Evaluation Design for the Transition to High-Value Agriculture Project in Moldova

Final Report

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The views and opinions expressed herein are those of the authors and do not necessarily represent those of MCC or any other U.S. Government entity.

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Note to the reader

This package includes two documents: the original evaluation design report (pages 1-A.1) and an addendum to the report (which is included as Appendix B). The addendum discusses revisions to the design and reflects the final approach.

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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 experienced a decline in its agricultural sector, accompanied by a decline in its standard of living. This economic situation 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 the country in an excellent position to expand the production and sales of HVA products, as a means both to redress poverty and 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) project and the Road Rehabilitation project. The THVA project comprises several activities intended to increase rural incomes and catalyze future investments in HVA; this report describes the design that we plan to use to evaluate the effectiveness of the THVA project.

Based on an initial list of research questions, Mathematica Policy Research originally designed evaluations for some of the specific THVA project activities (Borkum et al. 2012; Fortson et al. 2012; Fortson and Fortson 2011). However, since those designs were developed, MCC and the Millennium Challenge Account-Moldova (MCA-Moldova) have developed a revised list of research questions. The updated research questions are closely aligned with the program logic and reflect a more holistic view of the THVA project. In addition to covering a broader set of outcomes, there is a greater focus on understanding the reasons why expected outcomes were or were not realized, how the different activities interacted, and whether outcomes are sustainable. Therefore, although some of the originally planned evaluation activities will continue, they will be embedded within the broader evaluation described in this report.

The THVA evaluation will rely on two complementary evaluation components. The first is an impact evaluation, which focuses on evaluating the effectiveness of the project in the areas of Moldova where key activities are concentrated (Chapter II provides more detail about the THVA activities). The impact evaluation will compare the changes in outcomes over time in areas in which these activities are being implemented with similar areas in which they are not being implemented. It will draw primarily on longitudinal quantitative data collected from farm operators in 2013–2014 (before the completion of the compact activities), as well as in 2018–2019 and 2020–2021 (several years after the end of the compact). The second component is a performance evaluation, which will draw primarily on qualitative data collected in 2013, 2014, and 2015, as well as new data to be collected between now and 2022. In addition to these qualitative data collected from a variety of stakeholders (for example, farm operators, water user

associations [WUAs], regional training service providers, local and national government officials, and value chain buyers), the performance evaluation will also draw on quantitative data from recipients of loans provided by the project, various sources of administrative data, and a document review. The performance evaluation will involve triangulating information from the various 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 revised research questions.

In the chapters that follow, we provide context for the evaluation and describe the planned evaluation design in further detail. In Chapter II, we describe the program logic and activities of the THVA project, and in Chapter III we summarize what is known from the literature about the effects of similar interventions. In Chapter IV, we outline the research questions that the evaluation seeks to answer and describe the evaluation design and data sources that will enable us to answer these questions. We conclude in Chapter V.

II. OVERVIEW OF THE THVA PROJECT

In this chapter we provide context for the planned evaluation by describing the THVA project activities and the mechanisms through which they are expected to affect outcomes, as set out in the program logic. We also describe the ex-ante economic rate of return (ERR) that MCC calculated to compare the costs and expected benefits of the project.

A. Overview of project activities and program logic

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 program logic model illustrates the activities, sub-activities, and key outputs for the THVA project and links them to the expected short-, medium-, and long-term outcomes (Figure II.1). For each outcome, the logic model also includes a set of qualitative and quantitative key indicators that can be used to assess whether that outcome was achieved. The logic model also includes a set of key assumptions, which might be necessary for specific outcomes to be achieved. The project activities, as illustrated in the logic model, are as follows:

- **The Irrigation Sector Reform Activity and Centralized Irrigation System Rehabilitation Activity (ISRA-CISRA)** aim to improve access to irrigation on agricultural land. These activities are being conducted in up to 11 (of about 80) Centralized Irrigation Systems (CISs) in different regions of Moldova; historically, these 11 systems covered an area of about 15,535 hectares. 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.

  The irrigation management transfer sub-activity of ISRA, which has been underway in the 11 selected CIS areas since 2010, has provided technical assistance and training to create local WUAs and build their capacity to manage and maintain the CISs. ISRA also supported the transfer of the management and operations of the CISs from the government of Moldova to the WUAs under a new legal framework. This framework includes a law defining WUAs as legal entities and another law granting them long-term water rights. As of May 2015, WUAs have been registered in all 11 selected CIS areas, and management transfer has been completed in 10 systems.

  ISRA also includes the river basin management sub-activity, which aims to ensure a sustainable long-run supply of water in Moldova (including, but not limited to, the 11 selected systems). This sub-activity includes support for the passage of a water law to govern water use in Moldova, assistance to the government of Moldova to develop river basin management plans, the installation of equipment to monitor water quantity and quality, and training for staff and entities engaged in water management.

Figure II.1. Logic model for the THVA project

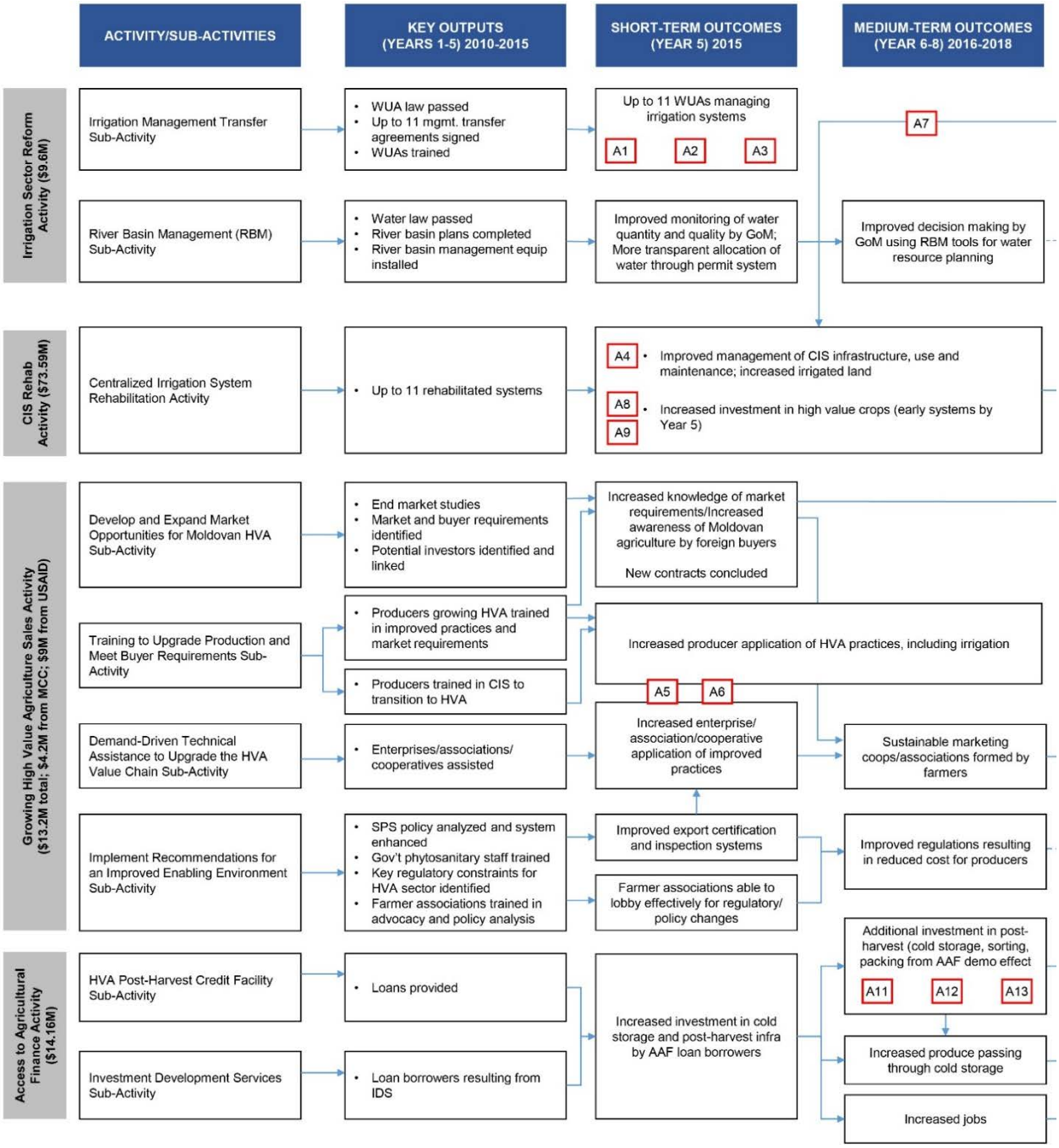
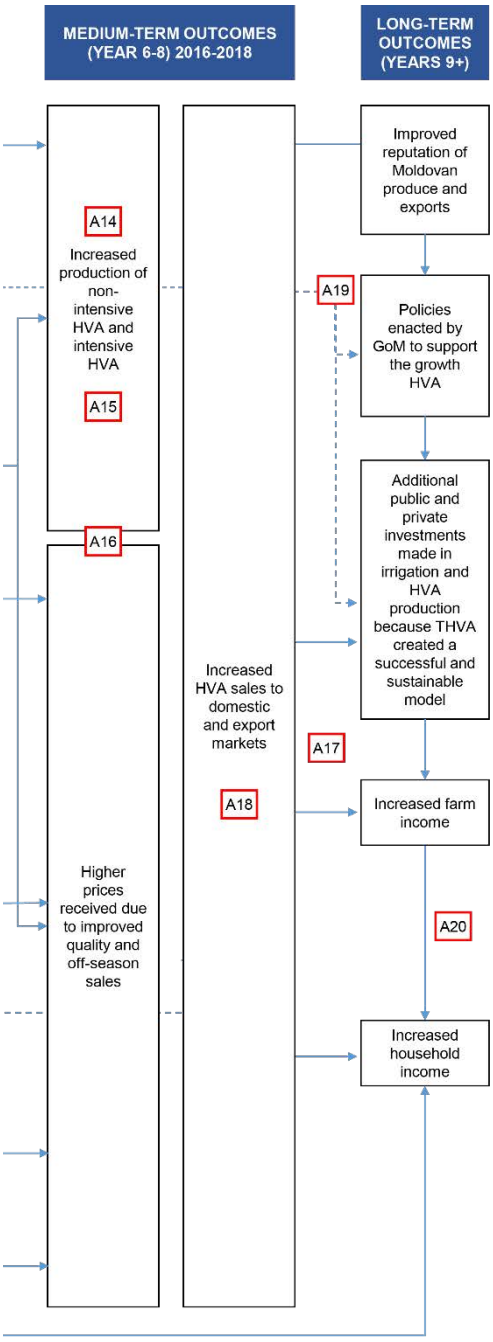


Figure II.1. Logic model for the THVA project (continued)



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

CISRA is intended to complement ISRA by rehabilitating the irrigation infrastructure (for example, replacing pumps and pipes) to deliver water to farmers' fields in the selected CIS areas.[1] The rehabilitated systems have been engineered such that farmers in some areas adjacent to the rehabilitated CIS areas ("border areas") will also be able to connect to the CIS (through connection points), increasing the number of potential beneficiaries from the rehabilitation.

In the short term, the program logic assumes that ISRA-CISRA will yield better-managed irrigation systems, laws that support a more transparent allocation of water, improved management of the irrigation infrastructure, and an increase in irrigated land. In the medium term, greater access to affordable and reliable irrigation is expected to increase farmers' willingness to invest in the production of high-value crops on land in the rehabilitated CIS areas.

- **The Growing High-Value Agricultural Sales (GHS)** activity, which is part of the Agricultural Competitiveness and Enterprise Development (ACED) Project, is funded jointly by MCC and the United States Agency for International Development (USAID). It is divided into four sub-activities: (1) HVA market development and expansion (including end-market studies and linkages to potential investors); (2) training to upgrade production and meet buyer requirements (both inside and outside the CIS areas that were selected for ISRA-CISRA)[2]; (3) demand-driven technical assistance to enterprises, associations, and cooperatives; and (4) the improvement of an enabling environment for HVA (including strengthening phytosanitary inspection and testing capacity).[3]

  These complementary sub-activities are implemented using a value chain approach, which means that they focus on particular crops and the challenges faced by various participants in each crop's value chain, including input suppliers, farmers, packers, consolidators, processors, transporters, and exporters. Using the different sub-activities as levers, the GHS activity aims to increase sales of HVA by addressing constraints specific to each selected value chain. The GHS activity is intended to affect value chain participants throughout Moldova, including but not limited to the CIS areas selected for ISRA-CISRA.

  In the short term, the GHS activity is intended to increase producer knowledge of market requirements and to enable producers to meet these requirements through improved practices and appropriate product certification and regulations. In the medium term, the

[1] Not all 11 systems will be fully rehabilitated. In one treatment CIS, 6-9 Cahul, the irrigation system is not likely to be rehabilitated given existing drainage issues. In addition, in treatment CIS 6-6 Chircani-Zirnesti, different geographic areas will be rehabilitated using different mechanisms (modules). Only some of these modules will be rehabilitated through MCC funding. Therefore, in practice, MCC funding will be used to fully rehabilitate nine systems and partly rehabilitate one. As we describe below, the impact evaluation will focus on these ten systems, although the performance evaluation will include all 11 systems.

[2] More recently, farmer training in the selected CIS areas—which aims to support the transition to HVA and the use of irrigation—has been separated into a separate subactivity. However, it is still included as part of the second subactivity (training to upgrade production and meet buyer requirements) in the program logic.

[3] Phytosanitary inspections provide assurance that plants or plant products are considered free of pests and conform to regulations.

ability to meet these requirements is expected to lead to increased production and higher prices and sales volumes in both domestic and export markets.

- **The Access to Agricultural Finance (AAF)** activity aims to increase competitiveness and profitability for farmers and post-harvest investors by enabling investments to increase production, cost-effectively sort and package produce, extend the production and marketing seasons, and bring produce to market. It consists of two subactivities: the investment development services sub-activity and the credit facility sub-activity.

  The investment development services sub-activity, which is implemented as part of the ACED project, is designed to enable farmers and rural entrepreneurs to develop relevant investment projects on a cost-sharing basis with Moldovan development investment providers.

  As part of the credit facility sub-activity, AAF is providing loans with terms of between three and seven years to farmers and rural entrepreneurs through participating Moldovan financial institutions for the purpose of supporting investments related to HVA production, processing, and sales. The eligibility criteria for AAF loans have changed several times over the course of the compact. Initially, these loans focused primarily on investments in post-harvest infrastructure such as cold storage, with loan amounts between $50,000 and $600,000. Entities throughout Moldova were eligible to apply for them. In November 2012, eligibility for AAF funding was restricted to farmers and businesses in the raions in which the 11 CIS areas targeted for rehabilitation are located (to facilitate the transition to HVA in these areas). In March 2013, eligibility was extended to borrowers in raions that bordered the raions that served these 11 CIS, and the minimum loan amount was decreased to $20,000. Subsequently, in January 2014, eligible investments for AAF loans were expanded to include equipment related to HVA production, such as greenhouse and irrigation equipment and the establishment of nurseries and plantations, and the minimum loan amount was decreased to $5,000. More recently, in April 2015, geographic eligibility for AAF loans was expanded back to include entities throughout Moldova (retaining the expanded set of eligible investments and $5,000 minimum loan amount).

  In the short term, AAF loans are expected to enable farmers and rural entrepreneurs to invest in cold storage and other post-harvest infrastructure, increasing access to post-harvest infrastructure more broadly.[4] In the medium term, increased use of these facilities is expected to enable producers to improve the quality of the products they provide to the market and to benefit from off-season sales—increasing prices and the volume of sales in domestic and export markets.

  In early 2015, the credit facility sub-activity was expanded to include a new component, the 2KR hire-purchase program.[5] This program enables farmers to purchase irrigation

[4] The expansion of AAF to include loans for greenhouses and irrigation equipment took place after the program logic was developed. Though this is not reflected in the program logic, the expansion is designed to complement the other THVA activities in increasing HVA production and sales.

[5] To maintain consistency with the previous draft of this report and other evaluation products, we continue to refer to loans for HVA-related investments as "AAF loans", and financing through the 2KR hire-purchase program as "2KR financing," even though both fall under the credit facility sub-activity of AAF.

equipment or farming equipment and machinery for irrigated land on a hire-purchase basis.[6] Buyers make an initial payment of 25 percent of the purchase price, and pay off the remaining amount in installments, typically over a three-year period. Because no interest is charged and there are no collateral requirements, this program may be attractive to farmers who are unable or unwilling to obtain credit for these purchases from other sources. The 2KR program is available to farmers throughout Moldova, but it is expected that farmers in the rehabilitated CIS areas will be especially well-positioned to take advantage of the program given that they will have access to irrigation. Because the 2KR program operates as a revolving fund, it is expected to continue to operate several years into the post-compact period.

The logic model (Figure II.1) 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. 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 being implemented more widely across Moldova) will enable these farmers to better understand and meet market requirements for these crops. The program logic suggests that the loan component of the AAF activity (which, during part of the implementation period, focused specifically on the raions 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. 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 evaluation design described in this report will enable us to assess whether the outcomes in the logic model 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 WUAs, 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 ERR, which compares the expected costs and benefits of rehabilitation.

Together, 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

[6] Because the 2KR component of the AAF activity was introduced after the program logic was developed, it is not explicitly reflected in the program logic. Nevertheless, is designed to complement the other THVA activities by encouraging investments in irrigation and HVA production, with the goal of increasing HVA production and sales.

