REPORT

FINAL REPORT

Moldova Transition to High-Value Agriculture Project Evaluation: Interim Findings

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STATEMENT OF INDEPENDENCE AND ACKNOWLEDGMENTS

Mathematica was contracted by the Millennium Challenge Corporation (MCC) to conduct an independent evaluation of the Transition to High-Value Agriculture Project in Moldova; this report presents interim findings from that evaluation. To inform this report, Mathematica collected data in conjunction with the Agricultural Development Institute (ADI) and a local consultant; these Moldova-based entities collected data that were used in the analysis, but did not otherwise contribute to the analysis and findings. The findings in this report represent the independent assessment of the authors, and do not reflect the views of MCC, ADI, or the local consultant. The authors report no conflicts of interest.

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ACRONYMS

AAF	Access to Agricultural Finance
ACSA	National Agency for Rural Development
ADI	Agricultural Development Institute
CISRA	Centralized Irrigation System Rehabilitation Activity
FAO	Food and Agricultural Organization
GHS	Growing High-Value Agriculture Sales
HVA	High-Value Agriculture
HVAA	High-Value Agriculture Activity
IFAD	International Fund for Agricultural Development
ISRA	Irrigation Sector Reform Activity
MAC-P	Moldova Agricultural Competitiveness Project
MCA-Moldova	Millennium Challenge Account – Moldova
MCC	Millennium Challenge Corporation
SDA-Moldova	Sustainable Development Account – Moldova
THVA	Transition to High-Value Agriculture
USAID	United States Agency for International Development
WUA	Water User Association

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I. INTRODUCTION

The Moldova Transition to High-Value Agriculture (THVA) project was sponsored by the Millennium Challenge Corporation (MCC) through its 2010–2015 compact with Moldova. The project sought to catalyze investments in high-value agriculture (HVA) products such as fruits and vegetables, with the ultimate goal of reducing rural poverty. It included several activities: (1) the Irrigation Sector Reform Activity and Centralized Irrigation System Rehabilitation Activity (ISRA-CISRA), which were two complementary activities that aimed to improve access to irrigation on agricultural land and—through a separate River Basin Management component—improve the management of water resources in Moldova; (2) the Growing High-Value Agriculture Sales (GHS) activity, which aimed to increase sales of HVA by developing and expanding markets, providing training, providing technical assistance, and improving the enabling environment for HVA; and (3) the Access to Agricultural Finance (AAF) activity, which provided financing for investments related to HVA production, processing, and sales, as well as for investments related to irrigation.

Mathematica Policy Research is conducting an evaluation of the THVA project that seeks to assess the impacts of the project and how and why those impacts were realized. This report presents interim findings following the 2017 agricultural season—two years after the compact closed—to provide an early indication of whether the anticipated longer-term impacts are likely to be achieved and why.[1] These findings will help MCC determine whether its investment is on track to meet its envisaged goals and understand the reasons why or why not. They will also provide valuable lessons for MCC, the Government of Moldova, and other donors and stakeholders interested in implementing future similar or related projects in Moldova and elsewhere.

The interim findings draw on qualitative and administrative data collected in the winter of 2017–2018. This round of data collection focused primarily on the centralized irrigation systems where water user associations (WUAs) were established and irrigation systems were rehabilitated through ISRA-CISRA; these areas were expected to benefit the most from the package of project activities. The data collection was designed to explore the initial experiences and perceptions of farmers, WUA staff, and other key stakeholders in the agricultural sector, after the rehabilitated systems had been operational for at least two agricultural seasons.[2] We also collected administrative and financial data from WUAs to better understand their operations in the post-compact period.

In the rest of this chapter, we briefly describe the THVA project, the research questions and design of the THVA evaluation, and the objectives of this interim analysis. In Chapter II we describe the data we collected for this report and our analytic approach. We present our main findings in Chapter III and our conclusions in Chapter IV.

[1] In Moldova, the agricultural season runs from early spring (approximately March) to late fall (approximately October) each year.

[2] In two of the ten systems rehabilitated by the project, rehabilitation was completed prior to the 2015 agricultural season; in all other systems rehabilitated by the project, rehabilitation was completed during the 2015 agricultural season. In total, six of the ten systems pumped water for at least part of the 2015 season.

A. The THVA project

The THVA project consisted of four complementary activities that were designed to address different constraints to HVA production and sales (Table I.1). These activities included the establishment of WUAs in 11 centralized irrigation systems, irrigation management transfer and rehabilitation in 10 of these systems, as well as activities implemented more broadly across Moldova, including activities to improve production techniques, increase access to markets, and increase access to finance for post-harvest infrastructure, on-farm irrigation equipment, and other types of investments.

Table I.1. THVA project activities

Activity	Description
Irrigation Sector Reform Activity (ISRA)	*Irrigation Management Transfer subactivity* Provided technical assistance and training in 11 centralized irrigation systems to create local WUAs and build their capacity to manage and maintain the centralized irrigation systems Supported transfer of the management and operations of the centralized irrigation systems from the government of Moldova to the WUAs under a new legal framework
	River Basin Management subactivity Supported policy reform and improvements to water resource management to facilitate a sustainable long-term supply of water throughout Moldova
Centralized Irrigation System Rehabilitation Activity (CISRA)	Rehabilitated irrigation infrastructure to deliver water to farmers' fields in 10 of the 11 selected centralized irrigation systems[a]
Growing High-Value Agricultural Sales (GHS) Activity[b]	Included complementary subactivities to increase sales of HVA by addressing constraints specific to selected crops' value chains; these subactivities included (1) HVA market development and expansion; (2) training to upgrade production and meet buyer requirements; (3) demand-driven technical assistance to enterprises, associations, and cooperatives; (4) the improvement of an enabling environment for HVA; and (5) farmer training and field demonstrations to support the transition to HVA and the use of irrigation in the targeted centralized irrigation systems
Access to Agricultural Finance (AAF) Activity[c]	*Loan program* Provided loans to farmers and rural entrepreneurs for investments related to HVA production, processing, and sales
	Hire-purchase program (administered by 2KR) Provided irrigation equipment, or farming equipment and machinery for irrigated land

[a] In one of the centralized irrigation systems selected for ISRA (Cahul), the system was not rehabilitated and management was not transferred.

[b] Part of the Agricultural Competitiveness and Enterprise Development project, funded jointly by MCC and the United States Agency for International Development (USAID) and implemented by USAID.

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

In the 10 of the 11 targeted centralized irrigation systems in which the THVA project established WUAs, the project transferred management of the systems to those WUAs and rehabilitated the centralized irrigation system infrastructure—which includes pumping stations, accumulation basins, and subterranean pipes designed to carry water from rivers to farmers'

fields.[3] At the end of the compact, the rehabilitated systems covered an irrigable area of about 11,680 hectares; many of them were engineered such that some farmers operating land in adjacent areas ("extension areas") were also able to connect to the centralized irrigation systems (through connection points), increasing the potential irrigable area by a further 3,537 hectares. The targeted centralized irrigation systems are located in the central and southern regions of the country, bordering the Nistru and Prut Rivers (Figure I.1).

Farmers operating land in these centralized irrigation systems were expected to benefit from the full package of THVA project activities. In particular, management transfer and system rehabilitation, together, were expected to increase access to reliable irrigation. Training, technical assistance, and other support for farmers and organizations in these systems were expected to help them meet market requirements for HVA crops. The loan program, by increasing access to post-harvest infrastructure, was expected to further enhance the ability of farmers who cultivate HVA crops to meet market requirements and benefit from higher prices. The hire-purchase program was designed to facilitate irrigation and HVA cultivation in these areas by providing a source of funding for farmers to invest in irrigation and farming equipment. (The hire-purchase program was administered by 2KR; we therefore refer to it as the 2KR hire-purchase program in the rest of the report.)

Because the THVA project activities were designed to be highly complementary in driving investments in HVA and long-term reductions in poverty, understanding the impacts of the project in these areas is of primary interest for the THVA evaluation. This report focuses primarily on these 10 centralized irrigation systems.

[3] An additional centralized irrigation system, Cahul, was initially included in ISRA. The WUA in Cahul was established and received initial technical support during the compact. However, MCA-Moldova subsequently decided not to rehabilitate the system and management was not transferred. The WUA in Cahul has therefore not been active since 2014 and is not covered in this report.

Figure I.1. Centralized irrigation systems targeted by the THVA project

B. Research questions and evaluation design

The THVA evaluation was designed to measure the impacts of the project, identify reasons why the expected outcomes were or were not realized, assess how the different activities interacted, and gauge whether outcomes are sustainable and cost-effective. The evaluation research questions are as follows (these questions are motivated by the program logic, which appears in Appendix A):

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 HVA, prices, and sales increase in the centralized irrigation system and extension areas? Were transition rates as projected in the Economic Rate of Return?

If results were not realized, why not? Was it because the logic was incorrect or incomplete, assumptions did not hold, or the project was not implemented as designed? Were there other external factors that affected the results?

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 HVA, why?

How did the THVA project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?

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 centralized irrigation system 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?

Are there indications that some of the long-term outcomes will be realized?

a. Are there indications that farm income will increase in the centralized irrigation system and extension areas?
b. Are there indications that the THVA project will be successful in its objective of creating an irrigation and HVA production model that could be replicated throughout Moldova?
c. Are there indications that the THVA project will be successful in its objective of creating a sustainable model for irrigation and HVA production?

What lessons can be drawn from analysis of the design, implementation, and results of the THVA project?

What is the ex post Economic Rate of Return of the THVA project?

To answer these questions, Mathematica is conducting a mixed-methods evaluation that includes an impact evaluation and a complementary performance evaluation. The impact evaluation focuses on estimating the impacts of the project on farmers in the 10 centralized irrigation systems that were rehabilitated through the project. The performance evaluation focuses on understanding how and why the intended results did or did not occur, the interaction between different activities, the long-term sustainability of the outcomes achieved, as well as lessons learned. Together, the evaluation relies on several quantitative, qualitative, and administrative data sources, which we describe below. (Figure I.2 shows how each data source will inform the research questions and Figure I.3 shows the anticipated data collection and reporting timeline.)

Impact evaluation. The impact evaluation is designed to measure the impacts of the project on irrigation use and cultivation of high-value crops, as well as associated longer-term outcomes. It compares farmers in the 10 systems targeted by the project to farmers in 11 comparison areas that were selected to be as similar as possible to the project areas. It relies primarily on quantitative survey data collected from farmers in the targeted and comparison systems before the rehabilitation (covering the 2013 agricultural season) and after the rehabilitation was completed (tentatively planned to cover the 2020 agricultural season). We summarized the findings from the farmer survey conducted after the 2013 agricultural season in a baseline report (Borkum et al. 2015).

Performance 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 an engineering assessment. Before the end of the compact we worked with our local data collection partners to conduct several rounds of qualitative data collection (2012, 2013, and 2014) and the survey of AAF loan borrowers (2015). The findings from these data were summarized in several reports (ACT Research 2013a, ACT Research 2013b, ACT Research 2014a, ACT Research 2014b, ACT Research 2015a, ACT Research 2015b, and Borkum et al. 2016a). We also conducted stakeholder interviews at the end of the compact, in late 2015, and prepared a memorandum with our key findings (Borkum et al. 2016b). This report draws on qualitative data collection covering the 2017 agricultural season, annual administrative data from WUAs since the end of the compact, and administrative data from participants in the 2KR hire-purchase program. Future data collection for the performance evaluation will include further rounds of qualitative data collection, annual administrative data collected from WUAs, and an engineering assessment. The final evaluation report, which we will prepare by late 2022 and finalize by early 2023, will integrate findings from the impact and performance evaluations.

Figure I.2. THVA evaluation data sources and research questions

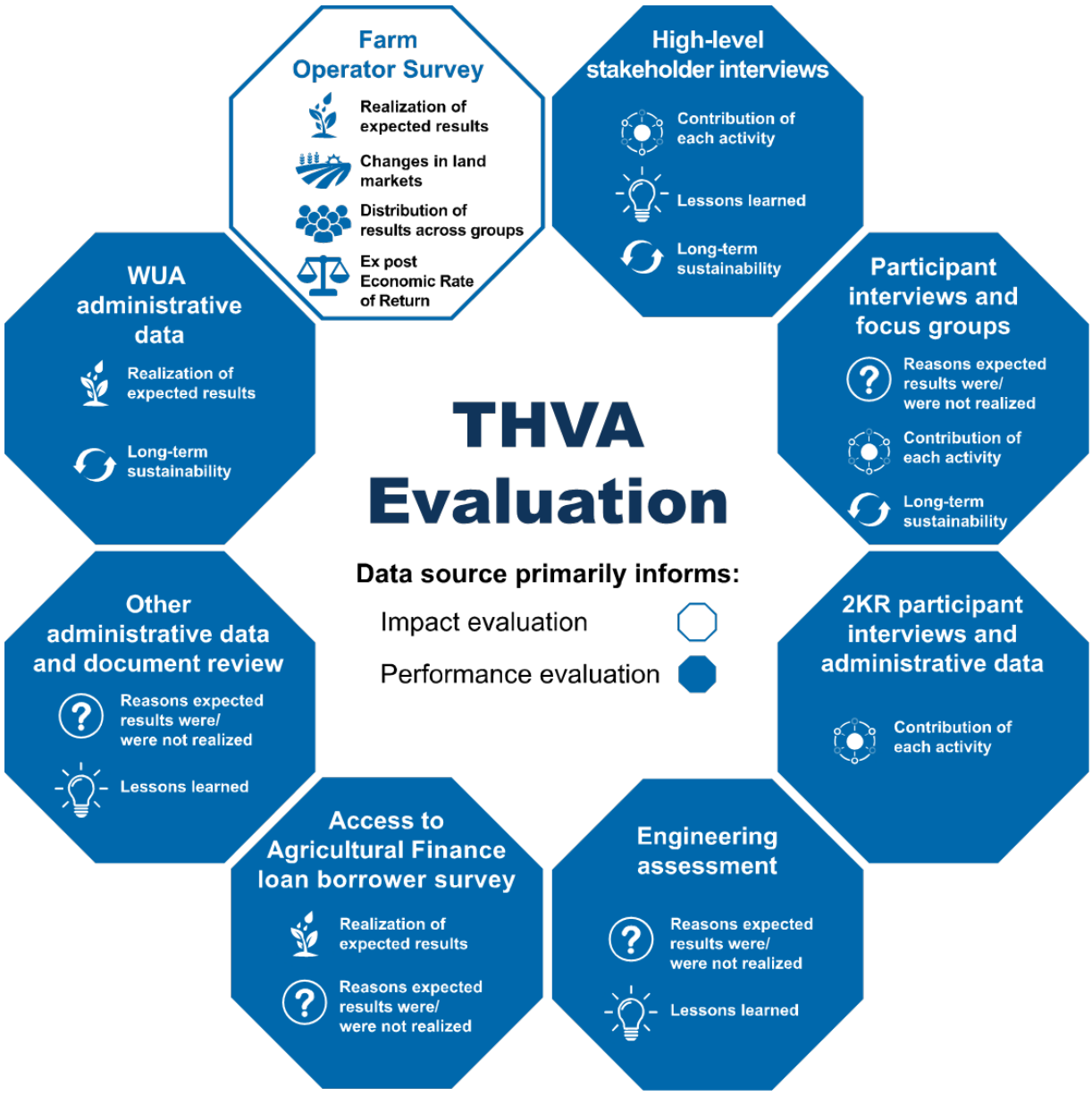
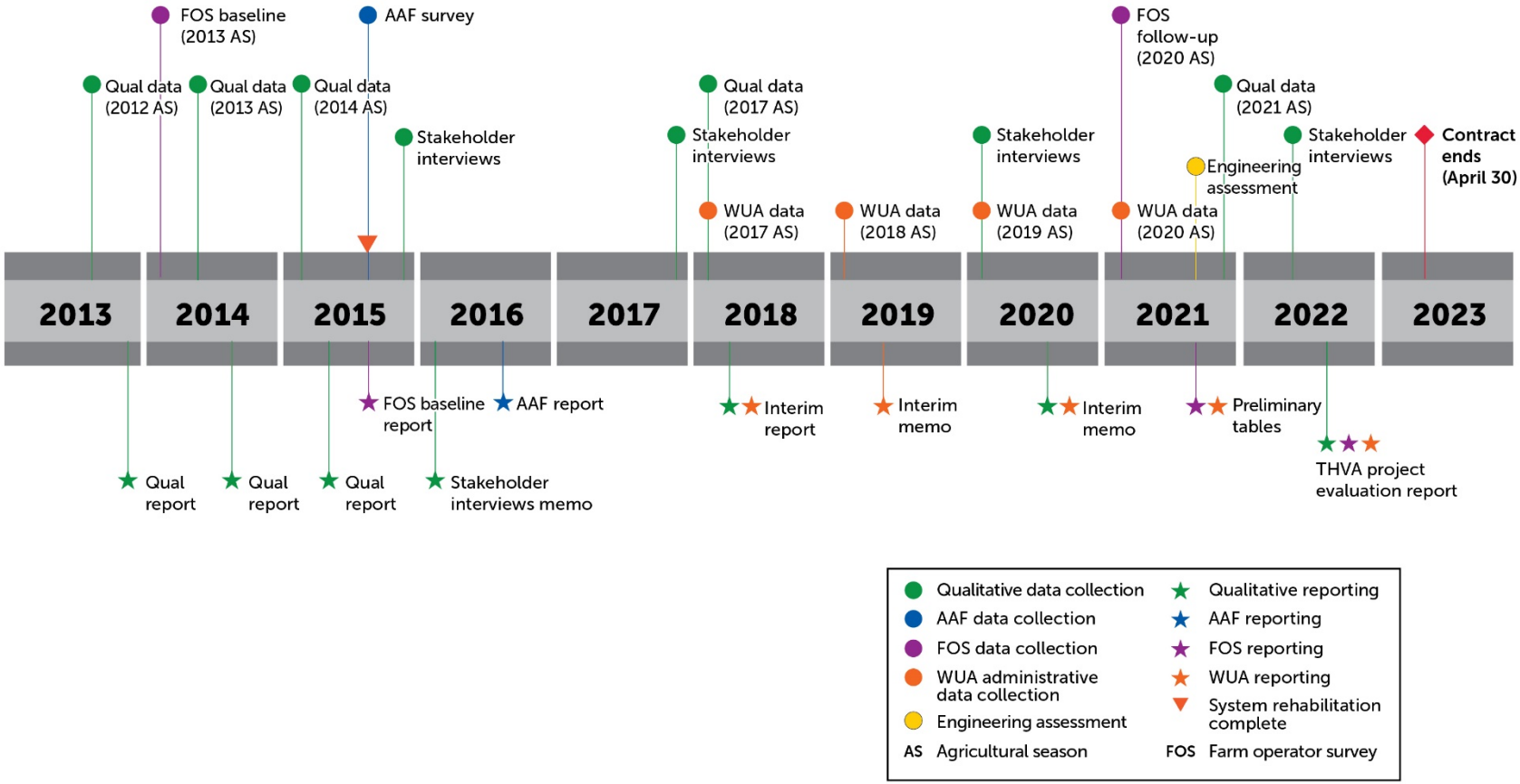


Figure I.3. Evaluation timeline



C. Objectives of the interim report

This report has two main objectives. First, it provides new information to address the research questions, informing our understanding of how and why things have evolved in these systems over the past two agricultural seasons, and lessons learned. Though subsequent data collection efforts will also inform the research questions, the present round was intended to provide early feedback and provide a sense of the dynamics. (Table I.2 shows how each of the seven topics in the report inform our understanding of the different research questions.)

Table I.2. Key topics for interim report and related research questions

Topic	Related research questions
Irrigation system functionality, irrigation use, and HVA cultivation (Section III.A)	Were the expected results realized from the THVA program logic?
	If results were not realized, why not?
Barriers to irrigation use and HVA production (Section III.B)	If results were not realized, why not?
	What was the contribution of each activity/subactivity to the results that were realized?
	How are the results from the project distributed?
	What lessons can be drawn from analysis of the design, implementation, and results of the THVA project?
Land consolidation and land prices (Section III.C)	How did the THVA project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?
WUA financial status (Section III.D)	Are there indications that some of the long-term outcomes will be realized?
	What lessons can be drawn from analysis of the design, implementation, and results of the THVA project?
Post-compact support for WUAs and farmers in the rehabilitated systems (Section III.E)	What lessons can be drawn from analysis of the design, implementation, and results of the THVA project?
Participation in and effects of the 2KR hire-purchase program (Section III.F)	What was the contribution of each activity/subactivity to the results that were realized?
Sustainability of the River Basin Management subactivity (Section III.G)	Are there indications that some of the long-term outcomes will be realized?

