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Moldova Transition to High-Value Agriculture Project Evaluation

Final Report

March 24, 2023

Evan Borkum, Jane Fortson, Irina Cheban, Seth B. Morgan, Naomi Dorsey, Cullen Seaton, and Hailey Hannigan

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Mathematica was contracted by MCC to conduct an independent evaluation of the Transition to High-Value Agriculture Project in Moldova; this report presents final findings from that evaluation. To inform this report, Mathematica collected data in conjunction with ADI and a Moldova-based consultant. The findings in this report represent the independent assessment of the authors, and do not reflect the views of MCC, ADI, or the consultant. The authors report no conflicts of interest.

Acronyms

2KR	Grant Assistance for the Food Security Project for Underprivileged Farmers
AAF	Access to Agricultural Finance
ACED	Agricultural Competitiveness and Enterprise Development
ACSA	National Agency for Rural Development
ADI	Agricultural Development Institute
CHIRPS	Climate Hazards Group InfraRed Precipitation with Station
CISRA	Centralized Irrigation System Rehabilitation Activity
CBA	Cost-Benefit Analysis
ERR	Economic Rate of Return
EQ	Evaluation Question
EU	European Union
GoM	Government of Moldova
GHS	Growing High-Value Agriculture Sales
HVA	High-Value Agriculture
IFAD	International Fund for Agricultural Development
ISRA	Irrigation Sector Reform Activity
MCA-Moldova	Millennium Challenge Account – Moldova
MCC	Millennium Challenge Corporation
RBM	River Basin Management
SDA-Moldova	Sustainable Development Account – Moldova
THVA	Transition to High-Value Agriculture
USAID	United States Agency for International Development
WUA	Water User Association

Executive summary

Overview of the Moldova Compact and the THVA Project

In 2010, the Government of Moldova (GoM) and the Millennium Challenge Corporation (MCC) signed a five-year, 262 million dollar Compact designed to address key impediments to Moldova's economic growth: (1) constraints to growing higher value crops and (2) deteriorated roads which raise the costs of production and trade. To address these constraints, the Compact—which entered into force in 2010 and closed out in 2015—included two projects: the Transition to High-Value Agriculture (THVA) Project and the Road Rehabilitation Project. In 2010, MCC contracted with Mathematica to conduct an independent evaluation of the THVA Project. This report presents the final evaluation of the Project.

The 129 million dollar THVA Project was designed to capitalize on Moldova's inherent advantages in the agricultural sector to expand cultivation of fruits and vegetables for the domestic and export markets. The Project, which was implemented by the Millennium Challenge Account–Moldova (MCA-Moldova) and has been supported in the post-Compact period by the Sustainable Development Account–Moldova (SDA-Moldova), included four complementary activities:

- The **Irrigation Sector Reform Activity (ISRA)** (8.1 million dollars), which supported improved management of water resources in Moldova and established associations of farmers (Water User Associations, or WUAs) to manage centralized irrigation systems in 10 targeted areas;
- The **Centralized Irrigation System Rehabilitation Activity (CISRA)** (99.8 million dollars), which rehabilitated the aging, existing centralized irrigation system infrastructure in those same 10 targeted areas;
- The **Access to Agricultural Finance (AAF) Activity** (17.1 million dollars), which improved access to post-harvest infrastructure and irrigation equipment through targeted loan and hire-purchase programs; and
- The **Growing High-Value Agriculture Sales (GHS) Activity**[1] (4.4 million dollars in MCC funds), which supported farmers and enterprises through training, technical assistance, market linkage support, and improvements to the enabling environment for high-value agriculture (HVA).

These activities were expected to contribute to the Project meeting its two-part objective, as outlined in the Compact: (1) increase rural incomes by stimulating growth in HVA; and (2) catalyze future investments in HVA by establishing a successful and sustainable model of irrigation system and water resource management and a conducive institutional and policy environment for irrigated agriculture.

CISRA and the WUA-related component of ISRA targeted 10 centralized irrigation systems located along the Prut River (Blindesti, Grozesti, Leova Sud, and Chircani-Zirnesti) and the Nistru River (Lopatna, Jora de Jos, Criuleni, Cosnita, Puhaceni, and Roscani).[2] In these areas, the Project rehabilitated the systems, constructing pumping stations, subterranean pipes, and reservoirs to pump water from the rivers to hydrants in farmers' fields. Two systems were completed before the 2015 agricultural season and the other eight systems were completed during the 2015 season. The systems serve some land directly (the

[1] The GHS Activity was co-funded by the United States Agency for International Development (USAID) and was implemented as part of the broader Agricultural Competitiveness and Enterprise Development (ACED) Project.

[2] The Project originally targeted 11 systems, and established a WUA in the 11th system, Cahul. However, MCC decided not to rehabilitate this system because the estimated costs of rehabilitating the other 10 systems did not leave sufficient resources for rehabilitating the drainage system in Cahul, which would be necessary to facilitate a transition to HVA. As a result, the WUA in Cahul was largely dormant during the Compact.

"command area") and had the potential to expand to serve other nearby land (the "extension area") through infrastructure investments from other funding sources. Farmers in the 10 targeted areas were invited to join the associated WUAs, which levy membership fees based on farm area and irrigation fees based on volume pumped. The WUAs have staff and elected representatives who work to manage the systems and conduct maintenance and repairs.

Evaluation questions, data sources, and analytic approach

The evaluation of the THVA Project sought to address eight evaluation questions (EQs):

EQ #1: Were the expected results realized from the THVA project logic?

EQ #2: How are the results from the Project distributed?

EQ #3: How did the THVA Project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?

EQ #4: If results were not realized, why not? What are the characteristics of systems in which irrigation use increased the most? The least?

EQ #5: What was the contribution of each activity/sub-activity to the results that were realized?

EQ #6: Are there indications that some of the long-term outcomes will be realized?

EQ #7: What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?

EQ #8: What is the ex-post Economic Rate of Return (ERR) of the THVA Project?

To address the EQs, we conducted a multi-component performance evaluation. The final evaluation draws primarily on WUA administrative data, the Water User Survey, and qualitative data (**Table ES.1**).

In this report, we bring together evidence across the three data sources—administrative, survey, and qualitative data—to address each EQ. We use three analytic approaches: (1) ex-post thematic analyses of administrative data from WUAs and survey data from water users in the 10 targeted systems; (2) ex-post thematic analyses of qualitative data from a diverse group of respondents, including respondents from similar but unaffected comparison areas and from non-Project areas in which WUAs were also established; and (3) pre-post comparisons of agricultural wages and land rental prices in the rehabilitated systems.

Table ES.1. Principal data sources for the final THVA Project evaluation

Data source (reference period)	Target group(s)	Key outcomes
WUA administrative data (2015–2021 seasons)	• WUAs in the 10 Project systems	• Use of the rehabilitated irrigation systems • Membership information • WUA fees and finances
Water User Survey (2020 season)	• Targeted all 315 farmers who pumped irrigation water through the 10 Project systems in the 2020 agricultural season • 305 water users responded to the survey; WUAs were able to provide limited information on most water users who did not respond	• Farm characteristics • Experience with irrigation and the WUA • Crops and area cultivated and irrigated • Access to post-harvest infrastructure • Participation in training • Farm labor and the market for land • Barriers to HVA cultivation
Qualitative data (2020 and 2021 seasons)	• Farmers (including water users and non-users) and WUA administrators in Project systems • AAF and GHS participants • Farmers and local government authorities in comparison systems • Water users and administrators of WUAs that had formed in non-Project systems • Ministry, donor, and other representatives	Questions were tailored to different respondents; interview topics included: • HVA prices and sales • Barriers to HVA cultivation • Land consolidation and land markets • Contribution of each activity • Policy changes • Lessons learned

Findings

Overall, the findings suggest that the THVA Project successfully met one part of its objective, to "catalyze future investments in HVA by establishing a successful and sustainable model of irrigation system and water resource management and a conducive institutional and policy environment for irrigated agriculture." Specifically, the Project successfully established and transferred irrigation management to 10 WUAs that have been sustained several years after the end of the Compact, are effectively managing irrigation in their systems, and have spurred broader adoption of the WUA model in Moldova.

However, in the 10 rehabilitated systems, the Project is unlikely to have met the other part of its objective, which was to "increase rural incomes by stimulating growth in irrigated HVA," given that it did not achieve most of the key related outcomes expected in the project logic. Although the Project led to increases in irrigation use and HVA cultivation, the transition to irrigated HVA crops in the rehabilitated systems did not occur to the extent envisaged and the Project's investments in those systems benefitted only a small number of water users. As a result, the Project is unlikely to have been economically justified according to MCC's Compact Closeout cost-benefit analysis (CBA) model, in which expected income benefits were driven by a widespread transition to HVA. Limited access to attractive sales markets and a shortage of rural agricultural labor were key barriers to achieving the expected outcomes. Below, we summarize the key findings in more detail, organized by EQ.

EQ #1: Were the expected results realized from the THVA project logic (with priority on the medium-term outcomes)?

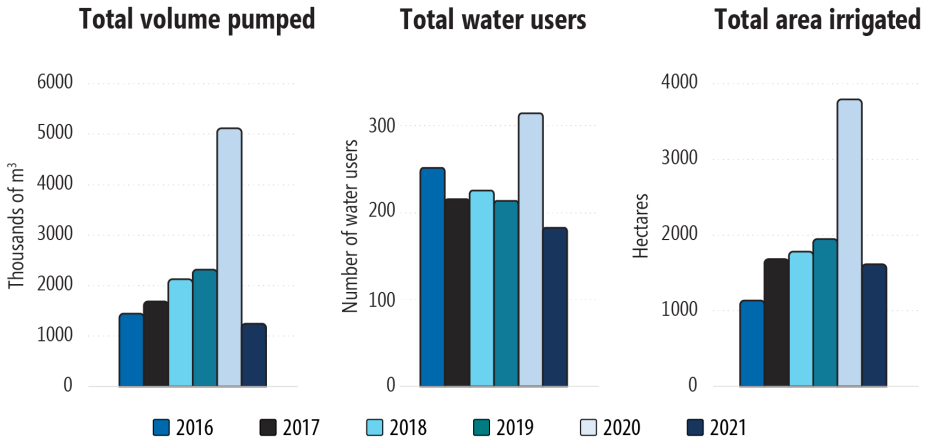
Most of the rehabilitated irrigation systems have operated without any major functionality issues through 2021, and most water users have been satisfied with WUA-provided irrigation services.

Through the 2021 agricultural season, most systems did not encounter any major functionality issues beyond what would be considered routine maintenance or minor repairs. SDA-Moldova has provided support when issues have arisen. WUA directors suggested that they did not expect major functionality issues because the systems were still operating well below capacity. The WUAs are managing the rehabilitated systems well, contributing to a substantial improvement in the availability of affordable irrigation water. Specifically, about 93 percent of water users in 2020 were totally or somewhat satisfied with the ease of working with the WUA for ordering and billing, 83 percent with the cost of water, and 90 percent with the timeliness of water delivery. These levels of satisfaction were substantially higher than those reported by farmers before the systems were rehabilitated and managed by WUAs.

The volume pumped, number of water users, and area irrigated in the rehabilitated systems grew gradually between 2016 and 2019; the larger increases that occurred in 2020 were reversed in 2021, reflecting the strong dependence of irrigation use on seasonal precipitation patterns.

Across all systems, irrigation use increased between 2016 (the first season in which all systems were fully operational) and 2019, but there was a much sharper increase in 2020 (**Figure ES.1**). Between 2019 and 2020, the total volume pumped across all systems more than doubled, the number of water users increased by almost 50 percent, and the area irrigated almost doubled. However, these increases were not sustained in 2021. The variability in irrigation use in recent seasons reflects the sensitivity of farmers' demand for irrigation water to precipitation. By all accounts, the large increase in irrigation use in 2020 was primarily due to an extensive drought, which increased farmers' demand for irrigation water both to irrigate non-HVA crops, which are not routinely irrigated in most of these areas, and in some cases to irrigate HVA crops more intensively. The decreases in irrigation use between 2020 and 2021 were driven primarily by higher levels of precipitation in 2021 across the rehabilitated systems.

Figure ES.1. Total volume pumped, number of water users, and area irrigated, 2016–2021



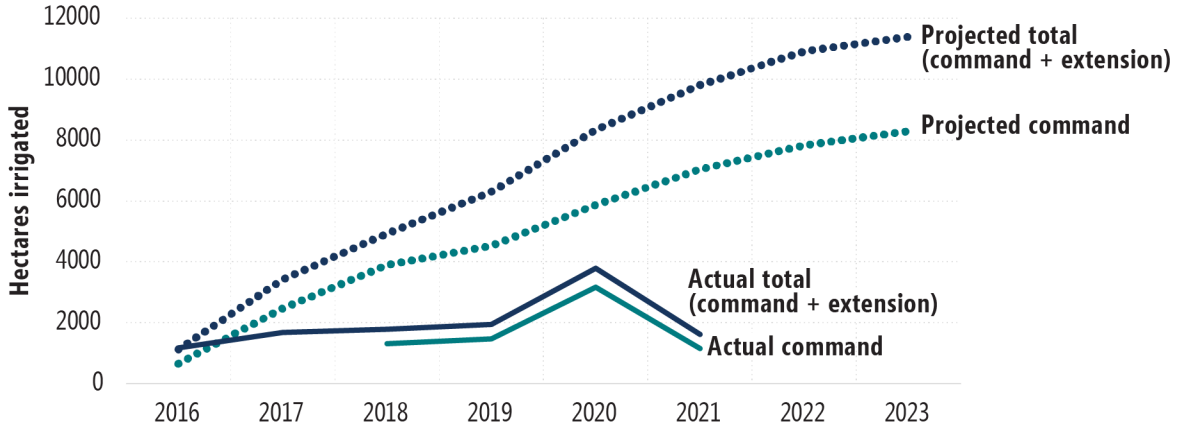
Source: WUA administrative data (2016–2021).

Note: The rehabilitated systems have the capacity to irrigate 12,830 hectares in the command area, as well as additional land in the extension area.

The area irrigated and area of HVA irrigated have fallen short of what was anticipated in MCC's Compact Closeout CBA model.

By 2019, the total area irrigated across all systems had reached about 31 percent of the projected 6,299 hectares in MCC's Compact Closeout CBA model (**Figure ES.2**). Despite the substantial increase in irrigation use in 2020, the area irrigated reached only 46 percent of the projected 8,328 hectares, and the area of irrigated HVA reached only about 52 percent of the projected 4,517 hectares (not shown). The shortfall in area irrigated relative to projections is even starker for the extension areas, where about 25 percent of the total projected area irrigated was achieved in 2020, relative to 54 percent for the command area. As a result of the decrease in irrigation use in 2021, the total area irrigated reached only 16 percent of the projected 9,795 hectares.

Figure ES.2. Total irrigated area versus CBA estimates, 2016–2021



Source: SDA-Moldova (actual total), WUA administrative data (actual command), and MCC's Compact Closeout CBA model (projected total and projected command).

Note: In 2016 and 2017, we have information about the total area irrigated but not the command area irrigated.

There are more opportunities for Moldovan farmers to sell HVA crops to domestic retailers, and there has been a positive trend in fruit exports, but several constraints remain.

Through the GHS Activity, the project expanded access to the domestic retail and export markets for some farmers, though it is difficult to assess its aggregate impact on sales to these markets. The domestic retail chain we interviewed suggested that there is an increasing trend in Moldova for domestic consumers to buy fruits and vegetables from retail chains rather than open markets and that the quantity of fruits and vegetables demanded by retail chains from producers has grown accordingly. However, several farmers we interviewed noted that the overall size of the domestic market is small and that there are several constraints to working with domestic retail chains, including lack of access to cold storage, a mismatch between retailer volume requirements and the volumes available from producers, and perceived unfavorable contract conditions.

Official national statistics show that between 2011 and 2020, there was a positive trend in the nominal value of Moldovan fruit exports and in the fraction of fruit exports destined for the European Union (EU) market. An increase in the quality of Moldovan produce in recent years due to the adoption of new varieties and technologies has enabled some larger farmers to meet quality standards demanded by EU buyers, as well as achieve higher prices for their produce more generally. However, the number of farmers in the rehabilitated systems who export is likely to be relatively small given the limited transition

to irrigated HVA crops in the systems to date and important constraints to participating in export markets, including Russian bans on Moldovan produce, high costs of introducing new varieties, increased transportation costs, a lack of post-harvest infrastructure, and strict EU documentation requirements.

The GoM has developed second river basin management (RBM) plans for the Nistru and Prut Rivers, building on the first plans developed during the Compact; the RBM platform for water use authorizations was sustained, but the two platforms for water management were not.

The RBM component of ISRA provided technical assistance to the GoM during the Compact to develop the first national six-year RBM plan for the Nistru River, and the EU supported the first national RBM plan for the Prut River around the same time. A second Nistru RBM plan is under development and is expected to be finalized in 2023; the second Prut RBM plan was approved in 2022. The RBM component of ISRA also established three new platforms related to water use and management. Common Platform 1 was a "one-stop shop" that was designed to streamline the water use authorization process for WUAs and other users. This platform is still operational, although several WUAs we interviewed said the process was complicated and/or lengthy and required support from SDA-Moldova. Common Platform 2 was designed to collate information related to water management, making it visible across institutions, and Common Platform 3 was the public use interface for this system. Common Platforms 2 and 3 fell out of use soon after the Compact due to turnover of trained staff and limited incentives for remaining staff to update and maintain the systems.

Less than one-third of water users participated in any type of GHS training; any impacts of training on improved practice adoption in the rehabilitated systems are unlikely to be widespread.

The GHS trainings are unlikely to have led to widespread changes in practice adoption in the rehabilitated systems. In particular, among the 30 percent of water users who attended GHS training, two-thirds already had experience irrigating in the system before rehabilitation and a similar fraction had pre-rehabilitation experience cultivating all the HVA crops that they irrigated in 2020—suggesting that the number of water users who were potentially spurred by the training to cultivate and irrigate HVA was relatively small. A small number of experienced HVA farmers might have adopted improved practices that they learned through value chain-focused trainings.

Water users' use of post-harvest infrastructure was limited in the 2020 season, suggesting that the AAF Activity did not result in the envisaged increase in use in these areas.

Despite the strong long-term benefits of investment in post-harvest infrastructure reported by AAF loan recipients, only about 14 percent of water users in the rehabilitated systems that irrigated in 2020 used a cold storage facility and only about 7 percent used other types of post-harvest infrastructure. Almost no water users used AAF-funded post-harvest facilities. The facilities that they used are also unlikely to reflect an AAF demonstration effect, for two reasons. First, the AAF end-of-Compact study (Borkum et al. 2016) found no evidence that AAF loans affected enterprises' decisions to invest in cold storage, given the availability of other sources of credit in the market (albeit at less attractive conditions). Second, few AAF-funded facilities were in or near the rehabilitated areas, making a local demonstration effect unlikely.

EQ #2: How are the results from the Project distributed?

Most of the benefits of improved access to irrigation through the rehabilitated systems have accrued to a relatively small number of farmers.

In 2020, there were 315 water users in total, of which more than half were concentrated in just two systems (Cosnita and Puhaceni on the Nistru River). Although the number of water users in 2020 was substantially greater than in other years, it is much lower than the several thousand farmers who MCC expected would benefit directly from improved access to irrigation. Further, in almost all systems, a handful of water users accounted for most of the volume pumped, and a relatively small fraction of farms accounted for most of the total area irrigated. Overall, these findings suggest that, in most systems, a handful of larger farmers were the main direct beneficiaries of improved access to irrigation, although in some systems up to a few dozen smaller farmers also benefitted.

The real median daily wage for agricultural laborers in the rehabilitated systems has increased by about two-thirds since rehabilitation, but these changes do not appear to be related to the Project.

In the 2020 season, about 42 percent of all water users in the rehabilitated systems employed any paid laborers. Using survey data, we estimate that the median wage for paid laborers across these systems increased by 69 percent in real terms between 2013 and 2020. In interviews, farmers and WUA directors largely attributed this increase to external factors such as national minimum wages and changing labor pools, rather than to the effects of the Project. Consistent with this, interviewees in comparison systems—similar centralized irrigation systems that were not rehabilitated through the Project—typically reported wages that were similar to those in the Project systems. Overall, the increase in wages in the Project systems appears to have been driven by external factors rather than improved access to irrigation, suggesting that this was not an important indirect channel of Project benefits.

EQ #3: How did the THVA Project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?

There has been considerable land consolidation in Grozesti and Chircani-Zirnesti—and to a lesser extent in the other Project systems—since system rehabilitation was completed; however, these changes also occurred in non-Project systems.

As of the 2021 season, the extent of land consolidation had been greatest in the four Prut River systems—Blindesti, Grozesti, Leova Sud, and Chircani-Zirnesti—where large farms of more than 100 hectares operate most of the land. In Blindesti and Leova Sud, there was a large degree of consolidation before system rehabilitation, but in Grozesti and Chircani-Zirnesti most consolidation has occurred since system rehabilitation was completed. The extent of land consolidation is more limited in the six Nistru River systems; the plots in these systems tend to be small and dispersed, which poses a challenge to further consolidation. Nevertheless, WUA directors report that land consolidation in the Nistru River systems, which had been ongoing for many years even before the Compact, has accelerated since system rehabilitation was completed, albeit at a slower pace than in the Prut systems. Most WUA directors in Project systems attributed increased consolidation to natural processes not necessarily related to system rehabilitation—small farmers selling or leasing their land due to old age or death of the owner, migration, or lack of interest in commercial cultivation. Consistent with this, several of the comparison systems have seen gradual and ongoing land consolidation by larger farmers over the past decade. The substantial land consolidation in the comparison systems over the past decade further suggests that consolidation in the rehabilitated systems is likely to have been driven by external factors rather than the effects of the Project.

The median land rental price in the rehabilitated systems increased by more than 50 percent since rehabilitation, and sales prices also increased substantially; external factors likely drove most of the increase in rental prices, but the Project likely contributed to the increase in sales prices.

Because land rental is much more common than land sales in rural Moldova, our quantitative analysis of land prices focused on rental prices. Using survey data, we estimate that the median rental price across the rehabilitated systems increased by 56 percent in real terms between 2013 and 2020. On average, interviewees in comparison systems reported rental prices that were similar to the 2020 median reported for Project systems. All comparison area interviewees agreed that rental prices had increased substantially over the past decade due to a broader trend towards increased land prices in Moldova and higher crop prices and yields for non-HVA crops used for in-kind rental payments. Overall, we cannot rule out that some landowners in rehabilitated systems received higher land rental prices because of the Project, but on average these effects appear to be small relative to the effects of external factors. Stakeholders in the rehabilitated systems indicated that land sales prices had also increased substantially since rehabilitation. Many attributed these increases in prices at least partly to improved access to irrigation, although interviewees in comparison systems also suggested that land sales prices in their systems had increased substantially over the same period.

EQ #4: If results were not realized, why not? What are the characteristics of systems in which irrigation use increased the most? The least?

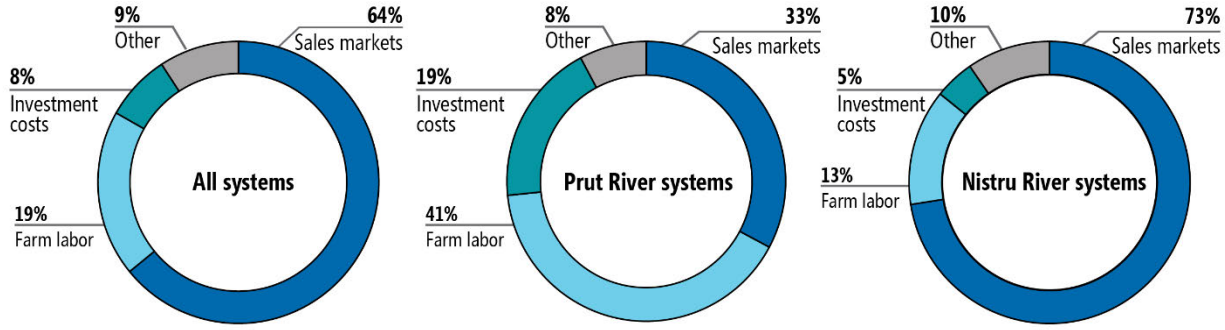
Through 2021, the Nistru River systems have seen greater irrigation use than the Prut River systems, on average; Leova Sud and Chircani-Zirnesti on the Prut River have seen the lowest use among all 10 systems.

The Nistru River systems have generally been used more consistently because they irrigate a larger area of HVA crops, which often require irrigation even in years with high precipitation. (Only one system on the Prut River, Grozesti, has had similarly high levels of use to the Nistru River systems.) Among all 10 systems, the Prut River systems of Leova Sud and Chircani-Zirnesti have seen the lowest irrigation use across all Project systems between 2016 to 2021. Most of the land area in these systems is operated by large non-HVA farmers who have little interest in transitioning to HVA crops and only demand irrigation water in low-precipitation years. Overall, variation in irrigation use across systems can be traced to: (1) farmers' pre-rehabilitation crop choice and experience (specifically, the extent of HVA cultivation immediately before rehabilitation); (2) farmers' success in forging market linkages (such as connections with export markets and contract farming arrangements); and (3) the presence of a core group of water users who are committed to irrigating regularly.

Water users and WUA directors identified limited access to sales markets and lack of farm labor as the main barriers to more farmers cultivating HVA; a lack of access to equipment was an additional constraint to irrigation in the high-demand 2020 drought season.

We asked water users in 2020 to identify the single most important barrier preventing more farmers in their system from cultivating HVA. A lack of access to attractive sales markets was by far the most common barrier, selected by 64 percent of respondents, followed by a lack of farm labor, selected by 19 percent; investment costs were cited as the main barrier by 8 percent of respondents and other barriers (including irrigation and farmer interest) were cited by about 9 percent (**Figure ES.3**). A lack of farm labor was cited more often in the Prut River systems because of their proximity to Romania, which offers higher-paying opportunities for laborers.

Figure ES.3. Barriers to more farms cultivating HVA, 2020



Source: Water User Survey (2020 season).

Note: Respondents were asked to indicate the biggest barrier preventing more farms in the command area from cultivating fruits and vegetables. Percentages are calculated among water users in the 2020 agricultural season. "Other" includes irrigation, farmer interest, and other responses provided by the respondent.

In interviews, farmers and WUA directors highlighted a lack of access to irrigation equipment services through the WUAs as an additional barrier to irrigation in the 2020 drought season. Most WUAs did not have enough equipment to meet the simultaneous demand from so many water users, nor did they have the types of equipment to irrigate the range of crops that required irrigation. This led to delays in irrigation, which adversely affected the production of crops that are sensitive to the timing of irrigation and meant that some water users were unable to irrigate as much as they would have liked.

The broader context of a declining interest in small-scale agriculture due to external factors also did not support the envisaged changes.

In the period since the Project was designed in the late 2000s, Moldova has seen substantial outmigration of its working age population, in large part due to increased employment opportunities in the EU. Further, the real wage for paid employment in Moldova has increased substantially over the same period. Together, these external factors have contributed to making small-scale agriculture less attractive as a source of livelihoods in Moldova. In this context, widespread investments in irrigation and HVA production by small-scale farmers were unlikely by the time the systems were rehabilitated in 2015.

EQ #5: What was the contribution of each activity/sub-activity to the results that were realized?

ISRA and CISRA made critical contributions to the positive results that were achieved in the rehabilitated systems.

Even in the absence of system rehabilitation, the formation of WUAs and management transfer to WUAs has resulted in clear benefits for farmers. Specifically, transitioning partly functioning non-Project systems to management by WUAs has reduced the price of irrigation water in these systems and improved the timeliness of water delivery as the WUAs have repaired infrastructure more rapidly and effectively coordinated irrigation among farmers. However, dilapidated infrastructure remains a major challenge for the sustainability of non-Project WUAs and for the cultivation of HVA crops, suggesting that CISRA also made an important contribution to the Project's results. In contrast, as mentioned earlier, the AAF Activity had limited effects on water users in the rehabilitated systems and it is unlikely that GHS trainings led many water users in these systems to transition to irrigated HVA production. Although

participants throughout Moldova might have benefitted from the AAF and GHS Activities, they were not geographically focused on the rehabilitated systems like ISRA and CISRA.

EQ #6: Are there indications that some of the long-term outcomes will be realized?

The relatively few farmers who irrigated through the rehabilitated systems have generally found it profitable to do so, despite increased input costs and necessary on-farm investments.

Most of the water users we interviewed reported that their profits had increased since the end of the Compact. Improved access to irrigation through the Project, together with the use of other modern technologies and practices, has increased yields and quality. This has enabled these farmers to sell larger volumes and obtain higher prices. Further, water users' use of irrigation in the 2020 drought season resulted in substantially better yields and quality compared to farmers who did not irrigate—some of whom lost the entire season's crops. However, the increased cost of inputs and the costs of necessary on-farm investments have reduced the magnitude of these gains. Unfortunately, gains in profits have been restricted to a small number of water users, and most farmers have been unable to overcome other barriers.

Almost all WUA directors in Project systems believed that their WUAs would be financially sustainable in the long run, but some were concerned by their low level of reserve funds; the extent to which WUAs can operate independently of support from SDA-Moldova is unclear.

WUA directors in Project systems believe that their WUAs can achieve financial sustainability by using surplus revenues from high-demand (low precipitation) years to cover deficits in low-demand (high precipitation) years—in some cases by adjusting their fees. However, several WUAs were concerned that this financial model had left them with limited (or zero) reserve funds to contribute to further infrastructure improvements or fund major repairs if they become necessary. Project WUAs also continue to rely on SDA-Moldova for legal, accounting, technical, and financial support through 2022, seven seasons after rehabilitation was completed. (The technical and financial support is related to infrastructure repairs and improvements, such as work to extend the reach of the systems in the extension areas, rather than routine operations.) This support was critical because the WUAs were new organizations that had little or no practical experience managing the rehabilitated systems at the end of the Compact. WUA directors highlighted their appreciation for the post-compact support provided by SDA-Moldova and its importance to sustaining and improving their operations. However, it is unclear how long SDA-Moldova will continue to exist and who will provide this support in its stead.

Several additional WUAs have been established or reorganized since the end of the Compact and have completed management transfer; the THVA Project supported the formation and operations of additional WUAs in several ways.

According to SDA-Moldova, by the end of 2021, there were 25 WUAs registered in Moldova in addition to the 10 that were established and had undergone management transfer through the Project (GoM 2021). By the end of 2021, 17 of these 25 WUAs had completed management transfer, and transfer was in process for the remainder. The formation of these WUAs was initiated by a handful of founding members in each system, typically led by larger farmers who had the most to gain from improved access to irrigation. Although the Compact ended before most of these WUAs were formed, the THVA Project supported their formation by: (1) developing the WUA Law, under which all WUAs were established; (2) enabling the management of non-Project WUAs to engage with and learn from Project WUAs; and (3) leading to the establishment of SDA-Moldova, which played a critical role in helping non-Project WUAs

navigate the establishment and management transfer processes and provided them with advice and technical support in organizing, launching, and carrying out their activities.

EQ #7: What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?

In future projects, it will be important to tailor the approach to specific areas, ensure farmers' commitment, include an early focus on market access, and provide adequate post-compact support.

The evaluation of the THVA Project identified several key lessons that might be relevant to similar projects that are implemented in the future. First, system rehabilitation and management transfer addressed a major constraint to cultivating HVA crops; effectively addressing other constraints might require an approach tailored to specific areas and farmers. Second, many farmers did not follow through on their stated commitment to become active WUA members; future projects could consider ways to assess and encourage farmers' commitment, such as requiring an up-front payment. Third, improving access to attractive domestic and export markets might need an early and intense project focus given the key role of market access in encouraging farmers to change their cultivation patterns. Finally, strong post-compact entities can substantially improve the sustainability of MCC's investments, especially when critical components are only implemented late in the compact period.

EQ #8: What is the ex-post ERR of the THVA Project?

The ex-post ERR of the Project is likely to be lower than the negative 5.5 percent estimated in MCC's Compact Closeout CBA model.

As discussed under EQ #1, the area irrigated in the rehabilitated systems—which is directly connected to the estimated benefits of the Project—has fallen short of the Compact Closeout CBA projections. There has also been considerable variation in area irrigated from year to year, which was not explicitly modeled in the CBA. Overall, whereas the CBA model projected that irrigated area would increase rapidly after the end of the Compact and be sustained at a high level, in practice, it increased more gradually initially and even decreased substantially more recently. This suggests that the Project ERR is likely lower than that estimated by MCC at Compact Closeout.

Implications

The THVA Project sought to address numerous constraints to the transition to HVA by improving access to reliable irrigation (through ISRA and CISRA), expanding access to domestic and export markets (through the GHS Activity), providing access to finance (through the AAF Activity), and increasing farmer knowledge (through the GHS Activity), among other activities. The experience of the THVA Project illustrates how challenging it can be to achieve substantial changes in farmer behavior when there are many constraints affecting farmers' irrigation use and crop choice. The findings suggest that future agriculture projects can take several steps to increase the likelihood of these changes:

- **Develop a clear, location-specific theory of how envisaged changes in irrigation use and cropping patterns might occur and design additional tailored interventions to support those changes.** This might include targeting certain types of farmers or geographies with interventions to address constraints specific to their irrigation and cropping choices. Even in a country as small as Moldova, there is sufficient heterogeneity across geographic areas to justify this type of tailored approach. For example, a different approach might have been needed in a system with many small farmers already cultivating vegetables versus one in which most of the land was operated by large

corn farms. This approach might also have helped better identify systems in which the envisaged changes were unlikely to occur.

- **Implement mechanisms that increase the commitment of farmers to participate in new farmer organizations like WUAs,** such as requiring farmers to make an affordable up-front financial investment before the project moves forward. This could help identify areas in which farmer commitment to the project is high and avoid investing heavily in farmer organizations that are unlikely to have a broad base of support.
- **Maintain a strong focus from the outset on expanding access to domestic and export markets,** as market access is closely intertwined with crop choice and irrigation use. Market studies of specific value chains in specific areas might be helpful in developing tailored interventions that leverage available market opportunities. In cases in which existing market opportunities are limited, an agriculture project might not be successful in changing farmer behavior absent more intensive market-focused interventions to address this (for example, formation of farmer producer groups to access previously inaccessible markets).
- **Build in the post-project support that new farmer organizations like WUAs need** for the first several years after they begin to function. The five-year implementation period that MCC compacts and many other donor projects follow is likely too short for these new organizations to be self-sufficient by the end of the project; for new organizations to be effective, they need additional support and practical experience.

Together, these steps could contribute to future agriculture projects achieving their goals of increasing farmer profits and income, thereby reducing rural poverty.

I. Introduction

In 2010, the Government of Moldova (GoM) and the Millennium Challenge Corporation (MCC) signed a five-year, 262 million dollar Compact designed to address key impediments to Moldova's economic growth: (1) constraints to growing higher value crops in the agricultural sector and (2) deteriorated roads which raise the costs of production and trade. To address these constraints, the Compact—which entered into force in 2010 and closed out in 2015—included two projects: the Transition to High-Value Agriculture (THVA) Project and the Road Rehabilitation Project.

In 2010, MCC contracted with Mathematica to conduct an independent evaluation of the THVA Project. This report presents the final evaluation of the Project. In this chapter, we describe the Project and its anticipated effects, discuss its estimated costs and benefits, and outline the objectives of the report.

A. The THVA Project

The 129 million dollar THVA Project was designed to capitalize on Moldova's inherent advantages in the agricultural sector—including fertile soil, a suitable climate, and a relatively long agricultural season—to expand cultivation of fruits and vegetables for the domestic and export markets. The THVA Project included four complementary activities that were designed to address key constraints to the cultivation of high-value crops; in particular, lack of access to reliable irrigation; limited access to equipment and infrastructure to support production, processing, and sales; and limited access to attractive markets.

The THVA Project had a two-part objective, as noted in the Compact:

1. Increase rural incomes by stimulating growth in high-value agriculture (HVA)
2. Catalyze future investments in HVA production by establishing a successful and sustainable model of irrigation system and water resource management and a conducive institutional and policy environment for irrigated agriculture

The Project was implemented in coordination with the GoM through the Millennium Challenge Account–Moldova (MCA-Moldova). MCA-Moldova managed procurement and oversight of implementation contractors. Following Compact Closeout, the Sustainable Development Account–Moldova (SDA-Moldova) was established to continue oversight and support in the post-Compact period. As of 2022, SDA-Moldova is continuing to support the sustainability of Project investments.