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 II.1). Specifically, our sampling and analysis for the impact evaluation, described in Chapter IV, 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 WUA there, we still plan to include this system in the performance evaluation. This will enable us to explore, for example, whether the irrigation system in 6-9 Cahul was fully or partially rehabilitated through other funding sources.

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 II.1. 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. Economic rate of return

As described above, MCC's investment in the THVA project is expected to benefit farmers in the targeted CIS areas (and border areas) by improving agricultural production and sales. To determine whether these benefits justify the project's costs, MCC is interested in the ERR of the project.

The ERR is a summary statistic that reflects the economic merits of an investment. Conceptually, it is the discount rate at which the benefits of an intervention are exactly equal to its costs. The higher the benefits relative to costs, the higher the ERR. When developing the compact, MCC developed estimates of the ERR of the THVA project activities based on expected costs and expected benefits. MCC has since adjusted the ERR model to reflect changes in the project activities (for example, changes to CISRA construction plans) and updated information about the underlying assumptions, and produced revised ERR estimates (these are known as "ex-ante" estimates because project benefits have not been realized).

The main benefit stream in the ERR model is the net return from sales of fruits, vegetables, and non-HVA crops on newly-irrigated land in the ten rehabilitated systems. The ERR model computes this benefit stream separately for each system in each year, based on assumptions regarding the overall proportion of fruits, vegetables, and non-HVA crops cultivated; the rate at which land will transition to being irrigated; and the mix and profitability of specific crops. The costs in the model include the implementation and administrative costs of ISRA-CISRA and GHS; the costs of irrigation system operation, maintenance, and repair; and the costs of on-farm irrigation (equipment, maintenance, and labor). The latest ERR model (as of July 2015) estimates the total ERR across all ten rehabilitated systems as negative 1.7 percent.

As part of the evaluation, we will compute the ex-post ERR using updated estimates of benefits and costs across the ten rehabilitated systems as a whole (see Chapter IV for details). This ex-post ERR will not only enable MCC and other stakeholders to determine whether the THVA project was a sound investment (by comparing the ERR to the "hurdle rate" of 10 percent) but will also permit a comparison to other actual or possible investments.

III. LITERATURE REVIEW

Given widespread rural poverty in many developing countries, governments and development agencies are investing in agricultural interventions that aim to increase incomes and reduce poverty through improved farm production and sales. These interventions include improving management of irrigation systems, increasing access to irrigation, providing agricultural inputs (such as improved seeds and fertilizer), training farmers in improved practices, encouraging the cultivation of different crops (such as high-value crops), and introducing effective marketing and post-harvest practices, among others.

The magnitude of these investments is large. For example, the Food and Agriculture Organization of the United Nations (2000) documented 248 different irrigation infrastructure projects totaling more than $8 billion in investment costs from 1980–2000. The World Bank has allocated more than $400 million to agricultural training and education interventions over the past 20 years, and MCC has provided agricultural training to about 200,000 farmers in developing countries since 2004. In addition, the U.S. government's Feed the Future initiative, launched in 2009, is a $3.5 billion public investment in agricultural development and food security. Within Feed the Future, U.S.-based nongovernmental organizations have further pledged an additional $1 billion to implement large-scale farmer training programs in multiple countries (USAID 2012).

Given the magnitude of these investments, it is important to examine the extent to which they have been effective at achieving their goals. The evaluation of the THVA project described in this report will contribute to the evidence on the effectiveness of the types of agricultural interventions implemented under the project. To provide context for the evaluation, we review the existing evidence relevant to some of the key project interventions: the establishment and support of WUAs, irrigation infrastructure improvements, farmer training and other efforts to expand market opportunities, and agricultural finance. Finally, we describe how the THVA evaluation will contribute to this literature.

A. Water user associations

To encourage efficiency of water usage, many countries are reconsidering the way in which water resources should be managed and have moved toward a more decentralized system in which local water groups assume responsibility for irrigation operations and maintenance (Hodgson 2007). Several studies describe irrigation management programs in which WUAs were established or technical assistance was provided to existing WUAs. Hodgson (2007) described how many "transition" countries (Eastern European and former Soviet Union countries) are increasingly moving toward WUAs yet face significant challenges navigating the legalities of changing the ownership of irrigation systems from the state to the WUAs. A World Bank Institute paper (Xie 2007) provides an overview of how irrigation management transfer and participatory irrigation management initiatives have been adapted for many countries according to their political and economic environments. Xie found that a major challenge to WUAs is their financial sustainability—that is, structuring them so they are able to recover the costs of operating and maintaining the irrigation system and WUA.

Two review studies assess the success of WUAs in various countries and contexts. Mukherji et al. (2009) defined success by developing a composite success score for WUAs based on outcome and impact indicators. The outcome indicators include the financial viability of the WUA; the functional condition of the infrastructure; the extent to which water distribution is equitable, reliable, and adequate; community and gender participation in the WUA; degree of empowerment of the WUA; and the WUA's technical capacity. Impact indicators of success include changes in livelihoods and household wages and crop productivity. Given these criteria, Mukherji et al. (2009) showed that only 43 of 108 projects successfully met program objectives. A 2011 review of 24 WUAs throughout Asia determined that 17 of these WUAs were successful, with particular strengths in improving the functional condition of the irrigation infrastructure, increasing agricultural productivity, and improving household economic impacts (IEG 2011). The majority of WUAs assessed in both of these studies were in operation for between 4 and 10 years.

Individual studies of the effects of WUAs (few of which are rigorous impact evaluations) have mixed findings, which might reflect both different contexts and different implementation models. Wang et al. (2010) documented that WUAs are becoming more common in China; however, although WUA villages have higher water use efficiency than non-WUA villages, no clear benefits are obvious in terms of yield, income, and crop patterns. A 2008 study from Andhra Pradesh, India, reported negative results in that the WUAs had limited control over operations and management, fee collection, and dispute resolution, and did not empower the poor through participation or leadership (IEG 2008). In contrast, an evaluation by Bandyopadhyay et al. (2007) used a comparison group design to measure the impact of transferring irrigation management to WUAs in the Philippines. The study found increased maintenance of irrigation systems, reduced technical inefficiency, and a 2 to 6 percent increase in crop yields.

Finally, in Armenia, the Institutional Strengthening Sub-activity of the MCC compact provided technical support to strengthen the capacity and self-sufficiency of regional WUAs. This is especially relevant to ISRA in Moldova because Armenia and Moldova are both post-Soviet republics in the same region, and the structure of WUAs is similar in both countries. However, the activities differ in that the activity in Moldova involves establishing new WUAs, whereas in Armenia it entailed providing technical assistance to existing WUAs. Fortson et al. (2013) showed that implementers in Armenia succeeded in meeting all of the programmatic objectives: for example, management improvement plans were prepared and provided for each WUA, and WUAs also received office equipment (such as computers and software) and heavy equipment. WUAs improved their financial standing over a three-year period and increased their membership fee and cost recovery rates by 13 and 11 percentage points, respectively. However, given their large annual deficits, WUAs did not appear to be approaching financial solvency in the near-term. In addition, the authors warned that the apparent lack of commitment by members to strengthening activities might pose a serious challenge to the future sustainability of the WUAs.

Fortson et al. (2013) also found an increase in WUA participation in Armenia: in the final year of the program, WUA membership increased by 10 percentage points, and the share of water users reporting a village WUA representative increased by 24 percentage points. However, the research design for this evaluation only examined time trends, and the researchers cautioned that not all of these changes can necessarily be attributed solely to the Institutional Strengthening

Sub-activity. For example, rainfall varied substantially over the time period examined, and consequently, the distribution of irrigation water varied as well. It is therefore likely that the sub-activity played a role in improving these indicators but the exact contribution is unclear.

B. Irrigation infrastructure improvements

Studies that examine the effects of irrigation in different developing country settings have found that irrigation is generally associated with higher production and income. A literature review of projects in Asia showed that irrigation is associated with higher cropping intensity, land productivity, employment of farm labor, and agricultural wages; households in irrigated areas also experience higher incomes, lower income inequality, and lower poverty than rain-fed settings (Hussain and Hanjra 2004). Van Den Berg and Ruben (2006) showed that Ethiopian households with irrigation have higher expenditures and lower dependence on public programs than those without irrigation. Also in Ethiopia, a country in which only 5 percent of irrigable land is irrigated, Tucker and Yirgu (2010) found that, on average, households experienced a 20 percent increase in annual income from irrigating. However, the authors noted that market interventions are also necessary because "farmers face high costs and risks when entering markets, which severely limit the returns from irrigation" (p. 1).

A more rigorous study in northern Mali used a variety of quasi-experimental approaches to show how the redistribution of water to canals (through motorized pumps) increased access to irrigation and had positive impacts on poverty, agricultural production, and nutrition (Dillon 2008). Over the eight-year evaluation period, households with this type of irrigation access experienced substantially larger improvements in household consumption and agricultural production than households without access to irrigation.

Several studies have used a quasi-experimental approach to estimate the impacts of rehabilitating irrigation infrastructure. This is particularly relevant in the context of Moldova, in which CISRA seeks to rehabilitate Soviet-era irrigation systems that have largely fallen into disrepair. For example, Del Carpio et al. (2011) examined the impact of rehabilitating irrigation infrastructure on expenditures, agricultural production, and income measures in coastal Peru. Using a 10-year panel of national household survey data, the study identified treatment and comparison groups based on distance to the rehabilitation site. The study found that the project benefitted the poor not by increasing production in small household plots, but rather by providing poor farmers with better employment opportunities on larger farms.

Similarly, a 2008 study used a comparison group design to show that new construction and rehabilitation of existing infrastructure in Andhra Pradesh, India, resulted in increased wage employment, along with favorable impacts on yield and cropping intensity, and that net farm income increased by almost 60 percent (IEG 2008). However, the study also showed that there was less crop diversification than expected, substantial water wastage in the upper reaches of the canals, and very significant cost overruns and construction delays. Consequently, despite the positive impacts on income, the cost-benefit analysis was substantially less favorable than originally expected (the calculated ERR for the project was just 2 percent, compared to the original estimate of 19 percent). This study illustrates that, considering the high cost of most irrigation interventions, it is crucial to examine whether the effects are large enough to justify the costs.

C. Farmer training and other efforts to expand market opportunities

Interventions that could be effective in increasing market opportunities for new and existing producers of certain crops include farmer trainings, technical assistance to various market participants, efforts to improve linkages between farmers and markets, and other related activities. This section focuses mainly on the farmer training component, as other activities have been less commonly studied.

Studies that evaluate agricultural training programs have largely focused on measuring performance metrics related to the provision of training or conducting case studies (for example, Waddington et al. 2010), and the few rigorous evaluations of agricultural trainings in developing countries reported mixed results (IEG 2011). For example, in Myanmar, Kabir and Uphoff (2007) found that the majority of farmers in a community were using crop intensification practices three years after just one-third of farmers were trained. There was a diffusion of knowledge such that the trained farmers taught other local farmers the practices. However, in Indonesia, there was no evidence of improved crop yields or positive economic gains resulting from a training on pest management, although the training led to some increased knowledge (Feder et al. 2004). The authors suggested that the training topic might have been too complex for farmers to understand or communicate to other farmers. Finally, a study in Argentina reported mixed results, with different impacts for farmers based on their yields—low-yield farmers saw increased production, and larger producers saw improved quality (Cerdán-Infantes et al. 2008).

To date, there have also been five completed evaluations of agricultural training programs funded by MCC—in Armenia, El Salvador, Ghana, Honduras, and Nicaragua. Four of these evaluations used rigorous random assignment designs to estimate impacts. However, these designs faced several challenges, including limited exposure time to the intervention and limited ability to detect impacts on household income. Overall, these evaluations found mixed evidence of impacts on both intermediate outcomes (such as adoption of training practices) and the key measurable ultimate outcome, farm income. (Table III.1 provides more detailed information about these interventions and the evaluation findings). This suggests that impacts of agricultural training programs are likely to vary substantially based on the nature and location of the specific program.

Beyond farmer training, limited research exists on other activities to expand market opportunities, and the few existing studies have mixed results. In the Post-Harvest, Processing, and Marketing project in Armenia, enterprises and producer groups were trained in processing technologies, food safety, quality standards, financial analysis, and developing commercial linkages. Fortson et al. (2013) found that the majority of beneficiaries reported improvements in outcomes such as product and service quality, productivity, sales, and profits, and more than 70 percent of enterprises that reported improvements stated that project assistance contributed, at least in part. However, these findings are based on simple descriptive analyses that do not establish a compelling counterfactual for what would have happened in the absence of the project.

Table III.1. Findings from evaluations of MCC-funded agricultural training programs

Country	Intervention description	Evaluation design	Key findings
Armenia	Established demonstration plots and conducted training sessions for farmers on high-value crop substitution and cropping intensity, as well as efficient irrigation techniques	Randomized roll-out	Limited adoption of on-farm water management practices, possibly due to high costs of implementing the improved techniques and a lack of irrigation infrastructure. Small, positive impacts on the adoption of some HVA practices, such as soil preparation. However, no statistically significant impacts on the types of crops being cultivated, total production or sales, or agricultural income and profit.
El Salvador	Provided ongoing technical assistance and training, starter kits, demonstration plots, and technical and financial support for enterprises in the dairy, horticulture, and handicrafts value chains	Randomized roll-out	Impacts varied across value chains. Positive impacts on adoption of training practices and significant increases in farm income in the dairy value chain; impacts on adoption, but no impacts on farm income in the horticulture value chain; and impacts on employment but not income in the handicrafts value chain.
Ghana	Provided training in management, business planning, technology applications, and marketing to farmer-based organizations; participating farmers were also given a starter kit, protective equipment, and cash to facilitate land clearing	Randomized roll-out	On average, there was no impact on yields or crop incomes across the three regions included in the intervention. However, there was variation in impacts by region: the overall impact was driven by positive impacts in one region, negative impacts in the second, and no impacts in the third. Insufficient time to detect impacts and limited tailoring of training activities to regional differences in farmer capacity and crops might help explain these findings.
Honduras	Provided ongoing training and technical assistance, including financial support and extension services, in commercial horticulture production and marketing	Econometric model-based approach	A significant increase in income from horticultural crops, but no significant increase in net household income or household consumption.
Nicaragua	Provided technical and financial assistance to farmers and rural business owners, including improved access to technologies and markets, providing agricultural inputs, and establishing rotating funds at the cooperative level. The evaluation focused on the livestock and agriculture value chains (specific crops).	Randomized roll-out	Overall, farmers receiving technical and financial assistance experienced a 15 percent increase in targeted farm income over the baseline level. Allowing for variation in treatment intensity, farmers with longer exposure experienced a 30 percent increase in targeted farm income. There were no detectable impacts on household consumption, the proxy for household income.

Source: Information obtained from MCC website (http://www.mcc.gov/), accessed January 22, 2015.

HVA = high-value agriculture; MCC = Millennium Challenge Corporation.

D. Agricultural finance

IEG's (2011) review found a paucity of evaluations on agricultural finance interventions (defined as interventions that provide finance for agriculture-related activities), and thus broadened the inclusion criteria for the review to include other types of finance interventions for rural households. The review therefore included studies in which low-resource farming households had access to credit, cash grants, savings accounts, advisory services, insurance, and access to farmer cooperatives. Although this still yielded a limited number of studies, two-thirds of these studies found positive impacts on the welfare of rural households. The available evidence suggests that complementing credit with noncredit services, such as advisory services, might be especially beneficial.

In Armenia, the Water-to-Market credit program funded by MCC provided farmers with access to long-term credit if they participated in training and met other selection criteria qualifying them for loans. The evaluation of the credit program (Fortson et al. 2013) was limited by the small sample size of credit recipients, which limited both the statistical precision of the evaluation and the possibility of constructing a well-matched comparison group. Nevertheless, after controlling for baseline differences in a regression framework, credit recipients reported incomes that were, on average, substantially higher than those of nonrecipients. However, the limited sample size meant these differences were not always statistically significant, and the potential for biased estimates meant the authors could not conclude with certainty that credit led to enhanced economic outcomes.

E. Contribution of the THVA evaluation

The THVA evaluation will contribute to the literature on the effects of agricultural interventions in developing countries in several ways. First, there are still relatively few studies using rigorous evaluation designs that assess the impacts of these types of interventions. The planned evaluation will use a matched comparison group design that, although not as rigorous as an experimental design, will still enable us to plausibly attribute estimated impacts to the intervention. Second, the evaluation will also include a complementary in-depth performance evaluation component, which will draw on a rich set of qualitative and quantitative data sources. This will enable us to examine mediating pathways for each of the project activities, which are underexplored in the existing literature. Third, whereas existing evaluations typically focus on a single type of intervention, the THVA evaluation will focus on the impact of a package of complementary agricultural interventions. It will therefore enable us to determine the effects of a major effort to improve agricultural production and sales by simultaneously addressing multiple constraints, which could lead to larger impacts than activities evaluated in isolation (and is more closely aligned with MCC's approach to designing its compact activities). Evaluating a package of interventions will limit our ability to inform any specific literature because it will be difficult to disentangle the impacts of specific interventions; nevertheless, the performance evaluation will provide valuable evidence on how these interventions interact and which are more likely to be driving the estimated impacts.

IV. EVALUATION DESIGN

In this chapter, we describe our proposed design for the THVA evaluation. We begin by listing the research questions that the evaluation seeks to address and by providing a brief overview of the proposed evaluation design, which includes an impact evaluation and a performance evaluation. We then describe in further detail each of these two evaluation components, the data they will rely on, and how we will draw on the data to answer the research questions.