HVA = High-Value Agriculture, THVA = Transition to High-Value Agriculture, WUA = Water User Association

In addition, these findings inform the ongoing revision of the THVA evaluation design, including the timing, topics, and participants of subsequent data collection efforts. In Chapter IV, we discuss the implications of our findings in light of these two objectives.

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II. DATA COLLECTION AND ANALYSIS APPROACH

In this chapter we describe the qualitative and administrative data sources that inform the interim analysis. We also briefly describe the approach we used to analyze these data.

A. Qualitative data

This report draws on two sources of qualitative data: (1) interviews with high-level stakeholders and (2) interviews and focus groups with WUA executive directors and farmers in the rehabilitated systems. Mathematica staff conducted the interviews with high-level stakeholders. These interviews, which took place in November 2017, included organizations who were working (or had worked) in the rehabilitated systems since the end of the compact. (Table II.1 summarizes the organizations that we interviewed and the key topics covered in the interviews.)

Mathematica's local data collection partner, the Agricultural Development Institute (ADI), conducted the interviews and focus groups in the rehabilitated systems. These included interviews with WUA executive directors, large farmers in the systems, large and medium farmers in extension areas, and 2KR participants, as well as focus groups with small and medium farmers and with WUA sector representatives.[4,5] ADI conducted the interviews with WUA executive directors in all 10 rehabilitated systems, but focused most of the data collection on six systems: Blindesti, Grozesti, Chircani-Zirnesti, Jora de Jos, Cosnita, and Roscani. Mathematica selected these six systems to provide diversity in terms of their location (Prut versus Nistru Rivers) and percentage of area irrigated (based on data from the Sustainable Development Account – Moldova, or SDA-Moldova) (Figure II.1).[6,7] Mathematica observed the piloting of interview and focus group protocols in two systems in November 2017; ADI conducted the remaining fieldwork between December 2017 and January 2018. (Table II.2 summarizes the criteria that were used to select interview and focus group participants and the key topics covered.)

[4] We follow the farm size definitions from the Farm Operator Survey, which categorize farms based on land area operated: small farmers operate less than 10 hectares, medium farmers operate at least 10 but less than 100 hectares, and large farmers operate 100 hectares or more.

[5] WUA sector representatives are farmers who have been selected during the WUA General Assembly to represent farmers who own and/or cultivate land in a given sector of the rehabilitated centralized irrigation system.

[6] It was important to ensure diversity in terms of location because our end-of-compact stakeholder interviews suggested that WUAs in Nistru River systems might be more likely to succeed than those in Prut River systems. This is because the Nistru River systems were functional more recently than the Prut River systems, so farmers in these systems had more recent experience with irrigation and HVA production (Borkum et al. 2016b).

[7] 2KR participant respondents were selected from the subgroup of 2KR participants who operate farms inside the ten rehabilitated centralized irrigation systems.

Table II.1. High-level stakeholder interviews (2017), key topics

Organization	Key topics
Sustainable Development Account – Moldova (SDA-Moldova) *Successor agency to Millennium Challenge Account – Moldova (MCA-Moldova) tasked with supporting sustainability of compact investments*	• Status of activities related to irrigation infrastructure, implementation challenges, and future plans • Overall perceptions of WUA operations, reasons for variation in WUA performance, and risks to long-term WUA sustainability • Status of activities related to sustainability of water resources, implementation challenges, and future plans • Status of activities related to access to agricultural finance, implementation challenges, and future plans • Perceptions of overall THVA project effects
National Agency for Rural Development (ACSA) *State agricultural extension service*	• Nature and status of activities to support the sustainability of the THVA project since the end of the compact, and plans for future activities • Overall perceptions of WUA operations, support required by WUAs, and risks to long-term WUA sustainability • Conditions in the agricultural sector, including activities by other donors, changes in the policy environment, and external conditions • Perceptions of overall THVA project effects
Apele Moldovei *State water agency tasked with monitoring WUAs*	• Operational status of the Monitoring and Supervision Unit • Nature and status of support provided to WUAs by Apele Moldovei, and additional support required • Overall perceptions of WUA operations, reasons for variation in WUA performance, and risks to long-term WUA sustainability
2KR *Administrator of the 2KR hire-purchase program*	• Status of the 2KR hire-purchase program, changes over time, and main implementation challenges • Feedback from program participants • Patterns in the types of program participants, their location, and the type of equipment funded • Alternative sources of financing for 2KR investments, how they compare to the 2KR program, and how investments would have changed in the absence of the program
USAID *US government agency that is funding the High Value Agriculture Activity (HVAA), successor to the project under which GHS was implemented*	• Planned HVAA activities, including their nature, timing, and scale • Overall perceptions of WUA operations, support required by WUAs, and risks to long-term WUA sustainability • Conditions in the agricultural sector, including activities by other donors, changes in the policy environment, and external conditions • Perceptions of overall THVA project effects
Chemonics *Implementer of the HVAA*	• Planned HVAA activities, including their nature, timing, and scale • Overall perceptions of WUA operations, support required by WUAs, and risks to long-term WUA sustainability • Conditions in the agricultural sector, including activities by other donors, changes in the policy environment, and external conditions • Perceptions of overall THVA project effects

WUA = Water User Association

Figure II.1. Participant interviews and focus groups (2017–2018), locations

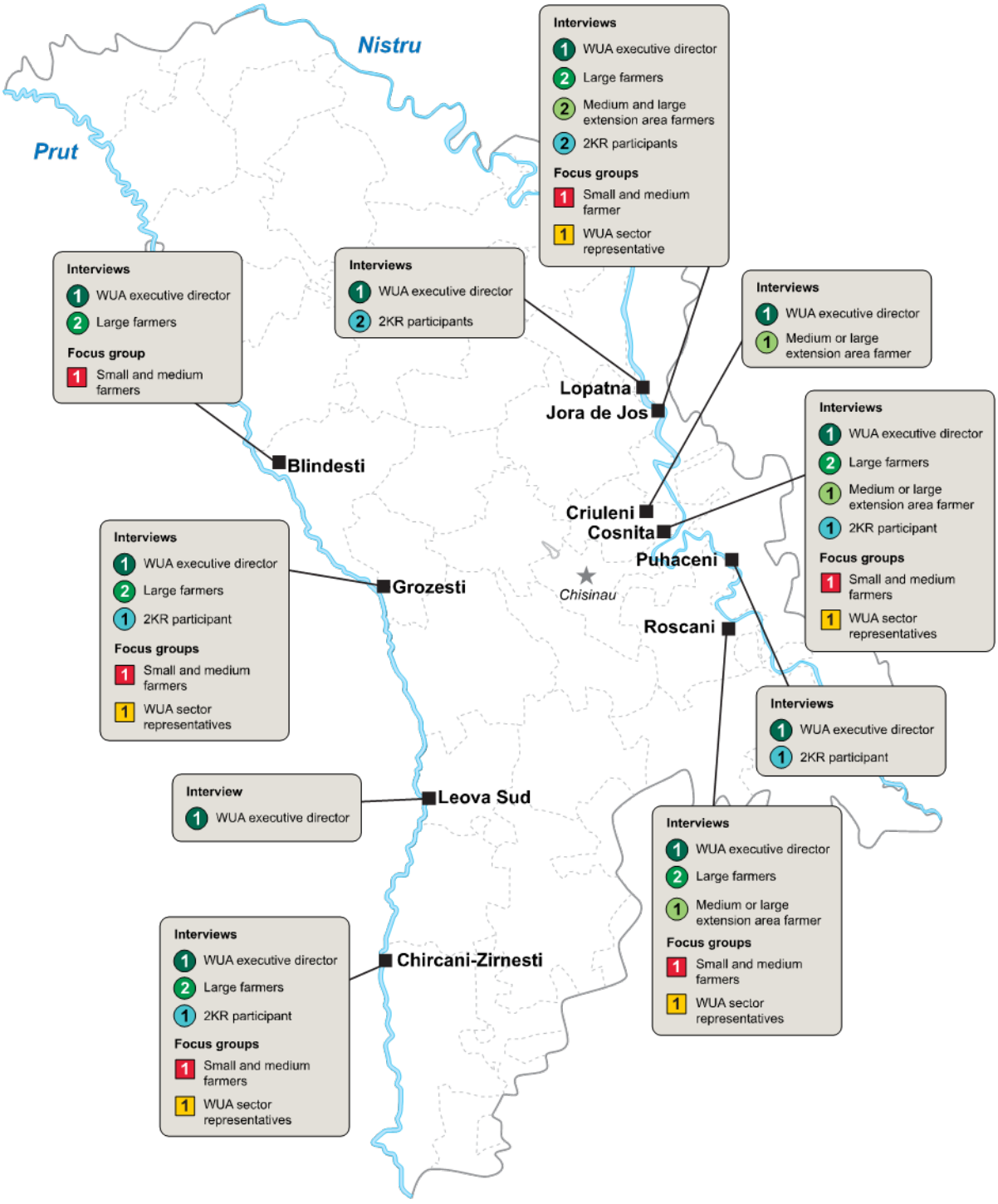


Table II.2. Participant interviews and focus groups (2017–2018), selection criteria and key topics

Respondent	Count	Selection criteria	Key topics
Interviews			
WUA executive directors[a]	10	WUA executive directors in all 10 targeted systems	• Functionality and reliability of centralized irrigation systems • Patterns of WUA membership and fee collection • Patterns of use of WUA irrigation services • Challenges with WUA operations and perceived risks to long-term WUA sustainability • Changes in on-farm investments, crop patterns, production practices, yields, postharvest practices, the land market, and other outcomes since rehabilitation
Large farmers in the system	12	Attempted diversity across all interviews in terms of WUA membership and irrigation status	• Patterns of WUA membership and fee payment • Patterns of use of WUA irrigation services, satisfaction with these services, and constraints to using these services • Changes in on-farm investments, crop patterns, production practices, yields, postharvest practices, the agricultural land market, and other outcomes since rehabilitation
Large and medium farmers in extension areas	5	Convenience sample of the few farmers who had connected to the rehabilitated systems	• Patterns of connections to the centralized irrigation system • Patterns of use of WUA irrigation services, satisfaction with these services, and constraints to using these services • Changes in on-farm investments, crop patterns, production practices, yields, postharvest practices, the agricultural land market, and other outcomes since rehabilitation
2KR participants	8	Convenience sample of participants who had signed a hire-purchase agreement by the end of 2016 and operate in a targeted centralized irrigation system	• Experience and satisfaction with the 2KR hire-purchase program process and loan conditions • Other sources of financing considered for the investment, and reasons for applying to 2KR • Interaction between 2KR equipment and irrigation through rehabilitated centralized irrigation system • How investment would have changed in the absence of the 2KR program
Focus groups			
Small and medium farmers in the system[b]	6	Attempted diversity within group in farm size, WUA membership and irrigation status, crops cultivated, and gender	• Patterns of WUA membership and fee payment • Patterns of use of WUA irrigation services, satisfaction with these services, and constraints to using these services • Changes in on-farm investments, crop patterns, production practices, yields, postharvest practices, the agricultural land market, and other outcomes since rehabilitation
WUA sector representatives[b,c]	5	Participants selected randomly within selected WUAs	• Functionality and reliability of centralized irrigation systems • Patterns of WUA membership and fee collection • Patterns of use of WUA irrigation services • Challenges with WUA operations and perceived risks to long-term WUA sustainability • Changes in on-farm investments, crop patterns, production practices, yields, postharvest practices, the land market, and other outcomes since rehabilitation

WUA = Water User Association

[a] In Blindesti, the WUA president participated in the interview with the newly-elected executive director. In Jora de Jos, the WUA president was interviewed instead of the executive director, because the latter had been interviewed (as executive director of Lopatna). In some systems, the WUA accountant also participated in the interview.

[b] Each focus group had between 8 and 11 participants.

[c] There was only one WUA sector representative in Blindesti, and therefore no focus group conducted.

B. Administrative data

In addition to the qualitative data described above, this report draws on two sources of administrative data:

- **Administrative and financial data from WUAs.** Mathematica's local consultant collected the following information from the 10 targeted WUAs in early 2018: (1) administrative data on membership and irrigation use for 2015–2017; (2) financial data for 2015-2017; and (3) administrative data on planned irrigation use for 2018. These data were obtained from the WUAs' membership database software (APAS), electronic accounting system (1C), pumping station records and water invoices, and discussions with the executive director, accountant, and other staff. (Table II.3 shows the key measures collected from WUAs.)
- **Administrative data from 2KR.** We also rely on administrative data on participants in the 2KR hire-purchase program. These data include background information about the participants (such as location, farm size, and crops cultivated), the value and nature of the equipment purchased through 2KR, and the status of repayments.

Table II.3. Administrative data collected from WUAs (2018)

Type of information	Key measures
Administrative information (2015–2017)	• Number of members and number of members who paid membership fees • Irrigation fee • Volume of water pumped • Number of farmers who irrigated • Area irrigated
Financial information (2015–2017)	• Revenues from membership fees, irrigation services, equipment services, and all other sources • All costs including electricity, salaries, taxes, and other costs • Balance in self-financing fund (revenues minus costs) • Cash balance
Future plans (2018)	• Expected membership fee, membership fee revenues, and irrigation fee • Expected volume of water pumped • Expected number of farmers who will irrigate • Expected area irrigated

C. Analysis approach

Our analysis drew on these interviews and focus groups to identify similarities and differences in perspectives across respondents, complemented by descriptive information from the administrative data. For the interviews that we conducted with high-level stakeholders, we drew on our interview notes to develop a set of initial themes soon after the data were collected. For the interviews and focus groups conducted by ADI, we analyzed the translated transcripts in NVivo, using a coding scheme that was mapped to the protocols and research questions. (ADI prepared the transcripts in Romanian and translated them into English.) We used the coded transcripts to triangulate responses across different respondent types and to study differences in findings across centralized irrigation systems. This approach enabled us to refine the themes developed from the high-level stakeholder interviews and develop additional themes. We also prepared summary statistics and data tables based on the WUA and 2KR administrative data, integrating these with our other findings. We present these integrated findings in the next chapter.

III. FINDINGS

In this chapter, we describe the experiences to date of WUAs and farmers operating in the 10 centralized irrigation systems in which the project established WUAs, transferred management of centralized irrigation systems to those WUAs, and rehabilitated the irrigation systems. Drawing on the administrative data, stakeholder interviews, and participant interviews and focus groups described in Chapter II, we first discuss how the systems are functioning and being used and whether farmers are transitioning to HVA production. We then describe the continuing barriers to irrigation use and HVA production, and discuss land consolidation and land prices in the systems. We explore how the WUAs are faring financially and the role of SDA-Moldova and other organizations in providing post-compact support to WUAs and farmers in the systems. Finally, we examine the experiences of early 2KR hire-purchase program participants, as well as the post-compact evolution of the data platforms and plans developed under the River Basin Management subactivity.

Key findings:

- In 2017, **all 10 rehabilitated systems were fully functional.**
- **Abundant rains and limited HVA production have curbed demand for irrigation** to date. About 1,680 hectares were irrigated in 2017, primarily by large farmers and primarily along the Nistru River.
- **There remain a number of barriers to irrigation** in the rehabilitated systems. These include an insufficient supply of on-farm irrigation equipment, pumps that can only supply large volumes of water, fragmented land holdings that limit efficiencies in irrigation, other technical problems with or design features of the rehabilitated systems, and the high and upfront costs of irrigation water.
- **Additional barriers**, including limited access to sales markets, lack of rural labor, and a limited desire and ability to invest in HVA, further **slow the transition to HVA.**
- **Larger farmers are best-positioned to overcome these barriers and benefit directly** from system rehabilitation by irrigating and transitioning to HVA crops. However, **small farmers could still benefit indirectly** by being able to rent out their land more easily and at higher prices.
- **Land consolidation has intensified due to system rehabilitation but is still proceeding at a slow pace** in most systems, especially on the Nistru River. Consolidation has led to an increase in the area cultivated, but has not led to large increases in the area irrigated.
- **WUAs on the Nistru River have a broader user base and are in a more stable financial position** than those along the Prut River.
- **SDA-Moldova provided critical support to WUAs** in maintaining the physical infrastructure of the rehabilitated systems, and in system operations and management since the end of the compact. However, **WUAs likely require continued technical support** in the next few years.

A. Irrigation system functionality, irrigation use, and HVA production

Irrigation system rehabilitation and management transfer through the THVA project were intended to increase access to reliable irrigation, addressing one of several barriers to HVA production. The project's Economic Rate of Return model assumed that irrigation use and HVA production would rise rapidly after system rehabilitation was completed. In this section, we summarize the state of the irrigation systems in the 2017 agricultural season—two seasons after the compact closed—and describe the extent of irrigation use and HVA production to date.

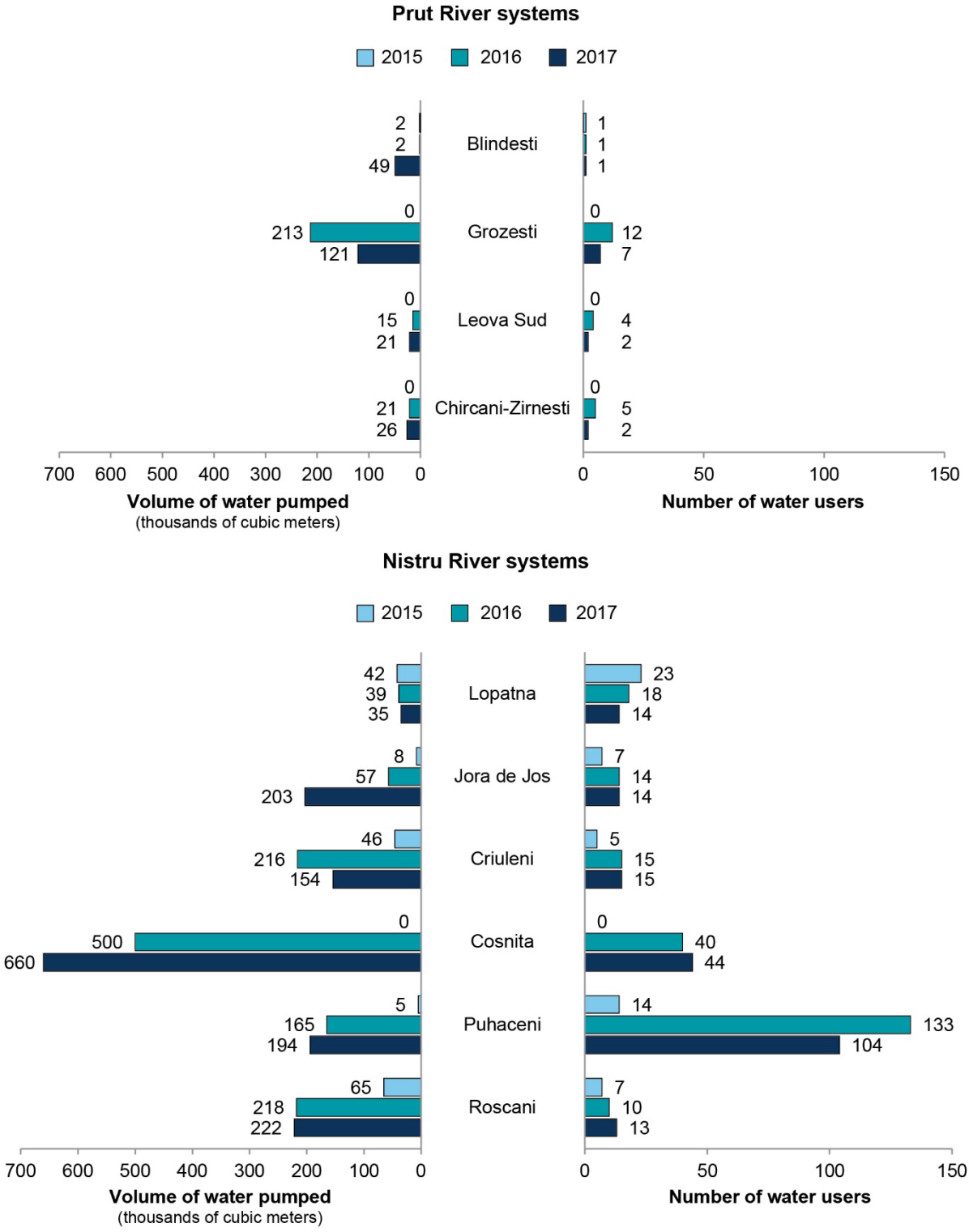
All 10 systems were fully functional in the 2017 season, and all but three were fully functional during the 2016 season. Though all major construction works were completed by the end of the compact, some systems required additional work to become operational after the compact. In Lopatna and Blindesti, the systems only became operational late in 2016 due to problems with the accumulation basins. In Criuleni, one of two rehabilitated pumping stations was not turned on until 2017. The system in Chircani-Zirnesti has been fully functional since the end of the compact but has expanded, as a new module (completed in 2016) became functional during the 2017 season. As we discuss in Section III.E, SDA-Moldova played a critical role in operationalizing many of the systems after the end of the compact by supporting physical improvements to the systems and technical assistance for system operators. Some systems—such as Lopatna and Blindesti—might not have become fully operational without this support.