The four Project activities were as follows (**Table I.1; Figure IV.1 and Appendix A** present the detailed project logic):

- The **Irrigation Sector Reform Activity (ISRA),** which established associations of farmers (Water User Associations, or WUAs) to manage centralized irrigation systems and supported improved management of water resources in Moldova;
- The **Centralized Irrigation System Rehabilitation Activity (CISRA),** which rehabilitated aging, existing centralized irrigation system infrastructure;
- The **Access to Agricultural Finance (AAF) Activity,** which improved access to post-harvest infrastructure and irrigation equipment through targeted loan and hire-purchase programs; and

- The **Growing High-Value Agriculture Sales (GHS) Activity,** which supported farmers and enterprises through training, technical assistance, market linkage support, and improvements to the enabling environment for HVA.

Table I.1. THVA Project activities

	Implementation	Geographic coverage and participants
Irrigation Sector Reform Activity (ISRA) Activity Cost = 8.1 million dollars	• Established 10 WUAs to manage and maintain centralized irrigation systems and supported the transfer of management of irrigation infrastructure from Apele Moldovei, a state agency, to those WUAs (Irrigation Management Transfer Sub-activity)[a] • Supported improved management of water resources through the River Basin Management (RBM) Sub-activity	• Irrigation Management Transfer Sub-activity established WUAs in 10 centralized irrigation systems throughout Moldova (**Figure I.1**) • Farmers in the communities served by these systems were invited to join the associated WUAs • RBM Sub-activity focused on the Nistru and Prut Rivers
Centralized Irrigation System Rehabilitation Activity (CISRA) Activity Cost = 99.8 million dollars	• Designed and constructed irrigation infrastructure to replace dilapidated infrastructure in 10 centralized irrigation systems	• CISRA rehabilitated infrastructure in 10 centralized irrigation systems throughout Moldova (**Figure I.1**) • Farmers owning, leasing, or borrowing land in these systems had the potential to use improved irrigation infrastructure
Access to Agricultural Finance (AAF) Activity Activity Cost = 17.1 million dollars	• Established a credit facility to provide loans for investments in post-harvest infrastructure (cold storage, packaging, and process equipment) and other investments in HVA production, processing, and sales [loan program] • Subsidized investment in irrigation equipment and farming equipment and machinery for irrigated land [hire-purchase program]	• Eligibility criteria for the loan program varied over time, but largely available throughout Moldova; in some periods, the program focused on the *raions* (districts) in which the 10 centralized irrigation systems were located • The hire-purchase program was available to farmers throughout Moldova
Growing High-Value Agriculture Sales (GHS) Activity[b] Activity Cost = 4.4 million dollars (MCC contribution) 11.5 million dollars (USAID contribution)	• Supported market development and expansion for Moldovan HVA (Sub-activity 1) • Provided training to upgrade HVA production and meet buyer requirements (Sub-activity 2) • Provided technical assistance to enterprises, associations, and cooperatives to upgrade the HVA value chain (Sub-activity 3) • Facilitated improvements to the enabling environment for HVA and strengthened sanitary and phytosanitary requirements (Sub-activity 4) • Provided training and field demonstrations to support the transition to HVA and use of irrigation in the targeted centralized irrigation systems (Sub-activity 5)	• Sub-activities 1, 2, and 3 focused on existing producers or other HVA value chain participants (cooperatives, processors, exporters, buyers, etc.) throughout Moldova • Sub-activity 4 supported changes that would affect all of Moldova • Sub-activity 5 focused on farmers cultivating land in the 10 centralized irrigation systems (**Figure I.1**)

HVA = High-Value Agriculture; WUA = Water User Association; MCC = Millennium Challenge Corporation

[a] The Project originally targeted 11 systems and established a WUA in the 11th system, Cahul. However, MCC decided not to rehabilitate this system because the estimated costs of rehabilitating the other 10 systems did not leave sufficient resources for rehabilitating the drainage system in Cahul, which would be necessary to facilitate a transition to HVA. As a result, the WUA in Cahul was largely dormant during the Compact.

[b] The GHS Activity was co-funded by the United States Agency for International Development (USAID) and was implemented as part of the Agricultural Competitiveness and Enterprise Development (ACED) Project, a broader project that was implemented by USAID and focused on improving Moldova's HVA sector.

Although some components of the Project were implemented across Moldova, the ISRA Irrigation Management Transfer Sub-activity and CISRA were implemented in 10 targeted areas. These areas were home to 10 centralized irrigation systems that had been built in the Soviet Era and had fallen into various states of disrepair. The 10 selected systems (**Table I.2**) were located along the Nistru and Prut Rivers (**Figure I.1**), which border Moldova to the East and West, respectively. In these areas, the Project rehabilitated the centralized irrigation systems, constructing pumping stations, subterranean pipes, and reservoirs to pump water from the adjacent rivers to hydrants in farmers' fields. (Farmers use on-farm irrigation equipment, such as sprinklers, to distribute the water.)

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

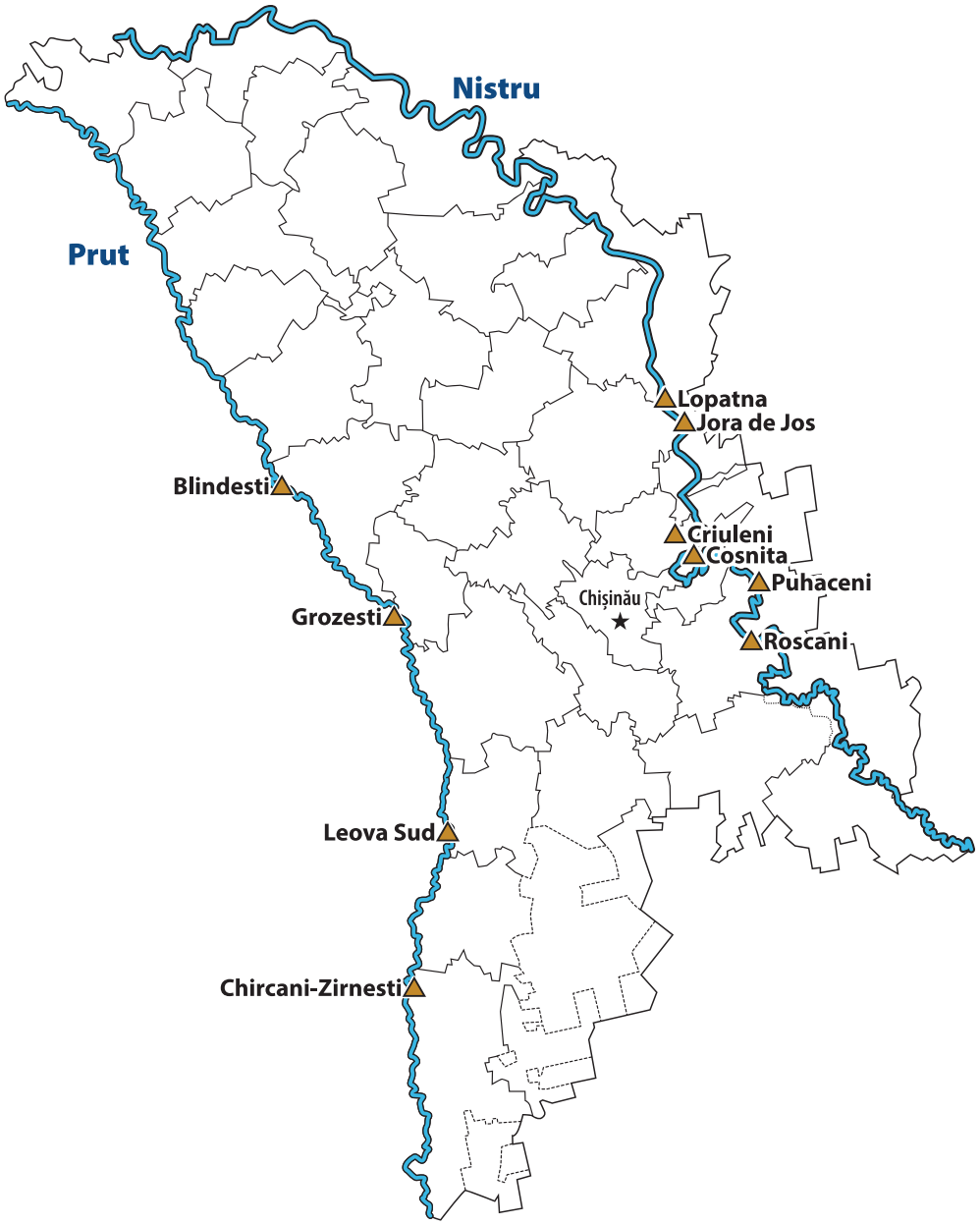


Table I.2. Centralized irrigation systems targeted by the THVA Project

System name	*Raion* (district)	Water source	Irrigable command area (hectares)
Blindesti	Ungheni	Prut River	587
Grozesti	Nisporeni	Prut River	1,100
Leova Sud	Leova	Prut River	980
Chircani-Zirnesti	Cahul	Prut River	3,367
Lopatna	Orhei	Nistru River	506
Jora de Jos	Orhei	Nistru River	1,270
Criuleni	Criuleni	Nistru River	764
Cosnita	Dubasari	Nistru River	2,483
Puhaceni	Anenii Noi	Nistru River	920
Roscani	Anenii Noi	Nistru River	853
Total	**--**	**--**	**12,830**

Source: SDA-Moldova.

Each targeted system serves farmers from one to three communities apiece (though some land is cultivated by large farms that have offices in Chisinau or other locations). In most cases, farmers live in nearby villages and cultivate plots of land in the area. That land can be located in the area served directly by the system—referred to as the "command area"—or it can be located outside that area. In many cases, farmers cultivate numerous small plots of land that are not contiguous (because land was fragmented at the time of Moldovan independence), both inside and outside the command area. The rehabilitated systems were designed to have the potential to serve other nearby areas outside the command area. For those areas—referred to as "extension areas"—the infrastructure to serve those areas was not constructed through the Compact, but the system had the potential to expand to serve those areas through future infrastructure investments. Two rehabilitated systems were completed before the 2015 agricultural season and the other eight systems were completed during the 2015 season; rehabilitation was originally planned to be completed earlier in the Compact but was delayed by the need to redesign the systems to reduce infrastructure costs and by procurement challenges. (**Figure I.2** shows examples of rehabilitated infrastructure in these systems.)

Farmers in the 10 targeted areas were invited to join the associated WUAs. The WUAs, which were established under a legal framework supported by the Project (the WUA Law), were registered in 2012 and took over management of the irrigation systems in 2013 (seven systems) and 2015 (three systems). WUAs collect annual membership fees from members based on the area of land that they own or lease in the system, as well as irrigation fees based on the volume pumped. They have a small staff and elected representatives who work to manage the systems, including conducting regular maintenance and repairs.

Though most of the supports provided by the AAF Activity and GHS Activity were implemented across Moldova, the GHS Activity provided targeted training (through Sub-Activity 5) in these 10 systems.

Figure I.2. Centralized irrigation system infrastructure

Note: The image on the left depicts the interior of a rehabilitated pumping station. The image on the right depicts a hydrant in the command area.

B. The cost-benefit analysis model and projected economic rate of return

To assess the economic value of the THVA Project, MCC developed a cost-benefit analysis (CBA) that compared the Project's costs to expected benefits. The anticipated benefit stream was the expected increase in incomes of farms in the 10 rehabilitated systems. To estimate those benefits, MCC made assumptions about the degree to which the Project would increase the area of irrigated land devoted to HVA cultivation, and, in turn, lead to increases in farm income. The CBA model that was prepared around the time of Compact signing estimated an economic rate of return (ERR) of 14.3 percent over a 20-year time horizon, above MCC's hurdle rate of 10.0 percent beyond which an investment is economically justified. The Project was expected to have about 29,000 beneficiary households over this period, including the following: (1) farming households irrigating through the rehabilitated systems (up to 3,100); (2) households with individuals employed in seasonal labor (about 9,300, which would benefit from higher wages due to greater demand for labor); (3) landowning households (about 15,000, which would benefit from increased rental income and land values due to increased land productivity); (4) AAF loan recipients (about 75); and (5) GHS technical assistance participants (an additional 1,300 outside of the rehabilitated systems, which would realize income gains) (MCC 2019).[3]

At Compact Closeout, MCC updated the CBA model to incorporate updated expectations related to key parameters. The Compact Closeout CBA model predicted an economic rate of return (ERR) of -5.5 percent, owing primarily to larger than anticipated construction costs and a sharp depreciation in the value of the Moldovan leu. This final evaluation report provides an opportunity to reassess key assumptions in the Compact Closeout CBA model using information about post-Compact irrigation use in the rehabilitated systems.

[3] The CBA model focused on benefits from irrigation through the rehabilitated systems.

C. Objectives of the final report

This report presents Mathematica's final evaluation of the THVA Project. It builds on findings established in our interim findings report (Borkum et al. 2018). We draw on data collected through November 2022 to describe the results of the THVA Project over six full agricultural seasons that have transpired since the Compact closed (and since system rehabilitation was completed) in 2015. The report aims to document the findings from the evaluation and suggest potential implications for future program design and implementation.

In Chapter II, we provide context for the evaluation effort by highlighting updates to the literature on similar agricultural programs. In Chapter III, we present a high-level description of the evaluation design, including the evaluation questions, data sources, and analytic approaches. Chapter IV presents our key findings, organized by evaluation question. We summarize our findings and discuss their implications in Chapter V.

II. Literature review

In 2015, we conducted a review of the existing evidence relevant to some of the key THVA Project interventions, which we summarized in our evaluation design report (Borkum et al. 2020).[4] In this chapter, we update our review with more recent studies relevant to the two interventions that accounted for the bulk of the Project's funding and were the focus of its efforts in the 10 rehabilitated systems: the establishment and support of WUAs and irrigation infrastructure improvements. We also briefly describe how the THVA Project evaluation will contribute to this literature.

A. Water user associations

Our earlier review of the literature found that WUAs were increasingly being established in countries that were formerly part of the Soviet Union, but that those WUAs faced significant challenges navigating the legalities of taking over the management and/or ownership of irrigation systems (Hodgson 2007). Further, a major challenge to WUAs globally was their financial sustainability—that is, their ability to recover the costs of operating and maintaining the irrigation system and WUA (Xie 2007). Reviews and individual studies of the effects of WUAs on water management and agricultural productivity had mixed findings, which might reflect both different contexts and different implementation models.

More recent studies continue to find that the financial sustainability of WUAs established under irrigation management transfer and participatory irrigation management initiatives is a major challenge. Senanayake et al. (2015) conducted a systematic review of 181 case studies of these initiatives and found that only about one-third of WUAs featured in these cases were financially viable. This might be in part because unpredictable revenue in agricultural markets makes it difficult for smallholder farmers to pay membership fees (Aarnoudse et al. 2018). In addition to poor cost recovery, studies in Burkina Faso (de Fraiture et al. 2014) and Haiti (Turiansky 2019) found low rates of participation in WUA communal workdays, suggesting that poor engagement of potential water users could lead to the degradation of irrigation infrastructure.

In the past few years, there have also been new evaluations of MCC-funded projects that established WUAs, several of which have identified challenges to WUAs' sustainability. For example, in Burkina Faso, Ksoll et al. (2021) concluded that WUAs established under MCC's Agricultural Development Project were effective at accomplishing only some of the tasks necessary to keep the irrigation systems in good working order; WUAs also experienced low rates of participation in communal workdays. In the face of high operating costs and suboptimal fee collection, many of the WUAs established through the Agricultural Development Project lacked financial solvency. In Senegal, Coen et al. (2019) found that the seven WUAs established by the Integrated Water Resource Management Project experienced mixed outcomes. The most successful WUAs were able to manage fee collection, oversee canal maintenance, and successfully issue maintenance contracts. Other WUAs suffered from low participation rates and did not fully assume the maintenance management role envisioned by the Project. None of the seven WUAs were able to achieve the level of financial sustainability required to cover maintenance costs without outside funds. Five years after the end of the Senegal Compact, the WUAs were falling behind in conducting routine maintenance on the irrigation infrastructure, leading to reduced water flow (Harris et al. 2021).

[4] We updated the evaluation design report in 2020 to reflect changes to the evaluation design but did not update the literature review conducted in 2015.

B. Irrigation infrastructure improvements

Our original review concluded that there is a substantial body of evidence suggesting that irrigation is generally associated with higher production and income. A more recent literature review published by the World Bank (Giordano et al. 2020) confirms several benefits of irrigation infrastructure improvements that appear across studies and settings. In particular, the authors assert that there is conclusive evidence to support the link between these interventions and outcomes such as increased agricultural productivity, decreased poverty, and improvements to health and nutrition. They also conclude that these interventions often have unintended negative environmental effects, that these frequently occur outside of the target geography, and that the magnitude of these negative impacts can significantly offset any positive economic impacts. Finally, they point out that effects of these interventions, both positive and negative, tend to be very unequal in their distribution across social groups, geographies, and time.

Despite the largely positive effects of irrigation infrastructure investments on households in target geographies described above, findings from recent studies suggest that the effects of specific projects are variable. For example, in their performance evaluation of MCC's Burkina Faso Agricultural Development Project, Ksoll et al. (2021) found strong positive effects of irrigation investments on agricultural profits, household incomes, and food security. In contrast, in Sanfo et al.'s (2017) study of farm ponds as a strategy to mitigate the effects of dry spells during the rainy season, also in Burkina Faso, found that uptake by farmers was severely limited by constraints on labor and capital. In their evaluation of MCC's Integrated Water Resource Management Project in Senegal, Coen et al. (2019) found that despite increased average agricultural profits following irrigation infrastructure improvements, there was no net change in average household income for farming households because these households significantly shifted their time away from other income-generating activities to spend more time farming. Further, although the intervention succeeded in persuading some farmers to switch from rice to high-value vegetable crops, the uptake of those crops fell significantly short of the Compact targets five years after the end of the Compact (Harris et al. 2021). Many farmers were reluctant to dedicate land to vegetable production because of perceptions that it was too risky and that up-front costs were too high. Overall, these examples suggest that, in some contexts, farming households can experience challenges in improving their incomes through irrigation infrastructure improvements.

C. Contribution of the THVA Project evaluation

The final THVA Project evaluation will contribute to the literature on the effects of irrigation-related investments in two important ways. First, this long-term evaluation examines the effects of WUA-managed irrigation infrastructure improvements over the course of six full agricultural seasons. The evaluation will contribute to our understanding of the long-term effects and sustainability of these types of investments and how they are affected by fluctuations in seasonal conditions—especially climatic conditions. Second, the THVA Project evaluation draws on a rich set of qualitative and quantitative data sources to examine mediating pathways underlying the effects of these investments, explain why the expected effects were not achieved, and understand variation in these effects across irrigation systems. This yields valuable lessons about project design and implementation that could influence future projects implemented by MCC and other donors.

III. Evaluation design

The THVA Project evaluation is a multi-component performance evaluation that addresses eight evaluation questions (EQs), drawing on administrative, survey, and qualitative data (**Table III.1**).

Table III.1. Evaluation questions, data sources, and outcomes

Evaluation question	Key outcomes by data source		
	Administrative data	Survey data	Qualitative data
EQ #1: Were the expected results realized from the THVA project logic?	• System functionality • Volume pumped • Number of water users • Area irrigated	• Satisfaction with WUA-provided irrigation • Area and crops irrigated • Participation in training • Participation in marketing associations • Use of post-harvest infrastructure	• HVA prices and sales • Water resource planning • Formation of marketing associations • Use of post-harvest infrastructure
EQ #2: How are the results from the Project distributed?	• Number of water users • Share of volume pumped by largest users	• Water user characteristics • Used of hired labor • Daily wage for hired labor	• Factors influencing the daily wage for hired labor
EQ #3: How did the THVA Project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?	• Extent of land consolidation	• Whether land was purchased, rented, or other • Land rental price	• Extent of land consolidation • Reasons for land consolidation • Factors influencing land rental and sales prices
EQ #4: If results were not realized, why not? What are the characteristics of systems in which irrigation use increased the most? The least?	• Variation in volume pumped, number of water users, and area irrigated across systems	• Barriers to HVA cultivation • Source of on-farm irrigation equipment	• Factors influencing variation in system use • Barriers to HVA cultivation • Availability of on-farm irrigation equipment
EQ #5: What was the contribution of each activity/sub-activity to the results that were realized?		• Use of post-harvest infrastructure • Participation in training	• Contribution of each activity (ISRA, CISRA, GHS, AAF)
EQ #6: Are there indications that some of the long-term outcomes will be realized?	• Number of WUA members • WUA membership and irrigation fees • WUA revenues and reserve fund balance		• Farmers' profits • Formation and experience of non-Project WUAs • Reputation of Moldovan produce and exports • Policy changes related to HVA
EQ #7: What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?	• Number of WUA members and water users	• Barriers to HVA cultivation	• Lessons learned
EQ #8: What is the ex-post ERR of the THVA Project?	• Area irrigated		

Guided by these questions, the evaluation assesses whether the Project's intended results were achieved, how those results were distributed across groups, and (if applicable) why the intended results were not achieved. The evaluation also explores the contribution of each component of the Project to the achieved results and whether the long-term outcomes are likely to be achieved. Finally, the evaluation identifies lessons learned from the Project and assesses the ex-post ERR. Though we collected administrative, survey, and qualitative data throughout the evaluation effort (**Appendix B**), the final evaluation draws most heavily on data collected since the 2018 interim study, specifically:

WUA administrative data. Since 2018, Mathematica and the Agricultural Development Institute (ADI) have collected data annually from the 10 Project-established WUAs.[5] These data have provided information on use of the rehabilitated irrigation systems—including key indicators such as the number of WUA members, number of system users, volume pumped, and area irrigated—as well as financial data, expectations for the future, and WUA administrators' perspectives on changes over time. In select years, to complement the data provided by WUA administration, we also collected limited information on crops and area irrigated from the water users that pumped the largest volumes of water.

Together, these data allow us to assess how use of the systems has changed over time and across systems. We collected data through the 2021 season, covering six full (annual) seasons since rehabilitation was completed. Detailed tables based on the WUA administrative data are included in **Appendix C.**

Water User Survey. In 2021, Mathematica and ADI conducted a survey of all water users—that is, all farms in the 10 Project systems that pumped irrigation water through the rehabilitated systems—in the 2020 agricultural season. 305 of the 315 water users responded to the survey; WUAs were also able provide limited information on most water users who did not respond to the survey. Data from the Water User Survey provide detailed information on the experience of farmers using the rehabilitated systems in 2020, including farm characteristics; experience with irrigation and participation in the WUA; crops and area cultivated and irrigated; access to post-harvest infrastructure; participation in training; land market transactions; farm labor; and perceived barriers to HVA cultivation.

These data provide information on the status of the rehabilitated systems five years (five full agricultural seasons) after rehabilitation was completed. Detailed tables based on the Water User Survey data are included in **Appendix D.**

Qualitative data. In 2021 and 2022, Mathematica and ADI conducted interviews with a range of informants (**Table III.2**). These interviews were designed to provide context on changes in the agricultural sector in Moldova more broadly, deepen our understanding of the Project results and reasons why some anticipated results were not realized, explore the contribution of different components of the Project to observed results, reflect on the likely long-term effects of the Project, and identify potential lessons learned that could be applied to future programs.

We collected data from Project systems, AAF loan recipients, and GHS participants. We also interviewed farmers and local government authorities in six systems that, at the outset of the evaluation, had been identified as similar to the THVA Project-rehabilitated systems. These comparison systems provide context for the changes that we observe in rehabilitated systems; that is, they provide an indication of how farmers' experiences might have evolved in the absence the THVA Project. We also collected data in WUAs that had formed outside the 10 rehabilitated systems; in these non-Project WUAs, we explored WUA formation, functioning, and sustainability.

[5] The 2018 WUA administrative data collection effort gathered data on the 2015 through 2017 seasons.

Table III.2. Qualitative data collection (2021 and 2022)

Respondents and timing	Respondent details	Number of interviews
Comparison systems • Six of the 11 systems identified during the design stage • November 2021 – January 2022	Local government authorities (mayors)	6
	Medium and large farmers	18
Non-Project WUAs • Six of the 14 non-Project WUAs that had experienced management transfer as of summer 2021 • November 2021 – January 2022	WUA administration	6
	Largest water users	12
Project WUAs • All 10 Project WUAs • August – September 2022	WUA administration	10
	Farmers (water users), with diversity along numerous dimensions, including farm size, system tenure, irrigation experience, and crops cultivated	30
	Farmers (non-users), with diversity along numerous dimensions, including farm size, WUA membership, and crops cultivated	10
AAF loan program • In the six *raions* (districts) in which the rehabilitated systems are located • August – September 2022	AAF loan recipients	8
GHS technical assistance • In the six *raions* (districts) in which the rehabilitated systems are located • August – September 2022	GHS technical assistance beneficiaries	8
Buyers and exporters • August – October 2022	Domestic buyer, identified by ADI	1
	Foreign buyer, identified by exporters	1
	Exporters, participants in the GHS Activity	3
Ministry, donor, and other representatives • August – November 2022	SDA-Moldova USAID Ministry of Agriculture and Food Industry Ministry of Environment International Fund for Agricultural Development National Agency for Rural Development CISRA design consultants Former ISRA implementer	10

WUA = Water User Association; AAF = Access to Agricultural Finance; GHS = Growing High-Value Agriculture Sales; ADI = Agricultural Development Institute; SDA-Moldova = Sustainable Development Account – Moldova; USAID = United States Agency for International Development; CISRA = Centralized Irrigation System Rehabilitation Activity; ISRA = Irrigation Sector Reform Activity

In this report, we bring together evidence across the three data sources—administrative, survey, and qualitative data—to address each EQ. We use three analytic approaches:

- **Ex-post thematic analyses of administrative and survey data.** Drawing on data from WUA administration and water users, we summarized key outcomes in the rehabilitated areas over time and across systems. For example, we summarized information on use of the irrigation systems (as measured by volume, number of water users, and area irrigated), the characteristics of water users (including their experience in the land and labor markets), and the experiences of WUAs (including the number of members, membership and irrigation fees, revenue, and reserve fund balance).
- **Ex-post thematic analyses of qualitative data.** Triangulating across a diverse group of respondents, we identified emerging themes as they related to the evaluation questions. For example, qualitative data helped us distinguish the key barriers to HVA cultivation, assess how much changes over time could be attributed to the Project, and identify lessons learned.
- **Pre-post comparisons of select outcome measures in the rehabilitated systems.** For a small number of measures (such as agricultural wages and land rental prices), we compared estimates collected prior to rehabilitation to estimates collected five full seasons after rehabilitation. The pre-rehabilitation estimates draw on data from the 2013–2014 Farm Operator Survey, which collected information after the 2013 season from a representative sample of 2,393 farmers in the command areas and 541 farmers in the extension areas of the 10 rehabilitated systems.

Importantly, we conducted much of the qualitative data collection in late 2022, after administrative and survey data had been analyzed. Sequencing the data collection in this way allowed us to explore findings from the administrative and survey data and to deepen our understanding the Project's results through targeted inquiries.

IV. Findings

In this chapter, we discuss the findings from the final evaluation of the THVA Project, organized by the evaluation questions presented in Chapter III. These questions explore the results of the Project (including the results that were achieved, what constrained or drove them, and how they were distributed), lessons that can be drawn from the Project for future investments, and the Project's economic benefits.

EQ #1: Were the expected results realized from the THVA project logic (with priority on the medium-term outcomes)?

The THVA project logic (**Figure IV.1**) anticipated that, in the short term, irrigation management transfer and system rehabilitation would lead to fully functioning irrigation systems that were managed by WUAs. In the medium term, the WUAs would manage and maintain these systems well; farmers would take advantage of access to affordable and reliable irrigation water to increase the area of land that they irrigated, especially to produce HVA crops. In the short and medium terms, the GHS Activity was expected to lead farmers and enterprises to apply improved practices, increase producers' awareness of market requirements, and improve the enabling environment for HVA. The AAF Activity would, in the short term, increase investment in post-harvest infrastructure by AAF loan recipients; in the medium term, it was expected to increase the volume of produce passing through cold storage, as well as lead to additional investments in post-harvest infrastructure. Together with irrigation management transfer and system rehabilitation, these activities would contribute to farmers achieving higher prices for and increasing their sales of these crops on both domestic and export markets in the medium term. At the same time, the RBM component of ISRA would lead to improvements in water resource monitoring and the process for allocating permits for water user in the short term, and improved water management in the medium term.

By Compact Closeout in 2015, the Project had achieved or had come close to achieving many of its output targets, according to MCC's Closeout indicator tracking table:

- **ISRA-CISRA.** ISRA successfully created and transferred centralized irrigation system management to 10 WUAs. CISRA rehabilitated these 10 systems, serving a total command area of 11,526 hectares. (This increased to 12,830 hectares by 2018 as the system in Chircani-Zirnesti was expanded in the post-Compact period with the support of SDA-Moldova, as described below.) These achievements fell slightly short of MCC's target of 11 functioning WUAs and 15,500 hectares served because MCC decided not to proceed with management transfer and system rehabilitation in one originally selected system (Cahul) and because of changes to the designs of the rehabilitated systems during implementation.
- **GHS Activity.** The GHS Activity was implemented as part of the Agricultural Competitiveness and Enterprise Development (ACED) Project; the ACED Project operated throughout Moldova (**Figure IV.2**). As of Compact Closeout, the ACED Project had provided technical assistance to 334 enterprises (almost triple the target), of which 57 were woman-owned or -managed and 19 were located in the rehabilitated systems (Chartock 2016). The ACED Project trained a total of 6,569 farmers (50 percent more than the target), of which 2,333 were women and 1,436 were located in the

rehabilitated systems (Chartock 2016). The ACED Project had also facilitated almost 30 million dollars in HVA sales (very close to the target of 31.5 million dollars).[6]

- **AAF Activity.** The Activity provided loans worth 11.7 million dollars (79 percent of the target) to 7 female and 55 male borrowers (a total of 62 borrowers, representing 83 percent of the target) throughout Moldova (**Figure IV.2**). These borrowers constructed 69 post-harvest infrastructure facilities (of which 20 were constructed in the 8 *raions* in which the rehabilitated systems were located), with a total capacity of 20,705 metric tons (double the target). The Activity also provided about 845,000 dollars' worth of hire-purchase agreements through 2KR to 4 female and 16 male purchasers throughout Moldova (no targets).

In this section, we examine the extent to which these outputs resulted in the expected short- and medium-term results in the rehabilitated systems.[7] We begin by assessing how well the rehabilitated irrigation systems are operating and how intensively farmers are using them to irrigate HVA crops. We then examine the extent to which these Project activities led to increases in prices and sales of HVA crops. Finally, we discuss short- and medium-term outcomes directly linked to other Project components, namely the RBM Sub-activity, the GHS Activity, and the AAF Activity. In **Appendix E**, we compare the achievements of selected outcomes to the targets in MCA-Moldova's end-of-Compact monitoring and evaluation plan (MCA-Moldova 2015).

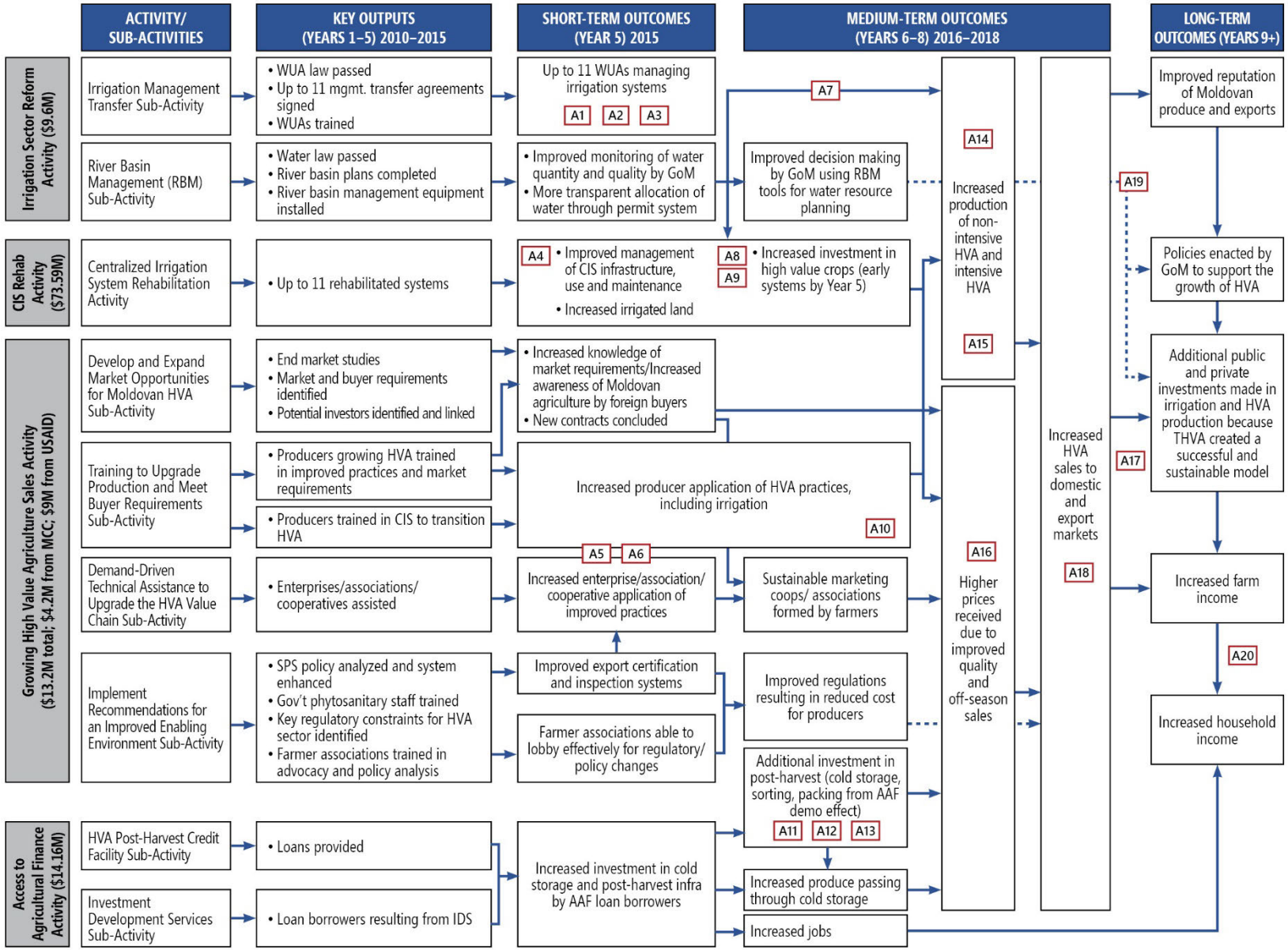
Key findings on irrigation:

- **Most of the rehabilitated irrigation systems have operated without any major functionality issues through 2021;** WUAs have addressed some functionality issues on their own and have addressed other issues with financial and/or technical support from SDA-Moldova.
- **Most water users have been satisfied with WUA-provided irrigation services,** and satisfaction seems to have increased markedly since the end of the Compact.
- The rehabilitated systems were used to **irrigate 3,790 hectares of land in 2020,** the highest-use season since rehabilitation.
- However, irrigation use in the rehabilitated systems depends strongly on seasonal precipitation and **has been lower and more variable than projected** in MCC's Compact Closeout CBA model; the envisaged **transition to HVA crops has been more limited than expected.**

[6] In the rehabilitated systems, the ACED Project organized 52 training seminars as well as a small number of farmer fairs, farmer field days at a demonstration plot, local and international study tours, and an Irrigation Technology Forum. The Project also disseminated technical bulletins and irrigation guides.