A. Research questions

The evaluation of the THVA project seeks to answer the following research questions:

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 ERRs?*
2. If results were not realized, why not? *Was it because the logic was incorrect or incomplete, assumptions did not hold, 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?[7]

[7] "Successful" would be demonstrated by: (1) other systems adopting the same approach with WUAs and management transfer agreements; (2) additional investments taking place in irrigation by the government or others; and (3) inclusion of the THVA approach in government strategies and priorities.

c. Are there indications that the THVA Project will be successful in its objective of creating a sustainable model for irrigation and HVA production?[8]

7. What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?
8. What is the ex post ERR of the THVA Project?

To answer these questions, we will conduct a mixed-methods evaluation of the THVA project that includes an impact evaluation component and a largely qualitative performance evaluation component (see Table IV.1 for a summary). The impact evaluation will focus on obtaining quantitative estimates of the effects of the activities and sub-activities taking place in targeted CIS areas, using data collected from farm operators in 2013–2014 (baseline) and up to two subsequent rounds, in 2018–2019 (first follow-up) and 2020–2021 (second follow-up). The performance evaluation will cover the project activities more broadly and will rely on primary qualitative data, quantitative data from AAF loan borrowers, administrative data, and document review. Data for the performance evaluation will be collected between 2013 and 2022.

Table IV.1. Approach to answering the key research questions

Research question	Impact evaluation	Performance evaluation
1. Were the expected results realized from the THVA program logic?	• Estimate impacts on key medium-term outcomes (e.g., area irrigated and area HVA cultivated)	• Assess the extent to which outcomes not covered by the impact evaluation were attained (e.g., assess improved management of CIS using data from farmers, mayors, WUA officials and staff, and Apele Moldovei)
2. If results were not realized, why not?	• Estimate impacts on key short- and medium-term outcomes to explain why some medium- and long-term outcomes were not achieved	• Assess successes and challenges of implementation and perceived risks to realizing results (e.g., using data from MCA-Moldova, ISRA contractor, and GHS contractor) • Examine barriers to benefitting from THVA activities (e.g., using data from farmers in treatment and border areas, WUA officials, AAF end borrowers, and GHS beneficiaries and stakeholders) • Understand the broader policy environment and ongoing challenges faced in the agricultural sector (e.g., using data from farmers in comparison areas, ministry of agriculture, and other donors)
3. What was the contribution of each activity/sub-activity to the results that were realized?	• Estimate levels of and impacts on outcomes linked to specific activities (e.g., use of irrigation from CIS, investment in irrigation equipment, use of cold storage,	• Determine the number and types of beneficiaries from administrative data to understand the reach of different activities (e.g., using administrative data

[8] "Sustainable" refers to: (1) whether the government is managing water resources as envisioned in the program logic so that expansion can occur in the irrigation sector; (2) whether the WUA model is effective at local water management (providing good water delivery service, recovering fees, maintaining the systems); and (3) whether national organizations and WUAs are coordinating as necessary.

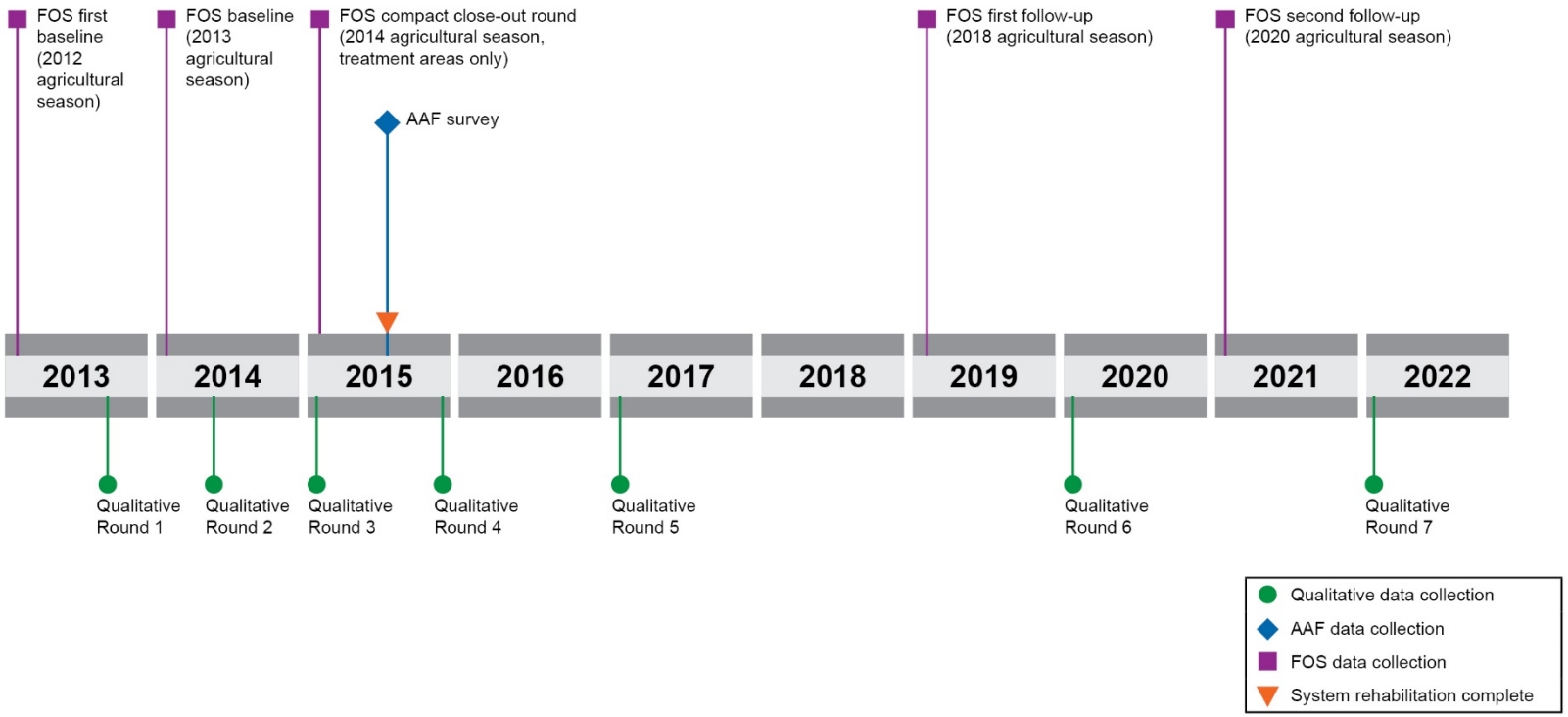
Research question	Impact evaluation	Performance evaluation
	GHS training attendance, and GHS practice adoption)	on AAF loans, 2KR financing, and GHS trainings) • Assess the extent to which specific THVA activities were "game changers" relative to the pre-existing situation (e.g., using data from farmers, AAF end borrowers, commercial banks, GHS beneficiaries and stakeholders, and other donors) • Assess perceptions of relative contributions of different THVA activities by those familiar with or benefitting from multiple activities (e.g., using data from farmers, mayors, and MCA-Moldova) • Examine perceptions of benefits by stakeholders linked to specific activities (e.g., using data from GHS technical assistance beneficiaries, GHS training participants, AAF end borrowers, and 2KR buyers)
4. How did THVA affect land ownership, leasing, and land values in the CIS and border areas?	• Estimate changes in land ownership and operations (e.g., the number of owners and operators) using listing data • Estimate impacts on rent per hectare	• Assess how and why changes in ownership, leasing, and land values occurred in affected communities (e.g., using data from farmers and mayors)
5. How are the results from the project distributed?	• Estimate impacts on key outcomes for specific subgroups (e.g., small farms and women-operated farms) • Estimate impacts on farm wages, on-farm labor by household members, and farm employment	• Examine variation in experiences with THVA activities of different types of beneficiaries (e.g., small versus large farms in treatment CIS areas, and female versus male-operated farms in these areas) • Qualitatively assess how and why agricultural employment opportunities and wages changed (e.g., using data from agricultural laborers and farmers)
6. Are there indications that some of the long-term outcomes will be realized?	• Estimate impacts on proximate medium-term outcomes (e.g., HVA production and HVA sales) • Estimate impacts on farm profits per hectare and household income, although these may take longer to manifest	• Examine perceptions of long-term sustainability of WUAs (e.g., using data from WUAs, farmers, and Apele Moldovei) • Examine perceptions of long-term changes in profits and household income (e.g., using data from farmers and mayors) • Assess whether broader policy environment and other sector activities can support long-term change (e.g., using data on ongoing activities of extension service providers, activities of other donors, and activities and policies of the ministries of environment and agriculture)
7. What lessons can be drawn from analysis of the design, implementation, and		• Examine lessons learned from implementers (e.g., using data from MCA-Moldova, ISRA contractor, GHS contractor)

Research question	Impact evaluation	Performance evaluation
results of the THVA Project?		• Examine suggestions for program improvement by beneficiaries (e.g., using data from AAF end borrowers, GHS beneficiaries, WUA officials, and farmers) • Synthesize findings on results (question 1), why they were/were not realized (question 2), and the contribution of different activities (question 3) to determine what could have been improved and how
8. What is the ex post ERR of the THVA Project?	• Use estimated impact on farm profits per hectare to compute impact on total profits and update the benefit stream in the ERR model	• Understand the likely trajectory of changes in profits by examining trends in irrigation and HVA cultivation (e.g., using data from farmers and administrative data from WUAs)

Figure IV.1 summarizes the timing of implementation and the data collection activities. The timeline shows that two rounds of quantitative data collection from farmer operators were conducted before the systems were rehabilitated—in 2012–2013 and 2013–2014—which could serve as baseline rounds for the evaluation. For reasons that we describe below, we plan to rely primarily on the 2013–2014 round to provide measures of baseline levels of key outcomes. (The timeline also shows that we conducted an additional data collection 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). We propose up to two rounds of follow-up data collection for the impact evaluation, to be conducted three and five years after all the systems have been rehabilitated (in 2018–2019 and 2020–2021, respectively). To maximize their value for the evaluation, the number of follow-up rounds, their timing, and the nature of the data that will be collected will be finalized using information available closer to the time (as described in more detail in Section IV.B.3).

The seven rounds of qualitative data for the performance evaluation will span the entire evaluation period, starting before rehabilitation was completed in any of the systems, and culminating in two rounds that will be conducted after the quantitative follow-up survey data have been analyzed and which are intended to help interpret the quantitative findings. Finally, we are collecting data from AAF end borrowers in mid-2015. In the remainder of this chapter, we describe in further detail the impact and performance evaluation components of the evaluation design, including our justification for the proposed timing of data collection.

Figure IV.1. Data collection timeline



B. Impact evaluation component

The impact evaluation component of the THVA evaluation will inform several of the research questions. In particular, the impact evaluation will be used primarily to measure the impacts of the project on several key medium-term outcomes (Question 1); measure changes in land ownership, leasing, and land values (Question 4); understand how impacts were distributed across beneficiaries (Question 5); and estimate parameters needed to revise the ERR (Question 8). It will also provide some information relevant to assessing the reasons why expected results were not realized (Question 2), the relative contributions of different activities (Question 3), and the extent to which long-term outcomes are likely to be realized (Question 6).

More specifically, the evaluation will measure impacts on medium-term outcomes such as area irrigated, area of HVA cultivated, use of cold storage, and membership in farmer associations (Question 1). If expected results are not realized, measuring impacts on short- and medium-term outcomes will be used to help understand why not (Question 2). Impacts on (or levels of) outcomes linked to specific project activities will provide some information on the relative contribution of different project activities (Question 3). An analysis of the extent to which the owners and operators of plots change over time (for example, whether land is consolidated under a few larger operators), together with impacts on plot ownership status and rent, will inform the analysis of leasing patterns and land values in the CIS and border area (Question 4). We will also be able to estimate impacts for different subgroups of beneficiaries such as small farms and woman-operated farms (Question 5), though statistical power might be limited for some analyses because of small sample sizes. Our analysis will also assess the impacts of the project on farm labor, in terms of both hours of work and wages, to capture how project results are distributed. In addition, we will be able to estimate impacts on farm profits and household income, though our ability to detect impacts will be limited because of high variability in these outcomes and because these impacts might not have fully manifested in the time frame of the evaluation. This will give some indication of the extent to which the long-term outcomes of the project are likely to be realized (Question 6). Finally, we will be able to provide information to update the ERR for the THVA project (Question 8).

Below we describe the design, analysis approach, sample size, and data sources for the impact evaluation component, as well as our approach to updating the ERRs.

1. Matched comparison group design

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 CIS areas (comparison areas) that are similar to the selected CIS areas (treatment areas) in terms of observable characteristics of the areas, and of the features of the irrigation systems, that could affect outcomes (Appendix A describes the procedure used to identify these comparison areas in further detail). 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 levels of outcomes and other farmer characteristics to statistically adjust for any remaining observable treatment-comparison differences that could be related to outcomes.

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 IV.2). 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 IV.2).

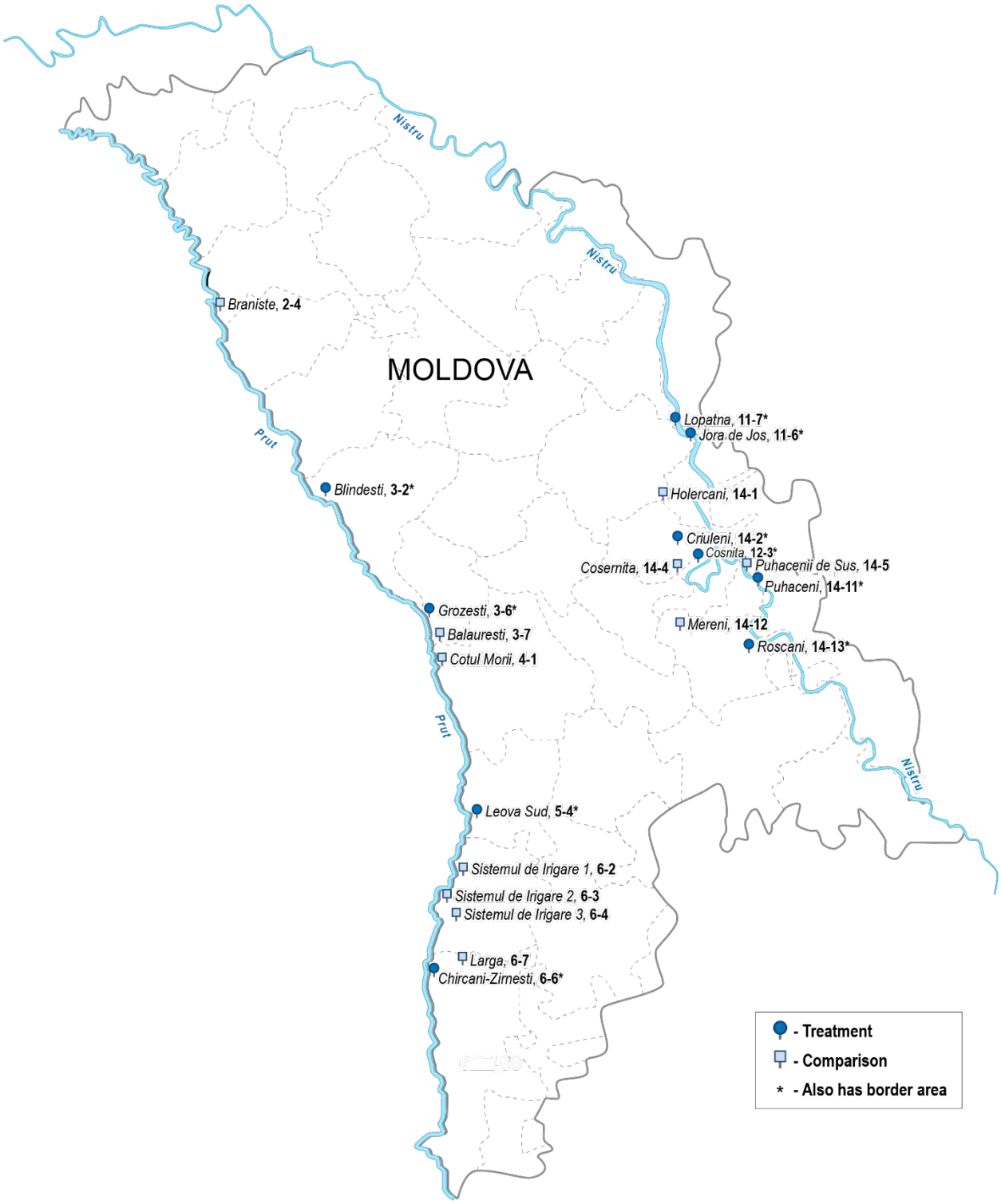
Table IV.2. Treatment and comparison CIS areas, by stratum

Stratum	Treatment CIS areas	Comparison CIS areas
1	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[a]	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

CIS = centralized irrigation system.

[a] 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.

Figure IV.2. Treatment and comparison CIS areas



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

To assess the plausibility of the comparison group design, we used data collected from a survey of farm operators in treatment and comparison CIS areas in 2013–2014, before system rehabilitation. If the treatment and comparison areas are similar in characteristics related to the outcomes of interest at baseline, we would be more confident that they would experience and react similarly to external events unrelated to the THVA project. For example, if crops grown are similar in treatment and comparison areas, profits are more likely to react in a similar way to external changes in market conditions.