In most systems, relatively few farmers have irrigated since the end of the compact; irrigation use has been concentrated among larger farmers and in systems along the Nistru River. Although all systems have been at least partly functional since 2016, in 8 of the 10 systems fewer than 20 farmers irrigated through the WUA in 2017 (Figure III.1).[8] Across all systems, there were 216 water users in 2017, comprising 4 percent of WUA members (at the system level, the percentage of WUA members who irrigated ranges from less than 1 percent to 27 percent). Although most systems had at least some small farmers who irrigated through the WUA, a handful of larger farmers—or even a single large farmer—were typically responsible for the vast majority of the volume of water pumped. Systems on the Nistru River, which had more recent experience with irrigation before the rehabilitation, had more farmers irrigating than those on the Prut River. These Nistru River systems include Puhaceni and Cosnita, the two systems with the greatest number of water users. In Puhaceni, many small farmers along the bank of the NistruRiver cultivated vegetables before the system was rehabilitated, irrigating directly from the river (some without the necessary water use authorization). After the system was rehabilitated, some of these farmers began to irrigate through the system instead. In Cosnita, which traditionally specialized in vegetables, many farmers were already irrigating through the system and continued to do so after the rehabilitation. The systems on the Nistru River also pumped substantially more water than those on the Prut River (245,000 m^3 per system, on average, compared to about 55,000 m^3 per system) (Figure III.1).

> *"All hope is with the large farming enterprise [which irrigated in 2017] and we don't know for how much longer this farming enterprise will continue to irrigate."*
>
> – WUA director, Prut

[8] In some systems there were minor discrepancies between the number of water users according to WUA administrative data (water invoices), which are shown in Figure III.1, and the number of water users reported by WUA directors in interviews. However, these discrepancies do not substantively affect our conclusions.

Figure III.1. Number of water users and volume of water pumped by system, 2015–2017



Source: 2018 WUA administrative data.

Note: The number of users and volume of water pumped includes extension areas. Data supporting this figure are shown in Appendix Table B.1.

The volume of water pumped and area irrigated increased in most systems between 2016 and 2017. The total volume of water pumped across all systems increased by about 17 percent between 2016 and 2017, with increases in 7 of the 10 systems (Figure III.1). In all systems, the area irrigated was relatively flat or increased between 2016 and 2017 (Figure III.2). In the two systems with the largest increases between 2016 and 2017—Grozesti and Jora de Jos—this was mostly driven by an increase in the area irrigated among farmers who irrigated in 2016, who observed the benefits of irrigation and were able to expand (for example, by purchasing additional irrigation equipment or consolidating additional land). Between 2016 and 2017, the total area irrigated across all systems increased by about 48 percent, from 1,134 hectares to 1,680 hectares.[9,10] In contrast, the Economic Rate of Return model that was updated in 2016, soon after the end of the compact, assumed that 3,422 hectares would be irrigated in 2017.[11] Most WUAs are optimistic that water use will further increase in 2018, as farmers see the benefits of irrigation and larger farmers consolidate land to take advantage of irrigation.

Abundant rains since the end of the compact have limited the demand for irrigation in the rehabilitated systems, especially because most farmers still cultivate non-HVA crops. Most HVA crops require regular irrigation at specific times, regardless of rainfall, whereas non-HVA crops are often able to rely on rainfall alone. In 2016 and 2017, the first two full agricultural seasons since the rehabilitation was completed, there was abundant rainfall, which reduced the need for irrigation because non-HVA crops still dominate the rehabilitated systems.[12] In particular, in many WUAs, farmers' use of irrigation was substantially lower than their expected demand—which they declare to the WUA before the start of the season for planning purposes. Some farmers who were planning to irrigate did not, and some used a smaller volume of water than they had planned. Demand for irrigation has been especially limited in the Prut River systems, where cultivation of HVA crops is less common than in the Nistru River systems.

"It was raining exactly when people wanted to irrigate."

– Small farmer, Prut

"The main cause [for limited irrigation] is that they produce cereals. The efficiency of irrigation is achieved only when you produce value added crops like vegetables, fruits and berries. For the rest, it is not profitable when used on cereals. […] It is because the price of cereals is very low."

– WUA director, Nistru

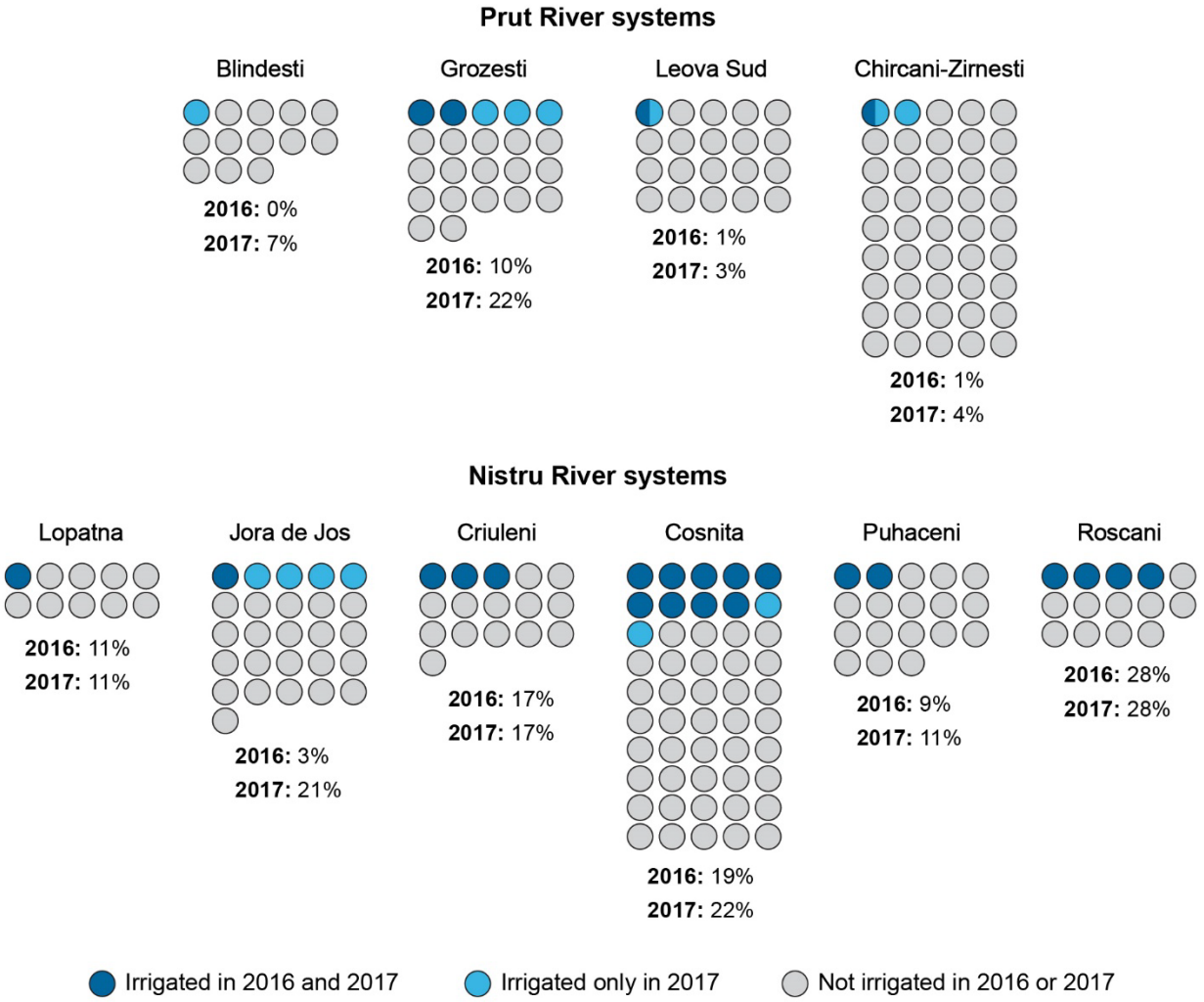
[9] The estimated area irrigated, which the WUAs reported to SDA-Moldova, might not be precise in all systems. These estimates could only be verified using primary data—mainly pumping station records and state subsidy applications—in some systems. Several WUA directors emphasized that they are focused on accurately recording the volume of water pumped and electricity used, rather than area irrigated.

[10] This represents a large increase from irrigation use prior to rehabilitation. In the 2013 agricultural season, an estimated 241 hectares were irrigated (Borkum et al. 2015).

[11] This target comprises 2,475 hectares in the centralized irrigation systems and 947 hectares in the extension areas. We are not able disaggregate the 1,680 hectares that were irrigated in 2017 into land in the centralized irrigation system and land in the extension area. However, we expect that the vast majority was centralized irrigation system land because irrigation in extension areas is still limited, as discussed below.

[12] Data from the State Hydrometeorological Service show that in the Central region, total rainfall over the agricultural season (March – October) was 41 percent (2016) and 24 percent (2017) higher than the 2002–2015 average. In the Southern region, total rainfall was 38 percent (2016) and 15 percent (2017) higher.

Figure III.2. Area irrigated by system, 2016–2017



Source: SDA-Moldova.

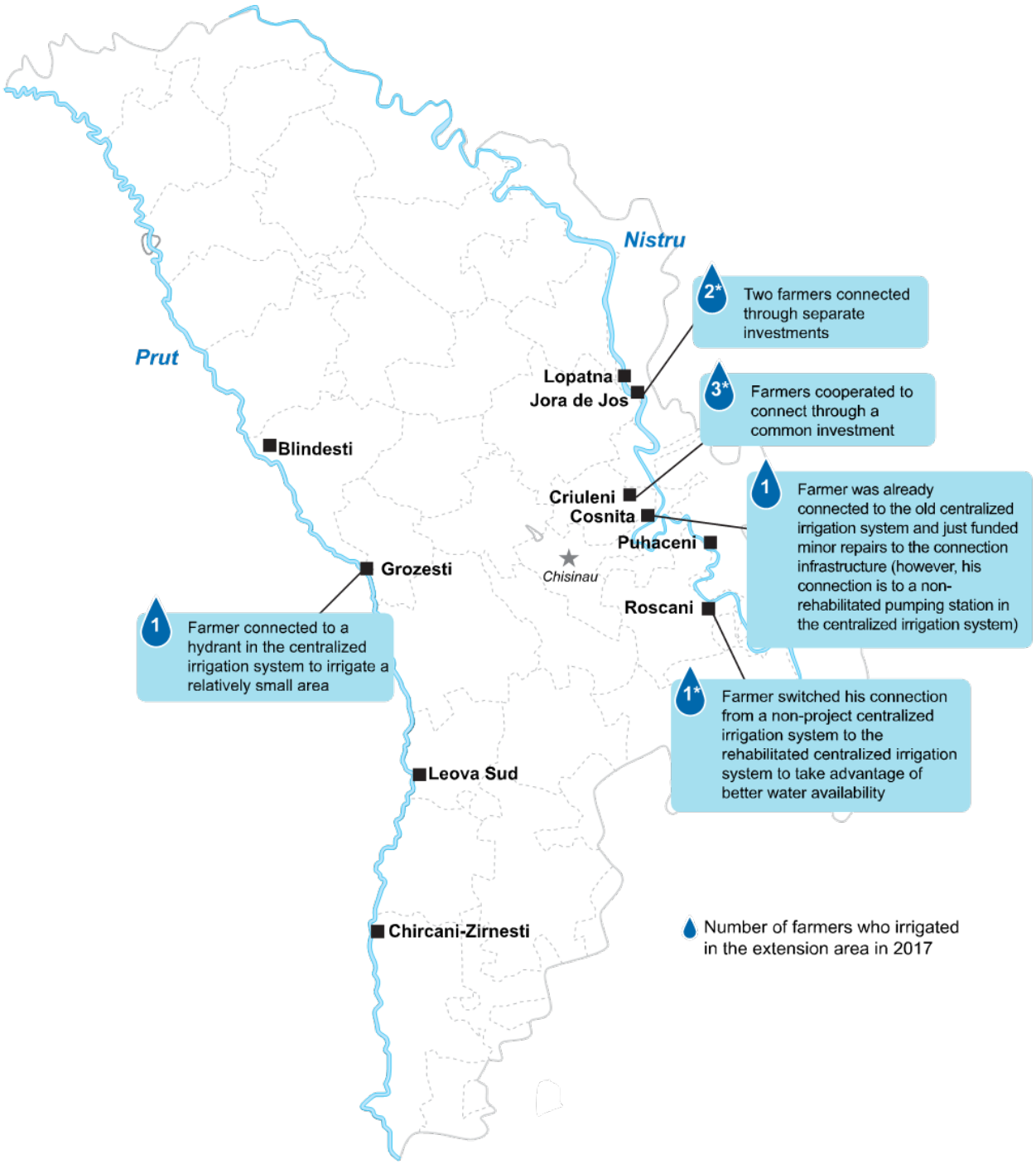
Note: Figure is a graphical representation of the area irrigated in each system in 2016 and 2017. Each dot represents 50 hectares of irrigable area within the centralized irrigation system. The area irrigated in 2016 is shaded in dark blue and the additional area irrigated in 2017 is shaded in light blue. The area shaded in light gray was not irrigated in either 2016 or 2017. The area and percentage irrigated within the centralized irrigation system may be slightly overestimated because reported area irrigated by CIS includes extension area land. The total system size and area irrigated have been rounded to the nearest 50 hectares. (In Leova Sud and Chircani-Zirnesti, an area of less than 25 hectares was irrigated in 2016, which is indicated with a half-shaded dark blue dot.) Dots do not represent geographic location within each system. The total percentage of irrigable area that was irrigated in 2016 and 2017 (based on unrounded numbers) is shown under the graphical representation for each system. Data supporting this figure are shown in Appendix Table B.2.

A few farmers used the rehabilitated systems to irrigate land in extension areas in 2017, but the high cost of infrastructure and equipment might limit future expansion. About eight extension area farmers in five systems were connected to the system and irrigated through WUAs in 2017 (Figure III.3). (Another three extension area farmers were connected but did not irrigate in 2017.) Though we do not have information on the number of hectares under irrigation in extension areas, we estimate that it is well below the 947 irrigated hectares expected in 2017 by the project's Economic Rate of Return model. These eight farmers exclusively irrigated HVA crops in the extension areas, including stone fruit, apples, vegetables, and nurseries. To physically connect to the centralized irrigation system, extension area farmers typically had to make substantial investments in infrastructure such as pipes and accumulation basins, which subsequently require regular (potentially costly) maintenance. These farmers also had to invest in additional equipment to irrigate once connected—for example, in electrical transformers, pumps, filters, and on-farm irrigation equipment. Farmers funded the necessary infrastructure and equipment through combinations of their own resources, loans from the International Fund for Agricultural Development (IFAD), and the 2KR hire-purchase program. However, these high overall costs could limit the number of additional extension area farmers who connect to the system and hence the extent of irrigation in extension areas.

> *"...[the extension area farmers who connected] have procured their own pipes. Then they constructed the water accumulation basins on their own. They procured their own plastic foil – even if they bought good quality for a good price, it is expensive. They connected to electricity, so they invested in electrical transformers. We are talking about millions of lei invested. And this was their personal investment."*
>
> – WUA director, Nistru

Nevertheless, some WUAs are expecting increases in irrigation in extension areas in the next few years. Despite the challenges of connecting extension area land to the rehabilitated systems, there are plans for new extension area connections in five systems. In some systems, these plans are still in the very early stages, but in others, farmers have made concrete progress towards connecting. For example, in Roscani, farmers are cooperating to connect an entire village in the extension area to the system—an irrigable area of around 100 hectares—with co-funding from IFAD. WUAs also expect some extension area farmers who have already connected to irrigate a larger area of land in the next few years (cultivating either existing HVA crops or new HVA crops), having seen the benefits of irrigation through the WUA. In addition to individual farmers connecting, SDA-Moldova also funded the rehabilitation of two additional irrigation modules in Chircani-Zirnesti in 2017, which extended the irrigable area in the system by one-quarter. There are currently plans to rehabilitate up to four additional modules in Chircani-Zirnesti, further extending the irrigable area in the system. The design for these modules is already completed and larger farmers in these areas have expressed interest in irrigation, but the WUA is still seeking funding for the construction of these modules.

Figure III.3. Irrigation in extension areas through the WUA in 2017



Source: 2018 interviews with WUA directors and farmers. Systems not indicated in the figure did not report irrigation in extension areas.

* = In each of these systems, another farmer is connected to the system but did not irrigate in 2017.

The vast majority of water users were satisfied with the irrigation services provided by the WUAs in 2017, but the WUAs' ability to meet higher levels of demand for water and irrigation equipment services has not yet been tested. In 2017 almost all water users were able to obtain the quantity of water demanded from the WUA when they demanded it. However, in most systems, the WUA's ability to meet user demand has not yet been fully tested because there are still few water users. Likewise, there is widespread concern that WUAs might not be able to meet demand for irrigation equipment services in the future. (For example, in 2017, in two systems with many users, users had to wait for irrigation equipment services, which meant they could not irrigate at the ideal time.) Finally, despite overall high levels of satisfaction with the WUA irrigation service to date, farmers in three systems expressed dissatisfaction with the low water pressure from some pumping stations, which impedes or slows irrigation.

"The association has only two reels, two that cannot be shared. People stand in a queue, but the crop needs water today, not tomorrow."

– WUA sector representative, Nistru

"We have a problem and that is insufficient pressure […]. In one irrigated sector the pressure is 1 bar, and farmers are forced to use an additional pump to increase the pressure for the Bauer [-brand] irrigation equipment to irrigate. It generates additional costs for the farmers, especially related to diesel fuel. The Bauer equipment needs at least 2-3 bars to functionally irrigate."

– WUA director, Nistru

"We conduct intensive work to ensure cooperation. When we receive water requests, we know in what zone every beneficiary is located and we know the other beneficiaries around the same station – we call, coordinate and cooperate."

– WUA director, Nistru

"There are times when a farmer comes and wants to irrigate using small Bauer [-brand] equipment, but he cannot load the pumping station pump. And in this case, the director used to consolidate us. If somebody with a small installation wanted to irrigate, he told them to wait for 2 days because another farmer will also come in to irrigate as well. So, he was consolidating us to try to load the pumps at their maximum, to make it efficient. The pumps are large and if they are not loaded to 30-40 percent, they just don't work. If there would be just one small farmer, he would not be able to irrigate at all."

– Large farmer, Nistru

Some WUAs are actively encouraging farmers to cooperate to irrigate through the system. As we discuss in Section III.B, the pumps in the rehabilitated systems can only pump large volumes of water, which makes it difficult and expensive to irrigate small areas. Therefore, for large-scale irrigation to occur, either farmers need to consolidate the land into larger holdings, or farmers in the same area need to cooperate to irrigate on the same schedule. Cooperation among farmers might be especially important in the short run because land consolidation is proceeding slowly in most systems (as discussed in Section III.C). A few WUAs are encouraging cooperation by coordinating the timing of irrigation among farmers to meet minimum volumes and reduce electricity costs. In some cases, this leads to slight delays relative to farmers' desired irrigations, but farmers prefer delays relative to not irrigating at all. However, because irrigation needs for HVA crops are crop-specific and even variety-specific, small farmers successfully transitioning to irrigated HVA crops on a wide scale would require substantial cooperation. Building extensive cooperation could be challenging without long-term external support (for example, through a new project) or strong leadership from the WUA.

The transition to HVA production has been slow, but improved access to irrigation increased yields and quality for existing HVA and non-HVA producers who irrigated. Most systems have experienced some increases in HVA production since the end of the compact.