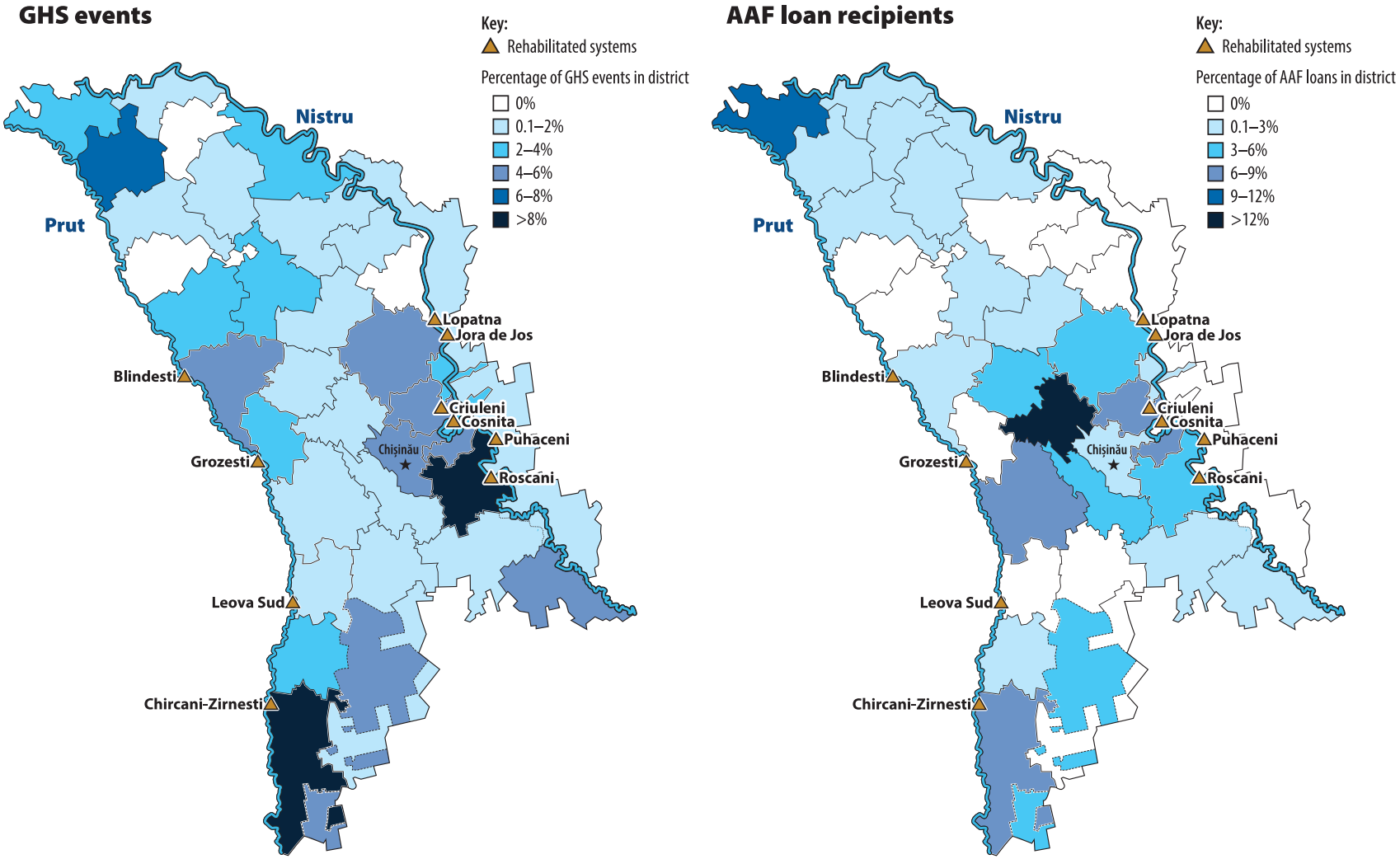
[7] In the project logic, the medium term was assumed to be between 2016 and 2018. We nevertheless assess these outcomes (through the 2021 season) because it was expected that the medium-term outcomes would be sustained and would continue to support the long-term outcomes.

Figure IV.1. Logic model for the THVA Project



Notes: The assumptions (A1 – A20) are described in **Appendix A**.

Figure IV.2. Locations of events (GHS Activity) and loan recipients (AAF Activity)



Source: Event database provided by the ACED Project implementer as of the end of December 2015 (GHS Activity) and Credit Line Directorate administrative data (AAF Activity).

Notes: Figure presents the share of events and loans in each *raion* (district). Events include training sessions, study tours, demonstrations, and other events.

1. Irrigation system functionality

Most of the rehabilitated irrigation systems have operated without any major functionality issues; SDA-Moldova has provided support when issues have arisen.

By the end of the 2015 agricultural season, all 10 Project WUAs were managing rehabilitated centralized irrigation systems, as anticipated in the project logic. Through the 2021 season, most of these systems did not encounter any major functionality issues beyond routine maintenance or minor repairs. The issues encountered—which included damaged hydrants, faulty pumps, and leaking pipes—did not disrupt irrigation service because the WUAs repaired them quickly or were able to work around them until repairs could be made. WUA directors did not expect major functionality issues because the systems were still operating well below capacity, as discussed below. If the WUAs conduct appropriate annual maintenance and the systems operate below capacity, they will likely be able to function for at least 20 years before major functionality issues appear.

WUAs have typically dealt with damaged irrigation infrastructure by conducting repairs with their own spare parts and/or funds. (Farmers who damage hydrants are responsible for paying for repairs, although the WUAs sometimes face challenges in obtaining these payments.) However, SDA-Moldova provided financial support in some cases—for example, in 2020 it contributed to replacing expensive pump parts in Grozesti, Jora de Jos, and Puhaceni—and helped coordinate repairs in these and other cases.

A few systems have recently faced more severe functionality challenges. In Roscani in 2021, a major pipe carrying irrigation water to farmers' fields cracked and leaked; it was replaced with financial support from SDA-Moldova. In Cosnita in 2020, an intake pipe from the river at one pumping station became clogged with sand, damaging some of the pumps. The WUA used its own resources to raise the pipe higher, above the riverbed, and SDA-Moldova helped coordinate these repairs; the WUA also replaced one irreparably damaged pump with an older (pre-Compact) one. In 2022, the WUA in Puhaceni had a clogged intake pipe, which it planned to address through its own resources.

The drainage system in Chircani-Zirnesti was not used in the 2020 and 2021 seasons due to low levels of precipitation.

Alongside its role as a supplier of irrigation water, the WUA in Chircani-Zirnesti provides drainage services to mitigate flooding in the system. These drainage services are potentially even more essential than irrigation services because, without drainage, cultivation might not be possible in large parts of the system. In the first couple of years after its rehabilitation, the drainage system was often clogged with mud, but equipment replacement and regular maintenance work in subsequent years helped to limit clogging and improve functionality. However, use of the drainage system has decreased substantially since 2018 because of two consecutive years with a relatively low volume of snowmelt and rainfall. (The volume of precipitation was substantially lower in 2020 than in 2019, but both were lower than typical for the system). Specifically, the volume of water drained decreased substantially from 379,000 cubic meters in 2018 to 44,600 cubic meters in 2019, and the drainage system was not used at all in 2020 and 2021. (Although 2021 saw relatively high precipitation levels, the system did not flood because the water table was depleted from the 2020 drought.)

From the perspective of the WUA's finances, it is advantageous not to have to use the drainage system because drainage costs are covered by WUA membership fees rather than through separate fees. It is infeasible to charge separately for drainage because most farmers in the system are not willing to pay for it. Therefore, maintaining and operating the drainage system implies additional costs without additional revenues.

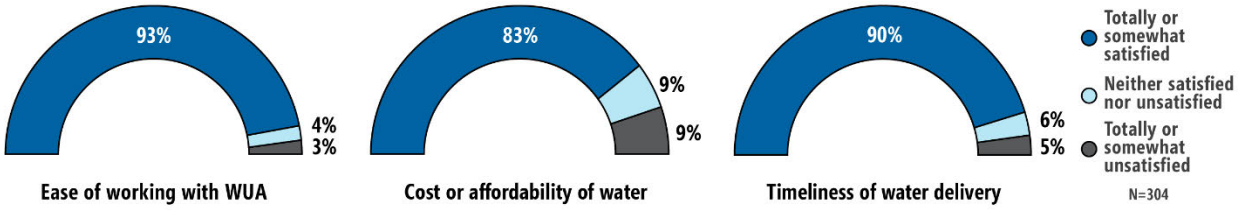
No additional irrigation modules were completed in Chircani-Zirnesti between 2018 and 2021.

Another unique feature of the Chircani-Zirnesti system is that it was designed to include up to 17 separate modules, which are effectively independent sub-systems within the broader system and were intended to make the provision of irrigation water more flexible and efficient. Through the Compact, 10 of these modules were constructed. The system was designed so that new modules could be added after the end of the Compact, if funding could be identified; between 2016 and 2018, three additional modules were completed with funding from SDA-Moldova. However, no new irrigation modules have been completed since, with the total number of completed modules remaining at 13.

Most water users have been satisfied with WUA-provided irrigation services.

According to data from the Water User Survey, about 93 percent of water users in 2020 were totally or somewhat satisfied with the ease of working with the WUA for ordering and billing, 83 percent with the cost of water, and 90 percent with the timeliness of water delivery (**Figure IV.3**). High levels of satisfaction were reported by users in both the Prut and Nistru River systems and satisfaction was substantially higher than it was prior to the Project.[8] In interviews, water users who had experience irrigating through Apele Moldovei, the state water agency, emphasized the improved timeliness and availability of supply associated with the WUA-managed systems. In particular, the process of ordering irrigation water from the state agency was slow and the availability of irrigation water was more limited (for example, because electricity to the pumps would occasionally be cut off due to non-payment of bills or because it would take a long time for the agency to repair damaged infrastructure). Overall, these findings suggest that the WUAs are managing the rehabilitated systems well, contributing to a substantial improvement in the availability of affordable irrigation water.

Figure IV.3. Satisfaction with WUA-provided irrigation, 2020



Source: Water User Survey (2020 season).

2. Irrigation use and HVA production

The volume pumped, number of water users, and area irrigated in the rehabilitated systems grew gradually between 2016 and 2019; the larger increases that occurred in 2020 were reversed in 2021, reflecting the strong dependence of irrigation use on seasonal precipitation patterns.

We examined how irrigation use evolved between 2016 (the first season in which all systems were fully operational) and 2021 (the most recent season for which we have complete administrative data from WUAs) by measuring (1) the volume of water pumped; (2) the number of water users; and (3) the area irrigated. More extensive use of the rehabilitated systems should be reflected in a greater volume pumped,

[8] In the 2013–2014 Farm Operator Survey, which captured satisfaction indicators for the 2013 agricultural season, 68 percent of respondents were satisfied with the ease of ordering and billing, 27 percent with cost, and 60 percent with timeliness. An important caveat is that the sample size for these indicators is small (only 39) because the Farm Operator Survey surveyed a representative sample of farmers, many of whom did not irrigate.

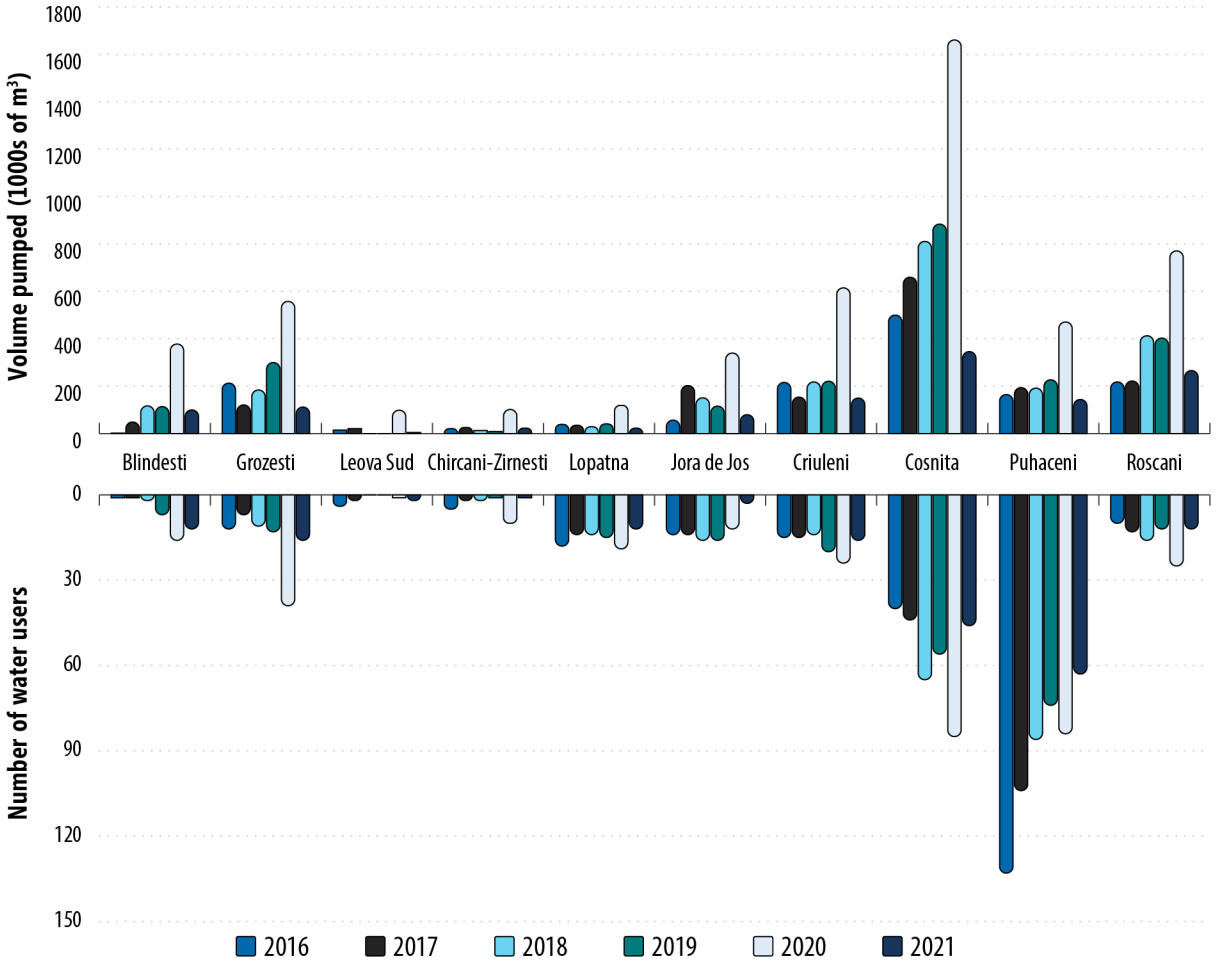
more water users, and a larger area irrigated. Overall, we find that these measures increased gradually between 2016 and 2019, increased sharply in 2020, and decreased even more sharply in 2021:

- **Volume pumped.** Across all systems, the total volume of water pumped increased annually between 2016 and 2019, with an overall increase of 60 percent over the period. In 2020, there was a sharp increase in the volume pumped in all 10 systems, with the total volume pumped across all systems more than doubling relative to 2019 (**Figure IV.4**). This was by far the largest annual increase (in both absolute and percentage terms) since the systems were rehabilitated. However, the higher volume pumped in 2020 was not sustained in 2021; it decreased in all systems, with a total decrease of about three-quarters (below 2019 levels).
- **Number of water users.** The total number of water users across all the systems—which had increased since system rehabilitation but was relatively stable between 2017 and 2019—increased by almost 50 percent in 2020, to 315 users. Nine of the 10 systems saw increases in the number of water users in 2020 (**Figure IV.4**); the only exception was Jora de Jos, where there was a small decrease in the number of water users because some small farm users passed away or stopped engaging in agricultural production. The number of water users decreased substantially to 183 users in 2021. All systems experienced a net decrease in the number of users in 2021, except for Leova Sud.
- **Area irrigated.** Similarly, area irrigated increased annually between 2016 and 2019—with an overall increase of 66 percent—and there was a much larger increase in 2020. The total area irrigated almost doubled, from 1,946 hectares in 2019 to 3,790 hectares in 2020, with all systems experiencing a substantial increase (**Figure IV.5**). The 3,790 hectares irrigated in 2020 comprised 3,166 hectares in the command areas and 624 hectares in extension areas.[9,10] The percentage of command area land irrigated in 2020 ranged from 9 percent (Chircani-Zirnesti) to 43 percent (Grozesti and Criuleni). The extension area composed a very small share of the total irrigated area in Roscani and Puhaceni, whereas in Blindesti, Cosnita, Criuleni, and Jora de Jos, it accounted for about one-fifth to one-half of the total irrigated area. Consistent with the changes in the volume pumped and number of water users, the area irrigated decreased in all systems in 2021, to a total of 1,612 hectares (a decrease of more than one-half). This was the first annual decrease since 2016, and took the area irrigated in 2021 to below 2019 levels.

[9] The estimate of 3,790 hectares irrigated in 2020 is based on WUA administrative data and is consistent with the area reported by SDA-Moldova. We also estimated the area irrigated from farmers' reports in the Water User Survey and obtained an estimate of 4,032 hectares (3,275 hectares in the command area and 757 hectares in the extension area). We focus on the estimate from WUA administrative data for comparability with other seasons, for which we only have estimates from the administrative data.

[10] In contrast, using data from the 2013–2014 Farm Operator Survey, we estimated that only 241 hectares were irrigated in 2013, a pre-rehabilitation season. However, this estimate is not directly comparable to the post rehabilitation estimates due to differences in methodology. Specifically, the pre-rehabilitation estimate was based on an extrapolation from a plot-level sample, whereas the administrative data used in 2020 were based on complete data provided to the WUA by all water users. Nevertheless, all stakeholders agreed that the area irrigated was substantially smaller before rehabilitation (with no irrigation in the systems that were nonfunctional at the time, which included most of the Prut River systems).

Figure IV.4. Volume of water pumped and number of water users by system, 2016–2021

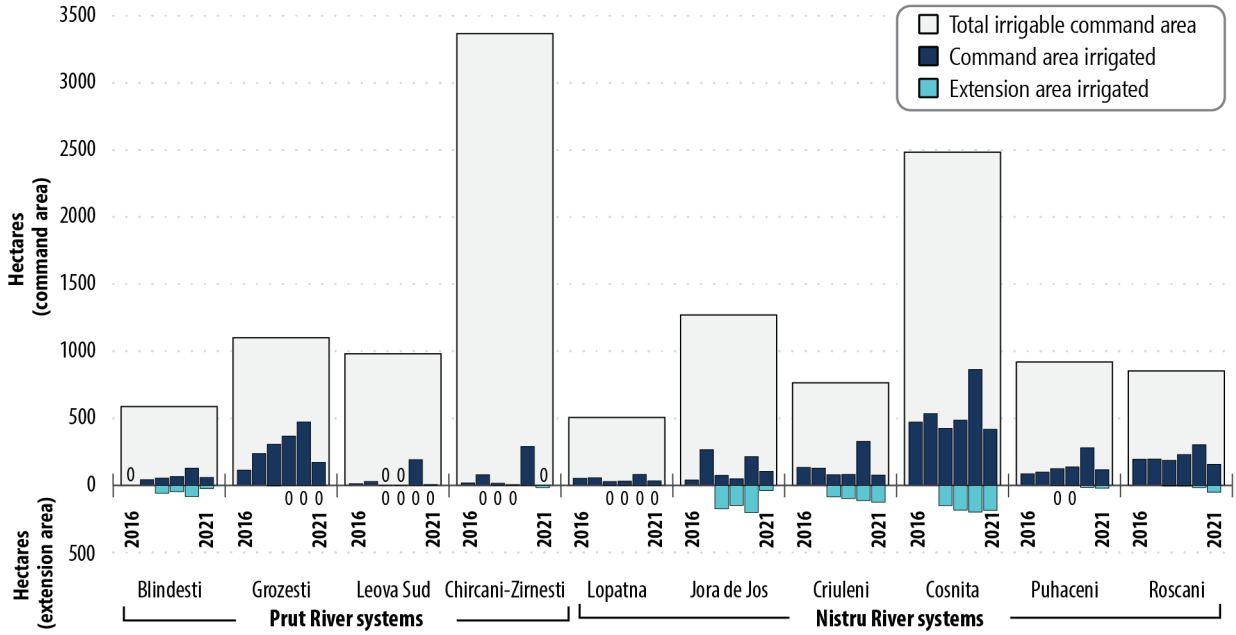


Source: WUA administrative data (2016–2021).

The variability in irrigation use in recent seasons reflects the sensitivity of farmers' demand for irrigation water to precipitation. By all accounts, the large increases in volume pumped, number of water users, and area irrigated in 2020 were primarily due to the extensive drought in 2020—one of the most severe in Moldova in recent years—which increased farmers' demand for irrigation water. This included demand for water to irrigate non-HVA crops, which are not routinely irrigated in most of these areas,[11] and in some cases to irrigate HVA crops more intensively. In Leova Sud, which did not pump any water in 2019, the WUA pumped a substantial volume in 2020 because a large farmer who operates most of the land in the system demanded water, mostly to irrigate non-HVA crops.

[11] Non-HVA crops generally require less water and less regular irrigation than HVA crops; irrigation of non-HVA crops is typically not profitable, except in low-precipitation years. Further, government subsidies to offset the electricity costs of irrigation are not available for most non-HVA crops, increasing the effective cost to farmers of irrigating them.

Figure IV.5. Irrigated area by system, 2016–2021



Source: WUA administrative data (2016–2021).

Note: The total size of the rehabilitated command area (box with gray shading) and the command area irrigated in each season (dark blue bars) appear above the horizontal axis. The extension area irrigated in each season (light blue bars) appears below the horizontal axis. We do not have information about how the total irrigated area in each system in 2016 and 2017 was divided between the command and extension areas; in the figure, we assume this was all command area land.

The decreases in irrigation use between 2020 and 2021 were driven primarily by higher levels of precipitation in 2021 across the rehabilitated systems. This largely obviated the need to irrigate non-HVA crops and reduced the intensity of irrigation for some HVA crops (or made irrigation of HVA crops unnecessary, in some cases). (As we discuss later, evidence suggests that the COVID-19 pandemic and the war in Ukraine were not responsible for these changes in irrigation use.) Irrigation use in 2021 was even lower than in 2019, a year in which precipitation was favorable for agricultural production of some crops and less favorable for others. In **Appendix F**, we use satellite data to estimate precipitation levels in the 10 systems across the seasons since rehabilitation. Those data confirm that precipitation levels were mixed for the 2019 season, lower than typical for the 2020 season, and higher than typical for the 2021 season. Overall, the patterns of irrigation use over the past few seasons suggest a strong dependence on precipitation. Indeed, in interviews conducted partway through the 2022 season, WUA directors and farmers indicated that 2022 was likely to be a drought season and that there had been an increase in irrigation use relative to 2021.

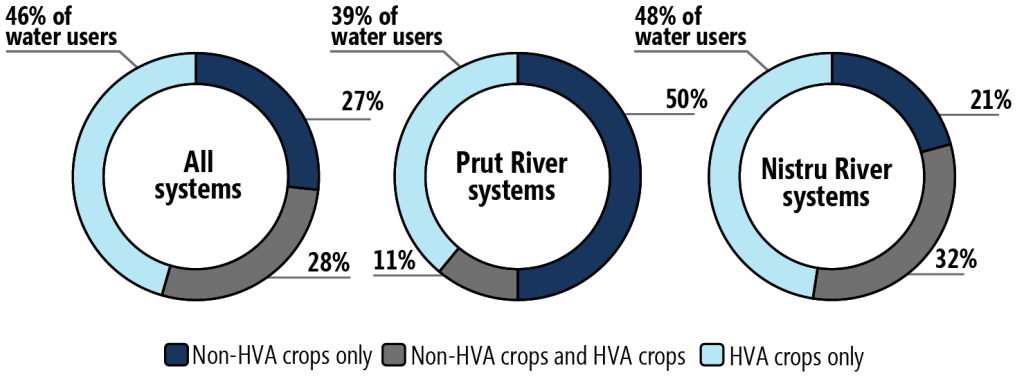
The fluctuation in water use from season to season is further illustrated by the variable use of irrigation water by individual water users. Across all systems, almost 8 in 10 water users in 2020 had been in the system since 2016 (the first full season of system operations). Among these users, 42 percent had irrigated in all six seasons through 2021 and 19 percent irrigated only in the 2020 season. The extent of persistence in irrigation among these water users is related to HVA cultivation because HVA crops are more likely to require irrigation even in relatively rainy seasons (as HVA crops require both more water and more regular irrigation than non-HVA crops). Specifically, among those who irrigated any HVA crops in 2020,

the median user irrigated in all the past six seasons through 2021, whereas among those who irrigated only non-HVA crops in 2020, the median user irrigated in two seasons.

Irrigation of non-HVA crops in the rehabilitated systems was uncommon, except in the 2020 drought season, when these crops were irrigated by about half of water users and accounted for about half of the area irrigated.

For the most part, we focus our analysis of crops irrigated in the 2020 season because it is the season covered by the Water User Survey. We examine cropping patterns both in terms of the percentage of water users irrigating each crop and the area covered by each irrigated crop, which provide complementary information about the extent to which various HVA and non-HVA crops were irrigated. About one-quarter of users in 2020 irrigated only non-HVA crops, one-quarter irrigated both HVA and non-HVA crops, and half irrigated only HVA crops (**Figure IV.6**).[12] In the Prut River systems, non-HVA crops dominated, with half of water users irrigating only non-HVA crops. In contrast, only one-fifth of water users in the Nistru River systems irrigated only non-HVA crops in 2020.

Figure IV.6. Crop types irrigated, 2020



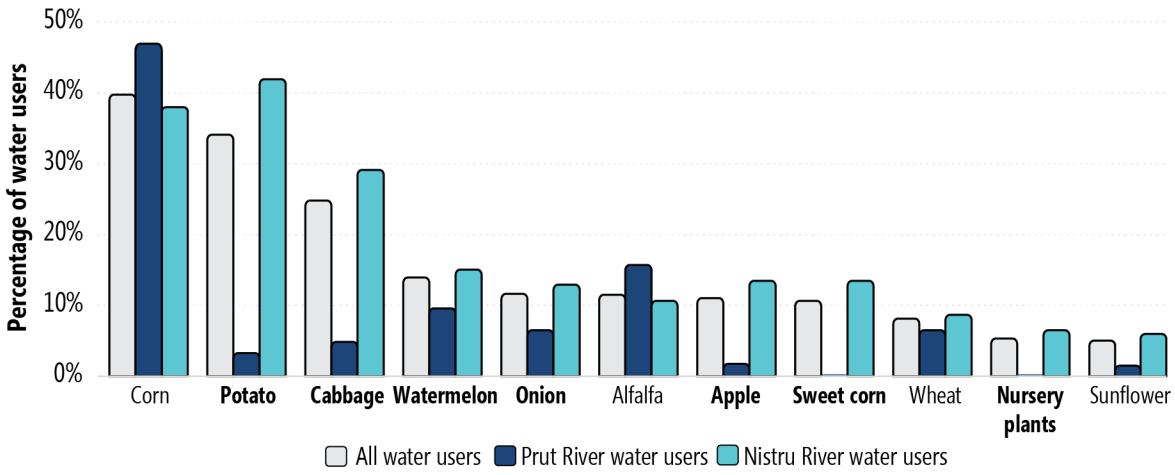
Source: Water User Survey (2020 season).

The most commonly irrigated crop in 2020 was corn (non-HVA, irrigated by about 40 percent of water users), followed by potato (HVA, 34 percent) and cabbage (HVA, 25 percent) (**Figure IV.7**). In Prut River systems, 47 percent of water users irrigated corn, 16 percent alfalfa (non-HVA),[13] and less than 10 percent irrigated other specific types of crops. There was more variation in the crops irrigated in the Nistru River systems, with potatoes (HVA, 42 percent of water users), corn (non-HVA, 38 percent), and cabbage (HVA, 30 percent) the most common.

[12] Only about 9 percent of water users irrigated any "intensive" HVA crops, defined as HVA crops cultivated in a greenhouse or orchards with a tree density of more than 1,000 trees per hectare.

[13] Some stakeholders consider alfalfa to be an HVA crop because it typically has higher returns than cereal crops (albeit not as high as some other HVA crops), especially if it is irrigated and cultivated at a relatively large scale. However, MCA-Moldova discussed this with several Moldovan agronomists early in the evaluation and they generally did not consider alfalfa to be an HVA crop.

Figure IV.7. Crops irrigated, 2020

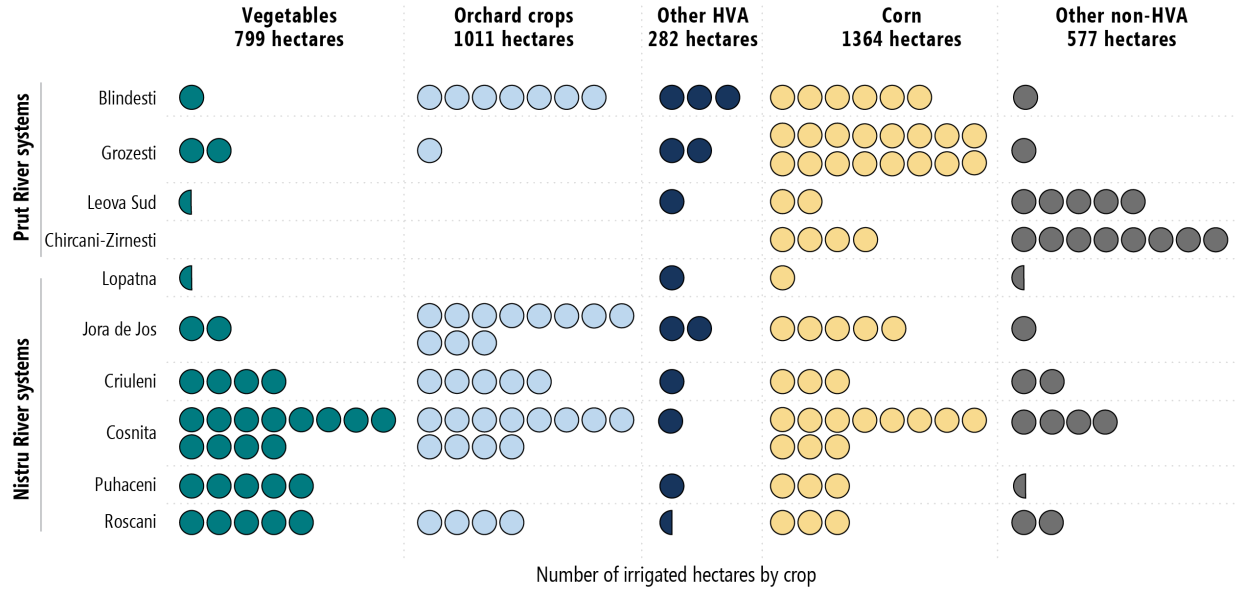


Source: Water User Survey (2020 season).

Note: HVA crops are shown in bold.

In terms of area irrigated, about 52 percent (2,091 hectares) of the total area of irrigated land across all systems in 2020 was used to irrigate HVA crops, and 48 percent (1,941 hectares) was used to irrigate non-HVA crops, based on water users' reports (**Figure IV.8**).

Figure IV.8. Crop area irrigated by system, 2020



Source: Water User Survey (2020 season).

Note: Figure is a graphical representation of the area irrigated by crop type in each system, including the command and extension area. Each dot represents 25 hectares. The areas irrigated have been rounded to the nearest 25 hectares; an area irrigated between 1 and 12.5 hectares is indicated with a half-dot.

Irrigation of HVA crops accounted for a greater percentage of the land area irrigated in Nistru River systems (66 percent, 1,698 hectares) than in Prut River systems (27 percent, 391 hectares). Among non-HVA crops, corn dominated the area irrigated (1,364 hectares, or 34 percent of the total area irrigated in 2020), whereas among HVA crops, apples and other orchard fruits (1,011 hectares, or 25 percent) and vegetables (799 hectares, or 20 percent, mostly potato, cabbage, onion, and sweet corn) were common. Most non-HVA irrigation occurred in the command area: almost 90 percent of irrigated extension area was devoted to orchard crops, 5 percent to other fruits, and 5 percent to vegetables (not shown).

Administrative data from WUA directors suggest that irrigation of non-HVA crops was much less common in seasons other than 2020. For example, we estimate that only about 20 percent of the overall irrigated area in 2019 and 5 percent in 2021 was devoted to non-HVA crops. The relatively larger area devoted to irrigating non-HVA crops in the 2020 season is because of the severe drought in that season, which made it necessary to irrigate those crops.

Most water users who irrigated HVA crops in 2020 had experience cultivating the same crops before rehabilitation, suggesting that relatively few farmers transitioned to HVA crops.

The THVA Project was designed to facilitate a widespread transition to cultivating HVA crops in the rehabilitated systems. However, the number of water users (315) in the high-use 2020 season was substantially fewer than expected.[14] Further, more than two-thirds of water users who irrigated HVA crops in 2020 had experience cultivating at least some of those crops before the systems were rehabilitated. Together, this suggests that relatively few farmers who irrigated in 2020 (about 73 across all 10 systems) had transitioned to entirely new HVA crops since system rehabilitation,[15] in contrast to the widespread transition to HVA that was envisaged. More broadly, 8 of the 10 WUA directors we interviewed reported that the area devoted to HVA crops had increased since the system had been rehabilitated but suggested that these increases were relatively small and gradual.

The area irrigated and area of HVA irrigated have fallen short of what was anticipated in MCC's Compact Closeout CBA model, suggesting that key medium-term outcomes related to irrigation use were not achieved to the extent envisaged.

MCC's Compact Closeout CBA model (updated in 2016) included annual projections for the area irrigated in each of the 10 rehabilitated systems; these projections are closely tied to the estimated economic benefits of the Project. By 2019, the total area irrigated across all systems had reached about 31 percent of the projected 6,299 hectares (**Figure IV.9**). Despite the substantial increase in irrigation use in 2020, the area irrigated reached only 46 percent of the projected 8,328 hectares, and the area of irrigated HVA reached only about 52 percent of the projected 4,517 hectares (not shown).[16] The shortfall in area irrigated relative to projections is even starker for the extension areas, where about 25 percent of the total projected area irrigated was achieved in 2020, relative to 54 percent for the command area. As a result of the decrease in irrigation use in 2021, the total area irrigated fell further behind the projections of the CBA model, reaching only 16 percent of the projection for that season. The CBA model projected that the area irrigated would stabilize at high levels and did not model the sensitivity of system use to

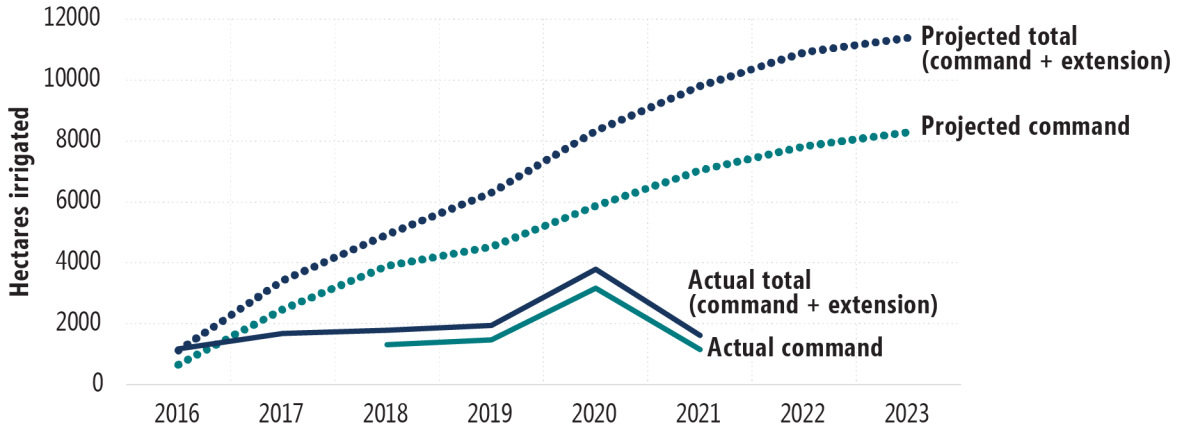
[14] The Compact and MCC's post-Compact monitoring and evaluation plan (MCC 2019) suggested that up to 3,100 households would benefit by irrigating through the rehabilitated systems by 2030. Given the trend in the number of water users since the systems were rehabilitated—and the additional consolidation of land—the total number of users by 2030 is likely to fall well short of this goal.