Our analysis indicated that, although the treatment and comparison areas are not identical at baseline, they are broadly similar in the characteristics that are most directly related to key outcomes. Specifically, despite some differences in cultivation of specific crops, the patterns of crop cultivation were broadly similar, and cultivation of HVA as a whole was similarly low in both the treatment and the comparison areas at baseline. Similarly, few farmers in either treatment or comparison areas used irrigation at baseline. Farm profits—the key outcome that the THVA project aims to affect—were also similar, though household income was significantly higher in the comparison areas. Although it will be important to control for observed baseline differences when estimating final impacts, the differences we identified are not large enough to suggest that comparison areas would likely experience vastly different changes in outcomes unrelated to the THVA project. Therefore, based on this evidence, the comparison group design seems to be plausible.

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.

We plan to conduct supplementary analyses that will include border areas together with the treatment group. Specifically, we will compare changes among farmers in treatment and border areas to changes in the comparison areas; these impacts are the most relevant for computing the ex-post ERR 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.) Our analysis of the 2013–2014 FOS data suggests that the combined treatment and border area sample was similar to the comparison area sample at baseline; therefore, impact estimates based on this approach are likely to be valid.

2. Analysis approach

a. Estimating the impacts of the THVA project

We will estimate the impact of the THVA activities on key outcomes using the following ordinary least squares regression model, applied to a sample of farm plots in the treatment and comparison areas:

$$(1) \quad y_{ij,post} = \alpha + \delta y_{ij,pre} + \varphi' X_{ij} + \pi' Z_j + \lambda_j + \beta T_j + \mu_j + \varepsilon_{ij}$$

where $y_{ij,post}$ is the outcome of interest (for example, cultivation of high-value crops) for plot *i* in CIS area *j* at follow-up; $y_{ij,pre}$ is the outcome for the same plot at baseline; X_{ij} and Z_j are vectors of baseline plot and CIS characteristics, respectively, that might be related to the outcome of interest; λ_j is a stratum fixed effect, estimated using a vector of binary indicators, one for each matched group of CIS areas; T_j is a binary variable equal to one if the plot is located in a treatment area and zero otherwise; μ_j is a CIS-specific random error term; and ε_{ij} is a plot-specific random error term.

The parameter of interest in Equation (1) is β, which gives the estimated average impact of the THVA project on the outcome. This regression model enables us to account for the features of the sampling design (described below), specifically the allocation of the sample by treatment-comparison strata, through the inclusion of λ_j. In addition, because the unit of intervention is the CIS area, we will account for the fact that outcomes in the same CIS areas are likely correlated when estimating the standard error for the difference β (this correlation is shown by the CIS-level error term, μ_j).

Because the THVA project is likely to affect the productivity of land even if the farm operator changes over time, the analysis will primarily focus on estimating changes in outcomes for a group of farm plots (based on the outcomes of the operators of these plots at a given point in time).[9] However, outcomes for the prerehabilitation owners of these plots could also be affected by the project, 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 operation in the listing data (see below), we will also conduct a supplementary analysis to estimate treatment-comparison differences for a sample of individuals who owned sampled plots before rehabilitation (in the 2013 agricultural season).[10]

[9] Some outcomes will be at the plot level (for example, hectares irrigated), and others will be at the operator level (for example, household income). For operator-level outcomes, we will estimate regression (1) using the outcome for each unique operator in the sample as the dependent variable (we will adjust the analysis weights to account for operators that operate multiple plots in the sample). The impact estimates for operator-level outcomes can be interpreted as applying to the operator of the average plot in the treatment CIS areas.

[10] To identify the sample for this supplementary analysis—if we determine that it is necessary—we would select a random subset of the farm plots sampled for the primary analysis. We would then determine who owned those plots in the 2013 agricultural season, and attempt to interview these original owners at follow-up (some of them would still be operating the plot at follow-up, and would already have been interviewed as part of our primary plot operator sample).

We will estimate two sets of results for each outcome—the first will exclude the border areas, and the second will include them together with the treatment group. The effect of including the border areas on the impact estimates is ambiguous. On the one hand, not all border area farmers are able to be served by the rehabilitated irrigation system (because the system has limited capacity), and those who do want to connect to the system will have to make additional investments. Because only some border area farmers will benefit from improved irrigation, including our sample of border area farmers (which is representative of all 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. If the results with and without the border area farmers are very different, it will be important to explore the reasons for smaller or larger impacts through the qualitative data described below.

b. Analysis of changes in land ownership and operations

The THVA project is expected to affect land ownership and leasing patterns in the CIS and border areas (Question 4). For instance, small land owners might sell or rent their land to large producers who are better positioned to take advantage of the improved irrigation (for example, because they are able to make the necessary investments in irrigation equipment, or to invest in new crops). This could lead to consolidation of land plots under a smaller number of operators. Alternatively, small land owners who are leasing their land to others might be encouraged to return to farm their land, leading to more fragmentation (or simply changes in operation).

We therefore also intend to analyze the change in land ownership and operations. Using a census (listing) of plots with owner and operator information, we will analyze changes over time in the treatment and border areas in terms of: (1) the total number of owners in each area, (2) the total number of operators in each area, (3) the distribution of farms in each area by farm size, and (4) the percentage of plots that are owner-operated. These changes can be compared with those in the comparison areas using the comparison group design to determine the extent to which they are related to the THVA project, rather than reflecting general trends in Moldova. The listing of plots will be conducted immediately before each follow-up round of the FOS, and will also be used to identify the current operators of the sampled plots—the individuals whom we will attempt to survey.

c. Interpretation

Because some THVA activities and sub-activities are not confined to the targeted CIS areas, the estimates described above should be interpreted with caution. Specifically, they should be interpreted as the impacts of the package of THVA activities implemented in treatment areas relative to the impact of the activities taking place in comparison areas. Some of these activities might be available in both areas, but the impacts could still be larger in the treatment group because many activities are implemented in just treatment areas and because of complementarities between activities.

For example, AAF loans were, for part of the implementation period, available to enterprises in both treatment and comparison CIS areas. However, because of complementarities between investments in HVA as a result of improved irrigation and access to post-harvest infrastructure as a result of AAF loans, the impact of AAF loans might be substantially larger in treatment areas.

Similarly, although 2KR financing is available throughout Moldova, farmers in the treatment CIS areas are likely to be best-positioned to make irrigation-related investments because they are expected to have access to reliable and affordable irrigation water. Furthermore, although many of the GHS sub-activities could affect producers nationwide, they might be expected to be particularly beneficial for farmers transitioning to HVA in the treatment areas, resulting in a larger impact of GHS. The overall estimate of the THVA project will therefore reflect these larger impacts of AAF loans, 2KR financing, and GHS, as well as the impacts of ISRA-CISRA, which are more specifically focused on the treatment rather than the comparison areas. This estimate is relevant because it reflects the impact of the full THVA project, including all the complementarities that were intended when the project was designed.

3. Data sources

a. Farm operator survey

The primary quantitative data source for the impact evaluation is the Farm Operator Survey (FOS), which is a survey of farm households or farms that operate in the treatment CIS areas, comparison CIS areas, or border areas. The sample of farms is drawn from a list of all farms that operate plots in these areas. Before sampling, farms are categorized by size, including land both inside and outside the CIS command area. Because relatively few medium (10–100 ha) and large (>100 ha) farms operate in these areas, the FOS collects data for all medium and large farms in these areas, as well as a representative sample of small (<10 ha) farms. The small farm sample was randomly selected from the list of all small farms in each area, with the number of farms selected depending on the number available in the area and its random assignment stratum. With appropriate weighting adjustments, the sample is representative of all farms in each of these areas.[11] To focus more specifically on land inside the CIS areas (or border areas), and to enable us to follow land plots over time, we also randomly selected one plot per selected farmer (up to three plots per large farmer) inside the relevant CIS area (or border areas).[12,13] The FOS will follow each of these plots over time, even if the plot is operated by a different farmer. Again, with appropriate weighting adjustments, the sample is representative of all plots in each of these areas.

The 2013–2014 FOS relied on two questionnaires: one for small and medium farms, and another (very similar) questionnaire for large farms, which are typically operated as businesses. The 2013–2014 FOS collected data on basic household/farm characteristics, together with a

[11] In two of the treatment CIS areas, 3-2 Blindesti and 6-6 Chircani-Zirnesti, we conducted sampling within subareas of the overall command area (upper and lower Blindesti and specific modules within Chircani-Zirnesti). This ensured that the sample was representative of each subarea, enabling us to estimate outcome levels for each subarea of interest (upper and lower Blindesti and the part of Chircani-Zirnesti that will be rehabilitated by MCC).

[12] We sampled multiple plots for large operators because, although there were few large operators, they accounted for a large fraction of plots in these areas.

[13] 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 lead us to omit large parts of the border area. 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.

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 (Table IV.3). Because the farmers operating plots in the CIS areas (and border areas) can cultivate land both inside and outside the CIS areas (or border areas), the 2013–2014 FOS gathered some information separately for the cultivated land inside these areas, to the extent possible.[14] For example, the survey gathered information on cultivation of HVA crops on the land inside these areas, but information on farm expenditures for all cultivated land together. The FOS also gathered plot-specific information for outcomes such as rent, cultivation, and irrigation. The content of the survey instruments for the follow-up rounds of the FOS is still to be determined; as we describe below, these surveys could be similar to the 2013–2014 survey or more concise versions that focus primarily on medium-term outcomes such as irrigation and cultivation of HVA crops.

Table IV.3. FOS 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

[14] As a legacy of the land privatization that took place in the 1990s, Moldovan farmers often cultivate multiple, noncontiguous plots of land that are typically less one hectare in size. When land was privatized, 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 and fields were not contiguous).

Module	Key topics covered
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; FOS = farm operator survey; HVA = high-value agriculture; WUA = water user association.

The 2013–2014 round of the FOS will serve as the baseline for the evaluation. This round was conducted between January and March 2014, and captured outcomes from the 2013 agricultural season. Although some of the THVA activities were already underway at this point, the irrigation system rehabilitation—which is expected to interact with other activities to drive changes in treatment areas—had not been completed as of the time of the survey. Further, there is no evidence from the 2013–2014 data of any substantive treatment-comparison differences in cultivation, farm profits, or other key outcomes which could have reflected changes in treatment areas in anticipation of rehabilitation (for example, large investments in seedlings). There was also no indication from these data or from qualitative data collected around the same time that the 2013 season was a particularly atypical year in terms of external conditions, such as drought. Therefore, we believe that the 2013–2014 round is an appropriate baseline for the evaluation.

An earlier round of the FOS, conducted in 2012–2013 (capturing outcomes from the 2012 agricultural season), was originally intended to be the baseline for the 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 WUAs. In theory, the 2012–2013 round could also be combined with the 2013–2014 round to examine trends in key outcomes over time. However, most key outcomes were either similar in the two rounds (for example, irrigation and HVA cultivation were limited in both years) or were measured differently, making comparisons challenging (for example, the questions on production and sales were much more detailed in 2013–2014, making it difficult to compare farm profits). Further, the samples in the two rounds are not comparable because they reflect different CIS area boundaries. Therefore, any trend analysis using the 2012–2013 data would require many caveats, and is likely to be of limited value.

Another round of the FOS was conducted in 2014–2015, focusing on the 2014 agricultural season and farmers' plans for the 2015 and 2019 agricultural seasons (especially related to irrigation and HVA cultivation) in treatment areas. This round was designed to inform the external final program review conducted as part of the compact close-out. Because this round was conducted in treatment areas only, it will not play a significant role in the impact evaluation. Nevertheless, it provided useful descriptive information on perceptions of project activities and farmers' future plans in treatment areas close to the end of the compact. By combining these data with the 2013–2014 round (which used the same sample of treatment area plots and comparable although not identical survey questions), we were also able to estimate trends in key outcomes such as irrigation and HVA cultivation over time which we presented to stakeholders in Moldova in May 2015. The findings from the 2014–2015 FOS will also help inform the performance evaluation—for example, by highlighting farmers' opinions that can be further probed in future qualitative work.

We propose up to two additional rounds of the FOS to serve as the follow-up for the evaluation: the first in 2018–2019 (covering the 2018 agricultural season), and the second in 2020–2021 (covering the 2020 agricultural season). Collecting data in 2018–2019 and 2020–2021 will enable us to measure the impact of the THVA activities after several postrehabilitation seasons. In 2018–2019, all systems will have experienced three full postrehabilitation agricultural seasons; in 2020–2021, all systems will have experienced five full postrehabilitation agricultural seasons. As mentioned above, the data collection will focus on the sampled plot at a given point in time (even if the operator has changed); if changes in farm operators are widespread (for example, because of land consolidation), data will also be collected from an additional sample of individuals who owned the sampled plots at baseline.

We recommend these follow-up intervals because they provide sufficient time for most impacts to manifest. For example, we will be able to observe how WUAs function—in terms of membership, financial status, and management—after they have been managing the system for several years. Farmers will also have had sufficient time to react to the improved access to irrigation water in terms of their irrigation and cultivation decisions and they will have had some experience in using the system. It would also allow time for changes in cultivation and irrigation to have manifested in terms of production and sales. Based on the projections in the ex-ante project ERR, about 74 percent of the total expected increase in irrigated land in the treatment and border areas would have taken place by 2018, and about 86 percent by 2020 (the increase is only expected to be fully complete by 2027). Therefore, changes in most of the medium-term outcomes in the program logic such as irrigation, HVA cultivation, and sales should have largely manifested by this time, and some changes in longer-term outcomes related to income might have also begun to manifest.

Including a second follow-up round will provide additional time for the medium- and long-term outcomes to manifest, inform the research questions related to long-term sustainability, and mitigate the possibility of an external shock that could affect the 2018–2019 results (for example, a drought). Collecting the second follow-up data in 2020–2021 rather than in 2019–2020 will increase the time available for outcomes to manifest and will be more useful in case there are multiyear shocks (for example, changes in access to export markets).

It is important to ensure that both of the proposed follow-up rounds are informative for the evaluation and justify the resources that they will require. Because it would be very costly to conduct and analyze two surveys with a similar level of complexity to the 2013–2014 baseline FOS, our primary recommendation consists of a more concise follow-up survey in 2018–2019 to capture medium-term outcomes (such as irrigation use and HVA cultivation) and a more extensive follow-up survey in 2020–2021 to capture medium-term as well as longer-term outcomes (such as farm profits). However, to ensure that this proposal will best serve the needs of the evaluation, we propose to use the following sources of information to inform a final decision on the number of follow-up rounds, their timing, and the nature of the data that will be collected:

- **WUA administrative data.** We intend to examine WUA administrative data to determine whether changes in the area of land that is irrigated—a key medium-term outcome—are substantial at the end of the 2018 agricultural season.

  If changes in irrigated land are small by 2018, few other changes are likely to have manifested, and conducting a follow-up round in 2018–2019 would be of limited value. In this case, we would recommend not conducting this follow-up round, and revisiting the WUA data at the end of the 2020 agricultural season. If changes in irrigated land are still small at that point, a concise survey instrument could be used to document the limited impacts on medium-term outcomes such as irrigation use and HVA cultivation. On the other hand, if changes in irrigated land based on the WUA data are more substantial by 2020, a more extensive survey instrument (similar to the 2013–2014 baseline instrument) that includes information on sales, revenues, and farm profits would be appropriate.

  On the other hand, if the changes in irrigated land based on WUA data are substantial by 2018, we would implement our primary recommendation, conducting a concise survey in 2018–2019 to capture impacts on medium-term outcomes, and a more extensive survey in 2020–2021 to also capture impacts on longer-term outcomes such as profits. (The alternative would be to conduct two extensive follow-up surveys in 2018–2019 and 2020–2021, which would be more costly, or a single extensive follow-up round in 2018–2019, which might not fully capture the long-term impacts of the project).

- **External conditions.** Farmers can face variable external conditions in any given year—including weather and market conditions—and it may be difficult to identify a "typical" year for agricultural production. Conducting two follow-up rounds (and two years apart) will help to smooth some of this variability. Nevertheless, we may learn through our local data collectors and consultants that one of the proposed follow-up years is so atypical that it will limit the value of the results. If we receive such information prior to the planned surveys, we will consider delaying the respective surveys (assuming that the shocks are transitory).

- **Potential spillovers in comparison areas.** The demonstration effect of ISRA-CISRA could encourage the establishment of WUAs in some of the comparison CIS areas and the rehabilitation of some of the comparison systems by other donors. This could compromise the validity of the comparison group as a counterfactual and bias the impact estimates. However, this is not likely to be a concern, since it would take some time for WUAs to be established, systems to be rehabilitated, and farmers to modify their behavior. If it does occur, it would not likely occur before the 2020–2021 round and, even then, only in a subset of the comparison systems. Through local consultants and qualitative interviews with Apele

Moldovei staff (who would be involved in any management transfer to new WUAs) in 2017 and early 2020, we will assess the extent to which these spillovers are likely to occur by 2020. If they are widespread, we will consider the nature of these spillovers and the areas in which they occurred in the interpretation of the findings from the 2020–2021 round.