However, this has typically involved just a few hectares or tens of hectares of new production cultivated by a small number of farmers. In most systems, stakeholders expect HVA production to increase further, but agree that progress will likely continue to be slow (as there remain several barriers to HVA production, as described in Section III.B). However, improved access to irrigation has led to improvements in the production of existing crops. Several large farmers who irrigated non-HVA crops experienced increases in yields that made it profitable to irrigate. Improved irrigation also led to diversification of existing HVA crops (including new advanced varieties), the establishment of more intensive orchards, and changes in irrigation and production practices for existing HVA crops (for example, increased intensity of irrigation, use of drip irrigation, and use of fertigation). This resulted in higher yields and better quality HVA products relative to before system rehabilitation.

"Yes, we made changes. Instead of 50,000 [corn] plants we planted 80,000 plants. We increased the number of plants per hectare due to irrigation being available. This in turn leads to an increase in yields."

– Large farmer, Prut

"For the apple orchard we established in 2017, we have used a different planting scheme from the one we used in 2014. The apple trees were planted closer to each other, which allowed us to have higher yields while the works are more efficient and the expenses are lower. Obviously, we use fertigation and the pruning is done duly."

– Large farmer, Nistru

In Chircani-Zirnesti, the rehabilitated drainage system has benefitted farmers by extending the cultivation season and reducing the risk of flooding. In the Chircani-Zirnesti system, which is prone to flooding, the THVA project rehabilitated drainage infrastructure in addition to irrigation infrastructure.[13] Before the drainage system was rehabilitated, cultivation could typically only start relatively late in the agricultural season, once the spring snow-melt subsided. By enabling farmers to begin cultivation at the appropriate time, earlier in the season, the rehabilitation has led to increases in yields. The improved drainage has also reduced crop losses due to additional spring flooding, which used to occur in the case of heavy spring rainfall and/or flooding of the Prut River. In some areas of the system, cultivation was previously not feasible at all because of regular flooding, but has now become feasible. The drainage system rehabilitation has also reduced flooding in several communities *outside* the system that are part of the same geographic basin, thus affecting a much larger area of land than the system itself. There have been some challenges with maintaining the rehabilitated drainage system infrastructure. For example, heavy winter snowfall in early 2017 damaged electricity pylons (transmission towers) that supplied the drainage pumps, some drainage pumps were damaged by intake of earth and other debris, and some drainage canal walls have eroded. Nevertheless, improved drainage has been one of the most important benefits of the project in the Chircani-Zirnesti system.

B. Barriers to irrigation use and HVA production

The THVA project intended to increase irrigation use and HVA production in the rehabilitated systems, which were limited before rehabilitation (Borkum et al. 2015). However, two full seasons after system rehabilitation was completed, use of irrigation was still not

[13] The system is drained twice each year, in fall and spring. It is drained in fall to evacuate water from the irrigation network before it freezes and causes damage, as well as to free up drainage canals for water from the spring snow-melt. It is drained in spring to remove the spring snow-melt, as well any excess water that accumulates on the land as a result of spring rainfall and/or flooding of the Prut River.

widespread in most of the rehabilitated systems, nor was there widespread transition to HVA crops. As described above, the limited demand for irrigation reflected abundant rain (reducing irrigation demand among producers of non-HVA crops) and the limited cultivation of HVA crops. In this section, we first describe remaining barriers to utilizing the rehabilitated systems and then discuss other key barriers to HVA production.

1. Barriers to irrigation use

The THVA project identified the lack of access to affordable and reliable irrigation water as a key constraint to increased HVA production, which it sought to address through WUA establishment, management transfer, and system rehabilitation. Although the limited irrigation use since the end of the compact largely reflected low demand for irrigation, our analysis identified several barriers that might constrain the use of irrigation even if demand were to increase. These barriers include the insufficient supply of on-farm irrigation equipment, system pumps that can only supply large volumes of water, fragmented land holdings, technical problems with and design features of the systems, and the high and upfront costs of irrigation water. We discuss these barriers to irrigation use in more detail below.

The quantity and type of irrigation equipment available through the WUA might not be sufficient to support increased demand for irrigation. The THVA project fully rehabilitated the irrigation infrastructure (pumping stations, subterranean pipes, accumulation basins, and hydrants) necessary to deliver water to hydrants in or near farmers' fields. However, farmers require additional irrigation equipment—such as pipes, sprinklers, or irrigation booms (which irrigate fields through large wings)—to connect to the hydrants to irrigate their farms. Recognizing the limited access to irrigation equipment by farmers in the rehabilitated systems, MCA-Moldova provided some units of equipment to each WUA, which they use to rent out equipment services to farmers. However, MCA-Moldova's resources for providing this equipment were limited, so they were only able to provide relatively few units. As mentioned earlier, there is a widespread concern that the WUAs will not have enough units of equipment to meet demand in future years, although so far this has not been a problem in most systems because of low demand for irrigation. WUAs also only have specific types of equipment, which may not be suitable for all types of crops or all types of areas. For example, the equipment most WUAs have is not suitable for irrigating very small areas; MCA-Moldova decided to provide equipment suitable for irrigating larger areas so that larger farmers could use it, with the expectation that some smaller farmers would also cooperate to irrigate larger areas. These challenges with the WUA's irrigation equipment are especially important for small farmers, who typically are not able to afford their own irrigation equipment. Some small farmers did acquire irrigation equipment, sometimes purchasing it secondhand or constructing their own rudimentary equipment from purchased parts to reduce the cost. In contrast, many medium and large farmers were able to purchase irrigation equipment that was suited to their specific needs through the 2KR hire-purchase program, other programs (for example, the European Investment Bank's *Livada Moldovei* [Gardens of Moldova] project or IFAD programs), or their own resources. Nevertheless, some large and medium farmers might still rely on the WUA's irrigation equipment if they do not have the resources to purchase their own equipment or if they would like to experiment with irrigation on a small scale (which would not justify purchasing their own equipment).

Insufficient supply of on-farm irrigation equipment

"I am very angry at the fact that [a lot of money] was invested [in system rehabilitation] from the start, but they didn't consider from the very beginning to also invest [a substantial amount of money] in order to purchase irrigation machines to use them for service. There are farming enterprises in the area who have no financial opportunity to procure this equipment […]. I did not irrigate in 2017, nor in 2016, because I had no equipment for irrigation." – Large farmer, Prut

"We have a fear that too many farmers will want [to use the WUA's irrigation equipment] and we will not be able to cover the demand." – WUA director, Prut

"As for irrigation equipment, I would say that a cause would be that farmers need smaller scale irrigation equipment formed of pipes and pistol nozzles. This would allow irrigating small areas [in contrast to] the large scale Bauer [-brand irrigation] equipment." – WUA director, Nistru

"We are grateful for the rehabilitated system, but they did not take into consideration small farmers... here they are at 200-300 hundred meters, and the Bauer [-brand irrigation equipment] is too large for 200-300 meters, and if smaller scale equipment would have been provided…" – Medium farmer, Nistru

"We could not irrigate. We had no drip irrigation equipment nor sprinklers. Using the WUA's Bauer [-brand] irrigation equipment was also not possible because the trees were already tall and we did not want to traumatize them." – Large farmer, Nistru

"We thought about using WUA irrigation equipment to irrigate […] corn. But at the point when we decided to irrigate, the corn was already tall and we could not irrigate using the wings of the WUA irrigation equipment." – Large farmer, Prut

The rehabilitated systems are designed to pump large volumes of water, making it costly to irrigate small areas. The rehabilitated systems were designed to irrigate large areas of land, with the expectation that farmers would cooperate or consolidate land when irrigating. (According to SDA-Moldova, the rehabilitated systems were designed to be able to irrigate at one time up to 20 percent of the land area in each system, and would function optimally if at least 12 percent of the land area was simultaneously irrigated.) Therefore, high-capacity pumps were commonly installed as part of the rehabilitation.[14] These pumps are not suitable for providing the small volumes of water necessary to irrigate small areas of land, both because the per-unit electricity cost is high for smaller volumes and because it is not economical to fill the system's pipes when only a small volume is demanded. This might continue to pose a challenge to irrigation in the systems until more small farmers cooperate to irrigate larger areas or more land consolidation occurs. Some stakeholders in the systems suggested that it would have been better to install a mix of large and small pumps at each station to give WUAs the flexibility to supply smaller quantities of water.

[14] There is some variation in the pump capacity across systems and pumping stations because the pumps serving each specific area were designed to provide a common flow rate of water per hectare. Therefore, lower capacity pumps were installed in pumping stations serving smaller areas. However, the typical capacity of the pumps was high.

Pumps in the rehabilitated systems supply only large volumes of water

"The [land] areas in our area are small […]. At the same time, the pumps have a large pumping capacity. We cannot start the pumps [to irrigate a small area of land]—for example, for a single hydrant, the pumps have to work at minimum capacity, while the energy consumption is very high, which in turn brings us to an increase to the price of water supplied." – WUA director, Nistru

"The pumps are very big [at one pumping station] and I don't know why they designed it like that. It could have been a large pump and a small pump, but they installed 2 large pumps. We think that was a design mistake. [Another pumping station designed to serve a smaller area] is the most productive place, because people irrigate a lot, plus this station is the most efficient and even small farmer can irrigate there. The pump is small and farmers can irrigate by themselves." – Large farmer, Nistru

"[…] We don't have a smaller pump designed for drip irrigation. This should have been planned, but it wasn't." – WUA sector representative, Nistru

Fragmented land holdings limit efficiencies in cultivating irrigated crops. Land holdings in rural Moldova were highly fragmented following the privatization that occurred after the fall of the Soviet Union. Consolidation of land plots into larger holdings is important for the envisaged increase in irrigation and transition to HVA crops to occur, for two reasons. First, as discussed above, the pumps in the rehabilitated systems are better suited to irrigating large, consolidated areas of land. Second, consolidation is necessary for farmers to benefit from economies of scale, which might be necessary for irrigation to be profitable (for example, to justify a large investment in irrigation equipment). As we discuss in Section III.C, consolidation is occurring in most systems but at a slow pace. This is largely because land holdings are so highly fragmented—necessitating sales or rental agreements with many owners—and because some owners are reluctant to sell or rent their plots, even for high returns.

Fragmented land holdings

Without consolidation it is difficult to operate and irrigate the land. Once lands are consolidated, operating it is another story. It's a lot easier to work on consolidated land compared to parceled land." – Large farmer, Nistru

"Of course I don't want to have land parcels on different fields. I want to have everything in one place. Even if I will want to irrigate, it will be much simpler." – Large farmer, Nistru

"[…] the land needs to be more compact (consolidated) so that I could irrigate, otherwise I will not manage." – Large farmer, Prut

Other technical constraints to irrigation in some systems include long distance between hydrants and low water pressure. In some systems, the long distance between hydrants is also a challenge to irrigating small areas because farmers' connections to the hydrants would be expensive and might have to cross other farmers' land. The distance between hydrants is suitable for irrigating large consolidated areas, which is what the systems were designed to do. A separate technical concern in a handful of systems, also mentioned earlier, is that the water pressure is lower than expected in some parts of the system, which makes it difficult to irrigate efficiently (or at all) using the necessary equipment. All of these technical concerns about the systems were more common in the Nistru River systems, possibly because those are the systems where more farmers have tried to irrigate or seriously considered it.

Technical problems or system design features

"Some farmers who want to irrigate have hydrants located too far from their lands." – WUA director, Nistru

"So, if [the hydrants in] our system [are] located at a distance of 300 m, and those who have land in the middle have 0.1 ha, then they don't have the possibility to irrigate." – WUA director, Nistru

"[…] there are problems at [a certain pumping station]—there is no pressure. The station outputs 5 atmospheres, and 500 meters away from it the hydrant outputs 2 atmospheres of pressure. I don't irrigate from [it]. Farmers run away from there, because they cannot irrigate. You cannot irrigate with a pressure of 2 atmospheres. You can't even do drip irrigation." – Large farmer, Nistru

"I irrigated only one hectare of land, as an experiment. I wanted to irrigate a larger area, but the problem was that the water pressure was insufficient. If the pressure was fine […] then I would have irrigated other lands too." – Large farmer, Nistru

The high and upfront costs of irrigation water is another, albeit less common, barrier to irrigation. Stakeholders in some systems suggested that farmers would irrigate more if the cost of irrigation water was lower, although most did not mention this.[15] Though farmers can recoup some of the costs of irrigation fees through government subsidies and fees have to be approved by members at the WUA general assembly, some farmers might not be aware of the subsidies, might face barriers in applying for them, or might not have participated in WUA meetings where the irrigation fees were approved. Several respondents also acknowledged that irrigation fees were necessarily high because relatively few farmers were irrigating through the WUA. Besides the cost itself, some farmers mentioned that making upfront payments for irrigation fees was challenging because they had not yet received income from selling their crops and also had to pay other upfront costs (such as seeds). However, as described in Section III.D, some WUAs have been willing to negotiate a payment schedule with farmers who cannot afford the upfront payment and have typically been able to collect these payments according to this schedule.

High and upfront costs of irrigation water

"If the water price would have been lower, then we would have irrigated more. But our case is like this—you have money, you irrigate, if not, then not— because if you irrigate, you have to pay immediately. You can't pay for it next year. […] Sometimes, if I don't have money, I don't even irrigate." – Large farmer, Prut

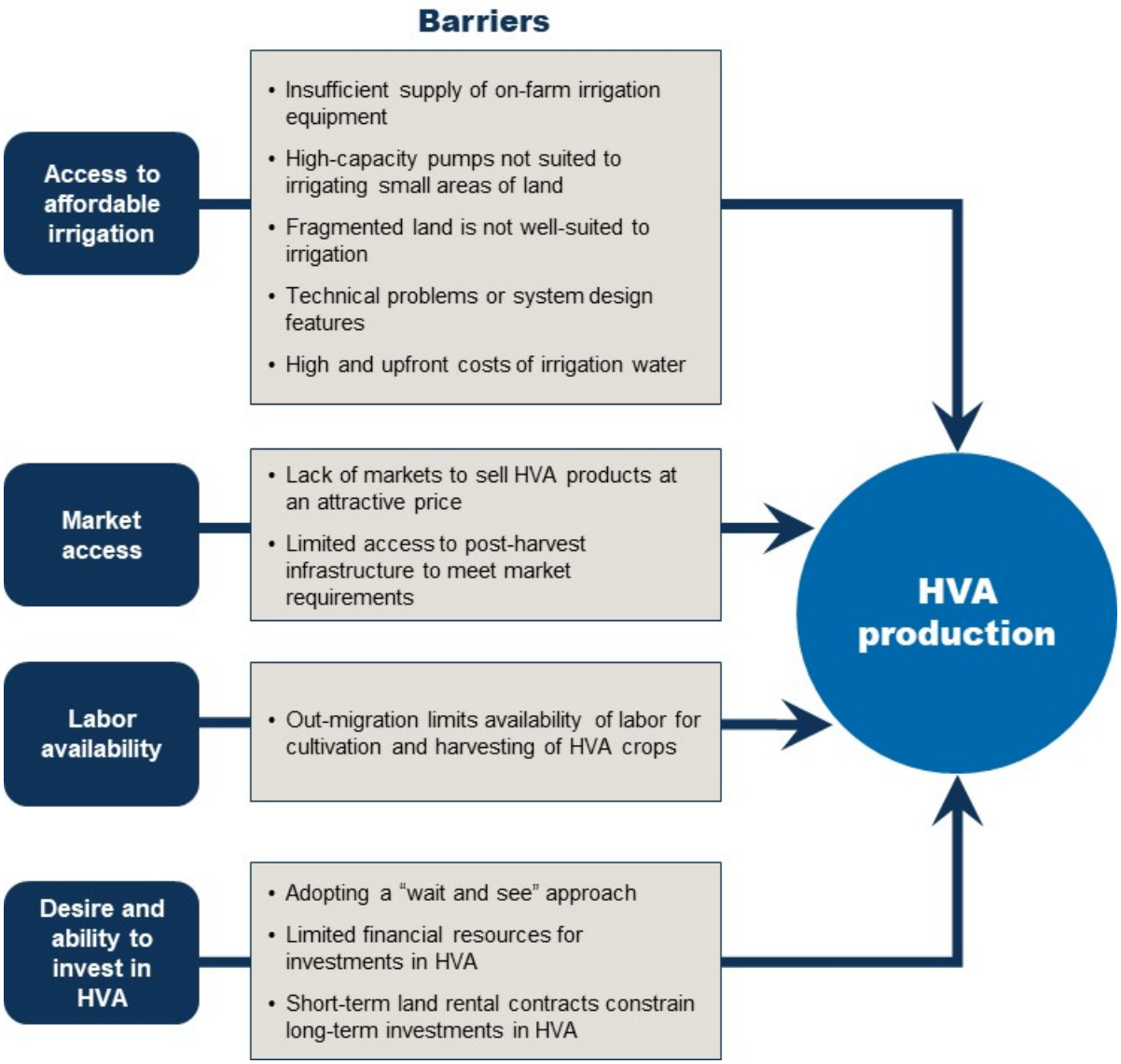
"One of the problems might be the lack of money to pay for irrigation water delivered." – WUA director, Nistru

[15] The costs of irrigating are large relative to other production costs. Using the average 2017 irrigation fee and volume pumped per hectare, we estimated the cost of irrigating separately for small, medium, and large farms. Drawing parameter estimates for median farm size and production expenditure (by farm size group) from the 2013 agricultural season (Borkum et al. 2015), we find that irrigating increases median production costs by about 64 percent for small farms, 72 percent for medium farms, and 53 percent for large farmers. This is likely a lower bound for the increase because it does not take into account additional costs such as irrigation equipment (either purchased by the farmer or rented as a service from the WUA).

2. Other barriers to HVA production

The THVA project was expected to address other barriers to HVA crop production by improving access to markets for HVA crops, training farmers in irrigation and HVA production, and funding post-harvest infrastructure. However, a lack of attractive markets for HVA crops continues to be an important barrier to HVA production, a barrier that may be compounded by a continued lack of access to post-harvest infrastructure. We also identified additional barriers to HVA production including a lack of rural labor, limited financial resources for investments in HVA, short-term land rental contracts that constrain long-term investments in HVA production, and farmers adopting a "wait and see" approach before transitioning to HVA. We discuss these additional barriers to HVA production in more detail below. (Figure III.4 illustrates the key barriers to HVA production, including the barriers to irrigation use discussed above.)

Figure III.4. Key barriers to HVA crop production



A lack of attractive markets continues to be a key barrier to transitioning to HVA crops. Most farmers believe that they do not have access to reliable markets where they can sell HVA produce at an attractive price. The perceived lack of access to attractive markets is compounded by limited market information, a high degree of foreign competition, and limited access to post-harvest infrastructure (which we describe in further detail below). Marketing challenges were more commonly mentioned in the Prut River systems, where farmers were less likely to have experience in selling HVA crops. Market access seems to be a bigger barrier for small farmers, as large farmers often have advance sales contracts with buyers (including foreign buyers) with whom they have established relationships. Although several stakeholders suggested that small farmers should cooperate through central collection and storage points which would give them more market power and access, these plans remain largely aspirational. Many stakeholders suggested that the market for fruits is more favorable than for vegetables because fruits can be exported for a high price (especially if irrigation increases their quality), whereas vegetables are typically sold within Moldova at low prices. Despite the broad challenges related to markets, a handful of large farmers recently started to export fruits to new markets beyond their traditional market of Russia, including Romania and Saudi Arabia (in one case). However, no farmers mentioned changes in the markets where they sell vegetables domestically (for example, increased sales to domestic supermarkets rather than regional open-air markets).