[15] About half of these were small farms (operating less than 5 hectares in the system) and three were large farms (operating more than 100 hectares).

[16] For consistency, we estimated these percentages based on SDA-Moldova's reports (GoM 2021) rather than on reports from the Water User Survey.

precipitation. Later, as part of addressing **EQ #4**, we explore the reasons why irrigation use fell short of what was anticipated.

Figure IV.9. Total irrigated area versus CBA estimates, 2016–2021



Source: SDA-Moldova (actual total), WUA administrative data (actual command), and MCC's Compact Closeout CBA model (projected total and projected command).

Note: In 2016 and 2017, we have information about the total area irrigated but not the command area irrigated.

Though overall use of the systems in extension areas has been lower than expected, there has been a sustained increase in the number of systems with extension area irrigation and the number of extension area water users.

By the 2019 season, there were nine extension area water users across five systems (Blindesti, Jora de Jos, Criuleni, Cosnita, and Roscani) who irrigated a total of about 481 hectares in the extension areas. In 2020, farmers in Puhaceni also began to irrigate in the extension area, and there were 31 extension area users in total across six systems (15 of these also irrigated in the command area);[17] as mentioned earlier, these 31 users irrigated about 624 hectares in the extension areas in 2020. About half of extension area users in 2020 funded the connection exclusively through their own resources or a loan (from a bank or through the 2KR program); the rest either connected directly to an existing hydrant on the edge of their fields (which was uncommon) or relied in part on contributions from other entities (such as the International Fund for Agricultural Development [IFAD], SDA-Moldova, or the local municipality).

In 2021, farmers in Chircani-Zirnesti also started irrigating in the extension area, and there were 30 extension area users in total across seven systems (mostly in Puhaceni), although the total extension area irrigated decreased to 458 hectares. Of the three systems that did not irrigate in the extension area in 2021, Grozesti had completed a basin and related infrastructure and began to irrigate in 2022, and only Lopatna had no short-term plans for extension area irrigation. Overall, these patterns suggest a sustained increase in both the number of systems irrigating in the extension area and the total number of extension area users relative to a few seasons ago, although the area irrigated is variable.

[17] The number of extension area users in 2019, 2021, and 2022 (expected) was reported by WUA directors. In 2020, we use the number of extension users verified in the Water User Survey (31 users), which is slightly larger than that reported by WUA directors (27 users).

Key findings on HVA prices and sales:

- There are **more opportunities for Moldovan farmers to sell HVA crops to domestic retailers,** but several constraints remain, and **the overall size of the Moldovan domestic market is small.**
- Some farmers are successfully **selling HVA crops in high-value export markets,** especially in the European Union, but **important challenges remain** for these opportunities to become more widespread.

3. HVA prices and sales

There are more opportunities for Moldovan farmers to sell HVA crops to domestic retailers, but several constraints remain, and the overall size of the Moldovan domestic market is small.

Increased HVA sales to the domestic retail market (supermarkets) are an important medium-term outcome in the project logic. The domestic retail chain we interviewed suggested that there is an increasing trend in Moldova for domestic consumers to buy fruits and vegetables from retail chains rather than open markets, as these chains have expanded their footprint from cities into (relatively large) villages. The quantity of fruits and vegetables demanded by retail chains has grown accordingly, leading to more opportunities for producers in the domestic retail market.[18] These opportunities are not limited to larger producers—domestic retailers also work with smaller producers. However, smaller producers' sales to domestic retailers would likely increase if they collectively marketed their produce through marketing associations. This might also require increased coordination in production—for example, for farmers to produce the same varieties of onion that could be aggregated to a larger sales volume.

According to the domestic retail chain we interviewed, it is advantageous for farmers to sell to retail chains as they can obtain contractual commitments for certain quantities and form trusted business relationships through repeat transactions. Most producers approach retailers directly through their logistics centers, but in cases of shortages, the retailers' buyers go to the wholesale market to identify promising producers. Retailers' acceptance of produce is conditional on quality standards, which domestic producers are increasingly able to meet due to adoption of modern technologies and practices. The domestic retail chain we spoke with suggested that Moldovan consumers prefer domestic produce because it is cheaper and tastes better than imported produce, although its visual appearance might not be as appealing. However, because of a lack of advanced cold storage facilities that can store produce for more than a few months, the retailer relies on imports to cover large parts of the year in which Moldovan produce is not available.

> "[Domestic] producers understand that they need to give more attention to the quality and visual appearance of the product. Ten years ago, they were selling the produce in the market, using cheap packaging such as bags—for example, cucumbers in bags, tomatoes in banana boxes or in different boxes, and the produce was not calibrated [that is, organized by size, appearance, and quality to make the package more presentable and uniform]. Now they know what calibration means, packaging, etc."
>
> *–Domestic retail chain*

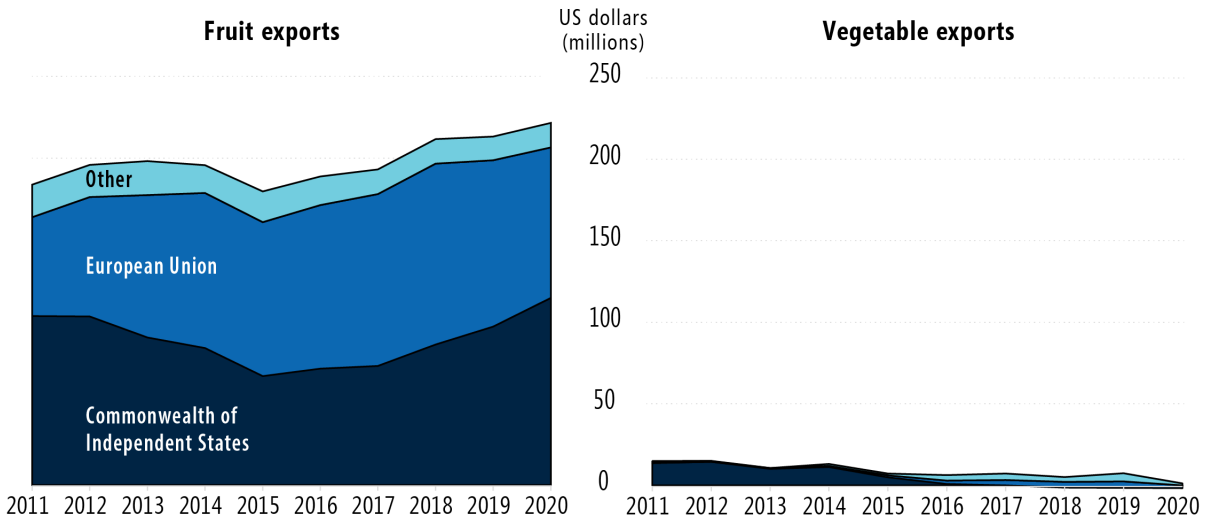
[18] We do not have data that would enable us to assess changes over time in the overall volume or value of produce purchased by domestic retailers from Moldovan producers.

On the other hand, some of the farmers we interviewed were less positive about sales opportunities for fruits and vegetables on the domestic market. Several noted that the overall size of the domestic market is small and cannot absorb the quantities of fruits and vegetables produced in Moldova. Farmers also identified several constraints to working with domestic retail chains, including: (1) lack of access to cold storage, which limits the ability of producers to preserve the quality of produce until it is sold or to sell it off-season; (2) inability of producers to meet large retailer volume requirements for some crops, especially vegetables (and a lack of cooperation among farmers to meet those volumes); (3) inability of retailers to absorb large volumes of other crops, especially fruits; and (4) perceived unfavorable conditions of the contracts between producers and retail chains.

The total value of Moldovan fruit exports has increased over the past decade, but the total value of Moldovan vegetable exports has decreased.

The project logic also posits an increase in Moldovan HVA sales to export markets. Official national statistics show that between 2011 and 2020, there was a positive trend in the nominal value of Moldovan fruit exports and a negative trend in the nominal value of Moldovan vegetable exports (**Figure IV.10**). The value of fruit exports is many times that of vegetable exports. In terms of destination markets, the fraction of fruit and vegetable exports destined for the European Union (EU)—a market that Moldovan producers are increasingly seeking to access because of its attractive prices and stable demand—increased over this period. By 2020, the EU market accounted for about 41 percent of the value of fruit exports and 52 percent of the value of vegetable exports. In conversations with stakeholders, we have learned that there has been an increase in exports to the EU market since 2020 as producers have pivoted in response to the conflict with Ukraine and the recent Russian ban on Moldovan produce (which we discuss below).

Figure IV.10. Moldovan export volumes, 2011–2020



Source: Statistica Moldovei (available at https://statistica.gov.md/en/external-trade-60.html, accessed November 9, 2022).

Note: Figure uses a three-year moving average to smooth year-specific shocks.

Many Moldovan producers can meet international quality standards; however, Russian bans on Moldovan produce, high costs of introducing new varieties, increased transportation costs, a lack of post-harvest infrastructure, and strict EU requirements are important constraints to increasing HVA exports.

The exporters we interviewed agreed that the quality of Moldovan produce had improved in recent years due to the adoption of new varieties and technologies and that much of this produce was suitable for export. GHS participants also reported an increase in HVA quality since the end of the Compact, facilitated in part by GHS and other donor support. This has enabled some farmers to increase their access to the export market—especially the EU, which has more rigorous quality standards than traditional markets accessed by Moldovan producers, such as Russia. Some larger farmers in the rehabilitated systems have started exporting fruit to the EU since the systems were rehabilitated; access to irrigation (and investments in cold storage) have enabled them to meet the required quality standards.

> "Recently we started to export to the EU. I consider this to be a success, because the difference between the market in the EU and that of Russia is very big, especially in terms of sales prices. Another big difference is the quality accepted on the EU market compared to the Russian market. The lower quality produce we can export to Russia is not accepted by the EU market, a fact that encourages us to continue developing our business to correspond to the level of the EU market. Another strong point of the EU market is stability, and that is not something the Russian market can offer now."
>
> *– GHS technical assistance participant*

However, there are several ongoing challenges to increasing Moldovan exports of HVA crops:

- **Russian market bans.** Moldovan producers' traditional primary market in Russia has been disrupted by intermittent Russian bans on Moldovan produce (most recently starting in August 2022). Moldovan exporters are therefore attempting to increase sales to the EU, as well as new markets in South Asia and the Middle East.
- **High costs of introducing new varieties.** The exporters and the EU-based buyer we interviewed all suggested that it is important to identify market niches in which Moldovan produce can be competitive; for example, exporting plums in the fall, when there is a market shortage in the EU. However, meeting EU demand for new varieties can be challenging. For example, most Moldovan apple varieties still cater to the Russian market and changing to EU-demanded varieties would take time and require large investments. Varieties of later-harvesting plums that could expand the window of fall sales in the EU require a license because those varieties are patented, imposing additional costs on farmers.
- **High transportation costs and long transport times.** Transportation costs have recently increased—in large part due to the war in Ukraine, which has increased fuel costs globally and forced Moldovan trucks to take a more circuitous route to overland export markets. Further, transport times for Moldovan produce exported to the EU are often longer than those of their competitors (from the EU or the Western Balkans)—given the geographic distance and lack of rail or maritime transport—which can reduce quality.
- **A lack of post-harvest infrastructure.** Limited access to post-harvest infrastructure is especially problematic for small producers and can negatively affect produce quality, making it more challenging to meet international buyer standards. The EU-based buyer of Moldovan fruits we interviewed highlighted the lack of appropriate packaging as a key constraint; the buyer must repackage Moldovan fruits, which imposes additional costs to purchasing from Moldova.

- **Onerous documentation requirements from the EU.** It has generally become more straightforward for Moldovan producers to obtain phytosanitary certificates for export compared to several years ago, but the EU recently introduced new phytosanitary requirements that are more difficult to meet because Moldovan laboratories are not equipped to test for them. (More generally, the EU has more onerous phytosanitary requirements than other markets.) Further, some European buyers require GLOBALG.A.P. or equivalent certifications, which are onerous and costly to obtain.[19] These requirements might constrain increases in exports to the EU market, even with adjustments to the export quotas.

> "The main change that occurred is related to fruit and vegetable export to the Russian Federation market. Exports used to be good, both via intermediaries as well as individually. You rented a truck and transported produce to the Russian Federation. Once problems with exports to Russia appeared, ordinary farmers encountered big problems. As for exports to the EU, it's not for everybody. Small farmers who don't have cold storage or packaging lines don't stand a chance on the European market because they cannot meet the consumer requirements and norms."
>
> *– GHS technical assistance participant*

> "From Moldova, we buy mainly plums. The advantage is the late delivery period from the end of September to the end of October. In this period, only Moldova offers plums, whereas the demand in Germany is still very good until the end of October. The disadvantage is the long transport route and customs clearance at the Romanian border. Often the goods have to be repacked—for example, in 5 kg wooden boxes. In most cases, this is not possible in Moldova, and means an enormous additional effort for us. Suppliers from Serbia can meet these requirements without any problems."
>
> *– EU-based buyer*

> "The EU is a trustworthy partner. We have increased quotas for export to the EU, we can freely export, but the problem is quality. Obtaining quality and being competitive requires us to invest additional money in the business. I have to buy a processing line, a sorting and washing line, packaging line, production line for boxes and much more, which I cannot afford."
>
> *– AAF loan recipient*

Some exporters are playing the role of marketing associations for smaller producers' HVA crops.

Associations or cooperatives focused on collective marketing of produce are still uncommon in Moldova, but some exporters play that role. Specifically, the exporters we interviewed exported both their own HVA produce and that aggregated from other producers. Some exporters engage just a handful of other producers in this way, whereas others engage many more. This provides a market for smaller producers who would have trouble meeting export requirements in terms of post-harvest processing, volume, or documentation. Typically, only larger producers have the capacity and resources to meet these

> "All the table grape farmers from the villages adjacent to our village are using our services. The grapes are brought in, sorted, packed in different containers and packaging forms to be exported. We have established partnerships with the [city hall] and the town halls in adjacent villages. We are obliged to buy first from the producers in this area, and if we still have the capacity and the financial means then we buy from others, too. This initiative was created by the Regional Development Agency, in partnership with the [city hall] and the team that won the tender, i.e., our cooperative."
>
> *– Exporter*

[19] GLOBALG.A.P. is an internationally recognized standard for farm production that covers food safety and traceability; environment (including biodiversity); workers' health, safety, and welfare; animal welfare; crop and pest management; and so on.

requirements and export independently, which enables them to capture a larger share of the final price relative to selling through exporters.

Farmers perceive that market prices for HVA crops have generally increased since system rehabilitation was completed, in part because of better quality associated with improved irrigation.

The project logic expected that farmers would obtain higher prices for HVA crops because of improved quality and off-season sales. We do not have quantitative data about crop prices, but most farmers we interviewed in the rehabilitated systems perceived that there had been a broadly positive trend in the prices of HVA crops since rehabilitation was completed. Several attributed this increase to improved quality resulting from irrigation and other complementary on-farm investments in modern technologies. (Fewer mentioned off-season sales, likely because use of cold storage in the rehabilitated systems is still limited, as we discuss later.) However, domestic market prices are still quite variable from year to year based on market conditions, and some farmers perceive that they are dampened by cheap imports. Further, farmers were likely reporting nominal increases in prices, and real increases would be smaller. Nevertheless, based on farmers' perceptions, HVA farmers in the rehabilitated systems have successfully achieved higher prices, especially in the export market. But the number of farmers benefitting in this way is likely to be relatively small given the limited transition to irrigated HVA crops to date; as we discuss below, many farmers in the systems perceive that they lack access to markets where they can obtain attractive prices for HVA crops.

Key findings on other Project activities:

- Moldova is **developing second RBM plans for both the Nistru and Prut Rivers,** building on those developed during the Compact; **the one-stop shop for water use authorizations has been sustained,** but the **common platforms for water management and decision-making have not.**
- The **share of water users whose agricultural practices might have been affected by participating in GHS training is relatively low.**
- Although much of the AAF-funded post-harvest infrastructure is still functioning and has been profitable for participants, **AAF did not result in a broader increase in use of post-harvest infrastructure** in the rehabilitated systems.

4. Improved water resource planning (RBM-related outcomes)

Moldova is developing a second RBM plan for the Nistru River and has developed a second one for the Prut River, building on the first plans developed during the Compact.

The RBM component of ISRA provided technical assistance to the GoM to develop the first national RBM plan for the Nistru River. This plan was implemented after the Compact, between 2017 and 2023, with the EU providing financial support and the Ministry of Environment monitoring implementation. A second Nistru RBM plan is under development; it is expected to be finalized in 2023 and implemented between 2024 and 2030, with funding primarily from the GoM and Swedish development agency. The first Prut RBM plan, which was developed at about the same time as the first Nistru RBM plan, except with funding from the EU, was implemented between 2016 and 2022. The second six-year Prut RBM plan was approved in 2022 and will be funded primarily from the GoM and the Austrian development agency.

The Ministry of Environment acknowledged that, although almost all the legislative and regulatory aspects of the first RBM plans were implemented, many other components were not (for example, those

related to physical infrastructure like water treatment stations). In large part this was due to limited budgets and human resources at the Ministry. However, the Ministry conducted a careful review of the first plans to identify key elements to carry over to or build on in the second plans and anticipates that the GoM will contribute additional funding towards implementation of these plans moving forward. The Ministry emphasized that the practice of multiple long-term planning cycles for water resource management with reviews after each cycle was new to Moldova, having started with the two RBM plans developed during the Compact (of which the Compact funded the development of the Nistru plan). The new RBM plans will explicitly address the increased frequency of drought and flooding due to climate change. They will also include sub-basin level plans and seek to further empower and fund local sub-basin committees to engage in decision making. These committees are staffed by representatives from local public administrations and agencies and were part of the RBM plan supported by the Compact; to date, the committees have played a consulting role but have lacked the financing to play a more formal role in sub-basin management.

There has been good coordination with Romania and Ukraine for river basin management, but coordination with Transnistria has been more challenging.

Effective river basin management in Moldova requires coordinating with Romania (Prut River), Ukraine (Nistru River), and Transnistria (Nistru River). The Ministry of Environment reported that coordination with Romania and Ukraine has been strong and constructive. There are bilateral committees with Ukraine and Romania, each comprising several working groups which each convene at least once per year. These groups discuss and address regulations, action plans, hydrological monitoring, and other issues of joint interest. In 2020, a joint long-term strategic plan for the Nistru River (through 2035) was approved by Moldova and Ukraine and acts as an umbrella plan for both countries' national plans. The Ministry hopes to incorporate some of the activities from this joint plan into Moldova's national plan—for example, constructing new water treatment stations.

With Ukraine, an important consideration is managing the environmental impact of Ukrainian hydroelectric plants on the Nistru River. Moldova conducted an assessment of this impact in 2021 and issued several recommendations, many of which were adopted by Ukraine. Importantly, these include a condition on the minimum river flows during drought; Ukraine operates a large hydroelectric reservoir that is essential to maintaining water flow in the Nistru River during drought. The war in Ukraine—and substantial staffing changes at the Ministry of Environment there—has hindered further communication and cooperation around the Moldovan recommendations, but Ukraine continues to abide by the recommendations agreed to.

The Ministry of Environment has also had meetings with Transnistria related to water management, and there has been cooperation and communication on technical issues. However, some aspects of water management involve political or legal issues that are more challenging to resolve. For example, it is challenging to align legal requirements related to water resource management, Transnistria does not share water monitoring data with the Moldovan authorities, and Transnistria has not provided formal input on the second Nistru RBM plan.

Low water levels in the Prut and Nistru Rivers because of drought are a challenge for river basin management and might constrain irrigation in some of the systems rehabilitated by the Project.

The low level of the Prut River in 2020 was a problem in one part of Chircani-Zirnesti, where the river fell below the intake pipe leading to the irrigation canal. The WUA had to dig the canal deeper to access water and is concerned that the problem will worsen in future drought years. Similarly, the WUA in Cosnita is concerned about water levels in the Nistru River falling below the intake valves at two

pumping stations. (This is not a problem in all systems—for example, the WUA in Lopatna noted that the intake valves are very deep in the river and were not affected by the relatively low level of the river in 2020.) A couple of the farmers we interviewed (in Blindesti and Criuleni) also expressed concern that low river water levels might make irrigation challenging in the future.

> "This was the lowest level of the Prut I can remember. I mean, we had situations when there were periods when we had to irrigate, and we didn't have water. We organized ourselves, we went and dug with shovels, and then the water came."
>
> *– WUA director, Project system*

WUAs had mixed views on how easy it was to apply for water use authorizations using the "one-stop shop" that the RBM component of the Project helped establish.

The RBM component of ISRA also supported the passage of a Water Law to govern water use in Moldova, which set out a new framework and procedure for obtaining water use authorizations. This was intended in part to provide WUAs—including those established through the Project and others established under the WUA Law supported by the Irrigation Management Transfer Sub-activity—with secure long-term water rights. The Project also established a "one-stop shop" (also known as Common Platform 1) to streamline the authorization application process, whereby applicants could submit a single package of the necessary documents to the national environmental agency to obtain authorization to pump water.

The Project WUAs obtained the necessary authorizations during the Compact. However, since the end of the Compact, at least one Project WUA has had to apply for their original authorization to be reissued because the volume pumped began to approach the limit specified in the original authorization. Further, as we discuss later, several additional WUAs (outside the Project-rehabilitated systems) have been established in Moldova since the end of the Compact, and most of these have taken over system management from the state agency; these WUAs have also had to obtain water authorizations.

As of 2021, the one-stop shop was still operational and used by the GoM to manage water resource allocations; the application process requires a water quality test, as well as the necessary documentation. Two of the non-Project WUAs said it was a straightforward process; the other four non-Project WUAs we interviewed and the Project WUA that reapplied for authorization said the process was complicated and/or lengthy and required support from SDA-Moldova. All the newly formed WUAs ultimately obtained these authorizations, which are valid for 12 years, and the Project WUA successfully obtained a reissued authorization for a larger volume of water.

The common platforms for water management and decision-making developed during the Compact were not sustained; there are ongoing challenges in monitoring water flow, but an increased focus on monitoring water quality.

The RBM component of ISRA also developed two platforms to improve water management. Common Platform 2 was designed to collate information related to water management, making it visible across institutions. Common Platform 3 was the public use interface for this system. As described in the interim evaluation report (Borkum et al. 2019), these platforms fell out of use soon after the Compact due to turnover of trained staff and limited incentives to update and maintain the systems.

Ministry of Environment staff suggested that at least some of the eight water monitoring stations established through the Compact are still operational. However, these data are being transmitted to Hydrometeo, the state hydrometeorological agency, for their own use rather than as part of a broader platform. Further, the Nistru riverbed still has not been mapped, which makes it difficult to accurately

estimate the flow of the river using the available monitoring station data. Therefore, improved monitoring of water resources and the subsequent use of this information for decision-making have not occurred to the extent envisaged in the project logic.

Ensuring high water quality is another important aspect of river basin management. Overall, water quality in the Prut and Nistru Rivers is high and suitable for use in irrigation. Since Moldova has become an EU candidate, it is required to implement the EU's water framework directive, which requires monitoring 45 water quality parameters; this task was also included in and funded as part of the second RBM plans.[20]

5. Practice adoption, formation of marketing associations, and improved regulations (GHS-related outcomes)

Less than one-third of water users participated in any type of GHS training; any impacts of training on improved practice adoption in the rehabilitated systems are unlikely to be widespread.

The project logic posited that farmer trainings conducted through the GHS Activity would increase the application of modern practices and use of irrigation for HVA crops in the rehabilitated systems in the short and medium terms, contributing to an increase in the volume and quality of HVA production in the medium term. Because GHS trainings were conducted several years before the Water User Survey, we assessed participation in these trainings by matching water user information (location, company and individual names, and phone numbers) to a list of participants recorded by the implementer. We estimate that about 30 percent of water users in 2020 attended at least one GHS training during the Compact, with similar participation rates in the Nistru and Prut River systems. Some of these participants attended trainings between 2012 and 2014, when trainings were conducted throughout Moldova and focused on practices in specific HVA value chains. These trainings were not focused on the rehabilitated systems because relatively few farmers in the systems were active in those value chains during the Compact. Most attended training in 2015, when the trainings were focused on the transition to HVA and use of irrigation in the rehabilitated systems.

We do not have direct measures of practice use among water users. However, based on water users' training participation rates and irrigation experience, the GHS trainings are unlikely to have led to widespread changes in practice adoption in the rehabilitated systems. Among the 30 percent of water users who attended training, many had relevant pre-rehabilitation experience: two-thirds had experience irrigating in the system and a similar fraction had experience cultivating all the HVA crops that they irrigated in 2020—suggesting that the number of water users who were potentially spurred by the training to cultivate and irrigate HVA was relatively small. As we discuss later, barriers like a lack of access to markets and limited rural labor appear to have been more critical constraints to transitioning to HVA crops than a lack of knowledge about cultivating and irrigating those crops. Although some experienced HVA farmers that attended value chain-focused trainings might have adopted improved practices, the share that both participated in these earlier trainings and cultivated the crops that the trainings focused on was relatively small. These trainings might have been more relevant in the systems several years after the Compact, had the envisaged transition to HVA occurred.

Farmer associations and cooperatives focused on collective marketing remain uncommon, but sector-level associations have contributed to changes in agricultural policies and regulations through lobbying efforts.

The THVA evaluation was not designed to fully assess the many short-term outcomes of the GHS Activity beyond those related to farmer training, the component of the Activity that would most directly

[20] Although Moldova is committed to ensuring water quality by monitoring relevant parameters, it is hoping to demonstrate that some parameters are not relevant to Moldova, which would reduce the cost of reporting.

affect farmers in the rehabilitated systems. Nevertheless, in interviews with stakeholders, we explored the extent to which other components of the Activity likely achieved the expected medium-term outcomes.

The project logic posited that, in the medium term, the GHS Activity would contribute to the formation of sustainable marketing associations and cooperatives. As mentioned earlier, domestic retailers and exporters suggested that collective marketing through these types of entities is still uncommon. Ministry of Agriculture and Food Industry staff also emphasized that most Moldovan farmers are not accustomed to or interested in cooperating in production or marketing, despite policies (such as subsidies for farmer groups) and donor-funded projects that have sought to encourage cooperation. Consistent with this, only about 20 water users in the rehabilitated systems that irrigated in 2020 were part of any type of association or cooperative (other than a WUA), and only about half of those said that their association or cooperative was involved in sales. In interviews, some smaller water users said that they occasionally cooperated with others in sales in response to a specific opportunity—for example, when a buyer was seeking a volume that they could not meet individually—but not in a formal or systematic manner. Together, the evidence suggests that these organizations largely did not materialize in the rehabilitated systems as envisaged in the project logic.

However, there is also a handful of broader, sector-level farmer associations that were supported by the GHS Activity. These include the Moldova Fruct Association, which focuses primarily on orchard crops and table grapes, and Berries of Moldova. These associations' key roles include lobbying for policy and regulatory changes, providing training and technical assistance to their members, and promoting exports (for example, by participating in international trade fairs, organizing buyer missions to Moldova, and communicating buyer requirements to their members). Since the end of the Compact, these associations have received support from USAID and other donors to increase their membership rates, financial sustainability, and capacity to fulfill their roles and serve their members. The project logic expected that these associations would lobby for policy and regulatory changes that would reduce costs for agricultural producers in the medium term. According to USAID, these lobbying efforts have occurred—in particular, changes to the input subsidy regime—and some of the related policies and regulations have been adopted by the GoM.

6. Investment in and use of post-harvest infrastructure (AAF-related outcomes)

Although AAF-funded post-harvest infrastructure is still functioning and has been profitable for loan recipients, water users' use of post-harvest infrastructure was limited in 2020, suggesting that the AAF Activity did not result in the envisaged increase in use in the 10 Project-supported systems.

AAF loan recipients used these loans to make substantial investments in post-harvest infrastructure by the end of the Compact, as envisaged in the project logic; the AAF end-of-Compact study (Borkum et al. 2016) found that the Project likely accelerated these investments by providing an attractive source of credit. The project logic predicted further investment in post-harvest infrastructure in the medium term, especially cold storage, as other farmers and enterprises would follow the example set by AAF loan recipients (through a "demonstration effect"). Together with the AAF-funded infrastructure, this was expected to facilitate an increased volume of produce passing through cold storage, contributing to an increase in prices because of higher quality and off-season sales. All eight AAF loan recipients we interviewed in 2022 (two of whom were water users in 2020) stated that the infrastructure built through the Activity was still operational as of 2021 and had been profitable (at least until the sharp increase in electricity prices since the start of 2022). Key benefits that have improved profitability include less spoilage; higher prices due to improved quality, off-season sales, and the ability to sell larger volumes directly to large domestic buyers or export markets; and rental income for those renting space in the

facility to others. Several AAF loan recipients noted the synergies between irrigation and cold storage, especially in drought seasons, with irrigation playing a critical role in producing a sufficient volume and quality to make the costs of cold storage worthwhile.

However, despite these benefits to AAF loan recipients, who were located throughout Moldova (mostly outside of the rehabilitated systems), cold storage facilities were used by only about 14 percent of water users that irrigated in 2020. The most common crops stored were apples and other orchard crops and vegetables (especially potatoes, onions, sweet corn, and cabbage). About one-third of the water users who used cold storage owned the facility themselves, and the rest mostly rented space in a cold storage facility. Use of AAF-funded cold storage by water users in 2020 was rare—using information on facility characteristics, we estimate that only two water users used an AAF-funded facility. Use of other types of post-harvest infrastructure besides cold storage was even less common than use of cold storage: only about 7 percent of water users used other post-harvest infrastructure (mostly precooling facilities and sorting lines), and we could not identify any AAF-funded facilities amongst them.[21]

Although almost all the post-harvest facilities used by water users in 2020 were constructed after the AAF Activity started, they are unlikely to reflect an AAF demonstration effect, for two reasons. First, the AAF end-of-Compact study (Borkum et al. 2016) found no evidence that AAF loans affected enterprises' decisions to invest in cold storage, given the availability of other sources of credit in the market (albeit at less attractive conditions). Second, few AAF-funded facilities were in or near the rehabilitated areas, making a local demonstration effect unlikely.

More broadly, several water users and other Project participants we interviewed noted that there had been an increase in the number of cold storage facilities in Moldova since the end of the Compact, supported in part by donor-funded projects like the World Bank's Moldova Agriculture Competitiveness Project. However, they had mixed views about the extent to which current cold storage capacity meets demand, and water users in several Prut River systems noted that cold storage and other post-harvest infrastructure was still almost non-existent in those areas. In general, only larger enterprises build their own cold storage facilities because of their greater financial resources, willingness to take on risk, and access to attractive markets; smaller farmers must rent space in others' facilities, often cooperating to meet the minimum volumes accepted by those facilities. Even larger enterprises face constraints that might deter investments in cold storage and other post-harvest infrastructure. A lack of financial resources, high interest rates for credit, a lack of attractive sales markets, limited rural labor, and other factors have constrained investment.

EQ #2: How are the results from the Project distributed?

In this section, we assess the distribution of the results from the Project. We focus on the rehabilitated systems—in which all Project activities were expected to interact—although the Project's GHS and AAF Activities also separately affected many farmers elsewhere in Moldova. Within the rehabilitated systems, we look at this evaluation question from two perspectives. First, we examine the characteristics of water users in the rehabilitated systems, who are the individuals and entities who benefitted most directly from system rehabilitation. Second, we examine the effect of the Project on farm labor, an indirect channel through which the Project might have benefitted those not using the systems. By encouraging farmers in the rehabilitated systems to transition to HVA crops, the THVA Project might have increased the quantity

[21] Overall, about 17 percent of water users in 2020 used at least one type of post-harvest infrastructure.

of farm labor employed and wages paid to laborers, assuming HVA production requires greater labor intensity and increases demand for labor.

Key findings on the distribution of results:

- Most of the **benefits of improved access to irrigation through the rehabilitated systems have accrued to a relatively small number of farmers;** there have been no more than 315 water users in any season since rehabilitation, and a few large users have accounted for most of the volume pumped and area irrigated each season.
- Overall, **water users employed almost 2,500 paid laborers in the 2020 season,** most of whom were female, but there is **little evidence that the Project led to widespread changes in farm employment.**
- The **median daily wage for agricultural laborers in the rehabilitated systems increased by about two-thirds** (in real terms) between 2013 and 2020, but **these changes do not appear to be related to the Project.**

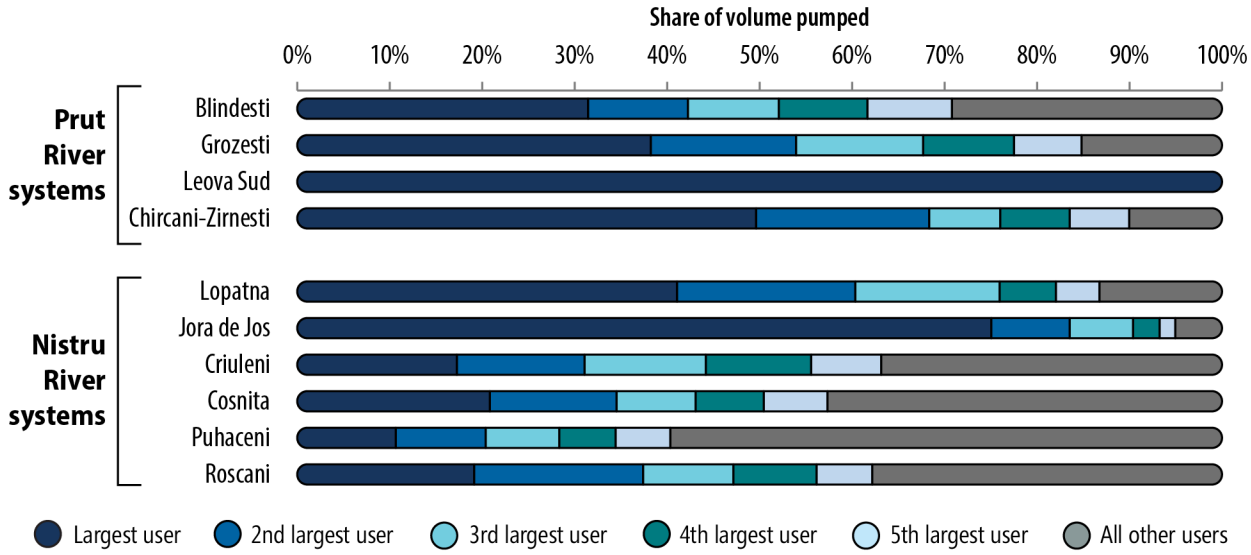
1. Characteristics of water users

In 2020—the year with the broadest use of the systems— there were 315 water users; most users were in the Cosnita and Puhaceni systems, almost all were members of WUAs, and a few large users accounted for most of the volume pumped.

In the 2020 season, there were 315 water users across the 10 rehabilitated systems. Although this was substantially greater than the number of water users in other years, it is much lower than the several thousand farmers who MCC expected would benefit directly from improved access to irrigation.

Though we focus on the 2020 season, there were many similarities between users in the 2020 season and the preceding seasons. First, most water users in 2020 were in Cosnita (85 users) and Puhaceni (84 users) on the Nistru River (**Figure IV.4**). (In the other 8 systems, there were between 1 and 39 users; the median number of users across all systems was 21.5). Second, almost all water users were WUA members. If a farmer wishes to irrigate, it is cheaper to join the WUA and pay adherence and membership fees than to pay the higher non-member irrigation fees. Third, in most systems a handful of water users accounted for most of the volume pumped (**Figure IV.11**). Specifically, in most of the systems (and all Prut River systems), the five largest users by volume accounted for more than 80 percent of the volume pumped in 2020. Puhaceni was the only system in which the five largest users accounted for less than 50 percent of the volume pumped. Among the five largest water users in each system in 2020 (46 users in total), about one-quarter were smaller farms (operating less than 10 hectares) and one-quarter were large farms (operating more than 100 hectares) (not shown). This suggests that most of the benefits of improved access to irrigation through the Project have accrued to a relatively small group of medium and large farmers.

Figure IV.11. Share of volume pumped by user and system, 2020



Source: Water User Survey (2020 season).