In sum, our primary recommendation consists of a concise follow-up survey in 2018–2019 and a more extensive follow-up survey in 2020–2021. However, at the end of the 2018 agricultural season, we will use available information to determine whether the 2018–2019 survey should be cancelled (if the WUA data show only small changes in irrigation) or delayed (if 2018 is a particularly atypical year). Further, at the end of the 2020 agricultural season we will use available information to determine whether the 2020–2021 survey should involve a more concise instrument (if the WUA data or the 2018–2019 analysis show only small changes in irrigation), be delayed (if 2020 is a particularly atypical year), or be interpreted more cautiously (if spillovers to some comparison areas have occurred). By maintaining flexibility to adjust to updated information in the planning of the follow-up surveys, we will be able to optimize the use of evaluation resources while still addressing the key research questions to the extent possible.

b. Farm operator survey listing

Before conducting each round of the FOS, a full listing of all plots in each treatment, border, and comparison area will be conducted; the listing will include information on the plot owner and operator, as well as the size of the farm. Because the impact analysis relies on following the same land plots over time, this listing is important to identify the current operator of each plot for the FOS. These data can also be used for the analysis of ownership and operation patterns and how these change over time, as we describe above.

4. Sample size and statistical power

The sample size for the impact evaluation was selected to satisfy two criteria. First, it had to provide sufficient statistical precision for the estimated impacts on key outcomes, which will be calculated by comparing the changes in outcomes in treatment and comparison areas. The overall sample size has a limited effect on statistical precision for the impact estimates because of the correlation in outcomes within CIS areas (which are fixed at 10 treatment and 11 comparison areas). Nevertheless, it is important to understand the magnitude of the impacts that a given sample size will enable us to detect. Second, the sample size had to yield relatively precise estimates of levels of key outcomes (or pre-post changes in these outcomes) for each treatment CIS area (and, for 3-2 Blindesti and 6-6 Chircani-Zirnesti, for subareas of a treatment CIS area). Although not required for the impact evaluation, MCC and MCA-Moldova expressed strong interest in these CIS-specific estimates. Based on these considerations, we selected a sample of about 4,000 farm operators (2,398 in treatment CIS areas, 1,001 in comparison CIS areas, and 547 in border areas) (Table IV.4).

Table IV.4. 2013–2014 FOS sample frame and initial sample

	Farm operators in 2013–2014 sample frame			Farm operators in 2013–2014 initial survey sample[a]		
CIS	Small	Medium	Large	Small	Medium	Large
Treatment command areas[b]						
3-2 Blindesti (upper)	107	5	4	75	5	4
3-2 Blindesti (lower)	22	2	2	22	2	2
3-6 Grozesti	916	1	1	270	1	1
5-4 Leova Sud	293	5	6	165	5	6
6-6 Chircani-Zirnesti (rehabilitated)[c]	404	15	8	200	15	8
6-6 Chircani-Zirnesti (nonrehabilitated)[c]	277	9	1	55	9	1
11-6 Jora de Jos	509	9	3	220	9	3
11-7 Lopatna	449	8	1	210	8	1
12-3 Cosnita	2,475	12	6	330	12	6
14-2 Criuleni	323	9	7	175	9	7
14-11 Puhaceni	2,790	17	3	331	17	3
14-13 Roscani	378	19	2	190	19	2
All treatment areas	**8,943**	**111**	**44**	**2,243**	**111**	**44**
Border areas[b]						
3-2 Blindesti	582	16	5	117	16	5
3-6 Grozesti	193	5	1	39	5	1
5-4 Leova Sud	463	9	6	93	9	6
6-6 Chircani-Zirnesti	89	4	3	18	4	3
11-6 Jora de Jos	29	1	4	15	1	4
11-7 Lopatna	82	1	1	17	1	1
12-3 Cosnita	95	1	0	19	1	0
14-2 Criuleni	93	4	4	19	4	4
14-11 Puhaceni	338	1	3	68	1	3
14-13 Roscani	365	15	1	73	15	1
All border areas	**2,329**	**57**	**28**	**478**	**57**	**28**
Comparison command areas						
2-4 Braniste	363	4	7	33	4	7
3-7 Balauresti	1,585	16	1	94	16	1
4-1 Cotul Morii	1,422	11	3	56	11	3
6-2 Sistemul de Irigare 1	1	1	2	1	1	2
6-3 Sistemul de Irigare 2	10	5	2	10	5	2
6-4 Sistemul de Irigare 3	16	1	2	16	1	2
6-7 Larga	218	10	3	108	10	3
14-1 Holercani	789	15	7	129	15	7
14-4 Cosernita	41	3	2	15	3	2
14-5 Puhacenii de Sus	1,830	51	21	298	51	21
14-12 Mereni	792	3	6	65	3	6
All comparison areas	**7,067**	**120**	**56**	**825**	**120**	**56**

[a] The number of completed surveys in 2013–2014 was smaller than this initial survey sample because of survey nonresponse.

[b] Sixteen 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).

[c] The rehabilitated module sample only includes the modules that MCC planned to rehabilitate as of late 2013. However, (a) rehabilitation plans might change, and (b) some of the nonrehabilitated modules might be rehabilitated through other methods.

CIS = centralized irrigation system; FOS = farm operator survey.

The 2018–2019 and 2020–2021 follow-up rounds will include interviews with the operators of the plots selected at baseline. Making assumptions about survey sample attrition, we can

estimate the minimum detectable impacts (MDIs)—the smallest impacts on key outcomes that our design will be able to distinguish statistically from zero (Table IV.5).[15]

Although the THVA project ultimately seeks to improve household well-being, measured by outcomes such as income, we are also interested in detecting impacts for more 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 FOS, 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 not implausible that we would observe impacts of this magnitude. For example, based on the March 2015 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.[16]

To answer some of the research questions, 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.

[15] As discussed above, we will estimate impacts with and without the border areas. The MDI calculations in Table IV.4 apply to the estimates without border areas; including this relatively small sample does not substantively affect the MDI calculations.

[16] 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.

The MDI for farm profit per hectare is $304 per hectare, from a negative baseline mean of $116 per hectare. (We focus on farm profit per hectare to account for variability in farm size; farm profit itself is 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 profit—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.

Table IV.5. Minimum detectable impacts for the THVA project evaluation

	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 (FOS), THVA evaluation sample.

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 FOS. 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 FOS, 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 FOS 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.

5. Updating the project ERR

We will use estimates from the impact evaluation to compute the primary expected benefit stream from the project, namely the increased farm profits resulting from increased production and sales of HVA crops. Specifically, we will use our estimate of the impact of the project on farm profits per hectare from the 2020–2021 follow-up survey.[17] By multiplying this estimate by the total land area in the treatment CIS areas (and border areas), we will be able to estimate the total benefits of the project in the 10 rehabilitated systems in 2020.[18]

We will combine the estimated benefits with estimates of project costs from MCC's ERR model to compute an updated project ERR (to address Question 8). We will include all costs related to ISRA-CISRA, which represent the largest share of THVA project costs. The ISRA-CISRA costs include the costs of system rehabilitation (the costs of the rehabilitation design, construction supervision, and the construction itself), other implementation costs (the costs of the resettlement action plan to compensate land users for disruption due to construction, ISRA implementation and support, and start-up support for WUAs), and MCA administrative costs associated with ISRA-CISRA (computed as a percentage of the total compact administrative costs, based on the proportion of total compact funding represented by ISRA-CISRA).[19]

The extent to which the costs of GHS and AAF should be included is less clear, because many components of these activities had a broader geographic scope and may have affected comparison areas, as well. Nevertheless, the impact estimates will capture the components of GHS and AAF that were unique to the treatment areas (such as the GHS CIS area training), as well as the interactions of these activities with ISRA-CISRA in the treatment areas (which may have contributed to the impact estimates). Therefore, it is appropriate to include a portion of the GHS and AAF costs in the ERR calculation; however, it is challenging to accurately estimate the correct proportion. Therefore, we will impose bounds on the ERR estimates by excluding (to estimate an upper bound ERR) or including (to estimate a lower bound ERR) the full costs of these activities. Because they are a relatively small component of the overall project costs, we do not expect including them to have a large impact on the ERR estimates, even if we include the full costs.

Some caution will be necessary in using the parameter estimates from the impact evaluation to update the ERR, for two main reasons. First, as we describe above, we have limited statistical power to detect impacts on the key outcome required to update the ERR—profits per hectare.

[17] As described earlier, we will focus on estimating impacts for this per-hectare measure (profits per hectare) rather than the overall measure (total profit) because the latter is highly variable and therefore results in very statistically imprecise impact estimates.

[18] Because our impact evaluation is only designed to estimate impacts for all ten rehabilitated systems as a whole, we will not be able to produce ex-post estimates of benefits or the ERR by system.

[19] The ERR model also includes costs associated with irrigation system operations, maintenance, and repair, as well as costs associated with on-farm irrigation (including the purchase of irrigation equipment, its maintenance, and the use of labor for irrigation). We will capture costs associated with irrigation system operations, maintenance, and repair by including irrigation-related fees in our measure of farm profits—under the assumption that WUAs are zero-profit entities, these should capture each farmer's share of these costs. We will also capture costs associated with on-farm irrigation in our measure of farm profits by measuring capital investments since rehabilitation, as well as annual maintenance costs and use of hired labor.

Therefore, the required parameters might be imprecisely estimated. Second, because of discounting, the benefits in the years immediately following rehabilitation make an important contribution to the ERR (even though the benefits will have only partly manifested), whereas we will only be able to provide estimates of impacts on profits five seasons after rehabilitation. Therefore, the updated ERR model will require an assumption of how changes in profits evolved immediately after rehabilitation, on which we will have limited information. Annual WUA administrative data on changes in irrigation, qualitative data collected in 2017, and quantitative data on changes in irrigation and cultivation from the 2018–2019 FOS might provide some information on the likely trajectory of farm profits.

These challenges suggests that it will be important to conduct sensitivity checks of the results. For example, we could reestimate the ERR using the upper and lower confidence interval bounds for the parameters to get a sense of the possible range of the ERR. We could also explore the effect of different assumptions regarding the evolution of the trend in profits over time. As mentioned above, we will also explore the sensitivity of the ERR to including GHS and AAF costs. We will then be able to use the range of estimated ERRs to assess the extent to which the original ERR was broadly consistent with the true returns of the project.

C. Performance evaluation component

The performance evaluation component of the evaluation will primarily enable us to assess whether some of the outcomes not captured in the impact evaluation (such as improved management of the CIS areas) were realized (Question 1), explore why desired outcomes were or were not achieved (Question 2), understand the interaction between different activities and assess which of these drove the quantitative impact estimates (Question 3), determine the likely long-term sustainability of the outcomes achieved (Question 6), and establish lessons learned (Question 7). It will also provide information relevant to the analysis of changes in ownership, leasing, and land values (Question 4), the distribution of project results (Question 5), and the project ERR (Question 8), although these questions will be answered primarily by the impact evaluation.

The performance evaluation 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 loan borrowers, administrative data, and a document review. The performance evaluation will answer the key research questions by 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.

1. Existing qualitative data

Qualitative data 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 will also provide valuable information specifically related to the GHS activity.

Different stakeholders were included in each round (Table IV.6). In all three rounds, stakeholders included farm operators, village mayors, and WUA executive directors in treatment CIS areas. Information from these stakeholders enabled us to better understand the experiences of farmers in these areas related to farm production (including production of HVA), access to and use of irrigation, awareness and perceptions of project activities, interactions with and activities of WUAs, and other topics. The 2013 qualitative data collection effort included five treatment areas and two comparison areas. The 2014 effort and 2015 effort included all 11 treatment CIS areas to enable us to better understand the diversity of experiences, perspectives, and implementation progress across all the treatment areas. MCA-Moldova's data collection contractor prepared a report summarizing the findings in each year (ACT Research 2013a, ACT Research 2014a, ACT Research 2015a).

Table IV.6. Existing qualitative data collection activities

Respondent	Number and location 2013	2014	2015	Key areas of focus
Conducted in CIS areas				
Small farm operators (FG) Medium-large farm operators Village mayors	5 T, 2 C 5 T, 2 C 5 T, 2 C	11 T 11 T 11 T	11 T 11 T 11 T	- Patterns of irrigation, cultivation, sales, and post-harvest practices, and barriers to change - Awareness and perceptions of WUAs - Awareness and perceptions of CISRA - Expected changes in irrigation and production
WUA executive directors WUA officials WUA sector representative (FG)	4 T[a] 6 T[a] --	11 T 11 T --	11 T -- 10 T	- Status and perceptions of ISRA - Perceptions of WUA sustainability - Status and perceptions of CISRA - Expected changes in irrigation and production
GHS CIS area training participants (FG)	--	--	2 T	- Perceptions of CIS area training - Intended adoption of training practices and perceived benefits
Other informants related to ISRA-CISRA				
ISRA contractor	2	--	--	- Implementation and status of ISRA - Perceived successes and challenges - Perceptions of WUA sustainability
Apele Moldovei	2	--	--	- Role in and perceptions of management transfer to WUAs - Perceptions of WUA sustainability
Construction companies	--	2	--	- Job creation due to construction - Disturbances in local communities due to construction, and steps to communicate and mitigate these
Informants related to the GHS activity				
Small farm operators in communities and value chains targeted for GHS value chain trainings (FG) Medium/large farm operators in communities and value chains targeted for GHS value chain trainings Mayors in communities targeted for GHS value chain trainings	3 4 3	-- -- --	-- -- --	- Challenges in cultivation and sales of targeted crops - Use of and attitude towards product upgrading practices - Awareness of, participation in, and perceptions of GHS value chain trainings (or reasons for not participating) - Intended adoption of training practices and perceived effects
GHS contractor	--	3	--	- Implementation of GHS value chain trainings, and perceived successes and challenges

Respondent	Number and location			Key areas of focus
	2013	2014	2015	
Value chain buyers (domestic)	--	5	--	- Experiences of purchasing and selling HVA crops - Awareness and perceptions of GHS value chain trainings
Regional training service providers	--	11	--	- Role in and perceptions of GHS value chain trainings
Agroinform	--	1	--	- Current and planned provision of extension services
National Agency for Rural Development (ACSA)	--	1	--	- Perceptions of GHS value chain trainings
Foreign buyers	--	--	5	- Experience of purchasing Moldovan crops and perceptions of these crops - Participation in and perceptions of GHS assistance to establish market linkages with Moldova - Expectations regarding the Moldovan HVA market
Beneficiaries of GHS technical assistance	--	--	10	- Participation in and perceptions of technical assistance - Perceived benefits of technical assistance

[a] The WUA in one of the five treatment CIS areas included in this round did not have an executive director in position; therefore, we interviewed two officials in this CIS area instead.

FG = Focus group; interview unless otherwise specified.

CIS = centralized irrigation system; GHS = growing high-value agricultural sales; WUA = water user association; T = Irrigation Sector Reform Activity and Centralized Irrigation System Rehabilitation Activity (ISRA-CISRA) treatment CIS area; C = ISRA-CISRA comparison CIS area

The 2013 round of qualitative data collection also captured information from the ISRA contractor, which focused on the status of WUA formation and management transfer, as well as the challenges faced; it also included interviews with Apele Moldovei personnel that focused on the transfer of water rights to WUAs under ISRA. In keeping with the progress of the activities, the 2014 round included interviews with construction companies responsible for the rehabilitation of the irrigation systems, focusing on job creation due to the activity, disturbances that farmers face due to construction, communication with local residents, actions taken to minimize negative impacts on farmers and maintain positive community relations, and other topics. The 2015 round included focus groups with WUA sector representatives to explore issues such as their overall experiences with ISRA-CISRA implementation, their perceptions of the WUA model and its likely sustainability, and expected changes in irrigation and production in the treatment areas. This round also included focus groups with participants of GHS CIS area trainings in the two CIS areas in which trainings had been conducted (as of the beginning of 2015); these focus groups aimed to understand the influence of these trainings on farmers' practices and their expected impacts.

The qualitative data also captured information related to the GHS activity. The 2013 round focused on the GHS value chain training subactivity, and included focus groups and interviews with farmers in communities and value chains targeted for the trainings, as well as mayors in these communities, to explore the challenges faced in production and sales in the value chain, farmers' experiences with training (or reasons for not attending training), and their use of agricultural practices. The 2014 round included interviews with several other stakeholders related to the GHS activity, including with Development Alternatives, Inc. (the GHS implementer), value chain buyers, regional training service providers, and officials at Agroinform and ACSA—again, these focused mainly on the GHS value chain training subactivity.

The GHS component of the 2015 round reflected a broader focus—beyond the value chain training subactivity—and included foreign buyers and beneficiaries of GHS technical assistance. Foreign buyers provided a perspective on the perceptions of Moldovan produce abroad and any changes in that perception over time. Beneficiaries of technical assistance described what kinds of assistance they received and how it influenced their outcomes. MCA-Moldova's data collection contractor also prepared a report summarizing these GHS-related findings in each year (ACT Research 2013b, ACT Research 2014b, ACT Research 2015b).

2. Additional qualitative data collection plans

To inform the research questions, we propose four additional rounds of qualitative data collection, taking place in 2015, 2017, 2020, and 2022. The upcoming 2015 round will include interviews with high-level stakeholders focused on implementation and sustainability and will occur in the fourth quarter, after the compact has closed.[20] To minimize the burden on respondents, we plan to use the information from the mid-2015 final program review report (which included interviews with many of the same stakeholders) to the extent possible, and will only gather information that is not available in that report. The 2015 round will also gather

[20] The exception to this timeline is interviews with businesses that did not apply for AAF credit and commercial banks, which are occurring in the third quarter of 2015.

information from 2KR to better understand the relatively new hire-purchase program and how to best capture its effects (for example, whether the scale of the investments is likely to be sufficiently large to be captured in the FOS follow-up rounds). The 2017 round will include farmers, WUA officials and staff, and local government authorities and 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 WUAs 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 2017 round will also gather additional data related to 2KR, which will continue to operate in the post-compact period, as well as beneficiaries of GHS technical assistance and extension service providers.[21] 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.[22] The timing of these last two rounds is designed to follow the quantitative data collection through the FOS, and will therefore complement the impact analysis. Table IV.7 shows the proposed respondents and key areas of focus for the qualitative data collection.