Lack of markets to sell HVA products at an attractive price

"Last time I attended the [WUA] meeting organized in [the system], I told them: 'If you think we don't know how to use irrigation water, then please tell us what crop to plant, where to sell it, at what selling price, so that at the end of the year my income would be at least 15 percent.' They all started laughing. Of course no one can provide such information." – Large farmer, Prut

"There is nowhere to sell the vegetables…Let's say we produce vegetables, but where do we take them to?" – WUA director, Prut

"Now, these vegetables can be produced, but there is no place for farmers to sell them. This is the main problem. And nobody wishes to invest, and end up with the product lying in the field without having anywhere to sell it—and even if they manage to sell it, they have to sell for a miserably low price." – WUA director, Nistru

"But how can we compare to [a] large farmer in Poland? He gets equipment subsidized, his land is subsidized. And you try to sell your strawberries in Chișinău for 80 lei and that Polish produce comes in and sells for 60 lei." – Small farmer, Prut

"Another problem is that farmers have nowhere to sell their produce. For example, if they harvested potatoes, they store them and they start to get rotten. Another farmer took a truckload of onions to the garbage in 2017 because it was rotten." – WUA director, Prut

Access to post-harvest infrastructure in the systems is still limited, which could compound the challenges related to marketing. Post-harvest infrastructure such as cold storage, sorting and packaging lines, and fruit drying facilities could enable farmers who produce HVA crops to receive higher prices for their products. Although additional post-harvest infrastructure was constructed in some systems since the systems were rehabilitated—including through the AAF loan program—access to this infrastructure is still limited. For example, stakeholders we interviewed were only aware of cold storage facilities in 5 of the 10 systems (in 3 of these systems stakeholders reported that the facilities were funded by the AAF loan program). In most cases these cold storage facilities are owned by one or two large farmers, who

do not have excess space to rent to other farmers (however, some farmers did rent out their sorting lines to others). In several systems, large farmers have plans to build additional post-harvest infrastructure—funded through their own resources or programs such as *Livada Moldovei*, IFAD programs, and the World Bank's Moldova Agricultural Competitiveness Project (MAC-P)—although these investments might take a few years to materialize. Overall, although few stakeholders explicitly mentioned the lack of access to post-harvest infrastructure as a key constraint to HVA production, this lack of access might limit farmers' ability to find attractive markets for their products.

A lack of rural labor due to migration constrains farmers' ability to cultivate and harvest HVA crops. Stakeholders in all systems mentioned as a key challenge the lack of labor in rural Moldova due to migration of young people. Because cultivating and harvesting HVA crops is typically labor intensive, limited labor supply could constrain the transition to HVA. Large farmers may be better-positioned to overcome this barrier than small farmers—for example, by shifting to more mechanized production or offering higher wages to attract laborers.

Lack of rural labor

"As long as there is a lack of labor force, I can plant neither orchards, nor vineyards, nor vegetables."
– Large farmer, Prut

"Another reason is that the local people are getting old, while the young people are leaving the country and don't want to get involved in agriculture. This is also a problem—there is nobody who would work."
– WUA director, Nistru

"I don't want to produce vegetables, because it is very labor intensive. And labor is scarce now."
– Large farmer, Nistru

"It's possible to produce both vegetables, and fruits, but the only problem is to find people for harvesting."
– Large farmer, Prut

Other key barriers to transitioning to HVA include a lack of financial resources, short-term land rental contracts, and farmers adopting a "wait and see" approach. Transitioning to HVA production can require substantial investments including planting materials, irrigation equipment, and other machinery and equipment. It could be challenging for many farmers to obtain the necessary financial resources to make these investments, though programs such as the 2KR hire-purchase program might help. WUA directors were more likely than farmers themselves to cite limited resources as a barrier, possibly because farmers are not yet at a stage where they are actively considering these investments. Another barrier to HVA production mentioned in some systems is the short duration of land rental contracts (typically three years)—especially for larger farmers who are interested in investing in fruit orchards or other perennial crops on land that they rent from small farmers. Larger farmers are reluctant to make these investments in HVA because of uncertainty over whether the lease will be renewed (and at what price). At the same time, small farmers are also reluctant to allow investments on the land that they rent out because it could constrain their future use or disposal of the land. Larger farmers would be willing to make HVA investments on land that they own, but, as we discuss in Section III.C, small farmers are much more willing to rent their land than to sell it. Finally, stakeholders in some systems suggested that more farmers needed to be convinced of the benefits of HVA

production—by observing other farmers in their community—before they would be willing to take on the risk of these investments. Even then, they might choose to gradually increase their HVA production rather than make a sudden large change.

Limited financial resources for investments in HVA

"Now even if you start producing vegetables, first of all besides irrigation equipment you must buy machinery: seeding machines, tractors, etc. This is a big problem." – WUA director, Prut

"The lack of financial resources [is a major barrier to HVA production]. You can buy machinery and equipment through 2KR, but starting an orchard requires accessing loans or using your own financial resources. Of course these are limited and small farmers are limited in financial capacity." – WUA director, Nistru

"[…] it's like a closed circle. Not being able to obtain financial benefits from producing cereals, they cannot invest in value added crops that would yield benefits. Value added crops require substantial investments at the beginning. But not having benefits from cereals they cannot develop their business." – WUA director, Nistru

"Even if the farmer is young, he still cannot decide [to plant HVA crops] because… let's talk even about strawberries—he, first of all, doesn't know what yields he'll have, and second, he doesn't have money to invest, because in order to plant one ha of strawberries you need to invest 100,000 [lei] only in planting material. Where would he get 100,000 [lei] from? He can't get them from the bank, he can't—he must have collateral." – Medium farmer, Prut

Short-term land rental contracts

"The land rental agreements are signed for a period of three years. I have bought this irrigation equipment for 1 million lei, which has a redeemed period of 5-6 years, but the rental period is three years. If a landlord comes and says he wants to terminate the contract and process the land independently, then I have to pay him 2-3 times more to maintain the field's integrity." – Large farmer, Prut

"I don't want to be in the situation where I made the investment, and the landlord decides to terminate the contract because he thinks the rent payment is low." – Large farmer, Prut

"Even if farmers who rent land would like to plant perennial plantations, their lease contracts are signed for 3 years and provide only for the production of annual crops. And when farmers want to plant orchards or vineyards, they want to plant on their own land, and not on rented land. Planting these crops will enable them to have higher incomes and they could also apply for subsidies." – WUA director, Prut

"The problem is in the land we rent—people don't want to lease it for 20 years so we could plant orchards. Thus, rent contracts are signed for short periods of time, which does not enable us to make investments in planting orchards. You cannot produce perennial plantations because people don't want to lease land for long periods of time. We will be able to plant orchards only if we can buy land and have it consolidated." – Large farmer, Prut

Adopting a "wait and see" approach

"It's the same as when someone suggests you taste something—you say you don't like it, but after you taste it then you start liking it. And those who irrigated this year and have seen the effect of irrigation they will also want to irrigate next year." – Small farmer, Prut

"For example, there is a person who planted tomatoes, and I have seen him irrigating and he struggled and then plowed them back in the soil and seeded corn on that area of land [...]. So we wanted to see the experience of that farmer, see what results he will obtain, because it is not correct to plant certain vegetables and not know what to expect. You [wait for] others to do it and then decide." – *Large farmer, Prut*

"Little time passed as well. We need 3-5 years until people will… decide [whether to produce HVA crops], seeing how others do." – Small farmer, Nistru

"I don't think there are so many farmers who have money and would be willing to risk it on such large areas of land. I think they are observing the results and then extending their areas [of HVA crops]." – WUA director, Prut

Farmers reported that lack of information was not a major constraint to irrigation or HVA production. A variety of organizations—including the Agricultural Competitiveness and Enterprise Development project (until early 2016), Agroinform, ACSA, and private companies (such as seed companies and irrigation equipment companies) have conducted regular seminars, trainings, and demonstration plots in the rehabilitated systems. These activities are generally open to all interested farmers, and are well-received by participants. In addition, farmers who are interested in specific types of information can often access it on the internet. Based on these reports, it appears that information about irrigation and HVA production is readily available.

"We receive good information from different places, and the internet contains all you need."

– Medium farmer, Nistru

"When the person is interested in something, he looks for information on his own. People have access to information."

– Small farmer, Prut

Large farmers are most likely to overcome the barriers to irrigation and HVA production and benefit directly from the project, but small farmers might still benefit indirectly. Overall, large farmers in the rehabilitated systems are better positioned to profitably irrigate and produce HVA crops relative to small farmers. They have better access to funding for irrigation equipment; more resources to invest in establishing new HVA production (for example, new orchards); established market relationships and the ability to seek out new markets, including for export; better access to post-harvest infrastructure; the ability to mechanize production and/or pay higher wages to overcome labor shortages; and the ability to use the large volumes of water provided by the rehabilitated systems. Therefore, large farmers are more likely than small farmers to increase their incomes directly as a result of the project. Nevertheless, small farmers might still benefit indirectly by being able to rent out their land more easily and at higher prices due to high demand from larger farmers. In addition, community members more broadly might benefit from increased employment

"There were not people who rented lands. Now there are people who look for land to rent."

– WUA sector representative, Prut

"[…] the number of both permanent employees as well as day laborers has increased since 2015 and will increase further because the orchards' surface will also increase. The difference between an orchard and a wheat field is the fact that all the works on the wheat field are mechanized, while in an orchard even doing mechanized pruning is more complicated. Therefore, labor use will be required."

– Large farmer, Nistru

opportunities and/or wages from working on larger farms, although a trend towards increased mechanization might limit these benefits to seasonal jobs related to pruning and harvesting.

C. Land consolidation and land prices

As mentioned earlier, the mass privatization of agricultural land in Moldova in the 1990s led to highly fragmented land holdings, as land operated by Soviet-era collective farms was divided into small plots that were distributed to a large number of individuals (Kutuzov and Haskins 2003). These individual farmers were often awarded land rights to several plots in a given area, which were typically not contiguous. In subsequent years, rural entrepreneurs consolidated some of these land plots into larger holdings by purchasing or renting plots from the owners, enabling them to operate the land more efficiently (Gorton, 2001). The THVA project was expected to further affect land consolidation in the rehabilitated systems. In particular, it could be profitable for operators to consolidate land plots to take advantage of efficiencies in irrigation through the WUA; as discussed above, fragmented land holdings are an important barrier to large-scale irrigation. In this section we explore whether and how land consolidation has occurred in the rehabilitated systems, and how the rehabilitation has affected land sales and rental prices.

Land consolidation has intensified as a result of system rehabilitation, but still involves relatively small areas of land in most systems, especially on the Nistru River. There has been a trend towards increased land consolidation in Moldova for many years, and stakeholders in most systems noted additional consolidation as a result of system rehabilitation. Overall, the extent of consolidation is largest in three of the Prut River systems—Blindesti, Grozesti, and Chircani-Zirnesti. In Blindesti, consolidation was mainly accomplished by existing large farmers even before system rehabilitation, but in Grozesti and Chircani-Zirnesti new large farmers have recently started cultivating land in the system, consolidating several hundred hectares of land. Land consolidation has proceeded more slowly in the other systems, and has mainly involved small expansions by existing farmers in these systems, typically by a few hectares or tens of hectares. Stakeholders in most systems expect land consolidation to continue in the future, but slowly. This is because the consolidation process requires negotiations with many owners of small plots, who are often reluctant to sell or rent their land—even in the case of small plots entirely surrounded by another farmer's land.

"If we compare the situation to what it used to be several years ago, we can observe more consolidated lands now. For example, [a certain company] had 400 ha of land 2 years ago, while now it has 700 ha, rented and bought. Another company had 800 ha and now came to managing 1,200 ha."

–WUA director, Prut

"There are positive changes. I am consolidating more and more land by renting or buying it. However, there is the problem of the farmers who own land in the middle of the field, and who neither want to exchange, nor to rent, nor to sell the land."

– Large farmer, Nistru

Land consolidation has largely occurred through rental or exchange, rather than through sales. Medium and large farmers typically consolidate land by renting land plots from small farmers (these renters typically pay a share of their production as in-kind rent). Small farmers can obtain more benefits from renting their land to larger farmers than from cultivating it themselves, because larger farmers are often better positioned to farm the land profitably. Although it is common for small farmers to rent out their land, they are generally more reluctant to sell it. This often reflects hopes of further appreciation in land value or expectations that they or their family members will cultivate the land in the future. The small farmers who do sell their

land typically do so out of financial need or an inability to continue farming (for example, due to old age). Less commonly, some small farmers rent or purchase land plots from other small farmers, becoming medium farmers. Another common mechanism for land consolidation is (often informal and temporary) land exchange, whereby larger farmers trade land plots with other farmers to fill in patchwork holdings or acquire contiguous plots.

"The farmers in our village no longer sell their land. It is more convenient for them to rent out the land than to sell it. Only those who are in urgent need of money sell the land. Land consolidation [also] occurs through land exchange. […] If a farmer owns more land in a field [that I cultivate], then I offer him my land plots in exchange for his land located on the field where I rent most of the land."

– Large farmer, Prut

"First of all, we exchange lands with other landowners. For example, if there's a landowner in the irrigation area, then I discuss with that owner and I offer him a piece of my land outside the irrigation area in exchange for his land in the irrigation area. Thus we do everything we can to consolidate land in the irrigation area. If it's a small farmer, we give him land somewhere else, but it must be conveniently located for that farmer, and that's how we consolidate land."

– Large farmer, Nistru

Land sales prices increased dramatically in the rehabilitated systems as a result of system rehabilitation; land rental prices also increased, but to a lesser extent. Most stakeholders in the rehabilitated systems reported that land sales prices increased several fold as result of rehabilitation. These increases began during the rehabilitation and continued after it was completed. They were driven by increasing demand for land in the systems, together with a limited willingness of farmers to sell. Many stakeholders expect sales prices to continue to increase, although the volume of sales might remain limited because of farmers' reluctance to sell. Land rental prices in the rehabilitated systems have also increased, driven by increased demand for land and higher productivity by farmers operating consolidated land. However, these increases have generally been lower than the increases in sales prices. There is limited scope for further increases in rental prices for land devoted to non-HVA crops because the profits from cultivating these crops (even by large farmers) are limited. However, rental prices could increase substantially if renters transition to cultivating more profitable HVA crops, especially if they seek to incentivize long-term leases to secure their investments in rented land (for example, investments in orchards).

"Before system rehabilitation, there were almost no companies looking to buy agricultural land here. Now we have plenty of buyers and 1 hectare of land can go for up to 3,000-4,000 Euros. Before the system rehabilitation, the price was around 1,000 Euro/ha."

– Large farmer, Prut

"Prices changed very much. In 2015 the price was 10,000 lei/ha and now it's 30,000 lei/ha. The price will keep increasing, because few want to sell and when someone sells everyone tries to offer a better price."

– Large farmer, Nistru

Land consolidation has led to larger areas of land being cultivated, but has not led to large increases in the area irrigated. The long-run prevailing trend in land consolidation—together with recent intensification arguably due to the project—has led to an increase in cultivated land in the rehabilitated systems, as productive farmers operated plots that small farmers had left fallow. However, land consolidation has not yet led to wide-scale irrigation in these systems. In the three Prut River systems where large-scale consolidation has occurred, farmers mainly produce non-HVA crops on the consolidated land. As discussed in Section III.A, abundant rains since the end of the compact meant that it was generally not necessary to irrigate non-HVA crops. However, farmers who consolidated land might be planning to irrigate non-HVA crops in dry years, or transition to HVA in the future. (One large new entrant in Grozesti irrigated sugar beets and corn in 2017, accounting for most of the water pumped by the WUA.) Further, in Chircani-Zirnesti, non-HVA farmers might have consolidated land partly because it

became more attractive for cultivation as a result of improved drainage, which was part of the rehabilitation work in this system. In other systems, the scale of consolidation is still too limited to lead to large-scale irrigation, even if consolidated land is used to cultivate HVA crops that require regular irrigation.

D. WUA financial status

WUAs' ability to cover their costs is critical to their long-term viability, which is necessary for increases in irrigation and HVA production to occur. WUAs rely primarily on revenues from membership fees and irrigation fees to cover their costs, which include electricity costs (mainly for pumping water), salaries, taxes, and other operational expenses. They also have some other, smaller, sources of revenue, such as fees for providing irrigation equipment services to water users and transportation services to the community. In this section, we assess their financial situation two years after the end of the compact.

Many farmers who do not irrigate through the WUA are not paying membership fees. When the systems were first rehabilitated, all land owners in the system who signed an expression of interest to join the WUA were considered to be WUA members and were expected to pay membership fees. (Land users who rented land were expected to join the WUA and pay fees on behalf of the owner, but this did not always occur because rental agreements are often informal or do not clearly stipulate who is responsible for these fees.) In practice, many WUA members never paid or stopped paying their membership fees because they do not use the WUA's irrigation services and therefore see no benefit in paying these fees, which are not legally mandatory.[16] Although the majority of farmers in the systems expressed interest in joining the WUA when it was established, farmers might not have clearly understood the expectation that they would pay membership fees or they may not have been strongly committed to paying them. SDA-Moldova suggested that, in retrospect, it would have been better to require WUA membership and fee payment, either through a law or a formal commitment by farmers made through the expression of interest. Several WUA directors also suggested that the law be changed to make membership fee payment mandatory in the future.

"The majority of members who do not pay the membership fee are saying that they don't irrigate and this is why they don't pay. This situation persists permanently, for many years."

– WUA director, Nistru

"We have forwarded proposals to the Ministry of Agriculture in the summer of this year when they asked us about what changes we want to have in terms of legislation to improve the way the WUA works. The first proposal was to have the law stipulate the obligatory nature of paying membership fees. This is an imperative factor for the WUA's future activity."

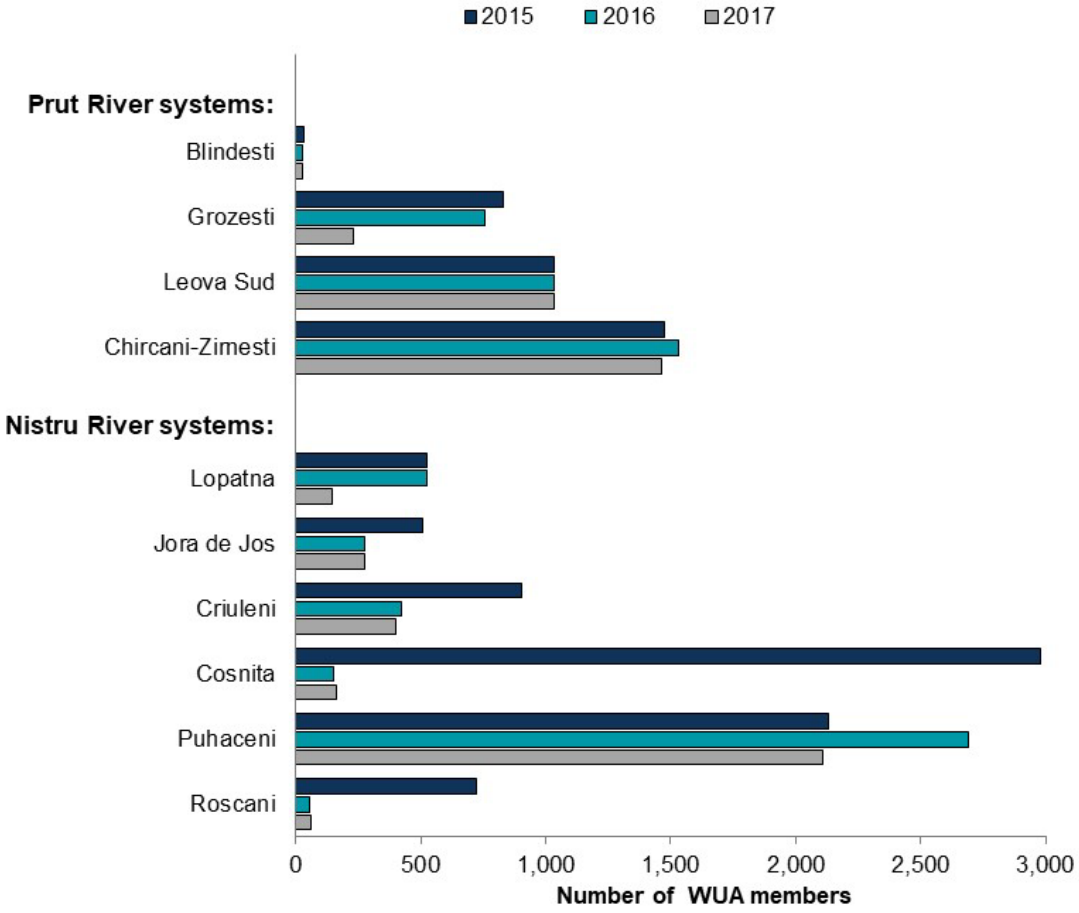
– WUA director, Nistru

WUAs have started to exclude members who do not pay fees from their membership lists; these farmers might not be willing to pay to rejoin the WUA in the future. Most WUAs have started to exclude members who have not paid fees for two or three consecutive years, resulting in large decreases in the number of members in some WUAs since 2015 (Figure

[16] In Chircani-Zirnesti, the WUA uses revenues from membership fees to provide both irrigation and drainage services. Most farmers (as well as other community members) in the system benefit from drainage because it reduces flooding in the system as a whole, but they still do not pay membership fees.