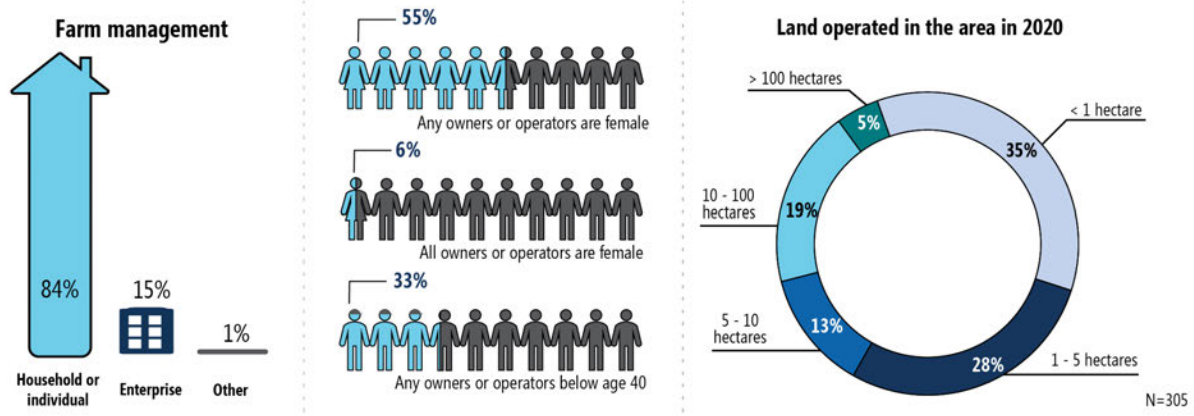
More than 8 in 10 water users in the 2020 season were households or individuals rather than enterprises; few water users were part of exclusively female-operated or female-owned farm operations.

Eighty-four percent of water users in the 2020 season were households or individuals, and almost all others were enterprises (**Figure IV.12**). Enterprises that were water users were more common on the Prut River, where they comprised about 28 percent of water users, compared to 15 percent on the Nistru River. Among the water users that were households or individuals, more than one-third reported that agricultural land holdings were not their main source of income (not shown), which could affect their interest in making further investments in irrigation. Households or individuals that did not rely primarily on their land holdings for income tended to operate smaller areas of land (a median of less than one hectare versus 2.7 hectares), used less irrigation water in 2020 (a median of 417 versus 2,757 cubic meters), and were less likely to have irrigated HVA crops in 2020 (56 percent versus 83 percent) than water users who did rely on their land holdings.

More than half of water users had at least one female operator (for households or individuals) or owner (for enterprises), but very few of those farms were entirely operated or owned by women (**Figure IV.12**).[22] Because advanced age might limit investments in irrigation and HVA production, we also examined the age of water users. The median operator age for water users that were households or individuals was 52 and the median owner age for water users that were enterprises (captured in age categories) was between 40 and 49. Overall, about one-third of water users had at least one operator or owner under the age of 40. Compared to older water users, water users under the age of 40 operated larger areas of land (a median of 3.9 hectares versus 1.4 hectares), used more irrigation water in 2020 (a median of 3,731 versus 1,572 cubic meters), and were more likely to have entered the system after rehabilitation (about 49 percent versus 29 percent) (not shown). However, they were equally likely to have irrigated HVA crops in 2020.

[22] About 85 percent of water users were farms operated or owned by only one or two individuals; it was common for household farms to be operated by one man and one woman, presumably spouses.

Figure IV.12. Water user characteristics, 2020



Source: Water User Survey (2020 season).

Most water users operated relatively small farms, which typically need to cooperate with other farms to irrigate; however, larger farms accounted for most of the area irrigated.

About 63 percent of water users in 2020 operated less than 5 hectares in the areas in which the rehabilitated systems were located (**Figure IV.12**), with the median water user only operating about 2 hectares.[23] Less than 5 percent of water users operated more than 100 hectares in these areas (this percentage was higher in the Prut River systems, about 15 percent, not shown). It was common for water users of all sizes to operate additional land in other areas, reflecting the fragmented nature of agricultural land holdings in Moldova. The median water user operated about double the area of land overall compared to land in the area in which the rehabilitated system was located (4 hectares versus 2 hectares).

The rehabilitated systems, which were originally designed to irrigate large Soviet-era collective farms, were designed to provide large volumes of water. The land in many of these systems became highly fragmented after the fall of the Soviet Union, and this is still the case in many systems despite some consolidation of land by larger farmers. It is challenging for small farms to irrigate fragmented plots independently because it is not technically feasible or economically viable for the WUA to pump small volumes of water (Borkum et al. 2018). For small farmers to irrigate, they must coordinate with others. If a larger user is irrigating regularly, small users connected to the same pumping station can irrigate on demand. If not, the WUA coordinates demand for water by small farmers who are located near one another (or are at least served by the same pumping station), so that the combined demand is sufficient to justify the cost of operating the pumps. In systems in which the water is pumped to a basin and then transported to hydrants using gravity, cooperation is not necessary because water is readily available at in-field hydrants without further pumping. Overall, irrigation by small farmers is more likely if there are many small farmers cultivating the same crops in nearby plots, which makes coordination easier, or if system design involves gravity-fed irrigation so that coordination is not necessary. However, as we

[23] To avoid possible confusion among respondents to the Water User Survey regarding the boundaries of the command and extension areas in the system, we asked them more broadly about the land that they operated "in this area." We expect this to be highly correlated with the area of land operated within the command and extension area boundaries. (The extension area boundaries are also not well-defined because they depend on whether and how farmers in adjacent areas connect to the system.)

discuss later, constraints like a lack of access to markets and limited rural labor are also critical barriers to small farmers transitioning to HVA crops, in addition to the challenges of irrigating through the systems.

Although most water users in 2020 were small farmers, these users only accounted for about 6 percent of the area irrigated in 2020. Large farms irrigated about 50 percent of the total irrigated area, and 44 percent was irrigated by medium farms of between 5 and 100 hectares. In the Prut systems, the percentage of the irrigated area attributable to larger farms was higher, about 75 percent.

Among water users in 2020, about one-third entered the systems after rehabilitation, one-third were in the systems but not irrigating before rehabilitation, and one-third were irrigating even before rehabilitation; new entrants are included among the largest water users.

The systems on both rivers appear to have attracted new farmers who took advantage of the improved access to irrigation. About one-third of water users in 2020 entered the systems after rehabilitation; most of these users entered in 2015, when system rehabilitation was complete, but additional users entered each year between 2016 and 2020. Among these new entrants, about 8 in 10 were smaller farms (operating less than 10 hectares) and only a handful were large farms (operating more than 100 hectares).

> "The decision to produce within this system was made because the irrigation system was rehabilitated and there is the possibility to irrigate. Out of all the agriculture-related risks, the most important and dangerous factor is drought. Thus, from the very start, we planned on cultivating lands in areas that can be irrigated."
>
> *– Water user (new entrant), Project system*

Overall, these patterns suggest that several systems are continuing to see a few new entrant water users each year, but generally to a lesser extent than in the years immediately following system rehabilitation. These new entrants are making a substantial contribution to irrigation in the rehabilitated systems: among the five largest water users in each system in 2020 (46 users in total), about half entered after system rehabilitation was complete. All systems except for Lopatna had at least one top-five water user in 2020 who entered after rehabilitation was complete, and in Grozesti and Criuleni all top-five users were new entrants.

2. Effects on labor markets

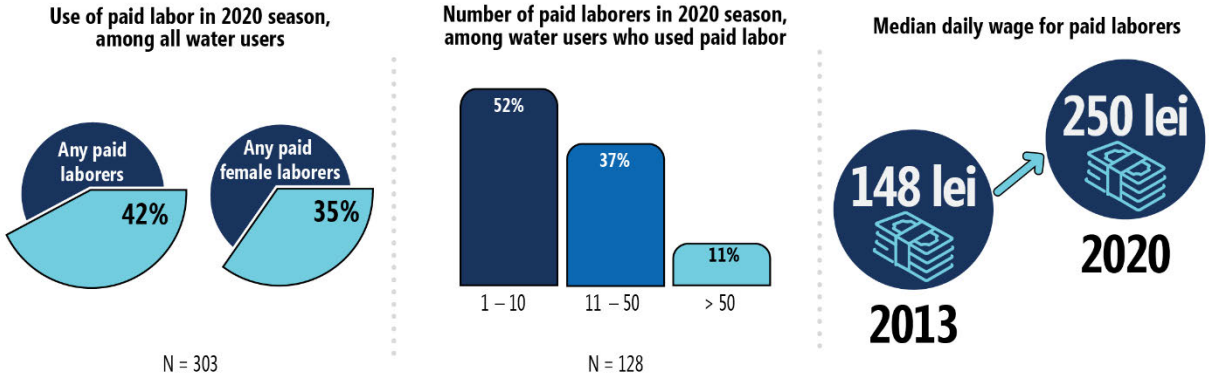
About 4 in 10 water users in the 2020 season employed paid laborers and in total they employed almost 2,500 paid laborers; however, there is little evidence that system rehabilitation has led to widespread changes in farm employment.

Water users in the rehabilitated systems use a variety of employment arrangements, with many small farmers relying on family labor, while others employ anywhere from a handful to a few dozen full-time employees and/or day laborers. In the 2020 season, about 42 percent of all water users in the rehabilitated systems employed any paid laborers and 35 percent employed any paid female laborers (**Figure IV.13**). About half of farms with hired laborers employed between 1 and 10 laborers, and only about one-tenth employed more than 50 paid laborers (the median farm with hired laborers employed 7 or 8 laborers). Overall, we estimate that water users employed almost 2,500 hired laborers in 2020, of which about two-thirds were female (not shown).[24]

[24] The water users who responded to the survey questions about farm labor (96 percent of all water users) employed a total of 2,398 laborers. To account for the small amount of non-response, we estimated the total number of laborers employed by water users by multiplying the mean number of laborers (7.91) by the total number of water users (315), which yields 2,492. We also examined the number of managerial or administrative staff hired by water users that were enterprises: on average, these enterprises had 3 such staff, with a total of about 105 across all water users that were enterprises.

We do not have the information required to quantitatively assess changes over time in hired labor for water users or for farmers in the system more generally. In interviews, farmers' reports of changes in hired labor since the systems were rehabilitated were mixed. Some reported that their employment arrangements had not changed much since the systems were rehabilitated, some increased the number of laborers as they increased the area cultivated and/or introduced new labor-intensive HVA crops, and others decreased the number of laborers as they mechanized their operations.

Figure IV.13. Use of hired labor, 2020



Source: Water User Survey (2020 season) and Farm Operator Survey (2013 season).

The real median daily wage for agricultural laborers in the rehabilitated systems has increased by about two-thirds since rehabilitation, but these changes do not appear to be related to the Project.

Based on Water User Survey data, the mean wage for paid laborers in the 2020 season was 232 lei (about 13 dollars)[25] per person-day and the median was 250 lei (about 14 dollars) per person-day; these average wages were very similar across the Nistru and Prut River systems. We can compare these estimates to estimated 2013 wages using the Farm Operator Survey, a representative survey of farmers in the rehabilitated systems. (Because of differences in the distributions of wages in the two surveys and outlying values, we compare the median wage.) In 2013, the baseline median wage was 148 lei (9 dollars) per person-day (in 2020 lei), suggesting that the median wage increased by 69 percent in real terms between 2013 and 2020.[26]

In interviews, farmers and WUA directors in the rehabilitated systems reported that laborers' wages had increased since the systems were rehabilitated. However, they largely attributed this increase to external factors such as national minimum wages and labor pools that are aging and shrinking from migration, rather than to the effects of the Project. Consistent with this, interviewees in comparison systems—similar centralized irrigation systems that were not rehabilitated through the Project—typically reported wages similar to those in the Project systems. These interviewees also noted that laborers' wages in their areas had increased substantially over the past decade for similar reasons. Overall, the increase in wages in the Project systems appears to have been driven by external factors rather than improved access to irrigation, suggesting that this was not an important indirect channel of Project benefits.

[25] We converted from lei to dollars using the average exchange rate in 2020 from the Bank of Moldova, which was 17.32 lei per dollar (available at https://www.bnm.md/en/content/official-exchange-rates, accessed November 22, 2022).

[26] Taking inflation into account, 1 leu in 2013 is equivalent to 1.48 lei in 2020, using data from the World Bank (available at https://data.worldbank.org/indicator/FP.CPI.TOTL.ZG?locations=MD, accessed November 9, 2022).

EQ #3: How did the THVA Project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?

Land fragmentation became a feature of agricultural land in Moldova when the Soviet Union collapsed, and the land formerly operated by collective farms was allocated to private individuals and entities. It was anticipated that, by making it viable to irrigate large areas of land in a reliable and affordable manner, the THVA Project might accelerate the consolidation of contiguous land parcels into larger farm operations that could take advantage of economies of scale in irrigated HVA production. The improved availability of irrigation would also make the land more valuable, enabling smaller landowners to receive higher prices for the land sold or rented to larger operations; this would provide another potential channel for increased incomes. In this section, we assess the degree of consolidation in the rehabilitated systems to date, the role of the Project, and how and why land prices have changed since system rehabilitation.

Key findings on land markets:

- There has been **considerable land consolidation** in Grozesti and Chircani-Zirnesti—and to a lesser extent in other Project systems—since system rehabilitation was completed**,** but **land consolidation also occurred in comparison systems** over the same period.
- The **median land rental price in the rehabilitated systems increased by more than 50 percent** (in real terms) between 2013 and 2020, and sales prices also increased substantially.
- **External factors likely drove most of the increase in land rental prices,** but **the Project likely contributed to the increase in sales prices.**

There has been considerable land consolidation in Grozesti and Chircani-Zirnesti—and to a lesser extent in the other Project systems—since system rehabilitation was completed; however, these changes also occurred in comparison systems.

As of the 2021 season, the extent of land consolidation had been greatest in the four Prut River systems—Blindesti, Grozesti, Leova Sud, and Chircani-Zirnesti. WUA directors estimate that about 70 to 90 percent of the land in these systems is operated by large farms of more than 100 hectares. In Blindesti and Leova Sud, there was a large degree of consolidation before system rehabilitation, although it has increased slightly since then. In Leova Sud, a single large farmer took over land previously operated by the other three large farmers in the system, further consolidating this already highly consolidated system. In contrast, in Grozesti and Chircani-Zirnesti there has been substantial additional consolidation by large farmers since system rehabilitation was completed, including by new entrants in Grozesti. In some years, these large farmers have consolidated a few hundred hectares of land.

The extent of land consolidation is more limited in the six Nistru River systems. According to WUA directors, in at least three of these systems (Lopatna, Cosnita, and Puhaceni), half of the land is operated by farms of less than 5 hectares. The plots in these systems tend to be small and dispersed, which poses a challenge to further consolidation. Nevertheless, WUA directors report that land consolidation in the Nistru River systems, which had been ongoing for many years before the Compact, has accelerated since system rehabilitation was completed. Most consolidation on the Nistru River has occurred by farms of 5 to 100 hectares and has occurred at a slower pace than in the Prut River systems, with a few hectares or tens of hectares consolidated each year. Water users also reported increases in the area of land operated since system rehabilitation was completed, consistent with land consolidation. Among water users in 2020 who were already operating in the systems before rehabilitation, about 3 in 10 reported increasing the area of land that they operated since the systems were rehabilitated.

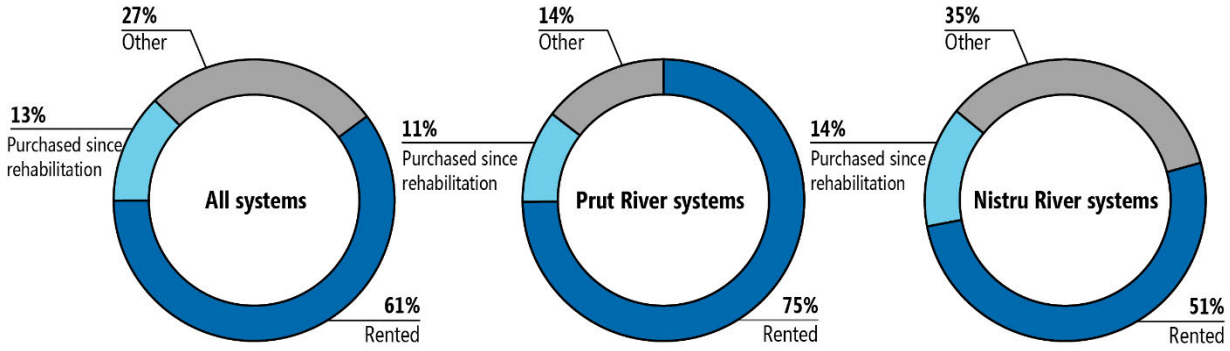
Most WUA directors in Project systems attributed increased consolidation to natural processes not necessarily related to system rehabilitation—in particular, small farmers selling or leasing their land due to old age or death of the owner, migration, or lack of interest in commercial cultivation (in part because of its low profitability). Consistent with this, several of the comparison systems are also highly consolidated. According to farmers and local government officials in those systems, they have seen gradual and ongoing land consolidation over the past decade, as larger farmers have taken over land operations from smaller farmers. Larger farmers are interested in consolidating land because of the economies of scale associated with modern, mechanized non-HVA production. The substantial land consolidation in the comparison systems over the past decade further suggests that consolidation in the rehabilitated systems is likely to have been driven by external factors rather than the effects of the Project.

> "Smaller farmers, those who had land, practically no longer cultivate the land because it is no longer profitable. Services and fuel are more expensive, there is nowhere to sell, because they have small quantities of produce. And they rented out their land or sold it to larger farmers, and, evidently, the large farmers' areas increased."
>
> *– Farmer, comparison system*

Most irrigated land in the rehabilitated systems in 2020 was rented, although some of it had been purchased since the systems were rehabilitated.

In both the Prut and Nistru River systems, consolidation continues to occur largely through land rental rather than sales, although some farmers have purchased land. Overall, about 61 percent of the command area irrigated in 2020 was rented land, and 13 percent had been purchased since the systems were rehabilitated (**Figure IV.14**). The remaining 27 percent was either owned by the operator before rehabilitation or used for free. (The Water User Survey does not provide an estimate of the share owned versus used for free; based on Farm Operator Survey data from the 2013 season, free use is relatively uncommon.) There was a striking difference in land ownership patterns across the two rivers: a larger fraction of irrigated command area land was rented in the Prut River systems (about three-quarters versus one-half in the Nistru River systems), although the fraction purchased since rehabilitation was similar. In the Nistru River systems, it is relatively more common for farmers to irrigate command area land that they owned before rehabilitation, whereas in the Prut River systems it is relatively more common for owners to rent land out to others to irrigate.

Figure IV.14. Land irrigated by water users, 2020



Source: Water User Survey (2020 season).

Note: Figure shows the percentage of irrigated command area land. "Other" includes land that was purchased before rehabilitation or is borrowed/used for free.

The median land rental price in the rehabilitated systems increased by more than 50 percent since rehabilitation, and sales prices also increased substantially; external factors likely drove most of the increase in rental prices, but the Project likely contributed to the increase in sales prices.

Because land rental is much more common than land sales in rural Moldova, our quantitative analysis of land prices focused on rental prices. Based on Water User Survey data, the mean annual rental price for irrigated land in the 2020 season was 2,962 lei (about 171 dollars) per hectare and the median was 2,312 lei (133 dollars) per hectare.[27] (The mean rental price was very similar between the Nistru and Prut River systems, although the median was higher in the latter.) Like for farm wages, we assessed changes in median rental prices since system rehabilitation by comparing them to median prices estimated from the Farm Operator Survey that was conducted after the 2013 season. The 2013 median annual rental price was 1,489 lei (86 dollars) per hectare (in 2020 lei), suggesting that the median rental price increased by 56 percent in real terms between 2013 and 2020.

Farmers and WUA directors in the rehabilitated systems had mixed views about the extent to which these increases in land rental prices were driven by the Project. To better assess this, we asked interviewees in comparison systems about these prices. Although reported land rental prices varied across interviewees in comparison systems, on average they were similar to the median 2020 prices reported for Project systems based on the Water User Survey. All comparison area interviewees agreed that rental prices had increased substantially over the past decade and mostly attributed this to a combination of: (1) a broader trend towards increased land prices in Moldova (in part due to demand from larger farmers for land to consolidate), (2) higher crop prices for non-HVA crops (since lessors are often paid in kind, this increases the monetary value of their rent payments), and/or (3) higher yields as large non-HVA farms have modernized and become more productive (since lessors are often paid a percentage of the crop yield). Overall, we cannot rule out that some landowners in rehabilitated systems received higher land rental prices because of the Project; about one-quarter of water users reported paying relatively high rents of at least 5,000 lei per hectare in 2020. However, on average, these effects appear to be small. Specifically, the similarity in current average land rental prices in the Project and comparison systems, together with the large increase over time in the comparison systems, suggests that the increase in average prices in the Project systems was driven in large part by external factors rather than improved access to irrigation.

The farmers and WUA directors we interviewed in the rehabilitated systems also agreed that land sales prices had increased substantially since rehabilitation, although in some systems little land is available for sale. Many attributed these increases in prices at least partly to improved access to irrigation through the Project. However, interviewees in comparison systems suggested that land sales prices in their systems also increased substantially over the same period. These interviewees' estimates of land prices and how they had changed were too variable—and the sample sizes too small—to meaningfully compare them between the Project and comparison systems. Nevertheless, according to other stakeholders we interviewed, improved access to irrigation contributed to the increase in sales prices in the Project systems.

[27] To pay their rent, most farmers contribute set quantities of non-HVA crops, such as wheat, sunflower, and/or corn, with only a small share of renters paying in cash.

EQ #4: If results were not realized, why not? What are the characteristics of systems in which irrigation use increased the most? The least?

We showed earlier that, although the rehabilitated irrigation systems were well managed and maintained by WUAs, the use of these systems by farmers fell short of expectations. In this section, we examine how and why irrigation use varied across systems and identify barriers to more farmers irrigating and cultivating HVA.

Key findings on barriers to the expected results:

- **Farmers' pre-rehabilitation experience cultivating HVA crops, farmers' linkages to markets, and the presence of a core base of water users who are committed to irrigating regularly** can help explain the variation in irrigation use across systems, with Leova Sud and Chircani-Zirnesti (Prut River) being used the least.
- Water users and WUA directors in the rehabilitated systems identified **limited access to sales markets and lack of farm labor as the main barriers** to more farmers cultivating HVA.
- **A lack of WUA-operated irrigation equipment constrained irrigation** in some systems in the high-demand 2020 drought season.
- The COVID-19 pandemic and the war in Ukraine have not yet affected irrigation use, but **the war in Ukraine might adversely affect irrigation use if higher electricity costs persist.**

1. Variation in irrigation use by system

Through 2021, the Nistru River systems have seen greater irrigation use than the Prut River systems, on average; Leova Sud and Chircani-Zirnesti on the Prut River have seen the lowest use among all 10 systems.

The average volume pumped, number of water users, and area irrigated per system have been greater in the Nistru River systems than in the Prut River systems. Though these differences were observed each year since rehabilitation, they have been more pronounced in relatively high precipitation seasons. For example, in the 2020 drought season, the average Nistru River system pumped more than double the volume of the average Prut River system and irrigated about 50 percent more land. But in the high-precipitation 2021 season, the average volume pumped was closer to three times higher in the Nistru River systems compared to the Prut River systems, and the average area irrigated was more than three times higher. The Nistru River systems have been used more consistently because they irrigate a larger area of HVA crops, which often require irrigation even in years with high precipitation. An important exception is Grozesti, a Prut River system that has had the second largest area irrigated among all 10 systems over the past several seasons. The area irrigated in Grozesti is less sensitive to variation in precipitation across seasons than in most other systems because, unusually, there are water users who regularly irrigate large areas of non-HVA crops; as we discuss below, this is because these water users have a reliable export market for these crops that makes it worthwhile to irrigate them.

Among all 10 Project systems, the Prut River systems of Leova Sud and Chircani-Zirnesti have seen the lowest irrigation use between 2016 and 2021. Specifically, these two systems have had the smallest number of water users and lowest volume pumped in all seasons. The total area irrigated in these systems was comparable to many other systems in the 2020 drought season, but by far the lowest across all systems in all other seasons. Leova Sud is a highly consolidated system in which most land is operated by a single large farmer who cultivates predominantly non-HVA crops and whose demand for irrigation depends heavily on precipitation levels. There are also large fluctuations in water use across seasons in

Chircani-Zirnesti because there are relatively few water users, and these users predominantly cultivate non-HVA crops. This is largely because small vegetable farms in the system have been supplanted by large non-HVA farms through land consolidation. WUA directors suggested that improved access to irrigation was unsuccessful in reversing this trend because vegetable processing factories that used to operate in the area and served as a key market for local vegetables closed several years ago.

Variation in irrigation use across systems can be traced to farmers' experience cultivating HVA crops, farmers' linkages to markets, and the presence of a core base of water users who are committed to irrigating regularly.

We identified several factors that might help explain which WUAs have greater and more consistent irrigation use than others:

- **Farmers' pre-rehabilitation cropping patterns and irrigation experience.** Demand for irrigation water was generally higher in the Nistru River systems than in the Prut River systems in part because some farmers in the former were already cultivating HVA crops that they were irrigating through the previous partly functioning system. After rehabilitation, many of these farmers began irrigating these existing crops through the WUA instead, and some consolidated or expanded their HVA operations (or new entrants did so). In contrast, large-scale non-HVA cultivation was well-established in most of the Prut River systems by the time the systems were rehabilitated, making a transition to HVA—with the associated higher and more consistent demand for irrigation water—more challenging.
- **Farmers' market linkages.** Market linkages can help explain the variation in irrigation use across Prut River systems. Water users in Grozesti regularly irrigate non-HVA crops in part because they export these crops; having buyers who are committed to buying these crops makes it worthwhile to bear the cost of irrigating them to make up for any deficits in precipitation. Further, there is substantial cultivation of sugar beets (an HVA crop) in this system under a contract farming arrangement (renewed annually) with a large German buyer. In Blindesti, a strawberry cooperative produces strawberries for export to Russia. In contrast, Leova Sud relies on one large non-HVA farmer who produces for the domestic market, and the processors who used to serve as a key market for vegetables in Chircani-Zirnesti closed many years ago.
- **A core base of water users who are committed to irrigating regularly.** Although irrigation use varies substantially from year to year based on seasonal precipitation patterns, most WUAs can rely on at least a small base of water users who are committed to irrigating regularly. In most systems, these are larger HVA farmers who typically account for most of the area irrigated and volume pumped; in Grozesti, there are also large non-HVA farmers who are committed to irrigating in most years because they export their crops, as noted above. WUAs can build on this base by adding additional water users whose demand for irrigation is less regular. In contrast, larger farmers in Leova Sud and Chircani-Zirnesti are satisfied with cultivating non-HVA crops for domestic sales; it is only worthwhile to irrigate these crops in dry years. As a result, demand for WUA-provided water in these systems is more sensitive to precipitation than in other systems; in high-precipitation years, there is very limited use of irrigation.

2. Barriers to irrigation and HVA production

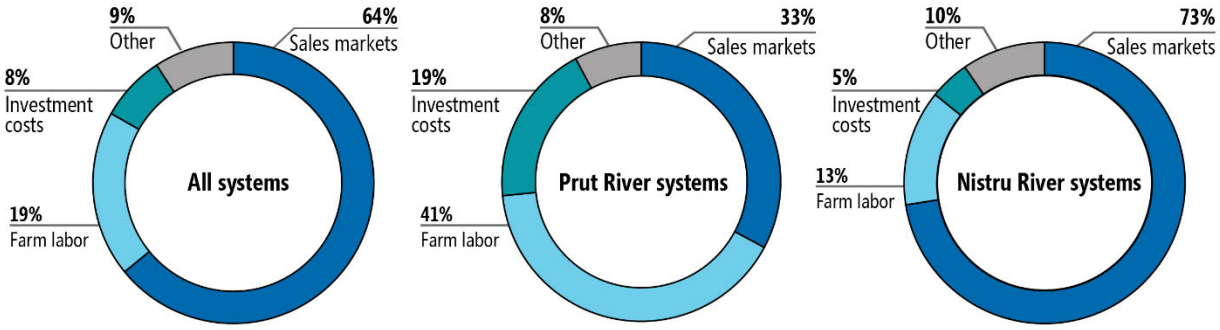
Water users and WUA directors in the rehabilitated systems identified limited access to sales markets and lack of farm labor as the main barriers to more farmers cultivating HVA.

Our interim study (Borkum et al. 2018), which was conducted after the 2017 season, identified several barriers that were slowing the transition to irrigated HVA in the Project systems. These included barriers related to irrigation (such as an insufficient supply of on-farm irrigation equipment, pumps that could only supply large volumes of water, and fragmented land holdings that limited efficiencies in irrigation), limited access to sales markets, lack of rural labor, and a limited desire and ability to invest in HVA.

To shed further light on these barriers, we asked water users in 2020 to identify the single most important barrier preventing more farmers in their system from cultivating HVA. A lack of access to attractive sales markets was by far the most common barrier, selected by 64 percent of respondents, followed by a lack of farm labor, selected by 19 percent; investment costs were cited as the main barrier by 8 percent of respondents and other barriers (including irrigation and farmer interest) were cited by about 9 percent (**Figure IV.15**). However, there was a substantial difference by river, with sales markets by far the most commonly cited barrier in the Nistru River systems (73 percent), whereas in the Prut River systems farm labor was the most commonly cited barrier (41 percent, followed by sales markets at 33 percent). The farmers we interviewed suggested that a lack of farm labor was more of a problem in the Prut River systems because of their proximity to Romania; agricultural laborers from Moldova can commute to Romania weekly and find higher wage work. More broadly, as we discuss below, there has been a substantial decrease in the size of the Moldovan labor force since the late 2000s because of outmigration to the EU, which would have contributed to the shortage of rural labor. Among the small sample of non-users we interviewed, those who commented on why they and/or other farmers did not cultivate more HVA crops also commonly pointed to the lack of farm labor as a key reason.

> "In my opinion, the main reason why people do not switch to fruits and vegetables is the labor force. In our area, most of the seasonal and full-time workers are 50 years old and older. Being close to Chisinau, the youngest go to work in Chisinau or go abroad."
>
> *– Farmer (non-user), Project system*

Figure IV.15. Barriers to more farms cultivating HVA, 2020



Source: Water User Survey (2020 season).

Note: Respondents were asked to indicate the biggest barrier preventing more farms in the command area from cultivating fruits and vegetables. Percentages are calculated among water users in the 2020 agricultural season. "Other" includes irrigation, farmer interest, and other responses provided by the respondent.

The shortage of farm labor is of less consequence to larger farms cultivating non-HVA crops, which have become increasingly mechanized over the years (in part as a response to the lack of labor), but is a major challenge for HVA producers, as HVA crops require more manual labor. In the Water User Survey, the average number of laborers employed per irrigated hectare for those irrigating only HVA crops was about five times higher than for those irrigating only non-HVA crops, confirming the labor intensity of these crops. As a result of labor shortages, some farmers reported having to pay to transport labor from tens of kilometers away.

> "Not only are there no workers, but there is no sales market either. We grow the crop, a quality one, we work a lot, but in the end we have nowhere to sell it. It would be good for producers to open collection facilities because a farmer cannot sell his production if he has only a few tons of yield."
>
> *– Water user, Project system*

WUA directors also consistently pointed to a lack of access to attractive sales markets and a lack of rural labor as the two main barriers to more farmers cultivating HVA. However, some suggested that the lack of rural labor could be overcome if there were better access to attractive markets, as increased profitability would enable farmers to offer higher wages to attract workers.

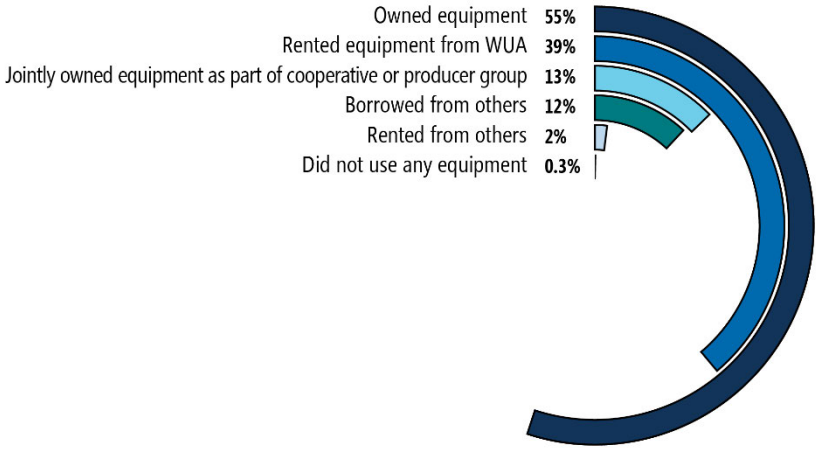
> "There used to be canning factories, which are no longer there. There was the tomato processing factory, it made tomato juice and tomato paste. And now it is no more. Vegetables can be sold at the sales market, but at the market you can only sell small quantities."
>
> *– WUA director, Project system*

WUA equipment rental services have helped to facilitate irrigation in the rehabilitated systems, but a lack of access to equipment was an additional constraint to irrigation in the high-demand 2020 drought season.

Almost all Project WUAs offer their members the opportunity to rent irrigation equipment services (comprising equipment, such as hoses and sprinklers, and workers to operate it); the equipment was provided to the WUAs by the Project, and SDA-Moldova has provided some additional equipment since the end of the Compact. Many water users, especially smaller farmers, still do not have their own irrigation equipment due to a lack of resources (or, in the case of non-HVA producers, because they rarely irrigate). Even some farmers who have their own equipment find it costly to operate because that requires fuel and labor.

Therefore, although most water users in 2020 irrigated using equipment that they owned themselves, it was also common to rent equipment services from the WUA. Specifically, about 55 percent of water users in 2020 irrigated using equipment that they owned themselves, and 39 percent rented equipment services from the WUA (**Figure IV.16**). A smaller percentage jointly owned equipment as part of a cooperative or producer group (13 percent) or borrowed equipment from others (12 percent). These sources of equipment were not mutually exclusive, and some users used multiple sources. However, one in five water users in 2020 used *only* equipment services provided by the WUA—most of these were small farms operating less than 5 hectares. This suggests that these services are playing an important role in facilitating irrigation for some water users, especially for smaller ones who do not own any equipment. The patterns in sources of irrigation equipment were broadly similar across the two rivers.

Figure IV.16. Source of on-farm irrigation equipment, 2020



Source: Water User Survey (2020 season).

Note: Percentages are calculated among water users in the 2020 agricultural season.

However, most WUAs did not have enough equipment to meet the simultaneous demand from many water users in the 2020 drought season. Even in systems where it was more common for water users to have their own equipment, a shortage of meters that the WUAs use to monitor water flow was a constraint to meeting demand in 2020 because the WUA does not provide irrigation water to farmers without measuring the volume provided so it can bill users appropriately. WUAs attempted to address the lack of equipment by providing irrigation services at night as well as during the day and by organizing the irrigation schedule as efficiently as possible. Nevertheless, it was common for water users to experience delays in irrigation, which adversely affected the production of crops that are sensitive to the timing of irrigation. In addition, the shortage of equipment meant that some water users were unable to irrigate the entire area that they would have liked to, and some potential users were unable to irrigate at all. The small sample of non-users we interviewed almost all emphasized the lack of access to irrigation equipment as a key reason for them not irrigating in 2020, despite the drought. Further, the equipment available through the WUAs was often insufficient for the range of crops that farmers sought to irrigate in 2020. For example, the equipment was typically well-suited to irrigating some types of HVA crops but not others and was not suitable for irrigating mature corn.

> "At the moment, I see the biggest challenge being the insufficiency of irrigation equipment. The majority of our water users are small farmers, who physically don't have the possibility to procure equipment, even if they associate in groups. Our association has six functional units of equipment to lease to water users, but these were too few to cover the demand. The queue of users who want to irrigate, especially in July, was reaching 10 days."
>
> *– WUA director, Project system*

> "In 2020, the WUA only had three units of irrigation equipment, and there was very high demand due to the drought. When the WUA irrigation equipment became available to me, it was already too late to irrigate."
>
> *– Farmer (non-user), Project system*

The WUAs were not expected to be able to meet all equipment needs when the systems were operating at capacity. Rather, it was anticipated that many farmers would invest in their own equipment, including through the 2KR hire-purchase program that was included in the AAF Activity. However, it appears that

many farmers—especially those who irrigated irregularly—did not find the costs of those investments worthwhile or affordable, which constrained irrigation when they needed to irrigate in the 2020 drought season. Overall, as we discuss above, the transition to HVA crops was limited primarily due to constraints like a lack of access to markets and limited rural labor; providing more equipment alone would be unlikely to greatly increase HVA cultivation.