Multiple rounds of qualitative data collection are necessary to ensure that we are able to fully answer the key research questions. Conducting the 2020 and 2022 qualitative rounds a year after the respective FOS follow-up rounds—once preliminary impact analysis is complete—will enable us to focus the qualitative data collection on topics that will help interpret impact findings. (Even if we determine that, because of limited changes in irrigation, a 2018–2019 FOS is not justified, a 2020 round of qualitative data will still be valuable to understand the reasons for these limited changes). The 2017 round will be used to understand how changes evolved between the end of the compact and the follow-up rounds. Without this round, there is a risk that we will not be able to capture key events or mechanisms that influenced outcomes. Finally, the late 2015 round will enable us to document the final status of implementation at the end of the compact, before some of the key stakeholders cease to operate (MCA-Moldova) or move on to other countries and projects (the ISRA and GHS implementers). This is an important component of the evaluation because the realization of medium- and longer-term outcomes in the program logic will be directly affected by the successes and challenges of implementation.

[21] If related projects are implemented in the post-compact period, we also expect to include the implementers of those projects in qualitative data collection.

[22] Although CIS 6-9 Cahul will not be rehabilitated through the compact, we intend to include it in most of the CIS-specific qualitative data collection (data collected from farmers, WUA officials and staff, and village mayors) through 2021. This will enable us to explore how the WUA in Cahul evolved and the extent to which this system was able to attract alternative investments for rehabilitation. If we learn about other systems in which WUAs were created and/or were rehabilitated following MCC's model, we will also gather data from those systems to understand the role of the THVA project in prompting these changes.

Table IV.7. Key areas of focus for qualitative data collection in 2015, 2017, 2020, and 2022, by respondent

Respondent	2015	2017	2020	2022	Key areas of focus
Farmers in treatment CIS areas		X	X	X	- Whether the WUA is functioning well and whether it will be sustainable - Changes in irrigation, farm production, sales, land ownership, leasing, land values, and other outcomes - Ongoing barriers to irrigating and transitioning to HVA - Why expected outcomes have not materialized (if applicable) - Perceptions of the contribution of different THVA activities
Farmers in comparison CIS areas			X	X	- Changes in irrigation, farm production, sales, and other outcomes - Awareness of WUAs in other areas and interest in forming a WUA
Farmers in treatment border areas		X	X	X	- Involvement with the WUA in the treatment area - Whether the WUA is functioning well and whether it will be sustainable - Changes in irrigation, farm production, sales, land ownership, leasing, land values, and other outcomes - Ongoing barriers to irrigating and transitioning to HVA - Why expected outcomes have not materialized (if applicable) - Perceptions of the contribution of different THVA activities
WUA officials and staff		X	X	X	- Whether the WUA is operating well, challenges faced, and whether it will be sustainable - Coordination with Apele Moldovei and government ministries - Process used to allocate water through the permit system, and how well it is working - Changes in women's leadership roles in the WUA
Agricultural laborers in treatment CIS areas			X	X	- Changes in employment opportunities and wages in the agricultural sector
Local government authorities/mayors		X	X	X	- Whether the WUA is functioning well and whether it will be sustainable - Changes in irrigation, farm production, sales, land ownership, leasing, land values, and other outcomes - Ongoing barriers to irrigating and transitioning to HVA - Why expected outcomes have not materialized (if applicable) - Perceptions of the contribution of different THVA activities
MCA-Moldova and MCC	X				- Lessons learned from implementation - Extent to which expected outputs were achieved, and why - Perceptions of the likely contribution of and interaction between different activities - Perceived risks to achieving long-term outcomes
GHS contractor and USAID	X				- Lessons learned from implementation of GHS - Extent to which expected outputs were achieved, and why

Respondent	2015	2017	2020	2022	Key areas of focus
					- Perceptions of the interactions between GHS subactivities, and likely contribution of different GHS subactivities - Perceptions of the interactions between the GHS activity and other THVA activities - Perceived risks to achieving long-term outcomes
Apele Moldovei	X		X	X	- Whether WUAs are functioning well - Reasons for variation in WUA performance - Perceived risk to the sustainability of WUAs - Extent to which other WUAs have been formed and other systems are being rehabilitated[a]
ISRA contractor	X				- Lessons learned from implementation of ISRA - Extent to which expected outputs were achieved, and why - Whether WUAs are functioning well - Reasons for variation in WUA performance - Perceptions of the interactions between ISRA-CISRA and other THVA activities - Perceived risks to achieving long-term outcomes
Ministry of Environment	X			X	- Development of river basin management plans, and related challenges - Monitoring of water quantity and quality, and related challenges - Process used to allocate water through the permit system, and how well it is working
Beneficiaries of GHS technical assistance (including Moldova Fruct and other producer and export organizations)		X		X	- Experiences with GHS technical assistance - Perceived benefits of GHS technical assistance for the recipient and others in the value chain - Interaction with other GHS sub-activities and other THVA activities - Role in marketing, organizing exports, and facilitating cooperation among producers, and main challenges faced (if relevant)
Traders/intermediaries				X	- Changes in quantity and quality of produce, and prices - Changes in types of buyers and ability to meet buyer requirements
Foreign buyers				X	- Awareness and perceptions of Moldovan produce - Changes in contracts with Moldovan producers and purchases of Moldovan produce
Domestic buyers				X	- Changes in quantity and quality of produce, and prices
Exporters				X	- Changes in the regulatory environment and certification process - Changes in the quantity, type, season, and destination of exports - Remaining barriers to export - Interaction with GHS technical assistance recipients

Respondent	2015	2017	2020	2022	Key areas of focus
Ministry of Agriculture	X		X	X	- The broader policy environment (including subsidies) and extent to which the THVA approach is included in policy - The market for Moldovan produce, phytosanitary and other requirements for export, and remaining barriers to export - Perceptions of whether long-run outcomes are likely to be achieved - Lessons learned from implementation - Other investments or other changes in the agriculture sector over the implementation period or since - Contribution of different activities to outcomes
AAF beneficiaries			X		- Longer-term effects of AAF investments - Additional AAF-related investments made
Businesses that did not apply for AAF credit	X				- Lessons learned from implementation - The agricultural credit market environment - Barriers to agricultural credit
Credit Line Directorate	X				- How implementation of AAF changed over time, and lessons learned - AAF application and approval process
2KR beneficiaries		X	X		- Experiences with the 2KR program - Nature of investments in irrigation and HVA - Effects of the investments
2KR	X	X	X		- Extent and nature of investments in irrigation and HVA - Perceptions of effects of the investments and contribution to long-term outcomes
World Bank and the International Fund for Agricultural Development	X			X	- Nature and scope of investments in the agricultural sector - Awareness of and interaction with THVA activities (if any) - Perceptions of whether long-run outcomes are likely to be achieved - Perceptions of whether the THVA project had a significant impact on Moldova
Commercial banks	X				- The agricultural credit market environment - Perceptions of the contribution of AAF activity - Barriers to agricultural credit
ACSA and Agroinform	X	X		X	- How activities were affected by GHS activity during and after the compact, including whether methods or offerings changed - Whether ACED training materials have been used by other training providers - Perceptions of whether the THVA project had a significant impact on Moldova

AAF = Access to Agricultural Finance; CIS = centralized irrigation system; ACED = Agricultural Competitiveness and Enterprise Development Project; GHS = growing high-value agricultural sales; ISRA-CISRA = Irrigation Sector Reform Activity and Centralized Irrigation System Rehabilitation Activity; THVA = Transition to High-Value Agriculture; WUA = water user association.

[a] If we learn that other systems have formed WUAs and/or will be rehabilitated following the THVA model, we will also collect qualitative data from those systems to understand the nature of these activities and how they were influenced by the THVA project.

3. Quantitative data from borrowers

We will complement qualitative data related to the AAF loan program (including from banks and entities that did not receive loans) with a largely quantitative survey of borrowers. These data are being collected in mid-2015, after most of the loans have been disbursed. They will provide information on, for example, the financial situation of borrowers, the credit environment at the time of the AAF loan, experiences with applying for AAF credit, the investments for which the loan was used, and use of new post-harvest infrastructure or other investments. We also included a small number of open-ended questions to qualitatively capture issues such as the extent to which the borrowers would have made these investments without the AAF loans, and the challenges they have faced in making these investments (Table IV.8 summarizes the modules and topics for the AAF survey). The survey will be administered to all, or nearly all, borrowers through the AAF loan program.

Conducting the survey of AAF borrowers in mid-2015 will enable us to gather information before it is difficult for borrowers to recall relevant details (the first loan was disbursed in January 2012, about 42 months before the survey). For example, if we conducted the survey several years from now, it might be difficult for respondents to accurately report on their experiences with AAF, the extent to which the AAF credit line differed from other sources of credit at the time, and whether they would have made similar investments without AAF. Obtaining accurate information on these topics can help us understand the extent to which AAF may have affected the agricultural credit environment and contributed to project outcomes.

Although the planned timing of the survey will limit our ability to explore the long-term effects of the AAF-funded investments, we plan to gather some relevant information on these effects in several ways. First, we will ask beneficiaries in the AAF survey about their expectations for the future use of their investments, their expected profitability, and plans for future related investments. Second, we plan to include a small sample of AAF borrowers in later rounds of the qualitative data collection (as shown in Table IV.7), to explore these longer-term effects in more detail. Third, we will capture data on the use of AAF-funded infrastructure (such as cold storage) in the follow-up rounds of the FOS, which will be informative as to how broadly some these investments are being used, and by whom.

Table IV.8. 2015 AAF survey modules

Module	Key topics covered
Information about enterprises and respondents	Core business activities and location of activities (at the time of AAF loan application); ownership structure, number of owners, and whether female-owned (at the time of AAF loan application); number of hectares cultivated in 2014 (if relevant); crops and amounts cultivated or processed/stored in 2014 (if relevant); manager gender, age, education, and experience (at the time of AAF loan application); respondent gender and position in enterprise
Enterprise characteristics in the 2014 fiscal year	Value of sales, profits, investments, and total assets and liabilities
Employment in the 2014 fiscal year	Number of full-time employees, by gender (managerial and other positions); number of part time employees and person-days used, by gender
Pre-AAF infrastructure	Purpose of AAF loan; availability of, usage, and ownership of this AAF-related infrastructure in the area prior to 2012; barriers to using this infrastructure
Investments prior to AAF	Interest in agricultural investments in the three years prior to the AAF loan; purpose and estimated cost of desired investments; whether a loan was applied for; reasons for not applying for a loan (if relevant); reasons for rejected loan application (if relevant); for approved loan applications, details including date of approval, source of credit, loan size, collateral value, term, and interest rate; whether met scheduled repayments; extent to which planned investments were made
Credit environment at the time of the AAF loan	Available sources of credit for AAF-related investments and how they compared to AAF (size, interest rate, terms, and collateral requirements); other barriers to obtaining credit; other barriers to making AAF-related investments
Experiences with AAF loan	How borrower was informed about AAF; whether and how investment changed to meet AAF criteria; total cost of investment; other sources of credit considered and applied for, and amounts received (if relevant); reasons for applying to AAF; size and terms of loan; satisfaction with application, approval, and distribution process; whether meeting scheduled repayments and reasons for non-repayment (if relevant)
Investments after AAF	Interest in AAF-related investments since the AAF loan was approved; purpose and estimated cost of desired investments; whether a loan was applied for; reasons for not applying for a loan (if relevant); reasons for rejected loan application (if relevant); for approved loan applications, details including date of approval, source of credit, loan size, collateral value, term, and interest rate; whether met scheduled repayments; extent to which planned investments were made; plans for future AAF-related investments and sources of funding
Use of infrastructure supported by AAF loans	Whether infrastructure is completed and fully operational; number, type, and location of intended, current, and future users of infrastructure; income obtained and expected from infrastructure investment; expected profitability of investment
Qualitative discussion	Counterfactual in the absence of AAF; challenges faced in obtaining and using AAF credit; suggestions for AAF program improvement

AAF = Access to Agricultural Finance.

4. Administrative data

The evaluation might also draw on different available administrative data sources, including:

- **AAF loan applicant intake form.** All applicants to the AAF credit program were asked to complete the loan applicant intake form. In practice, most (or all) completed forms are from applicants who actually received AAF credit. The intake data provide information about the loan characteristics (such as size and purpose of the loan), amount and type of collateral, financial information, and credit history. These data will provide important background on borrowers at the time of their application.
- **Administrative data from 2KR.** 2KR will collect data on beneficiaries of the 2KR hire-purchase program, which will include background information about the beneficiaries (such as location, farm size, and crops cultivated), the value and nature of the equipment purchased through 2KR, and the status of repayments. These data will provide valuable information on the number and types of 2KR beneficiaries and the investments made under the program.
- **WUA administrative data.** Each WUA maintains records on the association's balance sheet, paid membership, revenues, source of revenue, staffing costs, energy usage, and financial stability over time, number of disputes, and regular meetings and minutes. These data have the potential to provide insights into the management and functionality of the WUAs, as well as their sustainability.

  The WUAs also collect data on irrigation usage and cultivation for each plot, and plan to continue to collect these data moving forward. It is not possible to use these data for the impact analysis because we do not have comparable data for comparison areas. Nevertheless, for treatment areas, the WUAs could potentially provide information on cultivation and irrigation for all plots, rather than just the sample that is provided by the FOS. As described earlier, these data could be valuable in planning the timing and nature of follow-up rounds of the FOS. We anticipate reviewing key WUA data on an annual basis, at the end of the agricultural season. Some WUA data may be available from Apele Moldovei; we plan to use a local data collection partner or consultant to supplement those data through direct contact with the WUAs, as needed.
- **Administrative data from GHS contractor.** The GHS contractor collects information on different entities that are served by its subactivities, including farmers who are trained and organizations that received technical assistance. We could potentially draw on these data sources to understand how implementation was rolled out and why the activity did or did not have the expected results.
- **Administrative data from the Credit Line Directorate.** The Credit Line Directorate, which administers the AAF credit program, collects data on borrowers, including loan characteristics, borrower characteristics, and loan repayment history. The Credit Line Directorate also collects information on other loan programs that it administers; it might be possible to draw on these data as well, to learn about other credit programs that were operating over the same period.

This list of administrative data sources is not exhaustive; the qualitative data collection might reveal additional types of administrative data that could yield insights into the THVA project's implementation and outputs.

5. Document review

The document review will focus primarily on reports from the implementers of the THVA project activities and will provide information on what aspects of implementation went smoothly, the main changes to implementation that were made as a result, and the key lessons learned. Document review could also identify topics that could be important to explore in more detail through the qualitative data collection—for example, the qualitative work could explore specific ongoing challenges to successful implementation. Examples of documents to be included in the review include annual reports from the ISRA and GHS contractors and value chain assessments conducted by the GHS contractor. We will also review documents to determine how CISRA implementation differed from plans, which will affect who is considered a beneficiary of the program. Finally, the compact closeout report produced by MCA-Moldova and the final program review report that will inform that report (produced by an external consultant for MCA-Moldova), which will provide an overall assessment of implementation and project outputs, will be additional valuable sources of information.

V. CONCLUSION

This report has described a design to provide a comprehensive evaluation of MCC's THVA project in Moldova and to enable us to answer the key research questions posed by MCC. The design consists of an impact evaluation component and a performance evaluation component.

The impact evaluation component will compare outcomes for farmers in CIS areas that will benefit from the complementarities of the full package of THVA activities with similar comparison areas that will not. It will rely primarily on quantitative data collected from farmers in these areas in 2013–2014 (baseline) and up to two subsequent rounds, in 2018–2019 and 2020–2021 (first and second follow-up). To optimize their value for the evaluation, the number, timing, and nature of the follow-up rounds will be determined based on updated information available at the time. The impact estimates will have some limitations—for example, interpretation will be complicated by farmers in comparison areas receiving some components of the THVA project, and statistical power will also be limited for some key outcomes. Nevertheless, the estimates will provide credible evidence on the quantitative impacts of the full THVA package.