III.5).[17] The WUAs where membership has not decreased substantially are located on the Prut River: Blindesti had few members to start with (because there are relatively few farmers in the system), Leova Sud plans to exclude non-paying members starting in 2018, and Chircani-Zirnesti has not yet excluded members, hoping that more will pay fees because they all benefit from drainage services even if they do not irrigate. If excluded farmers want to irrigate through the WUA in the future, they will have to pay a substantially higher per unit cost for water, or they will have to rejoin the WUA—which requires paying fee arrears and may be subject to a three-year waiting period. Several farmers suggested that they would not be willing to pay the large lump-sum amount required to rejoin the WUA, even if they were interested in irrigating in the future.

Figure III.5. Number of WUA members by system, 2015–2017



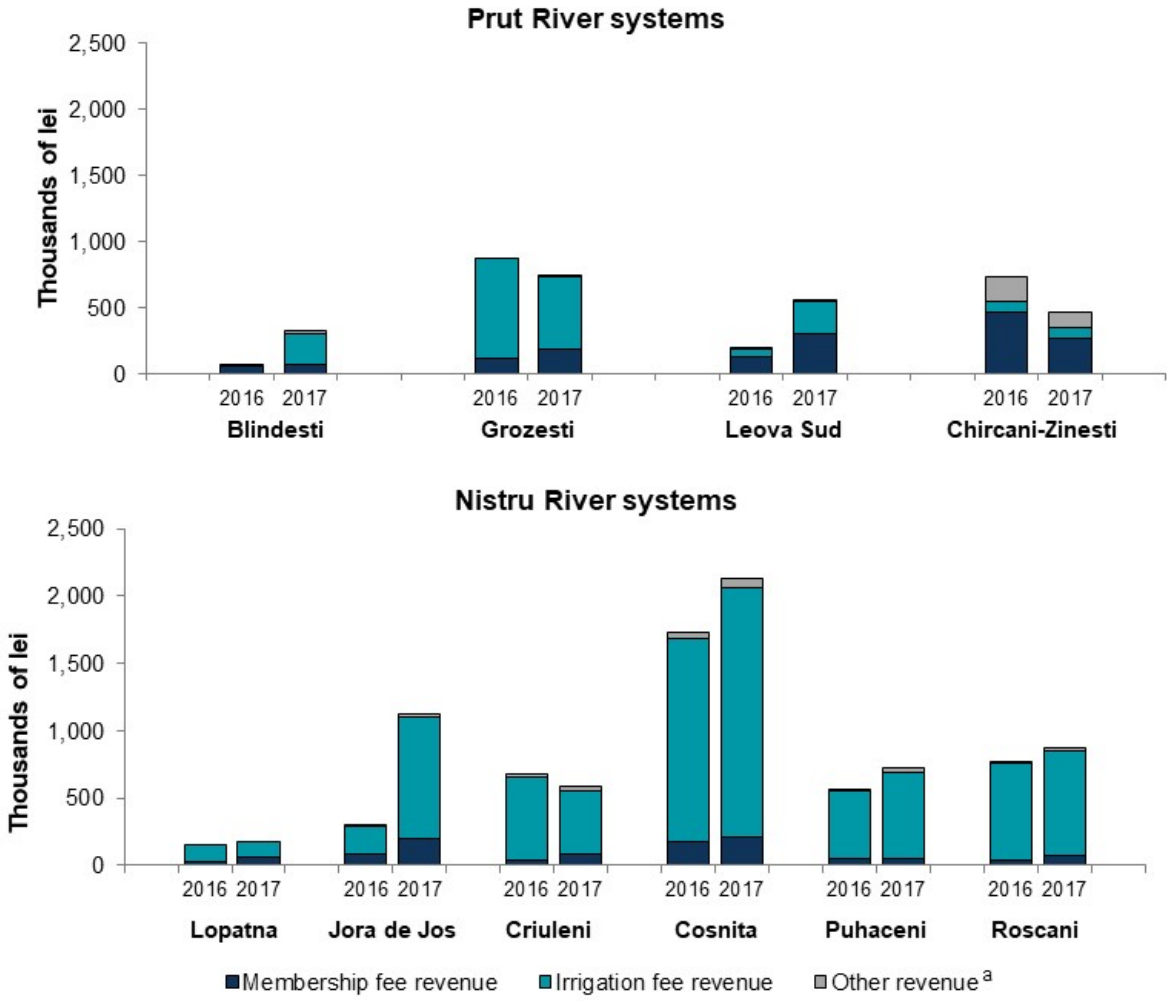
Source: 2018 WUA administrative data

Note: Data supporting this figure are shown in Appendix Table B.3.

[17] Some WUA members still do not pay membership fees, but it is difficult to obtain a precise estimate of the fee payment rate among members. WUAs report the number of *land users* who paid membership fees, but this is difficult to interpret because these land users might pay fees on behalf of members from whom they rent. It also is not possible to estimate the number of *hectares* for which membership fees were paid by dividing membership fee revenues by the fee per hectare, because these revenues can include partial payments, arrears from previous years, and advance payments.

Membership fees were intended to be sufficient to cover fixed costs, but in practice WUAs rely on irrigation fees to cover both variable costs and some fixed costs. Membership fees should cover fixed costs if all farmers are paying members; however, many farmers are not members and others are members but are not paying fees. As a result, the membership fee would have to be very high to cover fixed costs. (Many WUAs see even the current membership fees as a barrier, and would prefer to reduce them further.) Therefore, in practice, most WUAs try to recover some fixed costs through irrigation fees instead. These fees are easier to collect because WUAs often require water users (especially larger users) to pay up front before they receive irrigation water; even when WUAs allow users to pay irrigation fees after they sell their crops, most pay according to the agreed schedule. In 2017, revenues from irrigation fees were greater than revenues from membership fees in all systems except for Leova Sud and Chircani-Zirnesti (Figure III.6).

Figure III.6. WUA revenues, 2016–2017



Source: 2018 WUA administrative data

Note: Data supporting this figure are shown in Appendix Table B.4.

[a] Includes revenues from irrigation equipment services, transportation services, bank interest, housing rentals (to construction firm staff), and payments for organizing seminars (for the HVAA project).

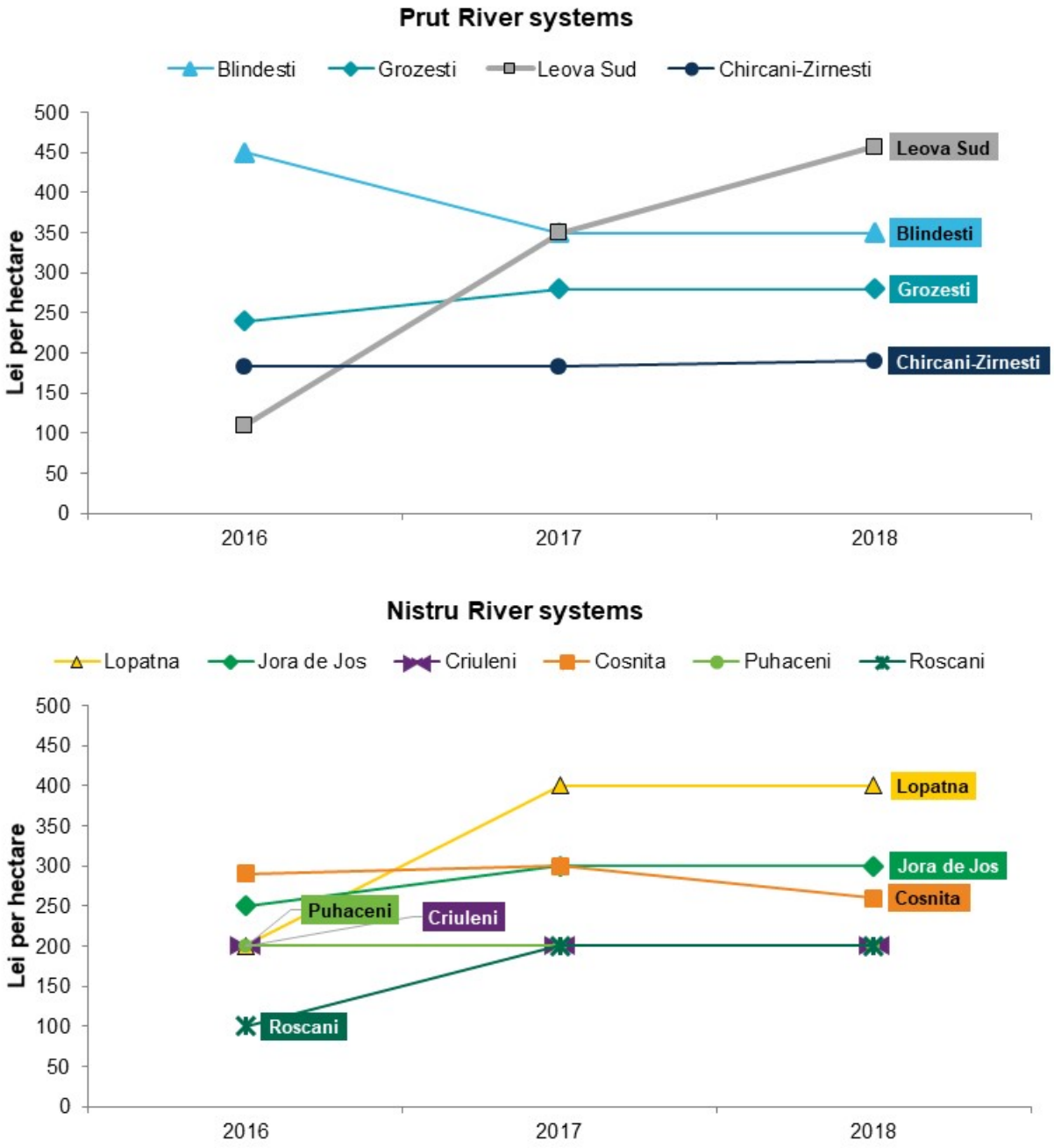
WUA revenues fluctuated substantially between 2016 and 2017 and might continue to be unstable given their dependence on weather and the decisions of a few water users. Between 2016 and 2017, total WUA revenues increased in seven systems and decreased in three systems (Figure III.6). Many of these changes were large—they ranged from a decrease of 36 percent to an increase of 347 percent—and were driven by fluctuations in revenues from both membership fees and irrigation fees. Changes in revenues from membership fees depend on the level of these fees (Figure III.7) and the extent to which they are paid. In Leova Sud, a large increase in the membership fee per hectare between 2016 and 2017 led to a large increase in revenues. In contrast, in Blindesti, revenue from membership fees was consistent between 2016 and 2017, despite a large decrease in the fee per hectare. In other systems, such as Chircani-Zirnesti (revenue decrease) and Jora de Jos (revenue increase), the membership fee was roughly stable but the extent to which these fees were paid changed. Changes in revenues from irrigation fees were largely driven by substantial changes in the volume of water pumped (Figure III.1). (There were some changes in irrigation fees over this period, but they were more stable than membership fees [Figure III.8].) In several systems, WUA revenues are sensitive to the decisions of the few dominant water users. For example, in Blindesti, the only water user is a single large farmer (new to the system) that started cultivating and irrigating sugar beets in 2017. This enabled the WUA to survive and has given it a chance of success, but the reliance on a single farmer and crop type means that the WUA is in a precarious position. Overall, WUA revenues might continue to be unstable until the WUAs establish a broader base of water users and farmers transition to HVA crops for which irrigation is less weather dependent.

Large water users have played an important role in covering revenue shortfalls and building WUAs' cash reserves. WUAs' revenues have generally fallen short of expectations because of low demand for irrigation. In three of the nine WUAs for which data were available, revenues were insufficient to cover costs in 2017 (Table III.1).[18] In many WUAs, large water users have played an important role in sustaining the WUA by making advance payments for membership and irrigation fees, often using the government subsidies they received for irrigating in the previous season. These advance payments have been critical in covering these WUAs' immediate costs and debts until they begin to receive revenues in the next season. These payments have also contributed—along with operating profits—to building WUAs' cash reserves, which can help WUAs cover their costs in low-demand (rainy) years and cover future maintenance needs. At the end of 2017, WUAs had cash reserves of about 170,000 lei (about $9,940), on average (Table III.1).[19]

[18] We use the standard accounting term "profits" for the differences between revenues and costs; however, WUAs are non-profit entities and their accounting system uses the term "self-financing fund." The WUA in Blindesti was unable to provide information about their profits or cash reserves.

[19] This conversion is based on the exchange rate of 17.10 lei per dollar on December 31, 2017, from www.oanda.com.

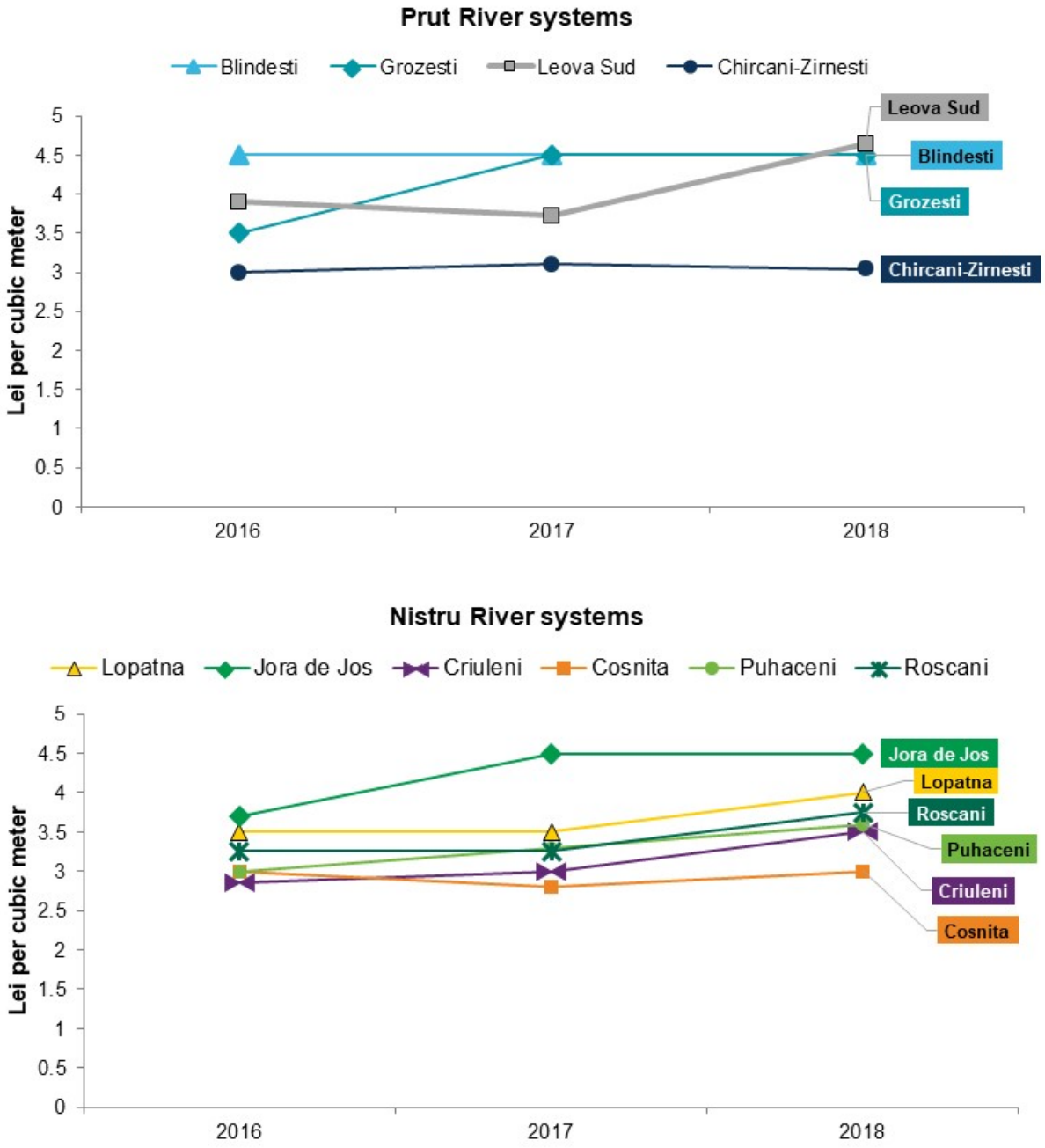
Figure III.7. WUA membership fees, 2016–2018



Source: 2018 WUA administrative data

Notes: 2018 fees were determined at the spring 2018 WUA general assembly. Data supporting this figure are shown in Appendix Table B.5.

Figure III.8. WUA irrigation fees, 2016–2018



Source: 2018 WUA administrative data

Notes: 2018 fees were determined at the spring 2018 WUA general assembly. Data supporting this figure are shown in Appendix Table B.5.

Table III.1. WUA net profits and cash reserves, end of 2017

System	Profits (thousands of lei)[a]	Cash reserves (thousands of lei)
Prut River systems		
Blindesti	NA	NA
Grozesti	-3	153[b]
Leova Sud	-36	37
Chircani-Zirnesti	0	143
Nistru River systems		
Lopatna	-5	24
Jora de Jos	110	255
Criuleni	39	292[c]
Cosnita	125	337
Puhaceni	57	129
Roscani	0	160

Source: 2018 WUA administrative data

[a] Defined as revenues minus costs.

[b] Includes 50,000 lei set aside for maintenance expenses.

[c] Includes 100,000 lei in an interest-bearing account.

NA = data not available

WUAs in Nistru River systems are in a more stable financial position than those in Prut River systems. Four of the six WUAs in Nistru River systems had positive profits in 2017, and only one (Lopatna) was not able to cover its costs. In contrast, only one of the three WUAs on the Prut River for which data were available was (just) able to cover its costs (Chircani-Zirnesti). The WUAs in Nistru River systems also typically had higher cash reserves than those in Prut River systems (an average of 199,500 lei compared to 111,000 lei).[20] As shown earlier, the WUAs in Nistru River systems also had more water users than those in Prut River systems (Figure III.1). The Nistru River systems include the only two WUAs with a relatively broad base of water users, namely Puhaceni and Cosnita. Revenues in the Nistru River systems—especially in these two systems—are therefore likely to be less sensitive to the irrigation decisions of a handful of farmers and hence more stable than those in Prut River systems.

E. Post-compact support for WUAs and farmers in the rehabilitated systems

In this section we describe the support provided to the WUAs by SDA-Moldova and other entities in the post-compact period. We also describe the support provided to farmers in the systems through USAID's HVA Activity, as well as future activities in these areas planned by other entities.

[20] This is true even if we adjust for system size to account for the fact that Nistru River systems are larger, on average. In particular, the average cash balance in the Nistru River systems is still about double that in Prut River systems even when scaled by the irrigable area in hectares (not shown).

Several organizations have helped sustain the WUAs since the end of the compact; support from SDA-Moldova has been especially critical. Implementation delays meant that the rehabilitated systems were only completed close to the end of the compact. Therefore, when the compact closed, the WUAs had little experience in operating and managing the rehabilitated systems (Borkum et al. 2016b). Several organizations provided post-compact support to assist the WUAs as they started to operate these systems. SDA-Moldova, the successor agency to MCA-Moldova, provided substantial support in maintaining and improving the physical infrastructure in the systems, provided technical assistance for WUA operations, and provided technical assistance to WUA management (we describe this support in further detail below). Apele Moldovei's monitoring and supervision unit also provided some post-compact technical assistance for WUAs' technical operations by training pump operators. However, the unit has limited financial resources and staff, and its future is uncertain because of government administrative restructuring. Therefore, this technical assistance was coordinated and supported by SDA-Moldova. ACSA also provided some technical assistance to the WUAs while SDA-Moldova was being established—for example, trainings for WUA accountants and logistical support for WUA meetings—although this work was limited because it was funded through ACSA's internal resources. Overall, the support WUAs received from SDA-Moldova was the most substantive, and without it many of the WUAs might already have failed. SDA-Moldova suggested that, in retrospect, government financial support for sustainability should have been included in the compact as a condition precedent rather than relying on the (fortuitous) establishment of SDA-Moldova.

SDA-Moldova helped maintain and improve the physical infrastructure in the rehabilitated systems. SDA-Moldova also contracted with two companies to conduct technical diagnostics and maintenance of rehabilitated systems during the defect notification (warranty) period. Stakeholders agreed that this work was critical in addressing technical defects in the systems while they were still under warranty, and that without SDA-Moldova it would have been difficult to fund this important diagnostic work and enable WUAs to take advantage of the defect notification period. In addition, SDA-Moldova funded other physical improvements to the systems such as improvements to the drainage infrastructure in Chircani-Zirnesti and repairs of a leaking accumulation basin in Blindesti.