Larger farms engaged in modern non-HVA cultivation are finding it modestly profitable, limiting their interest in transitioning to HVA crops.

Non-HVA cultivation is more profitable for larger farmers than it was a decade ago due to increased mechanization, new seed varieties, economies of scale, purchases of inputs in bulk, higher market prices, and strong relationships with buyers. As a result, many larger farmers are operating modern, mechanized, profitable non-HVA farms—despite increases in input costs and the effects of drought. This might help explain why large non-HVA farmers have been reluctant to invest in HVA. Specifically, having made substantial investments specific to non-HVA, being connected to committed buyers, and finding cultivation of these crops profitable, they might not be eager to take on the risk of investing in HVA despite the potential for better returns.

> "Strategically, in the future, it is possible we will cultivate fruits and vegetables, but at the moment we are not ready for such changes. We are specialists in the crop [soybeans] we have been growing for years and we are always developing this value chain. To switch to the cultivation of fruits and vegetables, very large investments are needed. In the future, if we switch to these crops, it will only happen if we have the entire post-processing and packing set to obtain a finished product that will go directly to the store shelves."
>
> *– Water user, Project system*

The external shocks of the COVID-19 pandemic and the war in Ukraine have had limited effects on the use of irrigation; however, the pandemic negatively affected labor availability for some HVA farmers, and the war might adversely affect irrigation use if higher electricity costs persist.

Most water users we interviewed reported that the pandemic did not affect their agricultural production or irrigation. Some operate highly mechanized farms that require few manual laborers, and others adapted to social distancing regulations by using smaller than usual groups of laborers. However, a handful of HVA farmers we interviewed found it difficult to hire the number of laborers they needed when they needed them—for example, to prune orchards or harvest spring vegetables—because of workers' fear of infection and the closure of the crossing from Transnistria. The limited availability of labor—together with the effects of the drought—led to lower quality, yields, and/or harvests for these farmers in 2020.

The effects of the war in Ukraine on irrigation through the WUA have mostly been limited through early 2022, with farmers' irrigation decisions largely depending on the level of precipitation. However, higher electricity costs associated with the war have contributed to an increase in irrigation fees by many WUAs. Together with higher prices for other inputs like fertilizer, this might affect famers' cultivation decisions and ability to afford irrigation if the situation persists. More broadly, geopolitical and macroeconomic instability might reduce farmers' willingness to make large investments, including in HVA production.

The broader context of a declining interest in small-scale agriculture due to external factors also did not support the envisaged changes in irrigation and HVA production. In the period since the Project was designed in the late 2000s, Moldova has seen substantial outmigration of its working age population. Specifically, the Moldovan labor force decreased by almost 20 percent between 2009 and 2021 (World Bank 2023). This has been driven in large part by increased employment opportunities in the EU, as visa requirements for Moldovans have been relaxed and the process for Moldovans to obtain EU

(mostly Romanian) passports based on descent has been eased.[28] Further, the real wage for paid employment in Moldova has increased substantially since the project was designed, increasing by almost 50 percent between 2009 and 2018 (Astrov et al. 2020). Together, these external factors have contributed to making small-scale agriculture less attractive as a source of livelihoods in Moldova. In this context, widespread investments in irrigation and HVA production by small-scale farmers were unlikely by the time the systems were rehabilitated in 2015.

EQ #5: What was the contribution of each activity/sub-activity to the results that were realized?

The project logic suggests that the Project activities were expected to work together in concert to increase the cultivation of irrigated HVA crops, the prices and sales of those crops, and, ultimately, the incomes of farmers cultivating them. As we showed earlier, some of the anticipated medium-term outcomes were achieved but others fell short of expectations. In this section, we assess how the various activities contributed to what was achieved.[29]

Key findings on the contribution of each activity:

- Transitioning partly functioning non-Project systems to **management by WUAs has led to tangible benefits for farmers**, suggesting that the **ISRA Irrigation Management Transfer Sub-activity made an important contribution to Project results**.
- However, **dilapidated infrastructure remains a major challenge** for the operations and sustainability of non-Project WUAs, suggesting that **CISRA also made a critical contribution** to Project results.
- The **AAF Activity had limited effects on water users in the rehabilitated systems** and it is **unlikely that GHS trainings led many water users to transition to irrigated HVA production.**

Even in the absence of system rehabilitation, transitioning partly functioning systems to management by WUAs has led to tangible benefits for farmers.

The Irrigation Management Transfer Sub-activity and CISRA were implemented as a package under the Project. As we describe later, several non-Project WUAs have been established and taken over management of partly functioning systems from the state agency since the end of the Compact—but those WUAs have not benefitted from system rehabilitation. Examining the experiences of these non-Project WUAs provides suggestive evidence on the effects of the Irrigation Management Transfer Sub-activity alone, because these WUAs effectively received a version of this activity but not CISRA.

All the water users served by non-Project WUAs that we interviewed perceived that they had benefitted from the WUA taking over management of the system. Specifically, the price of irrigation water decreased in most of these systems and water users view the price as more transparent. Further, in all the systems the timeliness of water delivery has substantially improved as the WUAs have repaired infrastructure more rapidly and have effectively coordinated irrigation among farmers.[30] Several water

[28] Moldova and Romania were part of the same union before the Soviet period.

[29] We do not discuss ISRA-RBM here, because it was largely separate from the other activities and had a much broader goal of contributing to comprehensive water resource management in Moldova.

[30] Coordination among larger farmers is necessary because the water pressure is often insufficient for several large farms to irrigate simultaneously, and coordination among smaller farmers is necessary because the systems cannot supply small volumes of water.

users reported that access to more affordable and timely irrigation in 2020 saved their harvests from the effects of the drought.

Therefore, even absent system rehabilitation like in the CISRA component of the THVA Project, the replication of the Irrigation Management Transfer Sub-activity in other systems has resulted in clear benefits for farmers in those systems. The certainty of having irrigation water on time at a reasonable price might help facilitate further investments in HVA production in these systems, although several farmers and WUA directors noted other barriers besides irrigation that might constrain these investments. These barriers are similar to those cited by stakeholders in Project-supported systems, and include lack of attractive markets, limited rural labor, high investment costs, and risk aversion among farmers. Nevertheless, there are concrete examples of increased investments in HVA in non-Project systems managed by WUAs. For example, in Holercani, entrepreneurial farmers have sought to take advantage of the improved availability of irrigation in some parts of the system by investing in modern intensive orchards and other HVA crops. Some of these farmers have also invested in cold storage infrastructure and are exporting their produce, especially orchard fruits and vine seedlings.

> "Previously there was no stability. Now we set the budget; we determine what is profitable and what is not profitable. Once there is the source of water, I can develop further, I can expand the area of cultivated land, I can think of a storage room or cold storage. Just next week, we set up a meeting to discuss the possibility of purchasing more efficient irrigation equipment. At the same time, I want to get a loan to buy a new tractor. All this I can do because I have a permanent source of water."
>
> *– Water user, non-Project system*

> "Presently, we have the freedom of action. Now it is all up to us. If any problems arise, they are solved very quickly once we all get involved. Even when there are broken/cracked pipes, we quickly identify the necessary technique/equipment, dig in the ground, and repair them. This is a high priority for us. If there are broken pipes during a dry year, and we do not have water for irrigation for a week, this is a major problem—so we do our best to avoid that."
>
> *– Water user, non-Project system*

However, dilapidated infrastructure remains a major challenge for the sustainability of non-Project WUAs and for the cultivation of HVA crops, suggesting that CISRA also made an important contribution to the Project's results.

Almost all non-Project WUA directors and water users noted that the infrastructure in their systems remains in poor condition, although there has been a noticeable improvement relative to when the systems were managed by the state agency—primarily because of faster repairs. In many WUAs, farmers are responsible for repairing infrastructure on their own land (secondary pipes and hydrants), and the WUA is responsible for repairing the central system (for example, pumps, central pipes, reservoirs, and buildings). The WUAs use their own resources and grants (mainly from SDA-Moldova, which also provides technical advice and oversight of works, but also from other donors like IFAD) to make regular repairs to keep the systems operational and fund

> "Our centralized irrigation system is very old—it's over 50 years old. The pipes are made of concrete from the times of the Soviet Union and are in a catastrophic state. I don't know how long it will hold. The pumps are also very old. At the moment, we only have the possibility to perform some repairs and we don't have the financial means to replace them. Major changes will be possible only if there is a project or a grant to help us out."
>
> *– Water user, non-Project system*

improvements where possible. The WUAs' own resources for this purpose come from WUA revenues, separate monetary contributions from members earmarked for infrastructure improvements, and electricity subsidies.[31]

These infrastructure challenges prevent the WUA-managed non-Project systems from reaching their potential. For example, there are parts of the systems that cannot be irrigated because the infrastructure has completely broken down, water must be pumped at lower pressure to limit damage to the system, and old pumps are inefficient and use a lot of electricity. The inefficient equipment and ongoing leaks imply that the price of irrigation water remains higher than it would be if the infrastructure were in better condition. The poor state of infrastructure is also a concern for sustainability, as it is likely to degrade even more over time without further investments. Overall, directors of the newly formed WUAs in non-Project areas suggested that they need more support upgrading system infrastructure to be sustainable in the long run, although a comprehensive rehabilitation (like CISRA) might not be economically viable.

The AAF Activity had limited effects on water users in the rehabilitated systems.

AAF loans for cold storage, post-harvest infrastructure, and equipment related to HVA production were largely provided to entities that were not located in or near the rehabilitated systems because HVA production in these systems was limited during the Compact. For part of the implementation period, these entities were required to be in the same *raions* (districts) as the rehabilitated systems or in neighboring *raions*, but this did not necessarily mean that they were convenient for farmers in the systems. As mentioned under **EQ #1**, use of cold storage by water users in 2020 was limited, with only 14 percent using a cold storage facility and 7 percent using other types of post-harvest infrastructure. Very few water users used an AAF-funded facility, and as discussed earlier, the facilities that were used by water users were unlikely to be the result of a demonstration effect from AAF. Therefore, while the AAF Activity might have had positive effects on loan recipients and farmers in other parts of Moldova, its contribution to the outcomes of farmers in the rehabilitated systems largely did not materialize.

It is unlikely that GHS trainings led many water users to transition to irrigated HVA production.

As mentioned earlier, about 30 percent of water users in 2020 attended at least one GHS training during the Compact; many of them attended trainings conducted towards the end of the Compact, which focused on irrigation of HVA crops. However, there is little evidence that GHS trainings drove farmers' adoption of irrigated HVA crops in the rehabilitated systems, given that about two-thirds of training attendees who irrigated in 2020 had pre-rehabilitation experience with irrigation (and with the specific HVA crops that they irrigated in 2020).

EQ #6: Are there indications that some of the long-term outcomes will be realized?

Under **EQ #1**, we focused on the achievement of medium-term outcomes in the project logic. We showed that the Project WUAs were effectively managing and maintaining the rehabilitated irrigation systems, which were functioning well and had substantially improved farmers' access to irrigation. However, medium-term outcomes related to the extent of irrigation use fell short of expectations, and there were substantial challenges in increasing sales of HVA crops to domestic and export markets, even though attractive prices were available for some HVA crops in those markets.

[31] These subsidies are paid by the state to help cover the costs of pumping irrigation water. They are available to farmers who irrigate certain HVA crops and are typically transferred to the WUA's account after the end of the season. It is common for members of WUAs to put these subsidies towards their fees, but in some cases WUAs use them to fund infrastructure improvements or other costs (with members' approval).

In this section, we focus on the extent to which the key long-term outcomes in the project logic were achieved or are likely to be achieved.[32] First, we examine the extent to which farmers' profits in the rehabilitated systems have changed since rehabilitation. This analysis draws primarily on qualitative data because collecting post-Project survey data on profits and incomes in rehabilitated and comparison systems was not included in the revised evaluation design (Borkum et al. 2020). Second, we assess several aspects of the long-term sustainability of the WUAs established through the Project, including their membership rates, the fees that they charge, and their overall financial position six full seasons (years) after rehabilitation was completed. Third, we examine the extent to which the THVA model was replicated in other parts of Moldova through the establishment or reorganization of additional WUAs and management transfer to those WUAs. Finally, we examine the reputation of Moldovan produce on the global and local market and supportive HVA-related policies implemented by the government.

Key findings on the potential to achieve long-term outcomes:

- The relatively few farmers who irrigated through the rehabilitated systems **have generally found it profitable to do so**, despite increased input and investment costs.
- The **number of WUA members in the Project WUAs has stabilized** over the past few seasons, at about 660 members across all 10 systems.
- WUA directors believe that the Project WUAs **can be financially sustainable in the long run** by using surpluses in high-demand years to cover deficits in low-demand years and by dynamically adjusting membership fees to cover remaining gaps in resources.
- However, some WUAs are **concerned by their low level of reserve funds**, and the extent to which **Project WUAs can operate independently of support from SDA-Moldova** is unclear.
- The THVA Project **spurred the establishment or reorganization of 25 additional WUAs** since the end of the Compact; several of these have made or are planning investments in system rehabilitation with donor support, albeit not on the scale of the THVA Project.

1. Effects on farmers' profits

The relatively few farmers who irrigated through the rehabilitated systems have generally found it profitable to do so, despite increased input costs and necessary on-farm investments.

Most of the water users we interviewed reported that their profits had increased since the end of the Compact. Improved access to irrigation through the Project, together with the use of other modern technologies and practices, has increased yields and quality. This has enabled these farmers to sell larger volumes and obtain higher prices. However, the increased cost of inputs and the costs of necessary on-farm investments have reduced the magnitude of these gains. Further, some farmers have struggled with prices varying from season to season based on market conditions, despite a broadly positive trend in prices. Nevertheless, these findings suggest that farmers in the rehabilitated systems have demonstrated the potential for increased profits using irrigation, especially for HVA crops.

> "Once we had the opportunity and irrigated, the grape seedlings were more beautiful, higher quality, and healthier. Previously, when I was using water from the pond to irrigate, I was not able to use the necessary volume of irrigation water. Our income has increased threefold since we started irrigating through this irrigation system. But we don't know what it's going to be like this year because the prices of inputs have increased."
>
> *– Water user, Project system*

[32] In the project logic, the long term was assumed to be 2019 and beyond.

Unfortunately, these gains have been restricted to a relatively small number of water users, and most farmers have been unable to overcome other barriers.

Improved access to irrigation has been especially critical in limiting financial losses in drought years.

Most water users we interviewed in the rehabilitated systems reported that their use of irrigation in the 2020 drought season resulted in substantially better yields and quality compared to farmers who did not irrigate—some of whom lost the entire season's crops. Although the increased use of irrigation led to higher production costs for water users, in many cases the higher costs were offset by higher market prices due to drought-related shortages. However, as discussed earlier, a lack of irrigation equipment might have constrained the benefits for some water users who were unable to irrigate to the desired extent, with the desired timing, or using the most suitable equipment. This was a particular challenge for water users who irrigated corn, the dominant non-HVA crop; several of these users reported that the less-than-ideal irrigation process meant that the benefits of irrigating corn ultimately did not justify the costs.

> "The drought did not affect agricultural production or irrigation or sales, because our orchard is irrigated and we did not lack water, we irrigated every time it was necessary. We had good yields, according to our expectations, because we irrigated on time without delay. Irrigation is extremely necessary for fruit production. We had the advantage in selling good quality produce for a good price compared to those farmers who couldn't irrigate."
>
> *– Water user, Project system*

> "In 2020, due to a very severe drought in our locality, the plums were the most affected. The plums were very small. And towards autumn, when we had to harvest them, the tree started to draw water right from these little plums. Because the tree has such an ability to draw moisture from the fruit in case it no longer has the ability to draw moisture from the roots in the ground. This process takes place to keep the tree alive. So that year we had a yield of small, low-quality plums. The sales were affected. We had to give the plums for drying, that is, at the lowest price. Because with such quality you could not go to market."
>
> *– Farmer (non-user), comparison system*

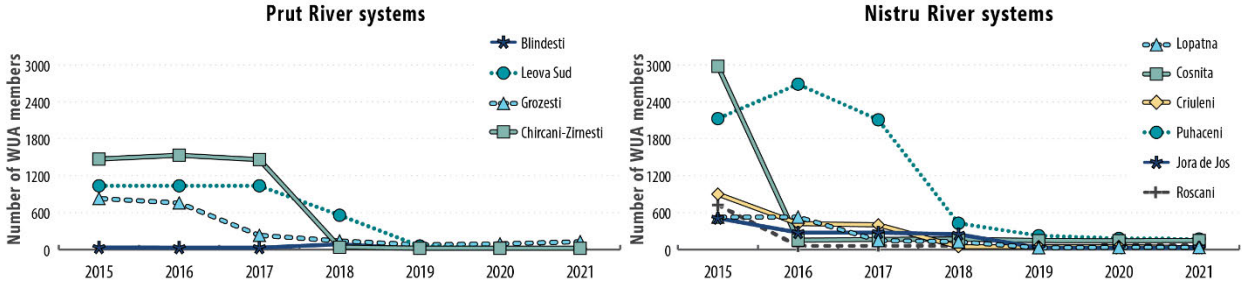
Consistent with the benefits of irrigation in the rehabilitated systems in 2020, farmers in comparison systems reported substantially lower crop yields in 2020 relative to a typical season. HVA producers in these systems also experienced lower quality because of the drought. Comparison area farmers who irrigated were able to mitigate these effects to some extent, depending on the volume of irrigation water available. This volume was limited for those irrigating using cisterns, but less so for those irrigating through (partly functioning but unrehabilitated) WUA-managed systems.

2. WUA sustainability

The number of WUA members has stabilized over the past few seasons.

WUAs are likely to be more sustainable if they have a stable base of fee-paying members. In most systems, large numbers of farmers agreed to become members because the Project required a majority of farmers to be members in order to move forward with WUA establishment and system rehabilitation; farmers had an incentive to join the WUA as the Project had the potential to improve wellbeing through irrigation and/or increased land prices. However, many of these initial members ultimately did not irrigate through the rehabilitated systems and never paid their membership fees. Exclusion of large numbers of members for non-payment of fees was common in previous years (**Figure IV.17**). However, by 2021 the WUAs had largely narrowed down their membership to those who regularly pay membership fees, and excluding members for non-payment had become less common. Across the 10 rehabilitated systems, there were 660 WUA members in 2021, similar to the total number of members in 2020 and 2019. In 2021, four WUAs had the exact same members as in 2020, and only two WUAs (Grozesti and Criuleni) experienced a net change of more than 10 members.[33]

Figure IV.17. WUA membership, 2015–2021



Source: WUA administrative data (2015–2017) and SDA-Moldova (2018–2021).

Several Project WUAs have begun to dynamically adjust their membership fees to cover their costs and improve their prospects for financial sustainability, given fluctuations in revenues from irrigation water across seasons.

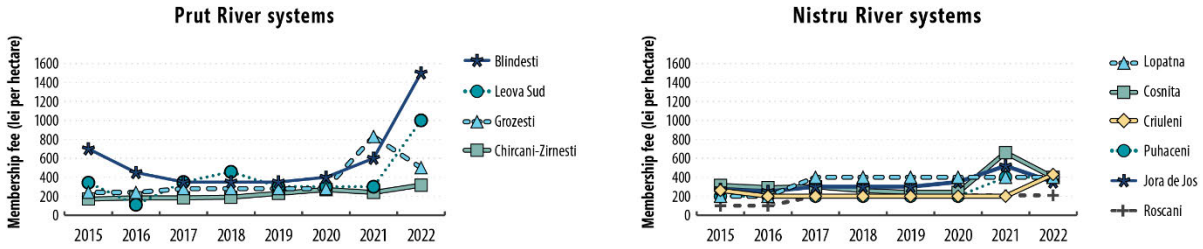
The envisaged financial model of the Project WUAs was that members would pay membership fees based on area cultivated, which would provide a reliable source of income to support the WUAs' fixed costs (primarily staff salaries). WUAs would then charge water users irrigation fees based on the volume of water used, setting these fees to cover the WUAs' variable costs (primarily the electricity costs of pumping water). However, in practice, revenues from membership fees have mostly been insufficient to cover WUAs' fixed costs since the systems were rehabilitated, and WUAs have been using irrigation fees to cover part of these costs and/or have been going into debt.

More recently, several WUAs have started to adjust their membership fees to ensure a more reliable basic income that will help cover their fixed costs and hence improve their prospects of financial sustainability. Specifically, WUA membership fees had remained relatively consistent over the past few seasons through

[33] The number of members has substantially exceeded the number of water users in most systems, even in the 2020 drought season. The farmers we interviewed who were WUA members but did not irrigate in 2020 suggested that this was because they could not afford irrigation fees and/or did not have access to irrigation equipment in that season. However, they (or their children) still hoped to irrigate in the future and were therefore remaining members in good standing; several reported having irrigated in 2022.

2020, and WUAs initially planned for this to continue into 2021 (**Figure IV.18**). However, five WUAs (Blindesti, Grozesti, Jora de Jos, Cosnita, and Puhaceni) raised their membership fees substantially partway through the 2021 season; the increases ranged from almost 50 percent to almost 200 percent and were retroactive, so even those who had already paid membership fees for the 2021 season had to pay the difference. These WUAs raised their membership fees in this way because 2021 was a relatively rainy year with low demand for irrigation water. As a result, revenues from irrigation fees were lower than expected, and the WUAs needed additional revenues to cover their fixed costs for the season, such as salaries. Of the remaining five WUAs, four kept their 2021 membership fees the same as 2020 and Chircani-Zirnesti reduced them slightly.

Figure IV.18. WUA membership fees, 2015–2022



Source: WUA administrative data (2015–2022).

Many WUAs have further adjusted their membership fees in 2022. In 2022, four of the five WUAs that increased membership fees during the 2021 season maintained them at a much higher level than in the past, with Blindesti implementing a substantial further increase. Another two WUAs, Leova Sud and Criuleni, have also implemented major membership fee hikes for 2022. Overall, 6 of the 10 WUAs appear to have moved by the 2022 season towards a financial model with higher membership fees than in the past.

> "The level of membership fees will always be set depending on the volume of irrigation water delivered by the WUA. If it is a rainy year, then membership fees will be established in the beginning of the year or be increased along the way so that it is possible to cover the expenses of the WUA. Whereas if it is a dry year, then obviously the membership fees level is going to be lowered. I think that the WUA members will be understanding of the fact that the level of the membership fee is directly proportional to the precipitation level of that year, and this will not affect the payment of these fees or membership within the WUA."
>
> *– WUA director, Project system*

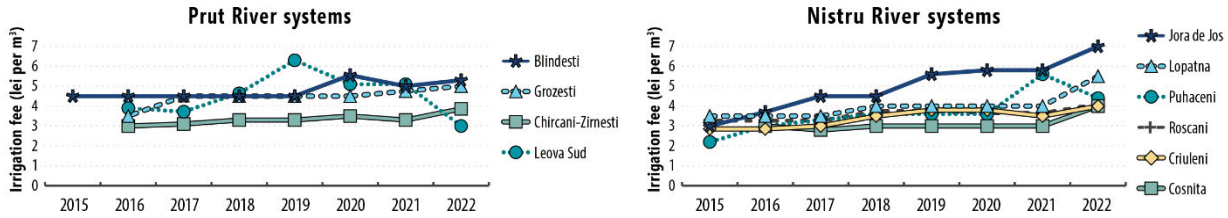
More generally, WUA directors are still striving for the membership fee to cover most of the WUAs' fixed costs, as envisaged when the WUAs were formed, which would enable them to lower the cost of irrigation water for users. However, the relatively low number of members and issues with incomplete or delayed payment of membership fees in some systems (despite the exclusion of many members for non-payment over the past few seasons) makes this challenging. In practice, most WUAs are likely to continue to rely to some extent on irrigation fees to cover part of their fixed costs, as well as to increase their reserve fund, which represents cumulative profits since the WUA was formed and serves as a financial buffer and funding source for infrastructure repairs and improvements. Nevertheless, the past couple of seasons have demonstrated the WUAs' ability to dynamically adjust their membership fees to meet funding gaps as they arise, thereby avoiding accumulating excessive debt or increasing irrigation fees to

unaffordable levels. All changes in fees are implemented through consultation and discussion with WUA members, through meetings of the annual General Assembly or extraordinary General Assembly held during the season.

Irrigation fees were stable between 2019 and 2021 for most WUAs, but many have implemented increases in 2022 because of higher electricity costs.

Irrigation fees in most systems remained somewhat stable over the past few seasons through 2021, with small or moderate changes in about half of the systems each year (**Figure IV.19**). Only Puhaceni substantially hiked irrigation fees in 2021, to help meet its fixed costs for the season. This increase occurred partway through the season but, unlike the increase in membership fees during the season, was not retroactive.

Figure IV.19. WUA irrigation fees, 2015–2022



Source: WUA administrative data (2015–2022).

Note: Blindesti, Grozesti, and Chircani-Zirnesti did not pump water in 2015 and therefore did not have an irrigation fee.

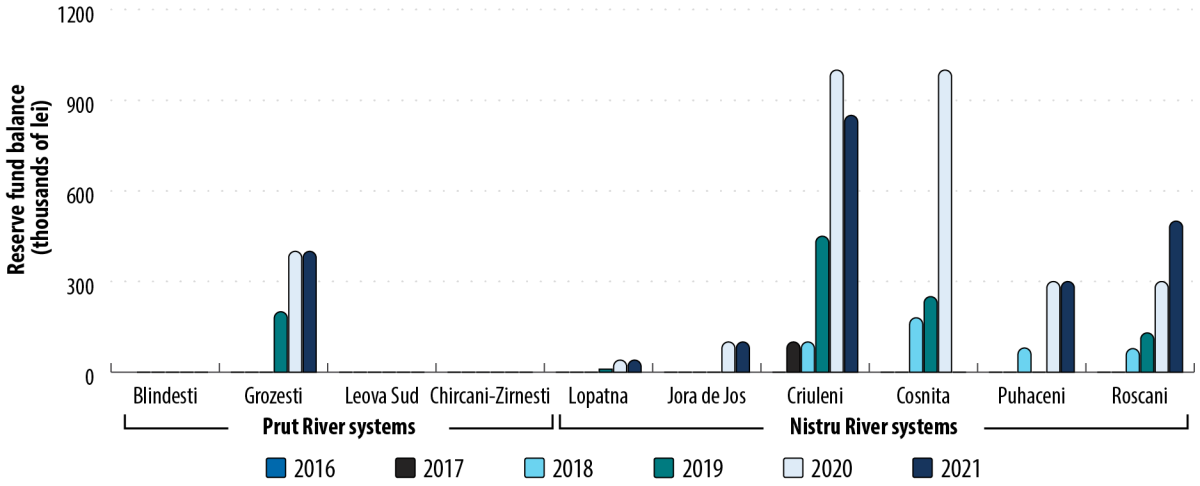
In contrast, six WUAs implemented an increase in irrigation fees of more than 10 percent in 2022. Together with Puhaceni, this implies that 7 of the 10 WUAs are charging substantially higher irrigation fees in the 2022 season than in the past. WUA directors attributed the increase in irrigation fees primarily to a large increase in the cost of electricity (as well as other costs like salaries, which have increased due to inflation and are partly covered by irrigation fees). Some WUA directors are concerned that, if the cost of electricity is sustained at a high level or increases further, irrigation water might become unaffordable for some existing or potential water users, as mentioned earlier.

High revenues in the 2020 drought season strengthened WUAs' financial positions; by the end of 2021, six WUAs had positive balances in their reserve funds, and none were in debt.

An important measure of a WUA's overall financial position is the balance in its reserve fund, which represents the financial buffer available to it. By the end of the 2019 season, WUAs in five systems (four on the Nistru River and Grozesti on the Prut River) had a positive balance in their reserve funds (**Figure IV.20**). As a result of increased revenues from irrigation fees, total revenues grew substantially in all systems from 2019 to 2020 (not shown), contributing to improvements in the reserve fund balances of several WUAs by the end of 2020.[34] Overall, 7 of the 10 WUAs had a substantial positive reserve fund balance by the end of 2020. As discussed earlier in this report, the Prut River systems (except for Grozesti) have a much smaller number of water users and pump a smaller volume of water, on average, than the Nistru River systems, which accounts for their lower overall level of reserves.

[34] The WUA in Blindesti reported a reserve fund of zero, the same as in 2019, but only because the WUA channeled its resources into the construction of new extension area infrastructure.

Figure IV.20. WUA reserve fund balance, 2016–2021



Source: SDA-Moldova.

However, all WUAs saw a substantial decrease in revenues between 2020 and 2021 because of the limited use of irrigation water in 2021. Specifically, revenues declined by almost two-thirds, on average, between 2020 and 2021. The average decrease in total revenues would have been even greater had some WUAs not raised their membership fees partway through the season, as discussed above. Nevertheless, at the end of 2021, 6 of the 10 WUAs still had a positive balance in their reserve funds.[35]

Almost all WUA directors in Project systems believed that their WUAs would be financially sustainable in the long run, but some were concerned by their low level of reserve funds.

WUA directors in Project systems believe that their WUAs can achieve financial sustainability by using surplus revenues from high-demand (low precipitation) years to cover deficits in low-demand (high precipitation) years—in some cases by adjusting their fees, as described earlier. However, several WUAs were concerned that this financial model had left them with limited (or zero) reserve funds to contribute to further infrastructure improvements or fund major repairs if they become necessary.

> "I think the WUA can be financially sustainable. With a reserve accumulated from the dry years, we can maintain the association in the years when people irrigate little. Practically, this is how it was in 2020 and 2021. We have the reserve with which we can survive until the start of the irrigation season."
>
> *– WUA director, Project system*

The extent to which Project WUAs can operate independently of support from SDA-Moldova is unclear.

Project WUAs continue to rely on SDA-Moldova for legal, accounting, technical, and financial support through 2022, seven seasons (years) after rehabilitation was completed. (The technical and financial support is related to infrastructure repairs and improvements, such as work to extend the reach of the systems in the extension areas, rather than routine operations.) This support was critical because the WUAs were new organizations that had little or no practical experience managing the rehabilitated systems at the end of the Compact, when system rehabilitation was completed. WUA directors

[35] The WUA in Cosnita had a large positive balance in previous years but had to deplete it in 2021 to raise the intake structures in the river to avoid them becoming clogged with sand.

highlighted their appreciation for the post-Compact support provided by SDA-Moldova and its importance to sustaining and improving their operations. Although this suggests that the establishment of SDA-Moldova was critical to the sustainability of the Project WUAs, it is unclear how long SDA-Moldova will continue to exist and who will provide this support in its stead.

3. Establishment and functioning of additional WUAs

Several additional WUAs have been established or reorganized since the end of the Compact and have completed management transfer; their formation was largely driven by farmers' desire to have irrigation water available for a lower price and in a timelier manner.

According to SDA-Moldova, by the end of 2021, there were 25 WUAs registered in Moldova in addition to the 10 that were established and had undergone management transfer through the Project (GoM 2021). A handful of these were established during the Compact—including the WUA in Cahul that was established as part of the Project but was inactive until recently—but most of them were established since 2018. By the end of 2021, 17 of these 25 WUAs had completed management transfer, and transfer was in process for the remainder, including Cahul. As mentioned earlier, we interviewed WUA directors and water users in six non-Project WUAs, which comprised one WUA that completed management transfer in 2014 (in Gura Bicului) and five WUAs that formed in 2018 or 2019 and had completed management transfer in 2020. Although this small sample is not representative of all non-Project WUAs, it provided valuable insights about the formation of these WUAs, how they function, and the key challenges and opportunities that they face.

In most of the systems in which these non-Project WUAs were formed, the state agency was previously providing water to farmers, primarily for the cultivation of HVA crops. However, farmers perceived the price of the state agency-provided water as high, which they attributed in part to an inefficiently large number of employees in the system and water loss from poorly maintained irrigation infrastructure.

> "[When the state agency was managing the system,] we were always short of water, or we were told that another farmer was irrigating at the time. Sometimes when I wanted to irrigate, something would go wrong with the system infrastructure or equipment and repairs would begin. I experienced only problems when I wanted to irrigate. For example, if I wanted to irrigate today, then only a week later would they provide me water. They were constantly saying that something was broken or there was no electricity, and so on."
>
> *– Water user, non-Project WUA*

Equipment breakdowns due to poor maintenance of the systems and slow repairs, together with occasional electricity cutoffs due to non-payment of electricity bills by the state agency, also meant that water was often unavailable when farmers needed it. Further, the existing irrigation infrastructure had degraded even further over the past few years (including because of theft), and the management of several WUAs mentioned that the GoM was planning to sell the equipment for scrap unless the systems were taken over by WUAs. This spurred farmers to form WUAs to protect the remaining infrastructure. The formation of these WUAs was initiated by a handful of founding members in each system, typically led by larger farmers who had the most to gain from improved access to irrigation.

The THVA Project supported the formation and operations of additional WUAs in several ways.

First, the WUAs were established under the legal framework of the WUA Law, which the Project helped develop. Second, the management of at least one of the non-Project WUAs conducted a formal visit to a Project WUA and held discussions with that WUA's management and water users, yielding valuable information and inspiration. Third, SDA-Moldova also played a critical role in helping the non-Project WUAs navigate the establishment and management transfer processes—especially by providing legal support—drawing on its staff's experience under MCA-Moldova during the Compact. The new WUAs consistently praised the support they received from SDA-Moldova, noting that it would have been challenging to undertake management transfer without it, given the legal complexities of the process. Beyond supporting WUA formation and management transfer, SDA-Moldova also provides other types of support to newly formed WUAs, including providing computing equipment and software, conducting geospatial mapping, offering training (in system operation and maintenance, budgeting and accounting, legal compliance, and so on), and providing co-funding and/or support for infrastructure improvements. This also suggests that it might be challenging to support the development of WUAs—or the creation of additional WUAs—without SDA-Moldova.

> "I can say that SDA-Moldova treated us very well, helped us, guided us. I am satisfied with the support provided by SDA, which was very helpful and constructive. With SDA support, a lot has been done, and the results can be seen."
>
> *– WUA director, non-Project WUA*

> "The Compact Project was the basis of the reform of the irrigation sector. This is where the reform started: the creation of associations and the attraction of investments."
>
> *– Ministry of Agriculture and Food Industry representative*

Many newly formed WUAs have a small number of water users but hope to attract more in the future—especially through infrastructure rehabilitation supported by international donors.

For example, four of the six non-Project WUAs we interviewed had between 2 and 10 water users each in the 2020 season. In some non-Project WUAs, the number of potential members is limited because only parts of the system are functioning, or the system is not pumping water at all. (Almost one-third of all non-Project WUAs were not pumping water as of 2021 because of the poor state of the infrastructure, but plan to protect the current infrastructure against further degradation and seek investments for rehabilitation or reconstruction [GoM 2021]). The directors of several of the non-Project WUAs we interviewed expressed optimism that—by demonstrating the effectiveness of the WUA-managed system and, critically, through infrastructure improvements to expand access to irrigation—WUAs will attract more users. Specifically, these WUAs have found or are seeking funding for infrastructure rehabilitation through SDA-Moldova and other donors like IFAD. The WUAs might also benefit from a new round of the World Bank's Moldovan Agricultural Competitiveness Project that includes 25 million dollars for irrigation system rehabilitation, as well as a large irrigation-related investment by the French Development Agency that is in the early stages of development. These investments could contribute to increasing the number of water users, which in turn could lead to decreases in the price of water due to economies of scale, attracting even more users. More broadly, the GoM recognizes the importance of irrigation for Moldovan agriculture and has been developing an irrigation strategy. However, the war in Ukraine has reoriented priorities to more pressing needs like alleviating the spike in energy prices, so the GoM resources available for irrigation-related investments might be limited in the short to medium term.

Several non-Project WUAs have a financial model that relies heavily on irrigation fees and deemphasizes membership fees.