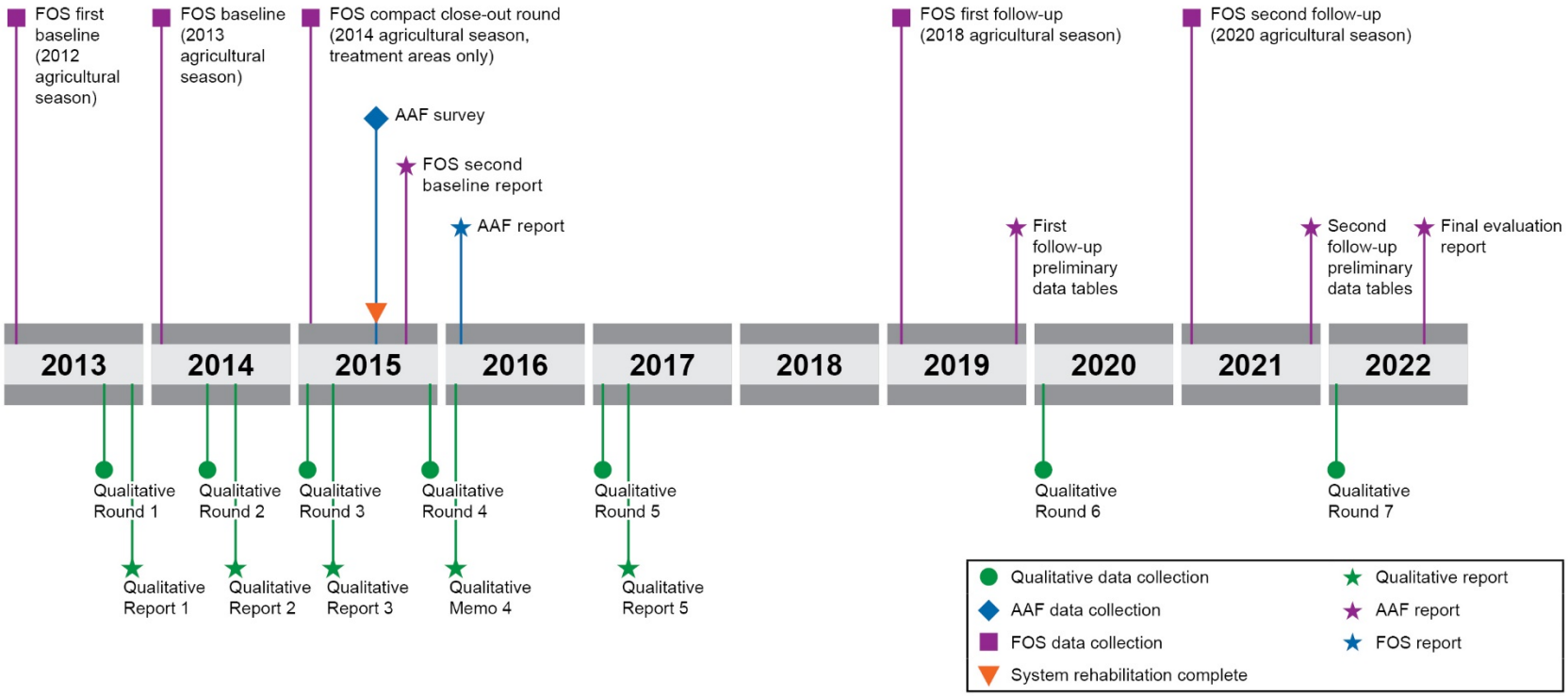
The impact evaluation will be complemented by the performance evaluation component, which will draw on primary qualitative data from a variety of stakeholders (collected in several rounds between 2013 and 2022), a 2015 quantitative survey of AAF end borrowers, administrative data, and document review. The performance evaluation will both facilitate the interpretation of the impact evaluation results and enable us to answer research questions not covered by the impact evaluation component.

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 V.1), and will inform the final evaluation findings. Intermediate products that have already been produced or are currently in process include qualitative reports (prepared by ACT Research) based on the 2013, 2014, and 2015 qualitative data collection efforts, and baseline quantitative reports based on the 2012–2013 FOS (Borkum et al. 2014) and the 2013–2014 FOS. Future intermediate products will include a memo summarizing the key findings from stakeholder interviews conducted in 2015, a report of the findings related to the AAF activity based on the survey with AAF borrowers and related qualitative data from nonrecipients and banks collected in 2015, and a report based on the qualitative data collection in 2017. We also plan to produce preliminary analytical tables based on the two follow-up rounds of the FOS in 2019 and 2021 to 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, 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 performance evaluation components of the design.

An important strength of the proposed THVA evaluation is that it builds on the existing evaluation designs and data already collected for separate evaluations of various THVA project activities and subactivities. By integrating these disparate components into a single evaluation design and supplementing them with additional data collected through 2022, we will be able to provide a more holistic long-term evaluation of the THVA project that is closely aligned with the program logic.

Figure V.1. Evaluation and reporting timeline



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APPENDIX A. SELECTION OF COMPARISON CIS AREAS

To identify comparison CIS areas for the impact evaluation of the THVA project, we implemented a multistage matching procedure to identify area(s) that were similar to each treatment CIS area in terms of characteristics such as geographical location, system characteristics, and crop patterns.

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 WUA status as the treatment area.[23] 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, using the set of potential matches identified in the first stage, we conducted a quantitative matching procedure to identify the best matches for each treatment area. 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 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, 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.[24]

[23] Some unaffected CIS areas had formed WUAs that were not directly related to the ISRA-CISRA activity.

[24] After the 2012–2013 FOS, we learned that comparison CIS 3-1 Sculeni overlapped significantly with the border area of treatment CIS 3-2 Blindesti; therefore, many farmers in 3-1 Sculeni could benefit from ISRA-CISRA. We therefore replaced 3-1 Sculeni with 2-4 Braniste for the 2013–2014 FOS, and will continue to use this area as the comparison for 3-2 Blindesti in future years.

APPENDIX B. REVISIONS TO THE EVALUATION DESIGN

In this appendix, prepared in August 2020, we describe revisions to the evaluation design presented in the body of this report. These revisions are motivated by what we have learned about the evolution of the rehabilitated systems since this report was approved by MCC in October 2015. The key change is to eliminate the planned impact evaluation and, accordingly, modify the performance evaluation to capture many of the outcomes that the impact evaluation was intended to assess.

Background

Since irrigation system rehabilitation through the project was completed in 2015, we have tracked the experiences of Water User Associations (WUAs) and farmers as part of the performance evaluation. Our interim evaluation findings—covering the 2017 agricultural season—were described in a report (Borkum et al. 2018) and evaluation brief (MCC 2019). In 2019, we measured key outcomes for the 2018 agricultural season, summarizing the findings in a memorandum. We will be collecting data from WUAs and water users to prepare another evaluation update (to cover the 2019 agricultural season); this data collection effort has been delayed due to the COVID-19 crisis. However, preliminary data from the Sustainable Development Account Moldova (SDA-Moldova) indicate that use of the irrigation systems in the 2019 agricultural season increased only slightly relative to the 2018 agricultural season.

The findings to date show that irrigated area has been well below the targets set in the original cost-benefit analysis (CBA)[25] (Figure B.1) and that there have been a relatively small number of water users (with some systems having just one or two users, not shown). This prompted Mathematica and MCC to reconsider the planned impact evaluation because impacts on farmers' outcomes were expected to be driven by changes in irrigated area.

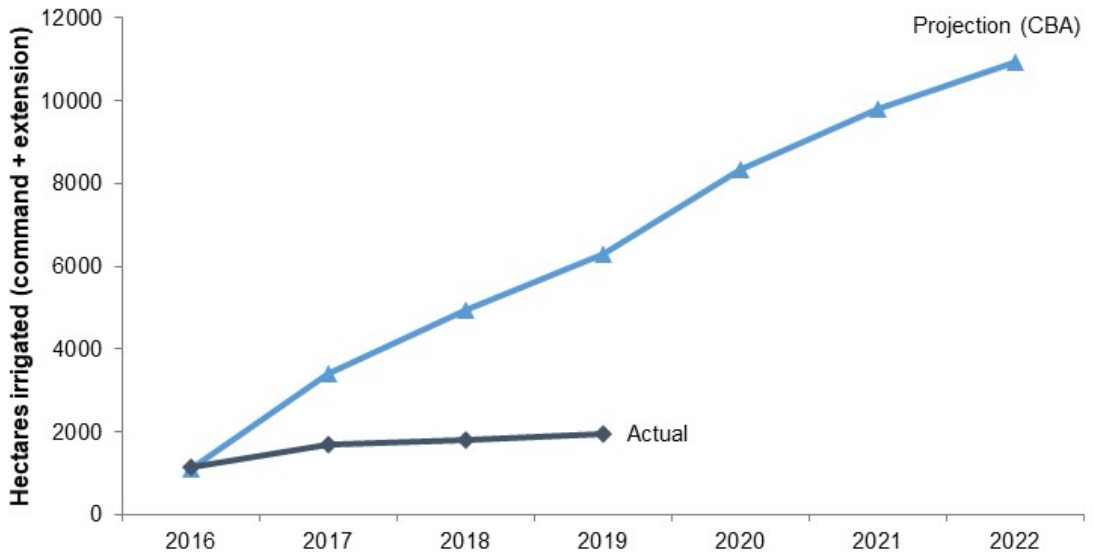
In considering revisions to the design, we also considered two other factors: the significant anticipated drought in the current (2020) agricultural season in Moldova and the COVID-19 crisis. The drought is expected to lead to greater use of the rehabilitated systems and a greater contrast in outcomes between rehabilitated systems and those that were not rehabilitated. Even with the drought, it is unlikely that irrigation system use will rise to the levels predicted in the CBA, nor are levels expected to be high enough to lead to statistically distinguishable impacts on outcomes (as discussed below). Nevertheless, the revised evaluation will capture detailed information about irrigation use and other outcomes in the 2020 season to understand the experience of farmers in the first post-rehabilitation season in which demand for irrigation is expected to be relatively high.

The effects of the COVID-19 crisis on the Moldovan agricultural sector are, at this point, unknown in nature, magnitude, and duration. Therefore, we have proposed to proceed with the evaluation activities, modifying data collection approaches as needed to reduce risk for

[25] In the body of the report, we refer to this as an ERR model. In this revision, we refer to this as a CBA model to reflect MCC's updated terminology.

interviewers and respondents. The revised evaluation will also gather information about how farmers and the agricultural sector more broadly have been affected by the crisis.

Figure B.1. Area irrigated in rehabilitated systems (CBA projection and actual)



Sources: MCC CBA model, WUA administrative data, and data from SDA-Moldova.

Design modifications and rationale

In Chapter IV of this report, we described our plan to conduct an impact evaluation, which would compare outcomes of farmers in rehabilitated and comparison systems using data from up to two rounds of a follow-up Farm Operator Survey (FOS). The first follow-up round, covering the 2018 agricultural season, would be conducted only if changes in irrigated land were substantial by that point in time. Consistent with this plan, we ultimately decided not to conduct the first follow-up round because administrative data from WUAs showed only small changes in irrigation by the 2018 season. If irrigation use continued to be limited through the 2020 agricultural season, the evaluation design called for conducting an impact evaluation after the 2020 season using an abbreviated version of the FOS. However, new information has led us to reconsider that approach.

In this appendix, we describe our plan to **eliminate the planned impact evaluation** (and associated FOS) and instead **assess outcomes through the performance evaluation**, which will be modified from the original approach. The key motivation for this change is that it is unlikely that the impact evaluation would be able to detect impacts of the expected magnitude on the main outcomes of interest, for several related reasons:

- As we note above, **irrigation system use has been limited** and is unlikely to rise to the levels predicted in the CBA, despite the severe drought in 2020. Though there could be some impacts of the project through other channels, irrigated area and associated cultivation

of high-value crops were the main outcomes in the program logic and CBA model; the impact evaluation was not powered to detect small impacts on these outcomes.

- **Relatively few farms have irrigated using the rehabilitated systems** (in the 2018 agricultural season, there were 226 water users of over 11,500 farms estimated to operate in command or extension areas). Therefore, even if water users experience large impacts, impacts on the average farm or farmer will be small.
- **Many water users were not included in the representative sample of farms surveyed at baseline** for the impact evaluation, either because they are new to the area or are smaller farms that (by chance) were not selected. (Of the largest water users in the 2018 season—the top five in each system, by volume pumped—only about one-third had been interviewed in the baseline FOS.) This means that we would not be able to control for baseline outcome measures, which reduces statistical power for the impact evaluation. For example, the minimum detectable impact for profit per hectare without individual-level baseline data would be about $567, almost double the original estimate (see Table IV.5).

Overall, the impact evaluation is not powered to detect the relatively small changes in key outcomes that we now expect, which makes it difficult to justify the high costs of conducting the FOS. Therefore, we propose to cancel the impact evaluation and modify the performance evaluation.

Like the original performance evaluation described in Chapter IV, the modified performance evaluation will continue to draw on WUA administrative data and qualitative data, albeit with some adjustments. It will also draw on several new data sources, including a survey of water users, administrative data from state agencies responsible for managing irrigation systems, an engineering assessment, and (possibly) satellite data. Below, we describe the modified performance evaluation in further detail.

Revised evaluation approach

The revised evaluation approach is a **multi-component performance evaluation**. It will integrate elements of a pre-post design for selected outcomes at the irrigation system level (for example, area irrigated, land rental prices, and agricultural wages), descriptive analyses of quantitative data collected both during and after the Compact, and thematic analyses of qualitative data collected during and after the Compact. The approach is conceptually similar to the originally planned performance evaluation described in the body of this report, but with additional emphasis on (1) calculating precise quantitative estimates of key outcomes in rehabilitated areas and (2) capturing more information about irrigation use and the experience of farms in comparison areas. These modifications were made with the goal of replacing some of the information lost with the elimination of the impact evaluation.

Research questions. Table B.1 summarizes how we will address the key research questions through the performance evaluation. (This table updates Table IV.1 in the body of the report; the data sources referenced in the table are described below.) We anticipate being able to answer almost all the original research questions, with the following exceptions:

- **We will not be able to provide quantitative evidence on the project's effects on prices, sales, and farm income** (included in research questions 1 and 6) because we do not plan to measure these outcomes through survey data collection. We had previously planned to measure these outcomes as part of the impact evaluation, although statistical power for measuring impacts on income would have been limited.
- Because eliminating the impact evaluation means that we will not have precise quantitative estimates of the counterfactual (as measured through comparison systems), **we will not be able to provide rigorous estimates of the impacts of the project on *any* outcomes**. Instead, quantitative evidence on the effects of the project will be more descriptive in nature. For example, we will be able to report on the hectares under irrigation (research question 1) and changes in land rental values (research question 4) in the rehabilitated systems, but we will not be able to compare those statistics with quantitative estimates from comparison areas. Therefore, we will not be able to attribute these estimates to the impacts of the project. Rather, we will provide descriptive quantitative evidence on the outcomes of the project and will use administrative and qualitative data to interpret these findings and place them in the context of broader changes in the agricultural sector in Moldova.

Table B.1. Revised approach to answering the key research questions

Research question	Approach (key outcomes in bold italics)
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?[a] Were transition rates as expected as projected in the CBA model?	• Estimate ***irrigation use*** (volume pumped) in rehabilitated systems (using WUA administrative data) and comparison systems (using data from state agencies, pending data availability) • Estimate the ***area irrigated*** by water users in rehabilitated systems (using Water User Survey and WUA administrative data) and interpret in the broader context (using qualitative data from comparison areas) • Estimate the ***crops irrigated*** by water users in rehabilitated systems (using Water User Survey) and interpret in the broader context (using qualitative data from comparison areas) • Provide suggestive qualitative evidence on changes in ***crop prices and sales*** (using qualitative data in rehabilitated and comparison areas) • Assess the extent to which expected outcomes of other activities (including the RBM component of ISRA, GHS, and AAF) were realized (using qualitative data)
2. If results were not realized, why not? Was it because the logic was incorrect or incomplete, assumptions did not hold, the project was not implemented as designed? Were there other external factors that affected the results? *What are the characteristics of systems in which irrigation use increased the most? The least?*[b]	• Assess successes and challenges of implementation and perceived risks to realizing results (using qualitative data, already collected and analyzed) • Examine barriers to benefitting from THVA activities and reasons for variation across systems (using qualitative data and the engineering assessment) • Examine the extent of irrigation in the 2020 drought year to help identify the most critical barriers to irrigation (using Water User Survey and qualitative data) • Understand the broader policy environment, the effects of the COVID-19 crisis, and ongoing challenges faced in the agricultural sector (using qualitative data)

Research question	Approach (key outcomes in bold italics)
3. What was the contribution of each activity/subactivity to the results that were realized (this includes analysis of each subactivity for ISRA, CISRA, GHS, and AAF)? If farmers transitioned to high-value agriculture, why?	• Determine the number and types of beneficiaries from administrative data to understand the reach of different activities (using administrative data, already collected and analyzed) • Assess the influence of GHS and AAF on Water Users (using Water User Survey) • Assess the perceptions of the relative contributions of different activities (using qualitative data)
4. How did THVA affect land ownership, leasing, and land values in the CIS and border areas?	• Provide suggestive quantitative evidence on ***land consolidation*** (Water User Survey) and changes over time in ***land rental prices*** (comparing Water User Survey to baseline FOS) • Assess how and why these changes occurred in affected communities and whether similar changes are occurring elsewhere (using qualitative data, including in comparison areas)
5. How are the results from the project distributed?	• Describe characteristics of water users and variation in key outcomes for specific subgroups of users—for example, small farms, female-operated farms, and farms that cultivated HVA crops before system rehabilitation (using Water User Survey) • Examine variation in experiences with THVA activities by different types of potential beneficiaries (using qualitative data) • Provide suggestive quantitative evidence on ***use of hired labor*** (Water User Survey) and changes over time in ***farm wages*** (comparing Water User Survey to baseline FOS) • Qualitatively assess how and why agricultural employment opportunities and wages changed and whether similar changes are occurring elsewhere (using qualitative data, including in comparison areas)
6. Are there indications that some of the long-term outcomes will be realized?	• Draw on findings in response to research question 1 • Provide suggestive qualitative evidence on long-term changes in ***agricultural profits and household income*** (using qualitative data in rehabilitated and comparison areas) • Assess perceptions of long-term sustainability and potential for replicability (using qualitative data and engineering assessment) • Assess whether the broader policy environment and other sector activities can support long-term change (using qualitative data)
7. What lessons can be drawn from analysis of the design, implementation, and results of the THVA project?	• Examine lessons learned from implementers and suggestions for program improvement by beneficiaries (using qualitative data, already collected and analyzed) • Synthesize findings on results (question 1), why they were/were not realized (question 2), and the contribution of different activities (question 3) to determine what could have been improved and how • Identify lessons around the design, construction, and maintenance of the rehabilitated systems (using engineering assessment)
8. What is the ex post ERR of the THVA project?	• Update key parameters in the Compact Closeout CBA model (using WUA administrative data and Water User Survey)

[a]We do not anticipate being able to provide quantitative evidence about changes in prices, sales, or farm income under the planned data collection effort.