> *"If [it] was not for [SDA-Moldova], I don't know what would have remained of us."*
>
> – WUA director, Nistru

SDA-Moldova supported technical assistance for irrigation system operations. During the post-compact period, SDA-Moldova has provided important support to the WUAs in the technical operations of the rehabilitated systems. The WUAs faced operational challenges when using these systems for the first time, because the systems are highly technologically advanced and WUA staff have limited engineering knowledge and experience. Therefore, WUA staff required practical trainings on use and regular maintenance of the systems during the season, winter shut-down of the systems, winter maintenance, and restarting the systems in spring. With the support and coordination of SDA-Moldova, Apele Moldovei conducted technical trainings for WUA staff on these issues and provided technical advice on system operations when requested.

SDA-Moldova also provided capacity-building and technical assistance to WUA management. In addition to the support for irrigation system operations, SDA-Moldova has also provided capacity-building support to WUA management. In particular, SDA-Moldova trained WUA directors, accountants, and councils on irrigation planning and how to set appropriate membership and irrigation fees. SDA-Moldova also provided capacity building to WUAs on how to use the WUA membership database software (known as APAS), as well as on the electronic accounting system (known as the 1C system). In addition, SDA-Moldova assisted WUAs in organizing their annual general meetings and sector meetings with WUA members, and also continued to monitor the monthly meetings of WUA boards.

"In case we have questions, we address [SDA-Moldova] and they help us, tell us what to do and how to do it—we get support from them."

– WUA director, Nistru

"[SDA-Moldova] know[s] of all our problems, we discuss them and look for solutions."

– WUA director, Prut

However, the WUAs likely require additional technical support over the next few years. Several stakeholders emphasized that the WUAs are still relatively new institutions and that they require several more years of capacity-building to further develop and be successful. One particular challenge is high staff turnover due to low or unpaid salaries, including among WUA directors and accounting staff. This means that many staff who were trained during and after the compact are no longer working for the WUA, so the current staff require additional support. (Many of the pump operators who were trained during the compact remain in those roles, but are close to retirement; WUAs are concerned about their ability to attract new, younger pump operators because of low salaries.) SDA-Moldova's work plan for 2018 includes additional support for WUAs (in addition to other technical activities such as the rehabilitation of additional irrigation modules in Chircani-Zirnesti, further maintenance-related activities, and finalizing the design of a drainage system in Cahul). However, it is currently unclear whether SDA-Moldova will continue to operate and offer this support *after* 2018—this depends on the availability of funds and the political environment. If SDA-Moldova is not available to support the WUAs after 2018 and other organizations are not able to provide comparable support, the WUAs might have trouble addressing their operational and financial challenges.

USAID's HVA Activity is supporting farmers in the systems to generate demand for irrigation services in targeted value chains. HVAA, which started in early 2017, continues many of the market-related activities that were funded under the Agricultural Competitiveness and Enterprise Development Project during the compact, but also includes additional activities to support irrigation in the systems and to support workforce development in the agricultural sector. The activities in the systems account for a relatively small share of the total project budget—about $2 million out of $21 million (although the full budget had not yet been committed as of November 2017). HVAA has coordinated these activities with SDA-Moldova from the beginning to avoid duplication of effort. SDA-Moldova focuses on supporting WUA development and HVAA works with farmers in targeted value chains to generate demand for irrigation services (which is consistent with the overall value-chain approach of the project). The targeted value chains include apples/stone fruit (together), table grapes, berries, honey, and open-field vegetables.

HVAA's activities in the systems to date have included organizational capacity and engineering assessments; trainings, study tours, and technical assistance; and grants for value chain investments. The organizational capacity and engineering assessments were designed to generate knowledge about the systems to inform future activities under HVAA. The organizational capacity assessments were conducted in all systems, and the in-depth engineering assessments focused on Puhaceni and Cosnita, two of the most promising systems in terms of the number of members who irrigate. The goal of the engineering assessments was to assess who is using irrigation water, who is likely to use it in the near future, and the major constraints to using it. For example, the Puhaceni study identified land fragmentation, large distances to water hydrants from many plots, and a lack of agricultural labor as important constraints (these are consistent with our findings in Section III.B). HVAA is also establishing demonstration plots, conducting field days and trainings, and sponsoring domestic tours for farmers in targeted value chains. Recent examples (as of mid-2018) include training related to orchard fruit quality in Cosnita, training on integrated pest management for vegetable production in Puhaceni, and a local berry production tour for female farmers in Cosnita. HVAA is also providing technical assistancevalue-chain producers—for example, it is assisting a cooperative interested in obtaining export certification. It also has a grant facility available for investments in targeted value chains. As of mid-2018, HVAA had awarded grants to two WUAs for irrigation equipment and additional pumps (Cosnita and Puhaceni, respectively), as well as a grant to a cooperative for production equipment; it has issued seven further calls for grants focusing on the rehabilitated systems.

Several initiatives by other entities will also affect these farmers in the next few years. Initiatives by other entities are also expected to affect farmers in the systems in the next few years. For example, with funding from the Food and Agricultural Organization (FAO), ACSA recently established demonstration plots in or next to three systems. Through another FAO project, ACSA will also be responsible for technical assistance in 10 demonstration plots in the 10 systems, which will focus on on-farm irrigation and which they expect to launch in 2018. The World Bank's Climate Adaptation project is expected to include additional demonstration plots in the systems, as well as other activities focused on the systems; however, project implementation has been delayed pending further discussion with the Government of Moldova.

F. Participation in and effects of the 2KR hire-purchase program

The 2KR hire-purchase program offers farmers throughout Moldova the opportunity to purchase irrigation equipment or other agricultural equipment for use on irrigated land at preferential terms. 2KR purchases the equipment free of value-added tax and customs duty on behalf of participants, who repay 2KR in four annual interest-free installments. In the rehabilitated systems, the program was intended to help farmers acquire on-farm irrigation equipment to take advantage of improved access to irrigation water. (Farmers in other areas of Moldova who were irrigating through other systems or sources could also participate.) In this section, we describe the pattern of participation in the hire-purchase program, the reasons for participation, and the effects of participation. These findings are based on interviews with 2KR and other stakeholders, a small number of program participants, and other farmers in the rehabilitated systems, as well as administrative data. The administrative data include basic information on 270 investments made by 126 2KR hire-purchase program participants between

the start of the program (in May 2015) and December 2017.[21] The program is expected to continue through 2025.

Medium and large farmers made nearly 90 percent of 2KR-funded investments. Large farmers made 52 percent of all 2KR-funded investments, and medium farmers made another 37 percent (Table III.2). Most of the investments made by large and medium farmers were for new irrigation equipment or components (71 and 59 percent of investments within each group, respectively; Figure III.9). Investments made by small farmers were less common (11 percent of total investments) but more diverse across the various investment types. More than half of the investments were made in 2015 (53 percent, not shown), with the remaining contracts signed in 2016 and 2017 (15 and 32 percent, respectively; not shown). The average cost of investments was 528,382 lei ($30,900) and the median price was 347,000 lei ($20,292). The median cost of investments increased with farm size, and was almost twice as large for large farmers compared to small farmers. Farmers planned to use investments on an average area of 30 hectares and a median area of 21 hectares (not shown). Almost all of the investments were intended to be used on an area with at least some HVA crops produced (the most commonly reported HVA crops were apples, plums, tomatoes, sweet cherries, peppers, table grapes, and potatoes; not shown).

Table III.2. 2KR hire-purchase program investments through December 2017, all participants

	All participants	Small farm participants (≤10 ha)	Medium farm participants (>10-100 ha)	Large farm participants (>100 ha)
Program participants				
Total number of participants	126	18	51	57
Participants who operated land in rehabilitated systems	24	5	8	11
Program-funded investments				
Number of investments				
Total	270	30	100	140
Median per participant	2	1	2	2
Range per participant	1-9	1-4	1-6	1-9
Investment cost				
Mean (lei)	528,382	471,329	487,984	569,463
Median (lei)	347,000	193,000	286,300	367,830
Mean (dollars)	30,900	27,563	28,537	33,302
Median (dollars)	20,292	11,287	16,743	21,511

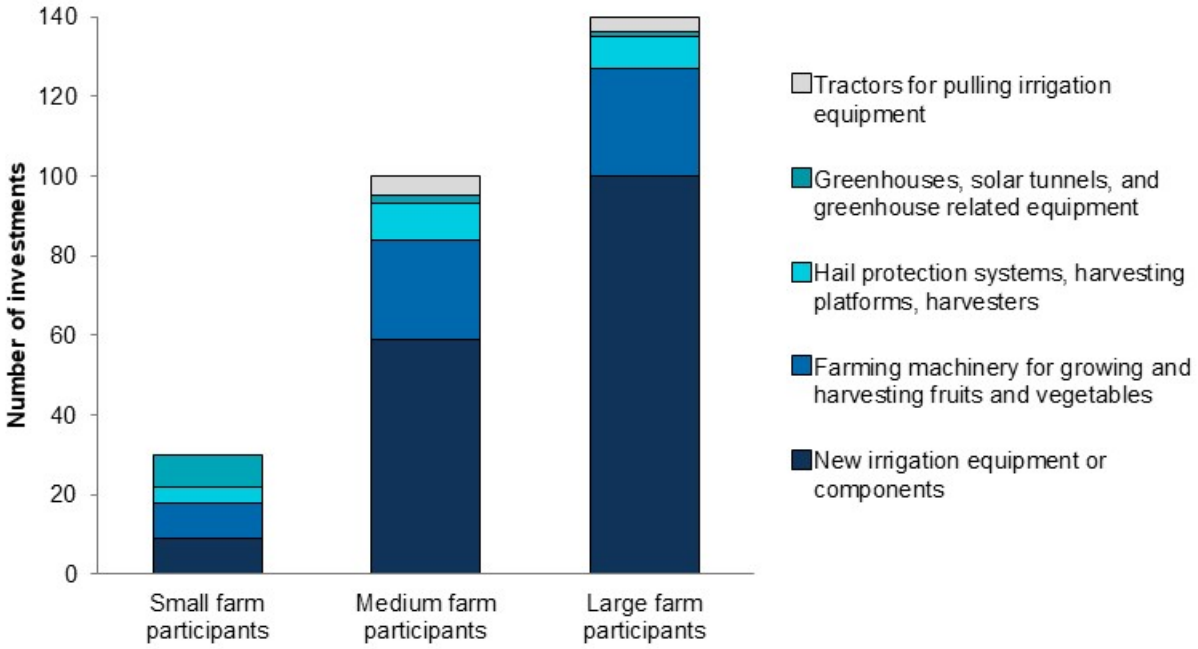
Source: 2KR administrative data based on investments made between May, 2015 and December, 2017.

Note: Currency conversions are based on the exchange rate of 17.10 lei per dollar on December 31, 2017 (the end of the period covered by these investments) from www.oanda.com.

ha = hectares

[21] Of these, 58 investments by 20 participants were made before the close of the compact on September 1, 2015.

Figure III.9. 2KR hire-purchase program investment types by farm size, all participants



Source: 2KR administrative data based on investments made between May, 2015 and December, 2017.
Note: Data supporting this figure are shown in Appendix Table B.6.

Farmers in the rehabilitated centralized irrigation systems have invested in 2KR-funded equipment, but most 2KR participants are from outside the systems. As of December 2017, about 19 percent of 2KR participants operate land in the rehabilitated systems; these participants represent 21 percent of all 2KR-funded investments and 17 percent of the total value of all investments. 2KR has made an effort to focus on the rehabilitated systems through outreach—for example, by attending WUA general assemblies and keeping in contact with WUA directors. 2KR has also increased the ceiling for equipment investments—in the rehabilitated systems only—from $100,000 to $150,000. The program is widely known in the rehabilitated systems, even among farmers who did not use it directly.

Most farmers who used 2KR in rehabilitated centralized irrigation systems were large and medium farmers in Nistru River systems. Of the 24 farmers who made investments through 2KR in the rehabilitated centralized irrigation systems, most were large and medium farmers (11 and 8 farmers, respectively; Table III.3). Most participants in the rehabilitated systems (75 percent) operated land in Nistru River systems. The average cost of investments across all systems was 438,800 lei ($25,661) and the median cost was 351,000 lei ($20,536 dollars); the median investment was more than four times greater for large farmers compared to small farmers. Most of these investments were for new irrigation equipment or components (66 percent). The remainder were investments in farming machinery for growing and harvesting fruits and vegetables; hail protection systems; and harvesting platforms, and harvesters.

Table III.3. 2KR hire-purchase program investments through December 2017, participants operating land in rehabilitated centralized irrigation systems

	All participants	Small farm participants (≤10 ha)	Medium farm participants (>10-100 ha)	Large farm participants (>100 ha)
Program participants				
Total number of participants	24	5	8	11
By system				
Prut River systems	6	1	1	4
Nistru River systems	18	4	7	7
Program-funded investments				
Number of investments				
Total	56	7	16	33
Median per participant	2	1	1.5	2
Range per participant	1-6	1-3	1-4	1-6
Investment cost				
Mean (lei)	438,800	76,729	345,742	560,722
Median (lei)	351,000	83,150	158,785	369,100
Mean (dollars)	25,661	4,487	20,219	32,791
Median (dollars)	20,526	4,863	9,286	21,585
Investment type (number of investments)				
New irrigation equipment or components	37	3	8	26
Farming machinery for growing and harvesting fruits and vegetables	12	4	5	3
Hail protection systems, harvesting platforms, harvesters	7	0	3	4
Greenhouses, solar tunnels and greenhouse related equipment	0	0	0	0
Tractors for pulling irrigation equipment	0	0	0	0

Source: 2KR administrative data based on investments made between May, 2015 and December, 2017.

Note: Currency conversions are based on the exchange rate of 17.10 lei per dollar on December 31, 2017 (the end of the period covered by these investments) from www.oanda.com.

ha = hectares

Similar to the overall program, the majority of the investments made by participants who operated land in the rehabilitated systems were made in 2015 (59 percent, not shown), with the remaining contracts signed in 2016 and 2017 (7 and 34 percent, respectively; not shown). Because most systems were not fully operational in 2015, this suggests that participants were making these investments in anticipation of improved access to irrigation. Farmers planned to use investments on an average area of 27 hectares and a median area of 25 hectares (not shown)

and the vast majority of the investments (89 percent) were intended to be used on an area with at least some HVA crops cultivated (not shown).[22]

Participants chose 2KR because of its attractive conditions, efficient application process, flexibility with repayments, and operational support. Funding for 2KR-eligible equipment was also available through other programs, such as *Livada Moldovei*, MAC-P, or IFAD programs, as well as through commercial banks. However, the 2KR hire-purchase program has several advantages over other sources of funding. First, the 2KR program offers more attractive conditions than most other sources of financing. There is no collateral requirement, no interest, annual rather than monthly repayments, and the equipment is exempt from value-added tax and customs duty, which substantially lowers its cost to participants. Second, the 2KR application process is simple and the approval is quick relative to other sources. Third, 2KR offers flexibility with the repayment schedule and works with farmers to reschedule repayments if they are facing cash-flow problems (for example, if they need more time to sell their harvest). Finally, 2KR provides additional support to farmers that other funding sources do not. They advise farmers about specific types of equipment that could meet their needs, provide training to participants on use of equipment (the supplier also provides training), and coordinate between the supplier and participant in case of any problems as the equipment is used (although this has not been common). They therefore provide support for the "full cycle" of the investment. Overall, participants are very satisfied with the program and their only suggestions for improvements to the program are to offer longer-term contracts and additional guidance on where to buy equipment.

"I considered it to be good for me to apply to 2KR, because the application process was easy and it collaborates quicker with us. IFAD is more complicated, because you have to obtain loans from banks. And banks in their turn create other problems."

– Large farm 2KR participant, Nistru

"We provide advice to farmers on how to access 2KR. We know people who applied to 2KR to procure irrigation equipment and other agricultural machinery […]. I am also a farmer, I also have agricultural activity, and I consider 2KR being the most accessible. It is ideal in the set-up in which it is now, especially for small farmers. Accessing it requires a minimal package of documents that can be filled out by anyone. Collateral is not necessary."

– WUA director, Nistru

Participants reported that 2KR facilitated investments that they would have made regardless, but these investments would have taken longer and been smaller without 2KR. Participants noted that they would have made the 2KR-funded investments even in the absence of the program. However, it would have likely taken longer because of a more complex application and approval process from other sources of financing, or the need to save up their

[22] These data do not provide the information needed to calculate the total area on which the 2KR-financed investments were used in the rehabilitated systems. Adding the area on which each investment was used could lead to double-counting because participants might have made multiple investments and might have used those investments on the same area of land. However, we can calculate a lower bound by summing the largest area reported by each participant (if the participant reported multiple investments). This approach essentially assumes that participants who made multiple investments used them on the same area of land. Using this approach, the lower bound is about 672 hectares across all systems. Further assuming that all of the 2KR-funded equipment was used on land irrigated through the WUA and that participants who invested in 2015 and 2016 continued to irrigate this land in 2017, this is about 40 percent of the total area irrigated through in these systems in 2017. This suggests that 2KR may have played a significant role in facilitating irrigation in the rehabilitated systems, as it was used by many of the larger farmers who were water users.

own funds (most indicated that, without 2KR, they would have self-funded the investment). Their investments would also typically have been a smaller (and likely less profitable) because they would not have benefitted from the attractive financial conditions offered by 2KR. Several of the participants interviewed believed that 2KR investments facilitated efficiencies in irrigation, less reliance on labor, and higher yields, leading to increases in income. Some participants also reported earning additional income by renting their irrigation equipment or providing irrigation services to other small farmers.

"Due to using the procured equipment and the irrigation possibilities, the quality of the nursery trees increased and the yields per hectare increased. Even though I am not the best specialist in producing technical crops, I still have results."

– Medium farm 2KR participant, Nistru

"Incomes increased because I had lower costs related to labor. So I had both – increased incomes and decreased costs."

– Large farm 2KR participant, Nistru

G. Sustainability of the River Basin Management subactivity

The River Basin Management subactivity supported new data platforms for water authorization and water management, as well as a river basin management plan to protect, improve, and ensure the sustainable use of water resources from the Nistru River. Together, these components were intended to contribute to comprehensive water resource management in Moldova. (The River Basin Management subactivity also supported the Water Law that provided the legal framework for WUAs' long-term water rights.) Below we briefly describe the sustainability of these components of the River Basin Management subactivity in the post-compact period, based primarily on interviews with SDA-Moldova.

The common platform for special water authorizations has been sustained. Common Platform 1, the electronic platform for special water authorizations, is designed to guide WUAs and other potential water users through the process of applying for these authorizations. (Special water authorizations are long-term authorizations for large-scale water use: for example, for irrigation, industrial purposes, or aquaculture.) The platform facilitates the process, which requires the approval of seven institutions. According to SDA-Moldova, Common Platform 1 is being used and is supported by a contact person within the former Ministry of Environment, who troubleshoots any technical issues. It is now compulsory for all applications for special water authorizations to be processed using this electronic system.

The platforms for water management have not been sustained, but may be built upon. The River Basin Management subactivity developed two platforms for water management. Common Platform 2 was designed to collate information from four institutions related to water management and make the information visible across them; Common Platform 3 was the public-use interface for this system. During the compact, staff in these four institutions were trained to use Common Platform 2 and Common Platform 3. However, in practice, these platforms fell out of use due to turnover of trained staff and limited incentives for remaining staff to update and maintain the systems. Although this suggests that these platforms were not sustainable as initially developed, the Austrian Development Agency is now developing an integrated environmental information system that will build on them. Therefore, the work done on these platforms under the compact might be sustained in a different form. (A condition for this new work is a government guarantee to assign dedicated staff—with a clear job description and acceptable salary—to oversee the new system, which should reduce staff turnover.)

It is unclear whether river basin management plans will be implemented. The river basin management plan for the Nistru River (which was supported by the compact) has been approved by the government, and the river basin management plan for the Prut River (which was supported by the European Union) is likely to be approved soon. However, SDA-Moldova is concerned that government administrative reform and a lack of resources might be a challenge for the implementation of these plans.

IV. CONCLUSION

In this report, we have presented interim findings on the Moldova THVA project evaluation following the 2017 agricultural season, two full seasons after the end of the compact. The objectives of this effort were to contribute to addressing the evaluation research questions and to inform potential adjustments to the evaluation design; in this chapter, we discuss the implications of our findings for each of these objectives in turn.