Since the systems were rehabilitated, revenues from irrigation fees have made a substantially more important contribution to Project WUAs' revenues than membership fees, given low membership rates and challenges with non-payment of membership fees. Recognizing this reality, several non-Project WUAs have chosen to reduce the emphasis on membership fees (although they all maintain membership fees, which are required by the WUA Law). These WUAs charge very small, symbolic, membership fees, or levy membership fees based on area irrigated rather than area cultivated (which many farmers perceive to be fairer). These WUAs hope to accumulate enough surplus from irrigation fees in dry years when demand for water is high to cover deficits in rainy years and to fund repairs and improvements. Even non-Project WUAs that charge membership fees based on area cultivated noted that these fees are not sufficient to cover fixed costs in rainy years. To cover those costs, they need to rely on income from irrigation fees, draw on the surplus from dry years, or raise fees the next year. Relying almost exclusively on irrigation fees appears to have worked well in the long-term for the WUA in Gura Bicului, which was established during the Compact and is currently in a strong financial position with a large reserve fund. However, this WUA has a large and committed base of users who irrigate regularly; it is too early to assess whether newly formed non-Project WUAs with fewer members will be similarly financially sustainable. Fortunately, most newly formed WUAs started operating in the 2020 drought season when high demand for irrigation water led to high revenues, enabling them to accumulate a large reserve fund.

4. Reputation of Moldovan produce and exports

The reputation of Moldovan produce is closely linked to quality relative to export market requirements. As mentioned earlier, the exporters and farmers we interviewed thought that the quality of Moldovan produce had improved over the past decade, in part due to the adoption of irrigation, other modern technologies, and new varieties. However, there are still challenges in consistently and more broadly meeting some foreign buyers' strict and market-specific quality standards, especially EU buyers. For example, the EU buyer we interviewed suggested that Moldovan plums were well known in Germany because they are the only ones available in late fall. However, his Moldovan suppliers (individual farms) were unable to meet his packaging requirements, often provided fruit that was too soft given the German market's preference for hard fruit and lacked access to varieties of plums and table grapes that are in demand in the EU market. Further, other factors not directly related to produce quality that we discussed earlier—Russian bans on Moldovan produce, high costs of investing in new varieties, high transportation costs and long transport times, a lack of post-harvest infrastructure, and strict EU requirements— are important constraints to increasing Moldovan HVA exports.

5. Policy changes related to HVA

The Ministry of Agriculture and Food Industry has implemented several policies to support the growth of HVA over the past few years. Most directly related to the Project, there have been efforts to improve legislation and reduce administrative barriers in the irrigation sector. These include the following: (1) changes to the agricultural subsidy regime, including introducing state subsidies for irrigation equipment and extending electricity subsidies to cover a broader range of irrigated crops and more months in the agricultural season; (2) improvements to the process of issuing (or reissuing) water authorizations to WUAs; and (3) adjustments to the WUA Law that governs WUAs' activities, including allowing the formation of WUAs for small-scale irrigation from lakes and ponds and enabling WUAs to increase their revenue streams by selling water for non-irrigation purposes. The Ministry of Agriculture and Food Industry is also exploring policy options to obligate more farmers in the rehabilitated systems to

irrigate their land, although it recognizes that this is challenging and remains aspirational at present. These policy-related efforts—many of which are being implemented with the support and advice of SDA-Moldova—build on the work of the THVA Project to facilitate broader and longer-term changes in the Moldovan agricultural sector.

EQ #7: What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?

In this section we summarize some of the key lessons from the THVA Project that might be relevant to similar projects that are implemented in the future.

Key findings on lessons learned:

- System rehabilitation and irrigation management transfer addressed a major constraint to cultivating HVA crops; **effectively addressing other constraints might require an approach tailored to specific areas and farmers**.
- Many farmers did not follow through on their stated commitment to become active WUA members; future projects could consider **ways to assess and encourage farmers' commitment**, such as requiring an up-front payment.
- **Improving access to attractive markets might need an early and intense project focus** given the key role of market access in encouraging farmers to change their cultivation patterns.
- **Strong post-compact entities can substantially improve the sustainability of MCC's investments,** especially when critical components are only implemented late in the compact period.

System rehabilitation and irrigation management transfer addressed a major constraint to cultivating HVA crops; effectively addressing other constraints might require an approach tailored to specific areas and farmers.

The project logic anticipated that improving access to irrigation water would remove a key barrier to cultivating HVA crops, leading to a transition to irrigated HVA production. MCC's CBA model quantified the expected extent and speed of this transition separately for each system. However, there was less of a focus on how the envisaged transition to HVA might take place in each of these heterogenous systems, which varied substantially in terms of pre-Compact land consolidation, cropping patterns, and irrigation use. For example, in some of the Nistru River systems, the land was highly fragmented, and it was common for smaller farmers to irrigate vegetables through the partly functional pre-rehabilitation systems. The envisaged transition in these systems would likely require the remaining smaller farmers who were not already irrigating vegetables to start doing so or to rent out their land to others who would. In that case, the Project could have engaged agricultural behavior change experts to encourage these farmers to take up HVA cultivation and/or land experts to help facilitate land consolidation by HVA farmers. Further combining pressurized irrigation with gravity-fed irrigation, wherever feasible, might also have facilitated additional irrigation by smaller farmers. In contrast, in some of the Prut River systems, most of the land was already highly consolidated among large well-established non-HVA producers. A large-scale rapid transition to HVA would have required these few farmers to begin cultivating HVA, which they likely were not interested in doing given their investments in developing large-scale modern non-HVA farms (and other barriers to cultivating irrigated HVA crops discussed earlier). Overall, developing system-specific theories of change grounded in each system's context might have helped the Project better support the transition to HVA in some systems and identify others in which

it was unlikely to occur. (These theories of change could have been informed, for example, by a mapping of land use patterns or extensive qualitative data collection.)

Many farmers did not follow through on their stated commitment to become active WUA members; future projects could consider ways to assess and encourage farmers' commitment, such as requiring an up-front payment.

As part of the WUA establishment process, the Project conducted several community meetings in the selected systems and solicited written expressions of interest from farmers to become WUA members. However, there was no mechanism to ensure that farmers who expressed interest at that stage would follow through on their commitment by paying membership fees and irrigating through the WUA. As a result, many of the original members never irrigated through the WUAs, did not pay membership fees, and were subsequently excluded from the WUAs. This left many WUAs reliant on a much smaller user base that irrigated much less land than anticipated. One approach to address this would have been to make WUA membership and fee payment compulsory, but this was unlikely to be feasible. An alternative would be to require farmers to make an up-front payment—framed, for example, as a small co-investment or advance payment of membership fees for the first season— to demonstrate their commitment to the WUA. Systems in which few farmers—especially large farmers accounting for a large area of land—were willing to make that financial commitment might not have been good candidates for rehabilitation. Although it might have been challenging to convince farmers to make this commitment, it would likely have given a more reliable sense of the likely uptake of irrigation than a simple expression of interest that farmers could abrogate at no cost.

Improving access to attractive markets is key to encouraging farmers to change their cultivation patterns and might need an early and intense project focus.

Limited access to attractive markets was consistently cited by farmers and other stakeholders as one of the main barriers to HVA adoption in the rehabilitated systems. As discussed earlier, smaller HVA producers lack access to domestic retail and export markets, and structures to coordinate marketing among Moldovan producers are still limited. Although the Project's GHS Activity explicitly aimed to improve market linkages for HVA producers and help them meet buyer requirements, it was geographically diffuse rather than specifically aimed at farmers in the rehabilitated systems (**Figure IV.2**). A more strategic and focused effort to leverage existing market opportunities for HVA farmers in the rehabilitated systems might have helped encourage more farmers to transition to HVA crops. These opportunities could have included, for example, supporting and formalizing coordination among small-scale vegetable producers to access the domestic retail market, helping larger fruit producers obtain certifications required by EU buyers, and supporting the aggregation of production from smaller fruit producers by exporters.[36] (Although system rehabilitation was only completed towards the end of the Compact, these system-specific market linkage efforts could have been implemented in systems that were already partly functioning before rehabilitation and had HVA cultivation, like many of the Nistru River systems.) Local market studies of the main HVA value chains in the rehabilitated systems conducted at the outset of the Project might have helped identify these market opportunities. Some systems in which there were no feasible attractive markets might not have been good candidates for rehabilitation.

[36] USAID's High Value Agriculture Activity in Moldova has supported some of these efforts in the post-Compact period, although they have not focused specifically on farmers in the rehabilitated systems. For example, the High Value Agriculture Activity supported the Moldova Fruct Association in assisting fruit producers obtain GLOBALG.A.P. or equivalent certifications.

Strong post-compact entities can substantially improve the sustainability of MCC's investments, especially when critical components are only implemented late in the five-year compact period.

The establishment of SDA-Moldova as a post-compact entity has proved critical to sustaining the Project WUAs since the end of the Compact, as well as in supporting the scale-up of the Project's WUA model to additional systems. Many SDA-Moldova staff—including its leadership—were also part of MCA-Moldova during Project implementation. These staff brought their knowledge of the Project and context, strong relationships with government entities, and commitment to the Project's success to bear in the post-Compact period. SDA-Moldova's support was especially critical because the systems were only rehabilitated towards the end of the Compact given delays in construction, so the new WUAs had little or no practical experience managing the systems before Compact Closeout. Although the continued engagement of SDA-Moldova raises questions about the WUAs' ability to operate independently in the future, many WUA directors believe that, without SDA-Moldova's post-compact support, the WUAs might have struggled to survive at all.

EQ #8: What is the ex-post ERR of the THVA Project?

As mentioned in Chapter I, MCC's Compact Closeout CBA model estimated an ERR of negative 5.5 percent. MCC has commissioned a new CBA drawing on the evaluation findings, which is currently in process. Below, we use findings from the evaluation to suggest how the ERR is likely to change.

Key finding on the costs and benefits of the Project:

- The **ex-post ERR of the Project is likely to be lower** than the negative 5.5 percent estimated in MCC's Compact Closeout CBA model because the CBA model **overestimated the extent of irrigation use.**

The ex-post ERR of the Project is likely to be lower than the negative 5.5 percent estimated in MCC's Compact Closeout CBA model.

As discussed under **EQ #1**, the area irrigated in the rehabilitated systems—which is directly connected to the estimated benefits of the Project—has fallen short of the Compact Closeout CBA projections. There has also been considerable variation in area irrigated from year to year, which was not explicitly modeled in the CBA. Overall, whereas the CBA model projected that irrigated area would increase rapidly after the end of the Compact and be sustained at a high level, in practice, it increased more gradually initially and has not reached the expected levels, particularly in rainy years. This is in part because the model predicted higher levels of irrigation use in extension areas than has been observed to date. Because irrigation use has not occurred to the extent anticipated, the Project ERR is likely lower than that estimated by MCC at Compact Closeout.

V. Conclusion

In this report, we have discussed the key findings of the evaluation of the Moldova THVA Project, as assessed more than six full seasons after the end of the Compact. In this chapter, we summarize the findings for each evaluation question and discuss their broader implications.

A. Summary of findings

Below we summarize the key findings related to each of the EQs (**Table V.1**). Overall, the findings suggest that the THVA Project successfully met one part of its objective, to "catalyze future investments in HVA by establishing a successful and sustainable model of irrigation system and water resource management and a conducive institutional and policy environment for irrigated agriculture." Specifically, the Project successfully established and transferred management to 10 WUAs that have been sustained several years after the end of the Compact, are effectively managing irrigation in their systems, and have spurred broader adoption of the WUA model in Moldova.

However, in the 10 rehabilitated systems, the Project is unlikely to have met the other part of its objective, which was to "increase rural incomes by stimulating growth in irrigated HVA," given that it did not achieve most of the key related outcomes expected in the project logic (**Table V.2**). Although the Project led to increases in irrigation use and HVA cultivation, the transition to irrigated HVA crops in the rehabilitated systems did not occur to the extent envisaged and the Project's investments in those systems mostly benefitted a relatively small group of farmers. As a result, the Project is unlikely to have been economically justified according to MCC's Compact Closeout CBA model, in which expected income benefits were driven by a widespread transition to HVA. Lack of access to attractive sales markets for most farmers and a shortage of rural agricultural labor were key barriers to achieving the expected outcomes. The broader context of a declining interest in small-scale agriculture—in part due to increased employment opportunities in the EU and higher real wages for paid employment in Moldova—also did not support the envisaged changes.

Table V.1. Summary of findings by evaluation question

Evaluation question	Key findings
EQ #1: Were the expected results realized from the THVA project logic?	More than six seasons after the end of the Compact, the Project WUAs are effectively managing and maintaining rehabilitated irrigation systems. The systems are all functioning well and have substantially improved farmers' access to irrigation water; they were used to irrigate 3,790 hectares of land in 2020, the highest-use season since system rehabilitation. Though there have been measurable changes as a result of the Project, many of the medium-term outcomes envisioned in the project logic have fallen short of expectations—including the extent of irrigation use in the rehabilitated systems—and the transition to irrigated HVA crops has not occurred to the extent envisaged.
EQ #2: How are the results from the Project distributed?	The direct benefits of improved access to irrigation through the rehabilitated systems have accrued to a relatively small group of farmers. There is little evidence that the Project increased the quantity of farm labor employed or wages paid to laborers.

Evaluation question	Key findings
EQ #3: How did the THVA Project affect land ownership, leasing, and land values in the centralized irrigation system and extension areas?	There has been ongoing land consolidation to varying degrees in most Project systems since the end of the Compact; however, these changes also occurred in non-Project systems. External factors likely drove most of the increase in land rental prices, although the Project likely contributed to the increase in sales prices in the rehabilitated systems.
EQ #4: If results were not realized, why not? What are the characteristics of systems in which irrigation use increased the most? The least?	Variation in irrigation use across systems can be traced to farmers' experience cultivating HVA crops, farmers' linkages to markets, and the presence of a core group of water users who are committed to irrigating regularly. Limited access to sales markets and lack of farm labor are the main barriers to more farmers cultivating HVA. The broader context of a declining interest in small-scale agriculture because of external factors also did not support the envisaged changes. A lack of WUA-operated irrigation equipment constrained irrigation in some systems in the high-demand 2020 drought season.
EQ #5: What was the contribution of each activity/sub-activity to the results that were realized?	The Irrigation Management Transfer Sub-activity made an important contribution to Project results, with WUAs providing tangible benefits to farmers. CISRA's rehabilitation of dilapidated infrastructure made a critical contribution to Project results. The AAF Activity had limited effects on water users in the rehabilitated systems and it is unlikely that GHS trainings led many water users to transition to irrigated HVA production.
EQ #6: Are there indications that some of the long-term outcomes will be realized?	Farmers who irrigated through the rehabilitated systems have generally found it profitable to do so, despite increased input and investment costs. WUA directors believe that the 10 Project WUAs can be financially sustainable in the long run by using surpluses in high-demand years to cover deficits in low-demand years and by dynamically adjusting membership fees to cover remaining gaps in resources. However, some WUAs are concerned by their low level of reserve funds, and the extent to which Project WUAs can operate independently of support from SDA-Moldova is unclear. The THVA Project spurred the establishment or reorganization of 25 additional WUAs since the end of the Compact; some have found or are seeking funding for partial infrastructure rehabilitation from SDA-Moldova and international donors.
EQ #7: What lessons can be drawn from analysis of the design, implementation, and results of the THVA Project?	System rehabilitation and irrigation management transfer addressed a major constraint to cultivating HVA crops; effectively addressing other constraints might require an approach tailored to specific areas and farmers. Future projects could consider ways to assess farmers' commitment to becoming active WUA members, such as requiring an up-front payment. Improving access to attractive markets might need an early and intense project focus. Strong post-compact entities can substantially improve the sustainability of MCC's investments.
EQ #8: What is the ex-post ERR of the THVA Project?	The ex-post ERR of the Project is likely to be lower than the negative 5.5 percent estimated in MCC's Compact Closeout CBA model.

Table V.2. Findings on achievement of medium- and long-term outcomes in the project logic

Key: ✓ = achieved; ◔ = partly achieved or evidence is mixed; ⊖ = not achieved

Project component	Outcome		Achievement
Medium-term outcomes			
ISRA	Improved decision-making by GoM using RBM tools for water resource planning	◔	Moldova is developing second RBM plans for both rivers, building on those developed during the Compact. However, the common platforms for water management and decision-making developed during the Compact have not been sustained.
CISRA	Improved management, use, and maintenance of centralized irrigation system infrastructure; increased irrigated land; increased investment in HVA crops	◔	The rehabilitated systems are being well managed and maintained by WUAs, but the increases in irrigated area and irrigated HVA have fallen short of expectations.
GHS	Increased producer application of HVA practices, including irrigation	◔	The fraction of water users that is likely to have adopted new agricultural practices as a result of participating in GHS training is relatively low.
GHS	Sustainable marketing cooperatives or associations formed by farmers	⊖	Associations or cooperatives focused on collective marketing remain uncommon in Moldova, and few water users in the rehabilitated systems were members of any type of cooperative or association (other than the WUA).
GHS	Improved regulations resulting in reduced costs for producers	◔	Phytosanitary certification for export is more straightforward than in the past, but stringent certification requirements from EU buyers are costly for farmers to meet. Sector-level farmer associations have successfully lobbied for some regulatory changes.
AAF	Additional investment in post-harvest infrastructure from AAF demonstration effect; increased produce passing through cold storage	⊖	Although AAF was beneficial for loan recipients, there is little evidence that it had a broader demonstration effect—especially in the Project systems, where use of post-harvest infrastructure like cold storage by water users remains limited.
AAF	Increased jobs	N/A	It is difficult to assess this outcome based on the limited data available. Most of the eight AAF loan recipients we interviewed reported increases in permanent staff and seasonal laborers, but this is a small non-representative sample and the magnitude of the increases varied substantially.
Multiple	Increased production of intensive and non-intensive HVA	◔	The area of irrigated HVA crops increased since the end of the Compact but has fallen short of expectations, and few farmers are irrigating intensive HVA crops.

Project component	Outcome		Achievement
Multiple	Higher prices received due to quality and off-season sales	✓	The quality of Moldovan produce has improved in recent years due to the adoption of irrigation and modern technologies, and there has been a broadly positive trend in prices as a result. Farmers with cold storage have benefitted from off-season sales, but many farmers—especially small ones—still have limited access to cold storage.
Multiple	Increased HVA sales to domestic and export markets	◔	There are more opportunities for sales of HVA crops to domestic retailers as those retailers expand. However, there are also several constraints, such as lack of access to cold storage, incompatibility of volumes offered and demanded, and perceived unfavorable contract conditions. Overall, the domestic market remains small and is affected by competition from cheap imports. In aggregate, there has been a positive trend in the value of Moldovan fruit exports over the past decade and increasing opportunities in the EU market. However, only larger farmers have the capacity and resources to benefit directly from these opportunities.
Long-term outcomes			
Multiple	Improved reputation of Moldovan produce and exports	◔	The reputation of Moldovan produce is closely linked to the quality, which has improved over the past decade, in part due to the adoption of irrigation and modern technologies. However, there are still challenges in consistently and more broadly meeting some foreign buyers' strict and market-specific quality standards, especially for EU buyers. Further, other factors not directly related to produce quality, like Russian bans on Moldovan produce, high costs of investing in new varieties, high transportation costs and long transport times, a lack of post-harvest infrastructure, and strict EU requirements constrain increases in HVA exports.
Multiple	Policies enacted by the GoM to support the growth of HVA	✓	The GoM is enacting several policy and regulatory changes in the irrigation sector that build on the THVA Project. These include improvements to the agricultural subsidy regime, clarifications to the process of issuing water authorizations to WUAs, and adjustments to the WUA Law that governs WUAs' activities.
Multiple	Additional public and private investments in irrigation and HVA production because THVA created a successful and sustainable model.	✓	An additional 25 WUAs have been established or reorganized since the end of the Compact and have undergone—or are in the process of—management transfer, following the Project model. Some have obtained and/or are seeking funding to improve the irrigation infrastructure in their systems; new projects by international donors might provide additional funding sources, but not yet at the scale of the Compact investments. Additional large-scale and costly investments in irrigation infrastructure are still required for these WUAs to expand their user base and realize their potential.
Multiple	Increased farm and household income	⛔	Farmers who irrigated through the rehabilitated systems have generally found it profitable to do so, despite increased input and investment costs. But, given the small number of water users, these benefits have not been widespread.

B. Implications

The THVA Project sought to address numerous constraints to the transition to HVA by improving access to reliable irrigation (through ISRA and CISRA), expanding access to domestic and export markets (through the GHS Activity), providing access to finance (through the AAF Activity), and increasing farmer knowledge (through the GHS Activity), among other activities. The experience of the THVA Project illustrates how challenging it can be to achieve substantial changes in farmer behavior when there are many constraints affecting farmers' irrigation use and crop choice. The findings suggest that future agriculture projects can take several steps—closely linked to the lessons in **Table V.1** (**EQ #7**)—to increase the likelihood of these changes:

- **Develop a clear, location-specific theory of how envisaged changes in irrigation use and cropping patterns might occur and design additional tailored interventions to support those changes.** This might include targeting certain types of farmers or geographies with interventions to address constraints specific to their irrigation and cropping choices. Even in a country as small as Moldova, there is sufficient heterogeneity across geographic areas to justify this type of tailored approach. For example, a different approach might have been needed in a system with many small farmers already cultivating vegetables versus one in which most of the land was operated by large corn farms. This approach might also have helped better identify systems in which the envisaged changes were unlikely to occur.
- **Implement mechanisms that increase the commitment of farmers to participate in new farmer organizations like WUAs,** such as requiring farmers to make an affordable up-front financial investment before the project moves forward. These mechanisms would have to be carefully calibrated to improve farmers' commitment while not being overly burdensome. But they could help identify areas in which farmer commitment to the project is low, to avoid investing heavily in farmer organizations that are unlikely to have a broad base of support.
- **Maintain a strong focus from the outset on expanding access to domestic and export markets,** as market access is closely intertwined with crop choice and irrigation use. Market studies of specific value chains in specific areas might be helpful in developing tailored interventions that leverage available market opportunities. In cases in which existing market opportunities are limited, an agriculture project might not be successful in changing farmer behavior absent more intensive market-focused interventions (for example, formation of farmer producer groups to access previously inaccessible markets).
- **Build in the post-project support that new farmer organizations like WUAs need** for the first several years after they begin to function. The five-year implementation period that MCC compacts and many other donor projects follow is likely too short for these new organizations to be self-sufficient by the end of the project; for new organizations to be effective, they need additional support and practical experience.

Together, these steps could contribute to future agriculture projects achieving their goals of increasing farmer profits and income, thereby reducing rural poverty.

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Appendix A. THVA project logic model assumptions

Table A.1. 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 centralized irrigation system 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

Appendix B. Data collected to inform the THVA Project evaluation

Table B.1. Data collected to inform the THVA Project evaluation

Data type	Data collection efforts
Qualitative data	• Interviews and/or focus groups with **farmers, WUA representatives, and/or mayors in rehabilitated systems** (2012, 2013, 2014, 2017, and 2021 agricultural seasons) • Interviews with **other informants related to ISRA-CISRA and the GHS Activity** (2012, 2013, and 2021 agricultural seasons) • Interviews with **beneficiaries of the AAF and GHS Activities and with GHS-related market informants** (2012, 2014, and 2021 agricultural seasons) • Interviews with **AAF non-beneficiaries and commercial banks** (2015 agricultural season) • Interviews with f**armers and mayors/local government authorities in comparison systems** (2012 and 2020 agricultural seasons) • Interviews with **water users and representatives of non-Project WUAs** (2020 agricultural season) • Interviews with **high-level stakeholders** (2013, 2014, 2015, 2017, and 2021 agricultural seasons)
Survey data	• **Farm Operator Survey,** first baseline (2012 agricultural season) • **Farm Operator Survey,** second baseline (2013 agricultural season) • **Farm Operator Survey,** Compact Closeout round (2014 agricultural season, rehabilitated systems only) • **Access to Agricultural Finance Survey** (2015) • **Water User Survey** (2020 agricultural season)
Administrative data	• **WUA administrative data** (2015, 2016, 2017, 2018, 2019, 2020, and 2021 agricultural seasons) • **AAF loan applications and administrative data** from the Credit Line Directorate (2012–2015) • **Administrative data** from 2KR (2015–2017) • **Administrative data from Apele Moldovei** (2019, 2020, and 2021 agricultural seasons)

WUA = Water User Association; ISRA = Irrigation Sector Report Activity; CISRA = Centralized Irrigation System Rehabilitation Activity; GHS = Growing High-Value Agriculture Sales; AAF = Access to Agricultural Finance; 2KR = Grant Assistance for the Food Security Project for Underprivileged Farmers

Appendix C. Findings from WUA administrative data

Table C.1. Volume of water pumped and number of water users by system, 2016–2021

	Volume of water pumped (thousands of cubic meters)						Number of water users					
System	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Prut River systems												
Blindesti	2	49	117	114	378	100	1	1	2	7	16	12
Grozesti	213	121	184	300	558	112	12	7	11	13	39	16
Leova Sud	15	21	0	0	99	5	4	2	0	0	1	2
Chircani-Zirnesti	21	26	13	9	102	23	5	2	2	1	10	1
Total (Prut)	252	218	314	424	1,137	240	22	12	15	21	66	31
Nistru River systems												
Lopatna	39	35	29	41	119	23	18	14	14	15	19	12
Jora de Jos	57	203	151	116	340	80	14	14	16	16	12	3
Criuleni	216	154	218	221	615	150	15	15	14	20	24	16
Cosnita	500	660	811	884	1,661	346	40	44	65	56	85	46
Puhaceni	165	194	192	227	471	144	133	104	86	74	84	63
Roscani	218	222	413	403	771	266	10	13	16	12	25	12
Total (Nistru)	1,195	1,468	1,813	1,892	3,978	1,009	230	204	211	193	249	152
Total (all systems)	**1,447**	**1,686**	**2,127**	**2,316**	**5,115**	**1,250**	**252**	**216**	**226**	**214**	**315[a]**	**183[b]**

Source: WUA administrative data (2016–2021).

Note: The number of users and volume of water pumped includes extension areas.

[a] SDA-Moldova reported 319 water users in 2020.

[b] SDA-Moldova reported 182 water users in 2021.

Table C.2. Volume of water pumped by user and system, 2020

System	Volume of water pumped (thousands of cubic meters)						
	1st largest user	2nd largest user	3rd largest user	4th largest user	5th largest user	All other users	Total
Prut River systems							
Blindesti	119	41	37	36	35	110	378
Grozesti	213	88	77	55	41	84	558
Leova Sud	99	0	0	0	0	0	99
Chircani-Zirnesti	50	19	8	8	7	10	102
Nistru River systems							
Lopatna	49	23	19	7	6	15	119
Jora de Jos	255	29	23	10	6	17	340
Criuleni	106	85	80	70	46	228	615
Cosnita	346	227	142	123	114	709	1,661
Puhaceni	50	46	38	29	28	280	471
Roscani	148	141	75	69	46	292	771

Source: WUA administrative data (2020).

Note: The volume of water pumped includes extension areas.

Table C.3. Area irrigated in the command area by system, 2016–2021

System	Area irrigated in the command area (hectares)						Total irrigable command area (hectares)
	2016	2017	2018	2019	2020	2021	
Prut River systems							
Blindesti	NA	NA	55	67	130	60	587
Grozesti	NA	NA	308	369	474	172	1,100
Leova Sud	NA	NA	0	0	193	8	980
Chircani-Zirnesti	NA	NA	17	7	291	0	3,367
Total (Prut)	NA	NA	380	443	1,088	240	6,034
Nistru River systems							
Lopatna	NA	NA	30	32	83	35	506
Jora de Jos	NA	NA	76	50	215	106	1,270
Criuleni	NA	NA	80	83	329	78	764
Cosnita	NA	NA	426	487	865	419	2,483
Puhaceni	NA	NA	126	139	281	118	920
Roscani	NA	NA	188	231	304	158	853
Total (Nistru)	NA	NA	926	1,022	2,077	914	6,796
Total (all systems)	**NA**	**NA**	**1,306**	**1,465**	**3,166**	**1,154**	**12,830**

Source: WUA administrative data (2016–2021).

Note: Area irrigated is rounded to the nearest whole number. The area irrigated in 2016 and 2017 is only available for the command and extension areas together (Table C.5).

NA = not available.

Table C.4. Area irrigated in the extension area by system, 2016–2021

System	Area irrigated in the extension area (hectares)					
	2016	2017	2018	2019	2020	2021
Prut River systems						
Blindesti	NA	NA	58	46	82	23
Grozesti	NA	NA	4	0	0	0
Leova Sud	NA	NA	0	0	0	0
Chircani-Zirnesti	NA	NA	0	0	0	16
Total (Prut)	NA	NA	62	46	82	39
Nistru River systems						
Lopatna	NA	NA	0	0	0	0
Jora de Jos	NA	NA	174	148	201	39
Criuleni	NA	NA	84	97	112	125
Cosnita	NA	NA	150	184	199	185
Puhaceni	NA	NA	0	0	15	20
Roscani	NA	NA	5	7	16	51
Total (Nistru)	NA	NA	413	436	543	420
Total (all systems)	**NA**	**NA**	**475**	**482**	**625**	**459**

Source: WUA administrative data (2016–2021).

Note: Area irrigated is rounded to the nearest whole number. The area irrigated in 2016 and 2017 is only available for the command and extension areas together (Table C.5).

NA = not available.

Table C.5. Total area irrigated by system, 2016–2021

System	Area irrigated in command and extension areas (hectares)					
	2016	2017	2018	2019	2020	2021
Prut River systems						
Blindesti	0	43	113	113	212	83
Grozesti	115	238	312	369	474	172
Leova Sud	13	30	0	0	193	8
Chircani-Zirnesti	20	80	17	7	291	16
Total (Prut)	148	391	442	489	1,170	279
Nistru River systems						
Lopatna	54	58	30	32	83	35
Jora de Jos	41	267	250	198	416	145
Criuleni	135	130	164	180	441	204
Cosnita	473	536	576	671	1,064	604
Puhaceni	87	100	126	139	296	138
Roscani	196	198	193	237	320	209
Total (Nistru)	986	1,289	1,339	1,457	2,620	1,335
Total (all systems)	**1,134[a]**	**1,679**	**1,781[b]**	**1,946**	**3,790**	**1,612**

Source: WUA administrative data (2016–2021).

Note: Area irrigated is rounded to the nearest whole number and might differ slightly from the sum of the areas irrigated within and across systems because of rounding.

[a] SDA-Moldova reported a total of 1,170 hectares irrigated in 2016.

[b] SDA-Moldova reported a total of 1,770 hectares irrigated in 2018.

Table C.6. Number of WUA members by system, 2015–2021

System	Number of members						
	2015	2016	2017	2018	2019	2020	2021
Prut River systems							
Blindesti	32	30	30	85	11	17	21
Grozesti	829	757	230	139	76	92	127
Leova Sud	1,036	1,036	1,036	557	57	23	20
Chircani-Zirnesti	1,472	1,533	1,461	39	21	21	21
Total (Prut)	3,369	3,356	2,757	820	165	153	189
Nistru River systems							
Lopatna	527	527	146	126	28	35	35
Jora de Jos	509	276	276	247	27	27	27
Criuleni	901	421	401	46	46	48	29
Cosnita	2,980	152	164	171	145	143	146
Puhaceni	2,129	2,690	2,110	427	225	180	171
Roscani	724	57	62	61	61	63	63
Total (Nistru)	7,770	4,123	3,159	1,078	532	496	471
Total (all systems)	**11,139**	**7,479**	**5,916**	**1,898**	**697**	**649**	**660**

Source: WUA administrative data (2015–2017) and SDA-Moldova (2018–2021).

Table C.7. WUA membership and irrigation fees, 2015–2022

	Membership fee (lei per hectare)								Irrigation fee (lei per cubic meter)							
System	2015	2016	2017	2018	2019	2020	2021	2022	2015	2016	2017	2018	2019	2020	2021	2022
Prut River systems																
Blindesti	700	450	350	350	350	400	600	1,500	4.50	4.50	4.50	4.50	4.50	5.55	5.00	5.30
Grozesti	241	240	280	280	280	280	830	500	NA	3.50	4.50	4.50	4.50	4.50	4.75	5.00
Leova Sud	343	110	350	457	300	300	300	1,000	NA	3.90	3.72	4.64	6.30	5.10	5.10	3.00
Chircani-Zirnesti	170	183	183	190	230	270	240	317	NA	3.00	3.10	3.30	3.30	3.50	3.30	3.86
Nistru River systems																
Lopatna	200	200	400	400	400	400	400	400	3.50	3.50	3.50	4.00	4.00	4.00	4.00	5.50
Jora de Jos	271	250	300	300	300	350	520	350	3.00	3.70	4.50	4.50	5.60	5.80	5.80	7.00
Criuleni	262	200	200	200	200	200	200	430	2.85	2.85	3.00	3.50	3.80	3.80	3.50	4.00
Cosnita	314	290	300	260	240	240	660	400	NA	3.00	2.80	3.00	3.00	3.00	3.00	4.00
Puhaceni	200	200	200	200	200	200	400	400	2.20	3.00	3.30	3.60	3.60	3.60	5.60	4.40
Roscani	100	100	200	200	200	210	210	210	3.26	3.26	3.26	3.75	3.75	3.65	3.65	4.10

Source: WUA administrative data (2015–2022).

Notes: Between 2018 and 2022, irrigation fees for Criuleni were higher in one part of the system that is located at a higher altitude due to higher marginal electricity costs of pumping water there (4.27 lei in 2018; 4.60 lei in 2019, 2020, and 2021; and 5.0 lei in 2022). Similarly, in Jora de Jos, irrigation fees in one part of the system were higher than in the rest of the system (7.00 in 2020 and 2021, and 8.00 in 2022).

Table C.8. WUA revenues, 2016–2021

	Revenues from membership fees (thousands of lei)						Revenues from irrigation fees (thousands of lei)						Other revenues (thousands of lei)						Total revenues (thousands of lei)					
System	2016	2017	2018	2019	2020	2021	2016	2017	2018	2019	2020	2021	2016	2017	2018	2019	2020	2021	2016	2017	2018	2019	2020	2021
Prut River systems																								
Blindesti	66	74	47	54	125	167	9	238	528	514	2,100	501	0	22	78	53	16	20	75	624	653	622	2,242	689
Grozesti	120	190	204	218	297	386	756	546	821	1,352	2,509	534	0	9	17	28	116	36	876	1,020	1,043	1,598	2,922	955
Leova Sud	134	309	284	192	213	217	61	246	0	0	505	24	8	6	0	0	40	13	202	315	284	192	758	254
Chircani-Zirnesti	473	274	384	451	475	629	75	82	40	31	356	78	192	117	13	0	113	12	740	430	436	482	944	720
Nistru River systems																								
Lopatna	31	58	91	68	54	90	125	117	116	163	478	93	0	0	0	1	9	0	156	174	207	232	541	183
Jora de Jos	85	195	157	179	232	259	210	911	677	580	2,023	396	11	19	32	38	26	0	306	892	867	797	2,280	655
Criuleni	42	82	62	58	97	91	616	476	758	841	2,377	539	18	35	20	48	133	6	676	875	840	947	2,607	636
Cosnita	182	217	234	199	285	452	1,500	1,847	2,433	2,651	4,985	1041	45	65	90	232	239	38	1,728	2,129	2,757	3,083	5,510	1,532
Puhaceni	54	47	52	38	75	128	496	641	684	817	1,697	645	9	32	30	71	120	21	560	763	765	926	1,892	794
Roscani	38	70	100	71	96	117	717	784	1,549	1,533	2,849	952	21	18	19	96	174	67	776	1,637	1,668	1,700	3,119	1,136

Source: WUA administrative data (2016–2021).

Note: Total revenues might differ slightly from the sum of the various sources of revenue because of rounding.

Table C.9. WUA reserve fund balance, 2016–2021

	Reserve fund balance at the end of the season (thousands of lei)					
System	2016	2017	2018	2019	2020	2021
Prut River systems						
Blindesti	0	0	0	0	0	0
Grozesti	0	0	0	200	400	400
Leova Sud	0	0	0	0	0	0
Chircani-Zirnesti	0	0	0	0	0	0
Nistru River systems						
Lopatna	0	0	0	10	40	40
Jora de Jos	0	0	0	0	100	100
Criuleni	0	100	100	450	1,000	850
Cosnita	0	0	180	250	1,000	0
Puhaceni	0	0	80	0	300	300
Roscani	0	0	78	130	300	500

Source: SDA-Moldova (2016–2021).

