784 dollars per lei (www.oanda.com). To account for outliers, continuous measures were top- or bottom-coded at three standard deviations above and below the mean for each farm size category (small, medium, large). Estimates are weighted using weights that adjust for sampling probabilities and survey nonresponse.

[a]MCC is interested in disaggregating this indicator by the gender of the farm operator; however, there were too few farmers irrigating in 2013 to disaggregate by gender.

CIS = centralized irrigation system, ha = hectare, HVA = high-value agriculture, WUA = water user association.

The measures presented in Table C.1 include the following:

- **Agricultural profits per hectare from crop production.** This measure is defined as total farm revenues from crop production minus total farm expenditures, divided by the farm's cultivated area. This measure of profits applies to the entire farm of the farm operators in our sample, and may include some land outside the CIS area or in border areas (about 61 percent of the farmers in our treatment CIS sample also cultivated some land outside the CIS area or in border areas). Mean profits per hectare from crop production in 2013 were about negative $442.[59]

- **Rent paid to lessors in CIS area, per hectare.** We computed this measure by dividing rent paid for each plot in the treatment CIS command area by the plot size, and then taking the mean over all plots. This measure was available only for plots that were rented (about 18 percent of sampled plots in the treatment areas), and had a mean of about $79 per hectare.

- **Agricultural wages paid in CIS area, per hectare.** We computed this measure by dividing annual wages paid to hired laborers for work on each plot in the treatment CIS command area by the plot area cultivated, and then taking the mean over all plots. Plots on which no labor was used were assigned a zero wage. These calculations yielded a mean wage of about $64 per hectare per annum.

- **Total area irrigated in CIS.** Because we had information on CIS area irrigated only for a sample of plots in the CIS area rather than for all plots, we had to estimate the total land area irrigated in two steps. In the first step, we calculated the average number of hectares that were irrigated per plot. This average was weighted so that the average was representative of all plots in the 10 treatment CIS command areas. In the second step, we multiplied this average by the total number of plots in those areas, which was 26,069 plots. Overall, we estimate that about 241 hectares were irrigated in the treatment CIS areas (about 2 percent of all treatment CIS area land).

- **Total area of HVA cultivated in CIS.** We estimated this measure using a similar two-step approach to the total area irrigated in CIS measure. In the first step, we calculated the (weighted) average number of hectares devoted to the cultivation of HVA crops per plot. In the second step, we multiplied this average by the total number of plots in the 10 treatment CIS command areas. Overall, we estimate that about 1,340 hectares in the treatment CIS areas were devoted to HVA (about 12 percent of all treatment area land).

- **Percentage satisfied with irrigation.** We measured satisfaction with various aspects of irrigation—cost, timeliness, and ease of ordering and billing—on a scale from 1 (lowest) to 5 (highest).[60] We focused on the percentage of respondents who reported that they were somewhat satisfied (4 on the scale) or totally satisfied (5 on the scale) with each aspect of irrigation, restricting our analysis to those irrigating using external sources (excluding those who were not irrigating or only irrigating with own sources). Based on this measure, the majority of respondents were satisfied with the timeliness and ease of ordering and billing of irrigation water (68 and 60 percent, respectively). However, only 27 percent of respondents were satisfied with the cost of irrigation water, and only 20 percent were satisfied with all three aspects. However, because very few respondents were irrigating using external sources (or even irrigating at all), the sample sizes are small; as a result, the confidence intervals are very wide.

[59] Consistent with the definition in MCA-Moldova's monitoring and evaluation plan, this indicator includes only revenues from crop production and not from livestock or garden plots. This explains why the estimated mean is lower than the treatment mean of negative $116 per hectare reported in Chapter III, which included these other components of farm revenues.

[60] The scale was: 1, totally unsatisfied; 2, somewhat unsatisfied; 3, neither unsatisfied nor satisfied; 4, somewhat satisfied; 5, totally satisfied.

- **Percentage aware of WUA.** To measure awareness of ISRA, we estimated the percentage of farm operators who were aware of a water user association in their community. Overall, we estimate that about 92 of all farms in the treatment CIS areas were aware of a water user association operating in their community. Because MCC is interested in how this awareness varies by the gender of the operators, we also disaggregated this indicator by whether the farm was operated by men, women, or both men and women.[61] Awareness was very high regardless of operator gender: about 89 percent of farms operated by men were aware of a water user association in their community, as were about 94 percent of farms operated by women and about 88 percent of farms operated by both men and women.

[61] As described in Chapter II, farms could have had multiple farm operators, who could have been all the same gender or a mix of both genders.

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