A. Contribution of interim findings to research questions

Below we summarize the key findings related to each of the research questions and the implications for the evaluation (Table IV.1). Overall, our findings cast doubt that the THVA project will achieve increases in irrigation and transition to HVA of the expected magnitude and timing, given low levels of irrigation use and HVA cultivation thus far and the many remaining barriers. However, the positive trend in irrigation use since the systems were rehabilitated suggests that some impacts might nevertheless be achieved. Larger farmers in particular may be in a stronger position to increase irrigation use and HVA cultivation in the future, although small farmers could still benefit indirectly from increased demand for and prices of their land plots. The long-term sustainability of the WUAs operating in these systems will depend heavily on the growth in irrigation use, among other factors. The WUAs in Nistru River systems—which had more recent experience with irrigation and HVA cultivation prior to system rehabilitation—are more likely to be sustainable than those in Prut River systems, given the Nistru River systems' broader user base and more stable financial situation. Finally, there are several valuable lessons for future similar projects, including potential considerations in establishing WUAs that will be sustainable and in designing new or rehabilitated irrigation systems that will be widely used.

In the final evaluation report, we will provide an updated, longer-term, assessment to address the key research questions. The findings from this interim report will enable us to see how the WUAs and irrigation use have evolved over time and across systems. These findings will also provide key insights on lessons learned.

Table IV.1. Contribution of interim findings to research questions and implications for the final evaluation

Research questions	Key interim findings	Implications for the evaluation
Were the expected results realized from the THVA program logic?	• The extent of irrigation and HVA cultivation two full seasons after system rehabilitation has fallen short of expectations in the Economic Rate of Return model. • Few farmers have irrigated land in extension areas through the WUAs, partly because of the high cost of infrastructure and equipment.	• The evidence suggests that the systems are not on track to realize the expected long-term results in the centralized irrigation system areas and extension areas.
If results were not realized, why not?	• Abundant rains and limited HVA cultivation have limited demand for irrigation to date. • Remaining barriers to irrigation include the insufficient supply of on-farm irrigation equipment, system pumps that can only supply large volumes of water, fragmented land holdings, technical problems with and design features of the systems, and the high and upfront costs of irrigation water. • Additional remaining barriers to HVA production include a lack of attractive markets, lack of rural labor, limited financial resources for investments in HVA, short-term land rental contracts, and farmers adopting a "wait and see" approach.	• Irrigation use might continue to be weather dependent in the absence of a large-scale transition to HVA. • Many of the barriers to irrigation and HVA production are likely to persist and could explain why long-term results were not achieved.
What was the contribution of each activity/subactivity to the results that were realized?	• Although some large farmers had improved access to markets and use of post-harvest infrastructure, most farmers continued to face market-related challenges. • Farmers in the rehabilitated systems have invested in equipment through the 2KR hire-purchase program. Most participants would have made similar investments even in the absence of 2KR, but the program enabled them to make faster and larger investments.	• Though other activities have played a complementary role, ISRA-CISRA is likely to drive most of the impacts in the rehabilitated systems, if they occur.
How did the THVA project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?	• Land consolidation has intensified as a result of system rehabilitation, but still involves relatively small areas of land in most systems, especially on the Nistru River. • Land prices have increased substantially as a result of system rehabilitation, more so for sales than for rentals.	• The slow pace of consolidation suggests that land fragmentation is likely to remain an important barrier to increased irrigation in the near future because it limits efficiencies in irrigation and the ability to use the large-capacity pumps in the systems. • Small farmers might benefit from increases in land prices, even if they do not benefit directly from increased irrigation (see below).

Research questions	Key interim findings	Implications for the evaluation
How are the results from the project distributed?	• Larger farmers are most likely to overcome the barriers to irrigation and HVA cultivation and benefit directly from the project in terms of increased agricultural income. • Small farmers might still benefit indirectly by being able to rent out their land more easily and at higher prices. • Community members might benefit from increased employment opportunities and/or wages from working on farms.	• Impacts of the project may vary considerably across farms of different sizes.
Are there indications that some of the long-term outcomes will be realized?	• The widespread non-payment of membership fees is a challenge for WUAs' financial sustainability. • WUA revenues from irrigation fees are also unstable given their dependence on weather and the decisions of a few large water users. • WUAs in Nistru River systems are in a more stable financial position than those in Prut River systems, and are more likely to be sustainable. • The common platform for water authorizations introduced during the compact has been sustained. The platforms for water management have not been sustained, but another donor might build upon them. It is unclear whether river basin management plans will be implemented.	• If WUAs do not broaden their user base and mitigate their weather-dependence, they might struggle to be sustainable. • Although the platforms for water management have not been sustained as is, they might still have a long-term impact on water management in Moldova if another donor builds upon them.
What lessons can be drawn from analysis of the design, implementation, and results of the THVA project?	• The project might have led to larger initial increases in irrigation if the rehabilitation had been focused on areas where farmers were in a position to quickly utilize irrigation; for instance, areas where farmers were already growing HVA or keen to transition to HVA, already had access to markets, and land was relatively consolidated or farmer networks were strong. • The project could have designed systems to better serve small farmers through smaller capacity pumps, closer distance between hydrants, an explicit project focus on farmer cooperation, and making more (or more varied) irrigation equipment available through the WUA. • Increasing WUA membership fee payment would lead to a broader and more stable financial base for the WUAs. One possible approach would be to make fee payment mandatory. • The new WUAs required substantial post-compact support, which could have been explicitly built into the compact agreement.	• These lessons could be applied by MCC or other donors in implementing similar projects in the future.

B. Implications for evaluation design

The interim findings have several implications for the design of the THVA evaluation. We describe these implications below, organized by the impact evaluation and performance evaluation.

Implications for the impact evaluation

- **The planned Farm Operator Survey covering the 2018 season should be delayed.** Because irrigation use to date has been much lower than expected, the large-scale quantitative follow-up Farm Operator Survey that was initially planned in early 2019 (after the 2018 agricultural season) would likely not add sufficient new information to merit the cost. As a result, MCC and Mathematica agreed to delay this survey, tentatively until early 2021 (after the 2020 agricultural season). This will be five full seasons after the systems were rehabilitated, which should be sufficiently long for impacts (if any) to manifest.
- **The impact evaluation should measure irrigation in multiple agricultural seasons.** As discussed earlier, irrigation through the WUAs is likely to depend heavily on rainfall until there is a large-scale transition to HVA production, which is likely to be slow. Therefore, it will be important to capture information about irrigation in multiple agricultural seasons. We plan to do this in the 2021 follow-up farm operator survey by asking respondents about irrigation in previous seasons, in addition to the 2020 season.
- **Following farmers rather than plots is appropriate given the expected pattern of impacts.** Our initial approach to the impact evaluation was to sample land plots at baseline and follow them over time, surveying the operator of the plot at follow-up. However, this is not well-suited to estimating impacts on irrigation and HVA production for large farmers (who have many varied plots and are expected to drive these impacts, if they occur), nor impacts on indirect outcomes for small farmers (such as increased incomes from plot rentals). This suggests that we change our approach to follow farm operators surveyed at baseline (rather than plots) to provide a more complete picture of the impacts of the project on operators in the rehabilitated systems, particularly given the finding that impacts are likely to vary by farm size.

Implications for the performance evaluation

- **The next round of participant interviews and focus groups should be postponed to follow the next round of the Farm Operator Survey.** Because we are planning to delay the follow-up Farm Operator Survey until early 2021, we also plan to delay further large-scale qualitative data collection until late 2021. This will enable us to use the qualitative data to interpret the impact evaluation findings.
- **The findings will inform the topics and participants for future data collection efforts**. The interim findings will inform the topics and participants for the late 2021 qualitative data collection effort, as well as stakeholder interviews planned either side of that effort. For example, it will be important to better understand why some systems are more successful than others (even among the Nistru River systems), understand how and why land consolidation and farmer cooperation have occurred, explore whether and how smaller farmers are benefitting from the project, and interview additional stakeholders (such as the *Livada Moldovei* project, which is active in the rehabilitated systems, and the Austrian

Development Agency, if they build on the water management platforms created during the compact).

- **We will attempt to collect additional and more accurate administrative information from WUAs in the future.** We could make several improvements to the annual WUA administrative data effort to make these data more informative. These include devising a more accurate system for WUAs to record the area irrigated, gathering estimates of the extent of land consolidation, gathering more explicit and detailed information about irrigation in extension areas (rather than relying on WUA director interviews), and requesting more information on the use of irrigation and HVA cultivation by the largest users in the system (to get a better sense of the extent to which a few large users are dominating water use and their characteristics).
- **An engineering assessment of the rehabilitated systems could be a valuable complement to the evaluation.** This assessment will help to better understand some of the constraints posed by technical problems and system design features that our interim findings identified. These include issues related to large pump capacity, low water pressure, and large distances between hydrants. We are currently planning to conduct this assessment in mid-2021.

Overall, the final THVA project evaluation will bring together findings from this interim report, baseline and end-of-compact reports, and qualitative, quantitative, and administrative data collected over the next several years to provide an in-depth and comprehensive assessment of the THVA project and lessons learned.

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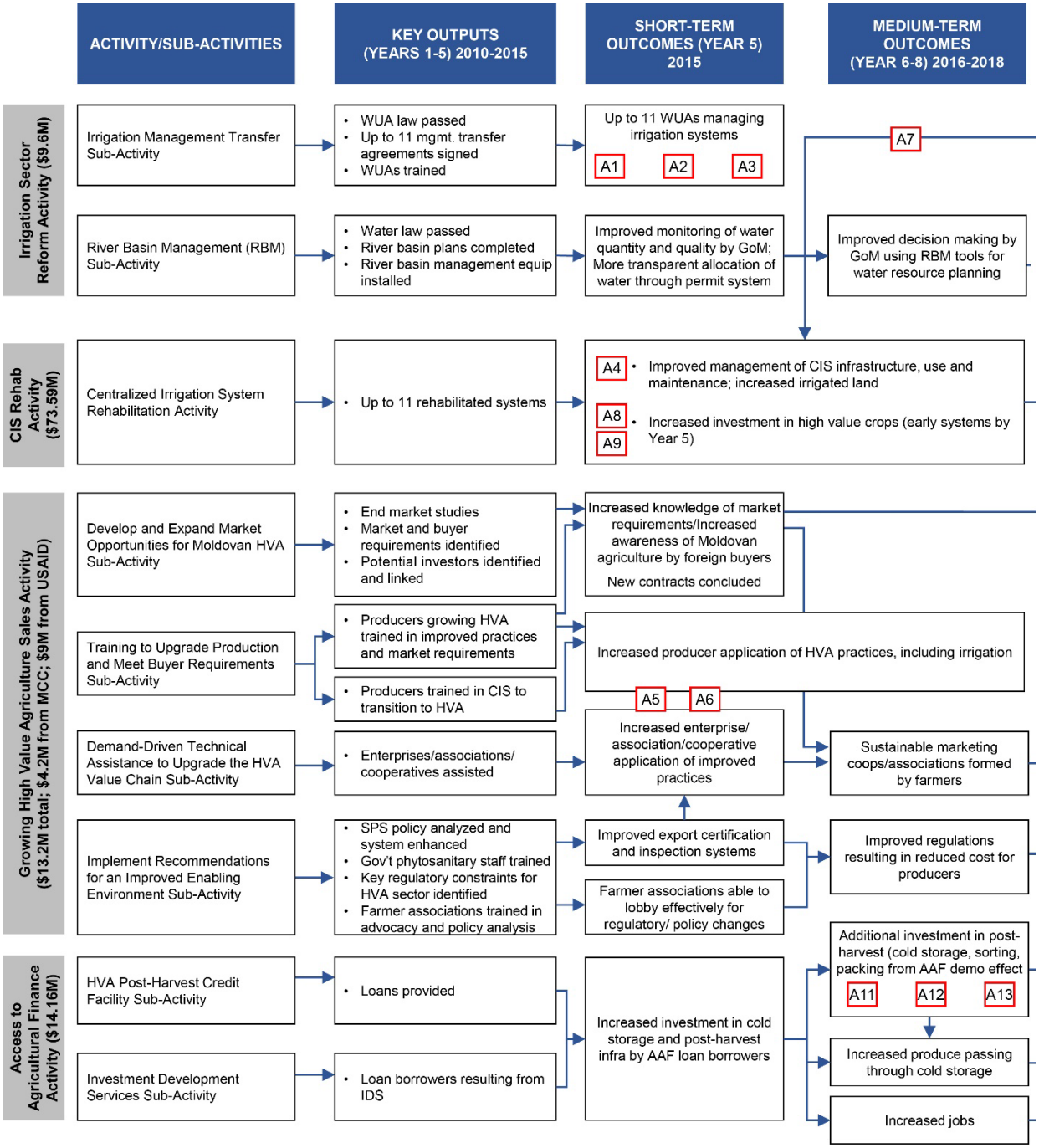
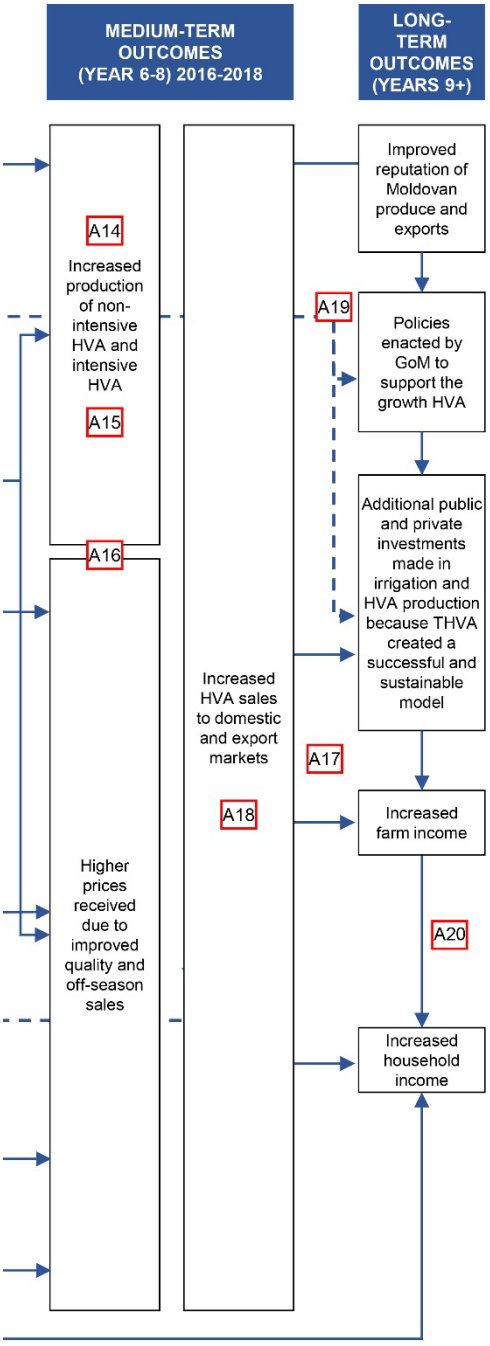
APPENDIX A

THVA PROGRAM LOGIC

Figure A.1. Logic model for the THVA project



Logic model for the THVA project (continued)



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

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APPENDIX B

SUPPLEMENTAL TABLES

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Table B.1. Number of water users and volume of water pumped by system, 2015–2017

System	Number of water users			Volume of water pumped (thousands of cubic meters)		
	2015	2016	2017	2015	2016	2017
Prut River systems						
Blindesti	1	1	1	2	2	49
Grozesti	0	12	7	0	213	121
Leova Sud	0	4	2	0	15	21
Chircani-Zirnesti	0	5	2	0	21	26
Total (Prut)	**1**	**22**	**12**	**2**	**251**	**217**
Nistru River systems						
Lopatna	23	18	14	42	39	35
Jora de Jos	7	14	14	8	57	203
Criuleni	5	15	15	46	216	154
Cosnita	0	40	44	0	500	660
Puhaceni	14	133	104	5	165	194
Roscani	7	10	13	65	218	222
Total (Nistru)	**56**	**230**	**204**	**166**	**1,195**	**1,468**
Total (all systems)	**57**	**252**	**216**	**168**	**1,446**	**1,685**

Source: 2018 WUA administrative data.

Note: The number of users and volume of water pumped includes extension areas. The information in this table is presented graphically in Figure III.1.

Table B.2. Area irrigated by system, 2016–2017

System	Total irrigable area (hectares)	Area irrigated (hectares)	
		2016	2017
Prut River systems			
Blindesti	642	0	43
Grozesti	1,100	115	238
Leova Sud	980	13	30
Chircani-Zirnesti	2,265	20	80
Total (Prut)	**4,987**	**148**	**391**
Nistru River systems			
Lopatna	512	54	58
Jora de Jos	1,300	41	267
Criuleni	778	135	130
Cosnita	2,483	473	536
Puhaceni	920	87	100
Roscani	700	196	198
Total (Nistru)	**6,693**	**986**	**1,289**
Total (all systems)	**11,680**	**1,134**	**1,680**

Source: SDA-Moldova.

Note: Area irrigated is rounded to the nearest whole number. The information in this table is presented graphically in Figure III.2.

Table B.3. Number of WUA members by system, 2015–2017

System	Number of members		
	2015	2016	2017
Prut River systems			
Blindesti	32	30	30
Grozesti	829	757	230
Leova Sud	1,036	1,036	1,036
Chircani-Zirnesti	1,472	1,533	1,461
Nistru River systems			
Lopatna	527	527	146
Jora de Jos	509	276	276
Criuleni	901	421	401
Cosnita	2,980	152	164
Puhaceni	2,129	2,690	2,110
Roscani	724	57	62

Source: 2018 WUA administrative data.

Note: The information in this table is presented graphically in Figure III.5.

Table B.4. WUA revenues, 2016–2017

System	Revenues from membership fees (thousands of lei)		Revenues from irrigation fees (thousands of lei)		Other revenues[a] (thousands of lei)		Total revenues (thousands of lei)	
	2016	2017	2016	2017	2016	2017	2016	2017
Prut River systems								
Blindesti	66	74	9	238	0	22	**75**	**335**
Grozesti	120	190	756	546	0	9	**876**	**745**
Leova Sud	134	309	61	246	8	6	**202**	**561**
Chircani-Zirnesti	473	274	75	82	192	117	**740**	**473**
Nistru River systems								
Lopatna	31	58	125	117	0	0	**156**	**175**
Jora de Jos	85	195	210	911	11	19	**306**	**1,126**
Criuleni	42	82	616	476	18	35	**676**	**593**
Cosnita	182	217	1,500	1,847	45	65	**1,728**	**2,129**
Puhaceni	54	47	496	641	9	32	**560**	**721**
Roscani	38	70	717	784	21	18	**776**	**872**

Source: 2018 WUA administrative data

Note: The information in this table is presented graphically in Figure III.6.

[a] Includes revenues from irrigation equipment services, transportation services, bank interest, housing rentals (to construction firm staff), and payments for organizing seminars (for the HVAA project).

Table B.5. WUA membership and irrigation fees, 2016–2018

System	Membership fee (lei per hectare)			Irrigation fee (lei per cubic meter)		
	2016	2017	2018	2016	2017	2018
Prut River systems						
Blindesti	450	350	350	4.50	4.50	4.50
Grozesti	240	280	280	3.50	4.50	4.50
Leova Sud	110	350	457	3.90	3.72	4.64
Chircani-Zirnesti	183	183	190	3.00	3.10	3.04
Nistru River systems						
Lopatna	200	400	400	3.50	3.50	4.00
Jora de Jos	250	300	300	3.70	4.50	4.50
Criuleni	200	200	200	2.85	3.00	3.50
Cosnita	290	300	260	3.00	2.80	3.00
Puhaceni	200	200	200	3.00	3.30	3.60
Roscani	100	200	200	3.26	3.26	3.75

Source: 2018 WUA administrative data

Notes: 2018 fees were determined at the spring 2018 WUA general assembly. The information in this table is presented graphically in Figure III.7 and Figure III.8.

Table B.6. 2KR hire-purchase program investments through December 2017, all participants

	All participants	Small farm participants (≤10 ha)	Medium farm participants (>10-100 ha)	Large farm participants (>100 ha)
Investment type (number of investments)				
New irrigation equipment or components	168	9	59	100
Farming machinery for growing and harvesting fruits and vegetables	61	9	25	27
Hail protection systems, harvesting platforms, harvesters	21	4	9	8
Greenhouses, solar tunnels and greenhouse related equipment	11	8	2	1
Tractors for pulling irrigation equipment	9	0	5	4
Total	**270**	**30**	**100**	**140**

Source: 2KR administrative data based on investments made between May, 2015 and December, 2017.

Note: The information in this table is presented graphically in Figure III.9.

ha = hectares

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