[b]Research question in italics was added to better understand the factors associated with success—an understanding which could be applied to other contexts and projects.

Data sources. Table B.2 summarizes all data collection efforts that were conducted for the evaluation through August 2020, when we prepared this appendix, and the proposed additional efforts for the performance evaluation moving forward. The data collection efforts completed through August 2020 are consistent with those described in Chapter IV, but the proposed additional efforts differ. Specifically, some of the additional efforts were not originally planned (indicated with an asterisk in Table B.2), and others have been modified (as described below). As mentioned earlier, given the elimination of the impact evaluation, a key change is that the evaluation will no longer include a follow-up round of the FOS.

Table B.2. Completed and proposed data collection efforts

	Data collected through August 2020	Proposed data collection
Qualitative data	• Interviews/focus groups with farmers, WUA representatives, and/or mayors in rehabilitated systems (2012, 2013, 2014, and 2017 seasons) • Interviews with other informants related to ISRA-CISRA and the GHS activity (2012 and 2013 seasons) • Interviews with AAF non-beneficiaries and commercial banks (2015) • Interviews with high-level stakeholders (2015 and 2017)	• Interviews with farmers and mayors/local government authorities in comparison areas (2020 season) • Interviews with farmers and WUA representatives in rehabilitated systems (2021 season) • Interviews with high-level stakeholders and representatives of non-project WUAs (2021 season) • Interviews with beneficiaries of the AAF and GHS activities and with GHS-related market informants (2021 season)
Survey data	• FOS, first baseline (2012 agricultural season) • FOS, second baseline (2013 agricultural season) • FOS, compact close-out round (2014 agricultural season, rehabilitated systems only) • Access to Agricultural Finance Survey (2015)	• Water User Survey (2020 season)*
Administrative data	• WUA administrative data (2016, 2017, and 2018 agricultural seasons) • AAF loan applications and administrative data from the Credit Line Directorate (2012–2015) • Administrative data from 2KR (2015–2017)	• WUA administrative data (2019, 2020, and 2021* agricultural seasons) • Administrative data from state agencies (2019, 2020, and 2021 agricultural seasons)*
Other		• Engineering assessment (2021 season)* • Satellite data (potentially)*

* = data collection effort not originally planned

In addition to the elimination of the FOS, the key changes to the data collection plans described in Chapter IV for the 2020 agricultural season and beyond are as follows:

- **WUA administrative data (modified).** We intend to collect one more round of WUA administrative data than initially planned (covering the 2021 agricultural season). Further, as

we did after the 2018 agricultural season, after the 2019 and 2021 agricultural seasons we will also contact the largest water users in each system to provide more precise information on area irrigated and crops irrigated in the command and extension areas. (The Water User Survey, described below, will gather data from these and other water users after the 2020 season.)

- **Administrative data from state agencies (new).** We will explore whether it is possible to obtain information on annual irrigation use in comparison systems that we identified as similar to the rehabilitated systems. These data might be available from state agencies responsible for managing irrigation systems not transferred to WUAs. Combined with interviews with mayors or other local government authorities and farmers in these systems (mentioned below), this will allow us to interpret the WUA data in the context of what is occurring in Moldova more broadly.
- **Water User Survey (new).** We also plan to conduct a survey of all farms that used the 10 rehabilitated irrigation systems during the 2020 agricultural season. In the 2018 agricultural season there were 226 water users across all 10 rehabilitated systems; even if there is a substantial increase in the number of users due to the drought in the 2020 season, we would expect no more than several hundred users. These data will complement the WUA administrative data by providing insights on the following: (1) crops cultivated in irrigated areas; (2) land consolidation by water users; (3) changes in land rental prices; (4) use of hired labor by water users and changes in agricultural wages; and (5) the extent of water users' engagement with other project-related activities (for example, use of AAF-funded cold storage and participation in GHS-funded trainings).
- **Engineering assessment (new).** We also plan to conduct an assessment of system engineering. The assessment will look at the design of the system—including whether the design is suited to users' needs—as well as construction and maintenance. This will inform our expectations of sustainability and discussions of lessons learned. We plan to conduct this assessment during the 2021 agricultural season, when the systems will be in operation.
- **Qualitative data (modified).** We plan to conduct two more rounds of qualitative data collection, which will include the categories of respondents summarized in Table B.3 (a modified version of Table IV.7 in the body of this report). Most of these interviews will be conducted after the 2021 agricultural season, with two exceptions. First, we plan to conduct interviews in comparison areas soon after the 2020 agricultural season to better understand how the severe drought and COVID-19 crisis affected farmers without access to rehabilitated irrigation systems. The interviews in comparison areas will also assess broader changes in these systems. We also plan to conduct interviews with non-project WUAs (management and a small number of water users) after the 2020 agricultural season to capture the dynamics of their formation—including how this might have been affected by the THVA project—and how they are operating.

  The qualitative data collection described in Table B.3 differs from the original plans in three main ways. First, it is more streamlined than the original plan in terms of the number of stakeholders included and the number of times we meet with each type of stakeholder. For example, we no longer propose collecting data from mayors in rehabilitated areas, or 2KR and 2KR beneficiaries, because we do not believe that this would add value to what we have learned from these stakeholders in previous rounds. Second, we have proposed cancelling

the qualitative data collection round originally planned for early 2020 and instead conducting a small qualitative data collection round in 2021 to capture the effects of the drought and COVID-19 crisis in the 2020 agricultural season. Third, we plan to purposefully select farmers for interviews (rather than conduct focus groups) to enable us to better explain the quantitative findings.

Table B.3. Plans for additional qualitative data collection

Respondent	Timing	Respondent selection	Key areas of focus
Farmers in comparison areas	After 2020 season	Purposefully select larger farmers—who are likely to be most comparable to water users in rehabilitated systems—covering a variety of crop types (such as extensive crops, vineyards, and orchards)	• How irrigation use, farm production, crop prices and sales, land consolidation, land prices, agricultural employment, agricultural profits and income, and other outcomes have changed over the past decade • Effects of the 2020 drought on irrigation, agricultural production, and sales, in the absence of system rehabilitation • Effects of the COVID-19 crisis on irrigation, agricultural production, and sales
Mayors or other local government authorities in comparison areas	After 2020 season	Mayors, cadastral engineers, and/or social assistance workers across up to 8 comparison systems	• How irrigation use, farm production, crop prices and sales, land consolidation, land prices, agricultural employment, agricultural profits and income, and other outcomes have changed over the past decade • Effects of the 2020 drought on irrigation, agricultural production, and sales, in the absence of system rehabilitation • Effects of the COVID-19 crisis on irrigation, agricultural production, and sales
Non-project WUAs formed since the end of the Compact	After 2020 season	WUA executive directors and water users in comparison and other non-project systems that formed WUAs	• Dynamics of WUA formation and extent to which it was influenced by the THVA project • Nature and scope of external support for WUA formation and operations, including coordination with state agencies • The WUA's ability to irrigate in the absence of CIS rehabilitation • Whether the WUA is operating well, challenges faced, and whether it will be sustainable
WUA leadership	After 2021 season	WUA executive directors in all 10 rehabilitated systems	• Reasons why expected impacts were or were not achieved • Key barriers to irrigation use, including in the 2020 drought season • Reasons why some systems have greater irrigation use than others • Long-term sustainability of the WUA • Effects of the COVID-19 crisis on irrigation, agricultural production, and sales • Additional questions based on the findings of the engineering assessment

Respondent	Timing	Respondent selection	Key areas of focus
Farmers in rehabilitated systems and border areas	After 2021 season	Purposefully select farmers with a range of experiences with the rehabilitated systems (for example, small farmers who irrigated and large farmers who did not)	• Whether the WUA is functioning well • Key barriers to irrigation use, including in the 2020 drought season • Changes in irrigation use, farm production, crop prices and sales, land consolidation, land prices, agricultural employment, agricultural profits and income, and other outcomes • Long-term sustainability of the WUA • Effects of the COVID-19 crisis on irrigation, agricultural production, and sales • Additional questions based on the findings of the engineering assessment
High-level stakeholders: SDA-Moldova, Ministry of Agriculture, Ministry of Environment, IFAD, USAID, and ACSA	After 2021 season	Knowledgeable informant in each organization	• Nature and scope of post-Compact engagement in the rehabilitated systems • Perceptions of whether the THVA project had a significant impact on Moldova, including perceived barriers to achieving the expected results and the perceived contribution of different components of the project • Perceptions of whether the anticipated long-term outcomes will be realized and of project sustainability • Lessons learned from the THVA project and the potential for replication • The broader policy environment, ongoing challenges faced in the Moldovan agricultural sector, and the effects of the COVID-19 crisis on the sector • Additional questions based on the findings of the engineering assessment
AAF beneficiaries	After 2021 season	Purposefully select beneficiaries in the raions in which the rehabilitated systems are located	• Longer-term effects of AAF investments on the beneficiary • Job creation directly and indirectly related to the AAF investment • Additional AAF-related investments made • Extent to which AAF investment has been used by other entities, and reasons why, and perceived effects on users • Extent to which AAF investment has been used by water users or GHS beneficiaries
Beneficiaries of GHS technical assistance	After 2021 season	Purposefully select beneficiaries in the raions in which the rehabilitated systems are located, covering a range of types of technical assistance	• Perceived long-term benefits of GHS technical assistance for the recipient and others in the value chain • Interaction with other GHS sub-activities and other THVA activities • Role in marketing, organizing exports, and facilitating cooperation among producers, and main challenges faced (if relevant)

Respondent	Timing	Respondent selection	Key areas of focus
Foreign buyers	After 2021 season	Select from buyers that engaged with the GHS activity	• Awareness and perceptions of Moldovan produce • Changes in contracts with Moldovan producers and purchases of Moldovan produce
Domestic buyers	After 2021 season	Select from buyers that engaged with the GHS activity	• Changes in the quantity and quality of produce and in prices
Exporters	After 2021 season	Select from exporters that engaged with the GHS activity	• Changes in the regulatory environment and certification process • Changes in the quantity, type, season, and destination of exports • Remaining barriers to export

- **Satellite data (new).** We are in the early stages of assessing the feasibility and cost of applying remote sensing methods to satellite data to measure crop cultivation over time in both rehabilitated and comparison areas. Under this approach, we would calibrate a crop prediction model using data from the baseline FOS (2013 agricultural season) and then apply the model to subsequent seasons. This approach could potentially provide accurate information about crops cultivated in these areas over several seasons, data which would not otherwise be available in the absence of the FOS. It would also provide a useful proof of concept of this approach for the broader field.

Updating the project CBA. MCC last updated the project CBA model in September 2016, about one year after the end of the Compact. This Closeout CBA model was the same as described in Chapter II; however, with parameter updates made after Compact Closeout, the overall ERR decreased to negative 5.5 percent. As described in Chapter IV, we had initially planned to compute the ex-post ERR using estimates from the impact evaluation to calculate the primary expected benefit stream from the project, namely the increased farm profits resulting from increased production and sales of HVA crops. However, with the elimination of the impact evaluation (and FOS), we no longer plan to measure farm profits after irrigation system rehabilitation.

Therefore, we plan to calculate the ERR using an alternative approach. We will update the following key parameters in the Closeout CBA model: (1) transition rates to irrigated land (using WUA administrative data); (2) the crop mix (fruit, vegetable, and non-HVA) on irrigated land (using Water User Survey data); (3) the annual dollar/Moldovan lei exchange rate, which affects the dollar value of estimated benefits; and (4) project, WUA, and on-farm irrigation costs (using MCC administrative data, WUA administrative data, and Water User Survey data, respectively). By considering the net present value of benefits and costs over a 20-year period, we will be able to produce updated ERR estimates by system and for the project overall. We will also explore which parameters are driving differences with the Closeout ERR estimate (for example, the extent to which differences are driven by the weakening of the Moldovan lei).

Given the absence of a true counterfactual and direct measurement of profits from irrigated land after system rehabilitation, the estimated benefit stream in the CBA model will rely heavily

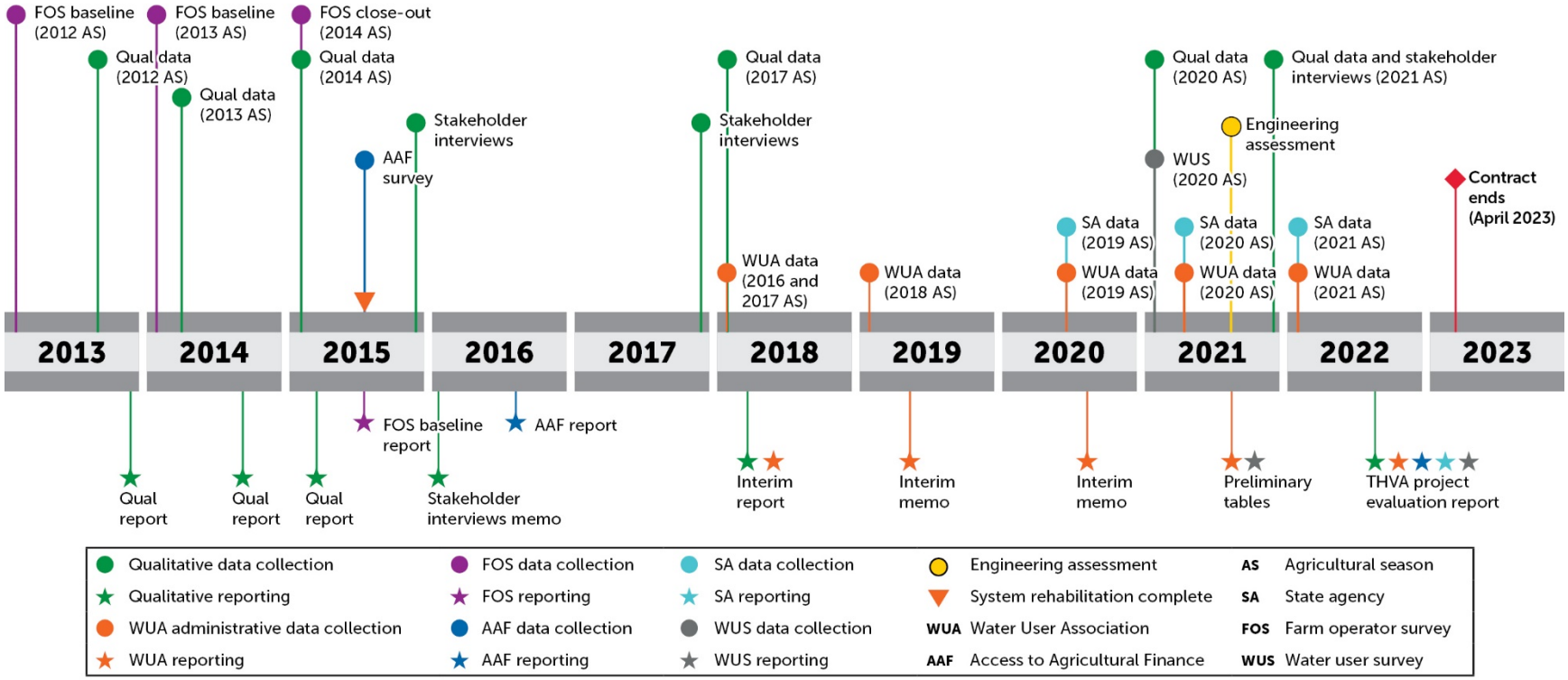
on assumptions in the Closeout model. Specifically, the model estimates profits per hectare from cultivating crops on irrigated land using a detailed set of assumptions about crop mix, production volumes, prices, and costs, which were developed by MCC in 2012 and which we will be unable to update. Therefore, we plan to assess the sensitivity of the ERR estimates to the assumptions about the overall increase in profits per hectare associated with irrigation.

Evaluation timeline

Under this plan, the evaluation will analyze results after up to six full post-rehabilitation agricultural seasons. Specifically, we will gather survey data five seasons after irrigation system rehabilitation was completed (the 2020 agricultural season). We will gather WUA administrative data for six seasons after rehabilitation was completed (through the 2021 agricultural season). Figure B.2 illustrates the revised evaluation timeline (equivalent to Figure V.1 in the body of the report). The final evaluation report, which will incorporate both quantitative and qualitative findings, as well as the results of the engineering assessment, will be completed as originally planned in 2022.

The ongoing global COVID-19 crisis might pose challenges for some of the planned data collection efforts. For example, we delayed the collection of WUA administrative data from the 2019 agricultural season, which was originally planned for early 2020, because our local data collection partner was unable to visit the WUAs in person due to safety concerns. Our local data collection partner is now conducting this effort by phone in summer 2020. If the COVID-19 crisis continues into 2021, we will consider postponing some of the planned in-person data collection efforts or adapting to phone-based data collection where feasible. We will discuss these possibilities with MCC over the next few months as the situation evolves. In our data collection efforts, we will capture information about the effects of the COVID-19 crisis so that we can assess how this external shock has influenced key outcomes.

Figure B.2. Revised evaluation timeline and activities



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