Appendix D. Findings from the Water User Survey

Table D.1. Farm characteristics, 2020 water users

	All water users	Prut River water users	Nistru River water users
Farm management			
Household or individual	84.3%	71.9%	87.5%
Enterprise	15.1%	28.1%	11.7%
Other	0.6%	0.0%	0.8%
Farm owners or operators			
Number of owners or operators			
1	43.2%	62.5%	38.1%
2	42.2%	32.8%	44.8%
3 or more	14.5%	4.7%	17.2%
Any female owners or operators	55.5%	38.1%	60.1%
All owners or operators are female	5.6%	11.1%	4.2%
Any owners or operators below age 40	33.1%	28.6%	34.3%
Farm operations			
Land operated overall in 2020			
Mean (ha)	72.3	185.4	42.0
Median (ha)	3.9	4.8	3.9
< 1 ha	17.8%	23.4%	16.3%
1 – 5 ha	37.0%	26.6%	39.7%
5 – 10 ha	13.9%	7.8%	15.5%
10 – 100 ha	21.5%	25.0%	20.5%
> 100 ha	9.9%	17.2%	7.9%
Land operated in the area in 2020			
Mean (ha)	25.2	74.1	12.2
Median (ha)	2.3	2.9	2.2
< 1 ha	35.4%	37.5%	34.9%
1 – 5 ha	28.2%	17.2%	31.1%
5 – 10 ha	12.8%	12.5%	12.9%
10 – 100 ha	19.0%	18.8%	19.1%
> 100 ha	4.6%	14.1%	2.1%
Among household farms	*N = 258*	*N = 46*	*N = 212*
Agricultural activity is main source of household income	62.0%	32.6%	68.4%

Source: Water User Survey (2020 Season).

Notes: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Sample sizes for statistics drawn from the full sample are 299–312 (all water users), 63–64 (Prut River water users), and 236–248 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

Table D.2. Farm experience, 2020 water users

	All water users	Prut River water users	Nistru River water users
First season operated in the area			
2010 or earlier	57.7%	54.7%	58.5%
2011 through 2014	5.1%	6.3%	4.8%
2015	12.2%	4.7%	14.1%
2016 or later	25.0%	34.4%	22.6%
Irrigated land before the system was rehabilitated	38.4%	10.9%	45.6%
Among farms that operated in the system in 2014 or earlier	*N = 190*	*N = 39*	*N = 151*
Operated more land in 2020 than 2014	30.5%	23.1%	32.5%
Operated same area of land in 2020 as 2014	63.7%	74.4%	60.9%
Operated less land in 2020 than 2014	5.8%	2.6%	6.6%

Source: Water User Survey (2020 Season).

Notes: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Sample sizes for statistics drawn from the full sample are 305–312 (all water users), 64 (Prut River water users), and 241–248 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

Table D.3. WUA membership and use of irrigation water in the 2020 agricultural season, 2020 water users

	All water users	Prut River water users	Nistru River water users
WUA membership			
Member of the WUA in 2020	99.7%	100.0%	99.6%
Among members:	*N = 303*	*N = 64*	*N = 239*
Year in which joined the WUA			
Before 2015	5.0%	0.0%	6.3%
2015	59.1%	26.6%	67.8%
After 2015	36.0%	73.4%	25.9%
Use of WUA-provided irrigation water in 2020			
Volume (median, cubic meters/ha)	1,162	549	1,357
Location of irrigated land			
Command area only	90.1%	92.2%	89.5%
Command area and extension area	4.8%	1.6%	5.6%
Extension area only	5.1%	6.3%	4.8%
Satisfaction with WUA-provided water			
Satisfied with ease of working with WUA			
Totally or somewhat satisfied	93.1%	96.9%	92.1%
Neither satisfied nor unsatisfied	3.9%	3.1%	4.2%
Totally or somewhat unsatisfied	3.0%	0.0%	3.8%
Satisfied with cost or affordability of water			
Totally or somewhat satisfied	82.9%	82.8%	82.9%
Neither satisfied nor unsatisfied	8.6%	9.4%	8.3%
Totally or somewhat unsatisfied	8.6%	7.8%	8.7%
Satisfied with timeliness of water delivery			
Totally or somewhat satisfied	89.8%	96.9%	87.9%
Neither satisfied nor unsatisfied	5.6%	3.1%	6.3%
Totally or somewhat unsatisfied	4.6%	0.0%	5.8%

Source: Water User Survey (2020 Season).

Notes: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Sample sizes for statistics drawn from the full sample are 304–312 (all water users), 64 (Prut River water users), and 240–248 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

Table D.4. Irrigation experience, 2020 water users

	All water users	Prut River water users	Nistru River water users
Source of on-farm irrigation equipment in 2020			
Did not use any equipment	0.3%	0.0%	0.4%
Owned equipment	54.8%	60.9%	53.1%
Rented equipment from WUA	38.7%	32.8%	40.2%
Rented equipment from others	2.0%	3.1%	1.7%
Borrowed from others	11.5%	20.3%	9.1%
Jointly owned equipment as part of cooperative or producer group	13.1%	7.8%	14.5%
Persistence in irrigation			
Number of seasons in which irrigated through the WUA, out of six full seasons since rehabilitation (2016–2021), among those who have been in the systems since 2016:			
1	19.4%	52.2%	11.9%
2	12.1%	30.4%	8.0%
3	4.0%	0.0%	5.0%
4	2.4%	2.2%	2.5%
5	20.2%	6.5%	23.4%
6	41.7%	8.7%	49.3%
Irrigation in 2021			
Irrigated in 2021	49.4%	35.9%	52.8%
Irrigated in 2021, among those who irrigated HVA crops in 2020	63.3%	59.4%	64.0%
Irrigated in 2021, among those who irrigated only non-HVA crops in 2020	10.8%	12.5%	9.8%

Source: Water User Survey (2020 Season) and WUA administrative data (irrigation use in 2021).

Notes: Table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Sample sizes for statistics drawn from the full sample are 305–312 (all water users), 64 (Prut River water users), and 241–248 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

Table D.5. Irrigation in the command area in the 2020 agricultural season, 2020 water users

	All water users	Prut River water users	Nistru River water users
Crops irrigated (* = HVA)[a]			
Corn	40.5%	50.0%	38.1%
Potato*	35.1%	3.3%	43.2%
Cabbage*	24.3%	5.0%	29.2%
Watermelon*	13.2%	8.3%	14.4%
Onion*	12.2%	6.7%	13.6%
Alfalfa	11.1%	16.7%	9.7%
Sweet corn*	11.1%	0.0%	14.0%
Apple*	10.8%	1.7%	13.1%
Wheat	7.8%	6.7%	8.1%
Nursery plants*	5.4%	0.0%	6.8%
By crop type			
Non-HVA crops only	27.0%	53.3%	20.3%
Non-HVA and HVA crops	27.0%	11.7%	30.9%
HVA crops only	45.9%	35.0%	48.7%
Any intensive HVA	8.5%	3.4%	9.7%
Among those irrigating HVA crops	*N = 210*	*N = 28*	*N = 182*
No experience cultivating any of those HVA crops prior to rehabilitation	31.0%	67.9%	25.3%
Experience cultivating any of those HVA crops prior to rehabilitation	69.0%	32.1%	74.7%
Area irrigated (hectares)			
Corn	1,361 (41.6%)	701 (55.7%)	660 (32.7%)
Other non-HVA crops	569 (17.4%)	351 (27.9%)	218 (10.8%)
Apple*	139 (4.3%)	2 (0.1%)	138 (6.8%)
Other orchard crops*	201 (6.1%)	19 (1.5%)	181 (9.0%)
Non-orchard fruit*	174 (5.3%)	93 (7.4%)	81 (4.0%)
Potato/cabbage/onion/sweet corn*	605 (18.5%)	23 (1.8%)	582 (28.9%)
Other vegetables*	153 (4.7%)	53 (4.2%)	100 (5.0%)
Other crops*	72 (2.2%)	16 (1.2%)	57 (2.8%)
Total	3,275	1,258	2,018
Total HVA*	1,344 (41.0%)	205 (16.3%)	1,139 (56.4%)

Source: Water User Survey (2020 Season).

Notes: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Area irrigated is defined as the area irrigated at least once during 2020, for each crop category and overall. Sample sizes for statistics drawn from the full sample are 295–296 (all water users), 59–60 (Prut River water users), and 236 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

[a] Other crops cultivated by 15 or fewer water users apiece: sunflower, carrot*, eggplant*, red beet*, garlic*, strawberry*, plum*, tomato*, pepper*, barley, sweet cherry*, pea*, table grapes*, walnuts*, zucchini*, radish*, bean*, cucumber*, tree fruit seedling*, muscat pumpkin*, soybean, sour cherry*, pear*, sugar beet*, lavender*, forage beet*, blackberry*, raspberry*, vine seedling*, apricot*, pastures/hayfields, sweet potato*, Paulownia*, blueberry*, melons*, cauliflower*, and onion for seeds*.

Table D.6. Extension area connections, 2020 water users

	Sample size	Estimate
Extension area connection		
Year connected	30	
2014 or earlier		3.3%
2015		33.3%
2016		3.3%
2017		0.0%
2018		36.7%
2019		10.0%
2020		13.3%
Source of resources for connection	28	
Personal/farm resources		57.1%
Loan from bank		10.7%
IFAD loan or grant		3.6%
Local municipality paid		28.6%
Other		25.0%

Source: Water User Survey (2020 Season).

Notes: Table shows the percentage among water users that irrigated in the extension area in 2020.

Table D.7. Irrigation in the command and extension area in the 2020 agricultural season, 2020 water users

	All water users	Prut River water users	Nistru River water users
Crops irrigated (* = HVA)[a]			
Corn	39.7%	46.9%	37.9%
Potato*	34.0%	3.1%	41.9%
Cabbage*	24.7%	4.7%	29.8%
Watermelon*	13.8%	9.4%	14.9%
Onion*	11.5%	6.3%	12.9%
Alfalfa	11.5%	15.6%	10.5%
Apple*	10.9%	1.6%	13.3%
Sweet corn*	10.6%	0.0%	13.3%
Wheat	8.0%	6.3%	8.5%
Nursery plants*	5.1%	0.0%	6.5%
Sunflower	5.1%	1.6%	6.0%
By crop type			
Non-HVA crops only	26.6%	50.0%	20.6%
Non-HVA and HVA crops	27.6%	10.9%	31.9%
HVA crops only	45.8%	39.1%	47.6%
Any intensive HVA	9.3%	3.2%	10.9%
Among those irrigating HVA crops	*N = 223*	*N = 32*	*N = 191*
No experience cultivating any of those HVA crops prior to rehabilitation	32.7%	65.6%	27.2%
Experience cultivating any of those HVA crops prior to rehabilitation	67.3%	34.4%	72.8%
Area irrigated (hectares)			
Corn	1,364 (33.8%)	701 (48.6%)	663 (25.6%)
Other non-HVA crops	577 (14.3%)	351 (24.3%)	226 (8.7%)
Apple*	283 (7.0%)	2 (0.1%)	282 (10.9%)
Other orchard crops*	727 (18.0%)	195 (13.5%)	533 (20.6%)
Non-orchard fruit*	210 (5.2%)	103 (7.2%)	106 (4.1%)
Potato/cabbage/onion/sweet corn*	624 (15.5%)	23 (1.6%)	601 (23.2%)
Other vegetables*	175 (4.3%)	53 (3.7%)	122 (4.7%)
Other crops*	72 (1.8%)	16 (1.1%)	57 (2.2%)
Total	4,032	1,444	2,589
Total HVA*	2,091 (51.9%)	391 (27.1%)	1,700 (65.7%)

Source: Water User Survey (2020 Season).

Notes: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Area irrigated is defined as the area irrigated at least once during 2020, for each crop category and overall. Sample sizes for statistics drawn from the full sample are 311–312 (all water users), 63–64 (Prut River water users), and 248 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

[a] Other crops cultivated by fewer than 15 or fewer water users apiece: plum*, eggplant*, carrot*, red beet*, garlic*, strawberry*, tomato*, pepper*, barley, sweet cherry*, pea*, table grapes*, walnuts*, zucchini*, radish*, bean*, cucumber*, tree fruit seedling*, muscat pumpkin*, soybean, sour cherry*, pear*, sugar beet*, lavender*, forage beet*, blackberry*, raspberry*, vine seedling*, apricot*, pastures/hayfields, sweet potato*, Paulownia*, blueberry*, melons*, cauliflower*, and onion for seeds*.

Table D.8. Labor employed in the 2020 agricultural season, 2020 water users

	All water users	Prut River water users	Nistru River water users
Number of workers employed			
Managers or administrators, among SRLs	*N = 35*	*N = 16*	*N = 19*
Men (mean number)	1.7	1.6	1.8
Women (mean number)	1.3	1.7	0.9
Total (mean number)	3.0	3.3	2.7
Paid laborers, among all water users	*N = 303*	*N = 64*	*N = 239*
Any paid laborers	42.2%	46.9%	41.0%
Any paid female laborers	34.7%	29.7%	36.0%
Number of laborers, among water users employing paid laborers	*N = 128*	*N = 30*	*N = 98*
1 – 10	52.3%	43.3%	55.1%
11 – 50	36.7%	30.0%	38.8%
> 50	10.9%	26.7%	6.1%
Wages for paid laborers			
Wage per person-day (median, lei per person-day)	*N = 124*	*N = 29*	*N = 95*
Mean (lei per person-day)	232	255	225
Median (lei per person-day)	250	250	250

Source: Water User Survey (2020 Season).

Note: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020.

Table D.9. Post-harvest processing in the 2020 agricultural season, 2020 water users

	Sample size	Estimate
Use of cold storage		
Used a cold storage facility	305	14.1%
Used an AAF-funded cold storage facility	305	0.7%
Ownership status of cold storage facility, among those using a facility	43	
Owned		34.9%
Rented		62.8%
Used for free		2.3%
Use of other processing or packaging facilities		
Used a processing or packaging facility	305	6.6%
Used an AAF-funded processing or packaging facility	305	0.0%
Type of processing or packaging facility, among those using a facility	20	
Sorting line		45.0%
Drying		10.0%
Packaging		10.0%
Canning		0.0%
Precooling		40.0%
Ownership status of processing or packaging facility, among those using a facility	20	
Owned		90.0%
Rented		10.0%
Used for free		0.0%

Source: Water User Survey (2020 Season).

Note: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020.

Table D.10. Participation in GHS trainings, 2020 water users

	All water users	Prut River water users	Nistru River water users
Participated in a GHS training	30.2%	31.1%	29.9%
Year of training(s), among participants	*N = 92*	*N = 19*	*N = 73*
2011	3.3%	0.0%	4.1%
2012	31.5%	10.5%	37.0%
2013	19.6%	15.8%	20.5%
2014	34.8%	21.1%	38.4%
2015	80.4%	89.5%	78.1%
Value chain of training(s), among participants	*N = 92*	*N = 19*	*N = 73*
Apple	28.3%	15.8%	31.5%
Table grape	6.5%	31.6%	0.0%
Stone fruit	18.5%	15.8%	19.2%
Tomato/cucumber/pepper/salad greens/culinary herbs	50.0%	47.4%	50.7%
Multiple/other	70.7%	63.2%	72.6%

Source: Water User Survey (2020 Season).

Notes: Unless otherwise indicated, table shows the percentage among water users that irrigated using the rehabilitated systems in 2020. Sample sizes for statistics drawn from the full sample are 305 (all water users), 61 (Prut River water users), and 244 (Nistru River water users). Sample sizes for statistics based on subsamples are shown in the table.

Table D.11. Land market in command area, 2020 water users

	Both rivers	Prut River	Nistru River
Area irrigated in command area[a]	*N = 288*	*N = 60*	*N = 228*
Total area (hectares)	3,111	1,258	1,853
Total area rented (hectares)	1,891	941	950
Total area purchased since rehabilitation (hectares)	392	135	257
Status of irrigated land (percentage of area irrigated)	*N = 288*	*N = 60*	*N = 228*
Rented	60.8%	74.8%	51.3%
Purchased since rehabilitation	12.6%	10.7%	13.9%
Rental price (annual)	*N = 90*	*N = 19*	*N = 71*
Mean (lei per hectare)	2,962	3,070	2,933
Median (lei per hectare)	2,312	3,000	2,000

Source: Water User Survey (2020 Season)

[a]Excludes 8 water users in Nistru River systems who had missing land market information.

Table D.12. Barriers to more farms cultivating high-value crops, 2020 water users

	All water users	Prut River water users	Nistru River water users
Perceived biggest barrier to more farms in command area cultivating fruits and vegetables	*N = 304*	*N = 64*	*N = 240*
Irrigation	2.3%	0.0%	2.9%
Sales markets	64.1%	32.8%	72.5%
Farm labor	19.1%	40.6%	13.3%
Investment costs	7.6%	18.8%	4.6%
Farmer interest	3.3%	6.3%	2.5%
Other	3.6%	1.6%	4.2%

Source: Water User Survey (2020 Season).

Notes: Respondents were asked to indicate the biggest barrier preventing more farms in the command area from cultivating fruits and vegetables. Table shows the percentage among water users that irrigated using the rehabilitated systems in 2020.

Appendix E. Monitoring and evaluation indicators

The final monitoring and evaluation plan for the Moldova Compact (MCA-Moldova 2015) includes targets for key indicators that were to have been achieved by the 2015 agricultural season. In **Table E.1**, we assess the extent to which the targets for several of these indicators were met by the 2020 agricultural season. We focus on the indicators for which the end-of-Compact monitoring and evaluation plan identified the independent evaluator as the responsible party for post-Compact reporting.

Table E.1. Key indicators from MCC's monitoring and evaluation plan (MCA-Moldova 2015)

Indicator	Baseline (2013)	Target (2015)	Achievement (2020)	Assessment
Annual profits for crop production in CIS (mean current dollars/ha *[inflation-adjusted measure: 2015 dollars/ha]*	-442 *[-451]*	390	NA	The final evaluation did not measure farmer profits. In the absence of an impact evaluation with a strong counterfactual, the costs of measuring profits would not be justified.
Rent paid to lessors in CIS (mean, current dollars/ha) *[inflation-adjusted measure: 2015 dollars/ha]*	79 *[81]*	100	170[a] *[156]*	By 2020, mean land rental prices per hectare exceeded the end-of-Compact target.
Agricultural wages paid in CIS (mean, current dollars/ha) *[inflation-adjusted measure: 2015 dollars/ha]*	64 *[65]*	180	358[b] *[329]*	By 2020, mean agricultural wages paid per hectare exceeded the end-of-Compact target.
Area irrigated in CIS (total, ha)	241	3,460	3,790	The area irrigated in 2020 exceeded the end-of-Compact target; however, the area irrigated in other seasons through 2021 was below the target.
Area of HVA irrigated in CIS (total, ha)	1,340	2,840	2,089	The area of irrigated HVA in 2020 fell short of the end-of-Compact target.
Percentage of water users in CIS satisfied with irrigation[c]	20	75	74	By 2020, water user satisfaction with WUA-provided irrigation was very close to the end-of-Compact target.
WUAs achieving financial sustainability[d]	0	0	NA	Measuring this indicator requires information about WUAs' operating costs; we were unable to obtain reliable information about these costs as part of the administrative data collection effort.

NA = not available, CIS = centralized Irrigation system, ha = hectares, HVA = high-value agriculture.

Source: Baselines (2013) are from Borkum et al. (2015). Targets (2015) are from MCC's end-of-Compact monitoring and evaluation plan (MCA-Moldova 2015). Achievements (2020) are from the Water User Survey for all indicators except for the total area irrigated in the CIS, which is from WUA administrative data. We converted 2020 monetary indicators from lei to dollars using the average exchange rate in 2020 from the Bank of Moldova, which was 17.32 lei per dollar (available at

https://www.bnm.md/en/content/official-exchange-rates, accessed November 22, 2022). Taking inflation into account, 1 dollar in 2013 is equivalent to 1.02 dollars in 2015 and 1 dollar in 2020 is equivalent to 0.92 dollars in 2015, using data from the World Bank (available at https://data.worldbank.org/indicator/FP.CPI.TOTL?locations=US, accessed February 6, 2023).

[a] For consistency with the baseline approach, we top-coded this measure at three standard deviations above the original mean before estimating the mean. (We did not bottom-code, because no values fell more than three standard deviations below the original mean.) As a result, the value reported here is slightly higher than the 171 dollars reported in Chapter IV. The median rent per hectare in 2020 was 133 dollars.

[b] For consistency with the baseline approach, we top-coded this measure at three standard deviations above the original mean before estimating the mean. (We did not bottom-code, because no values fell more than three standard deviations below the original mean.) The median wage paid per hectare in 2020 was zero.

[c] Totally or somewhat satisfied with cost, timeliness, and ease of ordering and billing.

[d] Defined as the number of WUAs where tariffs collected cover 100 percent of operating costs plus an amount for capital/replacement costs.

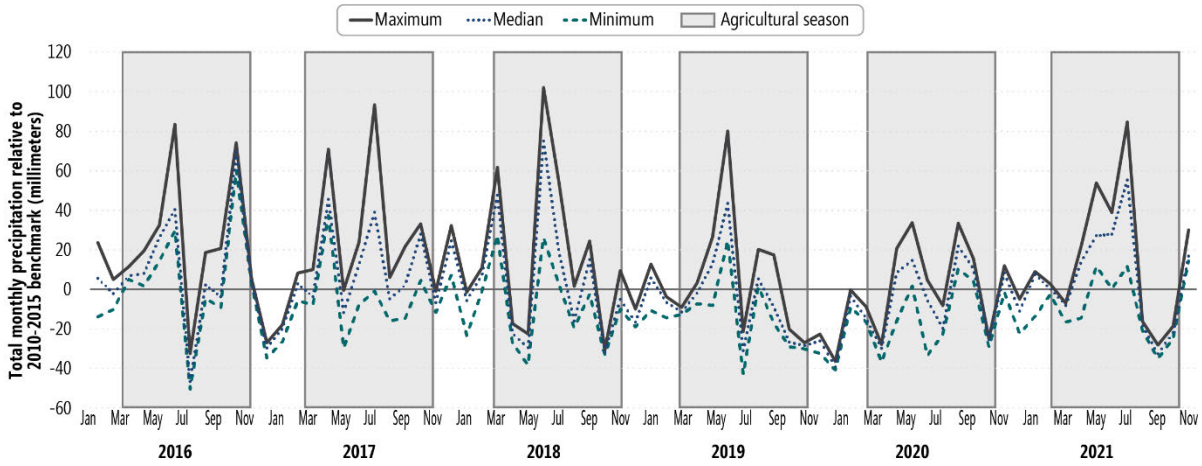
Appendix F. Precipitation patterns

We used satellite data from the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) database, which we accessed using Google Earth Engine, to analyze precipitation patterns in the 10 rehabilitated systems. We defined eight rectangular polygons that collectively encompassed all Project systems. Four of these rectangles lie along the Prut River (one for each Project system) and the other four along the Nistru River (there are six Nistru systems, but some are geographically close and share the same polygon). We then calculated CHIRPS average daily precipitation within each polygon for the period of January 2010 through December 2021.

To analyze these data, we aggregated the daily precipitation levels within each polygon to calendar months. For each calendar month, we used the average of the median precipitation levels across the eight polygons between 2010 and 2015 (before system rehabilitation was completed) to provide a benchmark. For example, we estimated the benchmark precipitation level for January as the average of median precipitation levels across the eight polygons in January 2010, 2011, 2012, 2013, 2014, and 2015. We then examined the minimum, maximum, and median monthly levels across the eight polygons between January 2016 and December 2021 (after system rehabilitation was completed) relative to these benchmarks (**Figure F.1**). Although the agricultural season in Moldova typically runs from the beginning of March to the beginning of November, fall and winter precipitation is also important for agricultural production because it affects soil moisture for the following season.

Our analysis confirms that the 2020 season was unusually dry compared to other seasons since the systems were rehabilitated. In particular, precipitation in the fall and winter leading up to this season was much lower than usual, suggesting that the soil would have been severely lacking in moisture at the start of the season. The average or below average levels of precipitation in spring were likely insufficient to compensate for this, suggesting an increased need for irrigation at the start of the season. Further, although there were above average levels of precipitation in early summer, levels in the middle of the summer were below average. This would have negatively affected crops with a crucial irrigation period in July and August, including corn, apples, and late-season vegetables. In contrast, the 2021 season was preceded by a fall and winter with typical precipitation levels and saw a summer with substantially above average levels. Overall, these precipitation patterns are consistent with the sharp increase in demand for WUA-provided irrigation water in 2020 relative to previous seasons, and the reversal of this demand in 2021.

Figure F.1. Rainfall patterns across systems, 2016–2021



Source: CHIRPS database.

Note: Figure shows maximum, median, and minimum total monthly precipitation across eight rectangular polygons that collectively encompass the 10 rehabilitated systems. These values are presented relative to a monthly benchmark, which was calculated as the average of median precipitation levels across these polygons between 2010 and 2015. The main agricultural season (March to early November) is shaded in light gray.

Appendix G. Stakeholder comments and evaluator responses

No.	Page	Comment	Evaluator Response
1	ix	It isn't very clear to me what the extension area is. Perhaps another sentence or two explaining how it expands the "command" system could be helpful.	We have expanded the text to explain this further.
2	xii	Is it possible to show the capacity of the system in Figure ES1?	We have added a figure note to indicate the total capacity in terms of area irrigated, which is 12,830 hectares (in the command area). (We opted not to include this in the figure itself because it would be more difficult to see the variation in area irrigated by year and because some of the area irrigated shown in the figure is outside the command area.) Capacity across the entire agriculture season is undefined for volume and number of users.
3	xii	*"There are more opportunities for Moldovan farmers to sell HVA crops to domestic retailers, and there has been a positive trend in fruit exports, but several constraints remain."* This is in passive voice, so it is not straightforward if the increased opportunities are a result of the project. Are they a result of the project? Is it unknown the degree of the impact from the project?	Based on the interviews we conducted, the project might have contributed to these increased market opportunities for specific farmers (for example, by facilitating improvements in quality that enabled farmers to export to the EU). However, it is difficult to assess the Project's aggregate impact on sales to the domestic retail and export markets because we do not have a measure of the counterfactual. Though we cannot assess the specific contribution of the GHS Activity to these results, we believe that the increase in market access is nevertheless of interest.
4	xii	*"The domestic retailer we interviewed suggested that there is an increasing trend in Moldova for domestic…"* This reads like you interviewed just one domestic retailer. Is that accurate?	Yes, that is accurate. We have revised the text slightly to make it clear that this is a domestic retail chain (of which there are only a handful in Moldova) rather than a single store.
5	xiii	The Common Platforms are not clear to me. Is Common Platform 1 the one-stop shop and 2 & 3 are something different?	Common Platform 1 is the one-stop shop; Common Platform 2 collates information related to water management, and Common Platform 3 is the public use interface. We have revised the text to clarify.
6	xviii	Was the post compact SDA support to the WUAs planned as part of the compact? The need for this kind of post compact support and training seems like an important lesson.	Our understanding is that the idea of establishing SDA-Moldova arose during the (later stages of the) Compact and was not planned at the outset.
7	13	It could make sense to include the logic diagram in the main body, or an abbreviated version. Defer to the M&E lead on this, though. (Note from the M&E lead: I agree, I think the logic or an abbreviated version in the main body would be useful since it's referenced a lot).	We have added the project logic to the body of the report. The assumptions appear in the appendix.
8	13	I'm surprised that that HVA sales is so close to the target when so little of the irrigation is being used. Why is this?	The GHS Activity was implemented as part of the ACED Project, which operated throughout Moldova. The indicators (and targets) refer to the Project's overall targets, rather than targets in the rehabilitated areas. We have revised the text to clarify.
9	22	Why are farmers funding extension areas when the command system isn't being fully utilized?	Farmers might be interested in irrigating specific areas of land that they own or rent; that land might lie outside the system in some cases.

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10	30	Many of our other evaluations found that the timing of the training in relation to the completion of the infrastructure was not optimal. Were there any issues with that here?	The GHS Activity included two main types of training for farmers: (1) value chain training, focused on practices in specific HVA value chains, and (2) CIS training, which focused on the transition to HVA in the rehabilitated systems. The first type was not focused on the rehabilitated systems because relatively few farmers in the systems were active in those value chains during the Compact (that is, these trainings might have been more relevant in the systems several years after the Compact, had the envisaged transition to HVA occurred). The second type was timed appropriately in the sense that the trainings occurred at the end of the Compact, when the systems were just starting to operate. However, the evaluation findings suggest that offering these trainings did not encourage many farmers to transition to HVA crops given the critical constraints that they faced (especially market access and farm labor). More broadly, a lack of knowledge does not appear to have been the main constraint to transitioning to HVA crops. We have added this information to the report.
11	31–32	I'm confused about the AAF activity. Did the activity directly build the infrastructure and give out loans OR give out loans for the infrastructure? Who decided what infrastructure to build? Were the water users the recipients of the loans or were the loans made to a broader group? Was the cold storage fully utilized, but not by the water users?	We have edited the text to clarify. In short, the AAF Activity provided loans for applicants throughout Moldova (most of whom were not in the rehabilitated systems) to invest in certain types of infrastructure. Unfortunately, we do not have information about the extent to which the cold storage was used relative to its capacity (but certainly most of it would have been used by farmers who were not water users in these 10 systems).
12	35	I would be interested in hearing more about the lessons on the pumped system with respect to the coordination of small holders in order to use the system in a cost-effective way. This is a lesson from other evaluations, and it could be helpful to understand what is and isn't working when large users aren't pumping. For example, is this the main constraint in the systems that aren't being used?	There are a few relevant lessons here about the use of the systems by small users. First, the design of the system matters. In gravity-fed systems (or parts of systems), small users are able to use the system simply by opening a hydrant rather than by coordinating pumping. Second, the ease of coordination for pumping depends on the context--in Puhaceni and Cosnita there are many small farmers with plots near each other and cultivating the same vegetables, which makes coordination easier. Where small users operate more scattered plots and/or cultivating different crops, it becomes more difficult. Third, while coordination might be a challenge for small farmers to irrigate, irrigation is only one of many constraints to changing cropping patterns. It seems unlikely that many small farmers would switch to HVA even if the systems could serve them on demand without coordination, given critical constraints like access to markets and a lack of labor. We have added this information to the report.
13	42	In the Market Linkages section, were any of these linkages facilitated by MCC or did these exist outside of the compact?	The farmers we discuss in this section do not appear on the list of GHS TA participants, so these market linkages do not appear to have been facilitated directly by the Project.
14	42	For Commitment to Irrigation, was it planned as part of project design that there would be regular users of the irrigation to support water use by smaller farmers?	In our understanding, this was not the plan at the design stage. Rather, it was expected that the systems would be widely and regularly used by the many farmers who had agreed to become WUA members, which included small farmers. The distinction between regular and irregular users only emerged after the end of the Compact as the systems began to operate.

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15	45	This seems to imply that the system doesn't have the capacity to support water users when the system is being more heavily used. Since the compact assumed that the system would eventually be fully utilized, were there provisions for the needed equipment?	In our understanding, the Project never intended for the WUA to provide farmers with sufficient equipment to use the systems at capacity. Rather, it was anticipated that many farmers would invest in their own equipment, including through the 2KR hire-purchase program that was included in the Project's AAF Activity. However, it appears that many farmers (especially those who irrigated irregularly) did not find the costs of those investments worthwhile and/or affordable, which was problematic when they needed to irrigate in the 2020 drought season. Overall, the more fundamental issue is that the transition to profitable HVA crops was limited, due to constraints like a lack of attractive markets and rural labor; providing more equipment is unlikely to have solved this problem. We have added this information to the report.
16	ix, 2	In the description of ISRA it says 10 WUAs, but wasn't it done in 11 WUAs? Also, the text says that CISRA and ISRA targeted 10 CIS, but I think it's more accurate to say 11? Or at least add a note mentioning Cahul? The text reads as though it was 10 from the beginning which, as you know, wasn't the case.	We think it will be clearer to external readers of the report to consistently discuss 10 WUAs/systems. We have added a footnote about Cahul and why it was excluded from rehabilitation.
17	ix, 1	Rather than saying two objectives, would you mind using the language we agreed on for the presentation - one objective with two parts?	We have adjusted the text accordingly.
18	x	In Table ES.1, can you specify under qualitative data if the farmers were water users or not water users or both? The reader won't see clearly that non-water users were part of that data collection process otherwise.	We have adjusted the table accordingly.
19	xi, 12	“Descriptive analyses” is not a standard methodology name used by MCC. The list of standard methodologies for performance evaluation are the following: (i) Pre-Post; (ii) Ex-Post thematic analysis; (iii) Pre-Post/with Comparison Group; (iv) Modeling; and (v) Other Performance. The report mentions thematic analyses and pre-post, but can the descriptive analyses be changed to align with a methodology on MCC's standard list?	We have adjusted the text accordingly.
20	xi	First sentence under “Findings” - same comment about saying one part of its objective.	We have adjusted the text accordingly.
21	xii–xiii or General	It would be helpful to compare actual results to the targets in the M&E Plan. The last version of the M&E Plan at the end of the program had a target for Year 5 for profits of crop production, rent, wage bill, area irrigated, and adoption of HVA crops. There were notes included saying that the final evaluation would compare findings with these targets, but also with the projection from the closeout ERR. The report has done a good job of comparing with the closeout ERR; however, some mention of the targets from the M&E Plan would be useful to remind readers that those targets were set. The targets were for Year 5, so it's hard to compare with the actual data since the years don't match, but perhaps a mention of whether those Year 5 targets were met by 2020?	We have added an appendix on the M&E indicators.

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22	General	We have estimates of area irrigated and area under THVA in the project areas from before the project (2009 and then updated in 2013), is there a reason those weren't used to show what the baseline level was? If Mathematica doesn't want to use those numbers (we put them in the post-compact M&E Plan) then an explanation for why (in the report) would be helpful.	We have added a footnote in the report (under EQ #1, section 2) that describes the 2013 estimate but also suggests that it might not be directly comparable.
23	xvi	I feel like an explanation for why so many "farmers" are not using the systems is missing from here. Why did thousands of "farmers" decide not to use irrigation when they had signed up as WUA members? The barriers cited for not cultivating more HVA are barriers for water users, right? Do the barriers differ for non-water users? (I know we don't have the same quant data, but from qualitative data I thought we would have more of an answer to this).	To clarify, we did not ask water users about their own reasons for not cultivating HVA (or not cultivating more), but about reasons why more farmers in the system were not doing so. We asked a similar question of WUA directors. That is, these barriers should be interpreted as the barriers for non-users, as perceived by water users and WUA directors. We have modified the text to make this clearer. That said, we also interviewed a small number of non-users in the Project systems. For these non-users, we generally did not ask them directly why they did not cultivate HVA crops (in part because some of them did). Rather, we asked them why they did not irrigate in 2020, despite the drought. They consistently pointed to a lack of equipment as a key reason, though some also mentioned a lack of resources to pay for irrigation water and other inputs. We have added this to the text in the response to EQ #4. In the course of these interviews, some non-users did mention the reasons why they and/or other farmers did not cultivate more HVA crops--a lack of labor was the most common reason. We have also added that to the text in the response to EQ #4.
24	xvii, 55	The funding for SDA-Moldova even through the first half of 2023 is in question. Perhaps we leave this statement more general?	We have adjusted the text accordingly.
25	2	Can you add in the GHS $ amount from USAID to show that ACED was much larger than just MCC's contribution? Could you also note in the footnote that it was implemented by USAID?	We have adjusted the text accordingly.
26	5	Can you provide the breakdown of beneficiaries between those groups mentioned? Since the 112,000 seems quite large compared to the number of water users, it would be helpful to provide more information on that number like it includes family members.	We have adjusted the text accordingly.
27	13	For the GHS Activity outputs can you provide the breakdown of how many of the trained farmers were in the 10 project areas and how many were outside? Can you also include the female/male breakdown?	We have added this information to the text.
28	13	In footnote #5, perhaps it could say that the USAID project ACED continued until 2016 of which GHS had been a part? I'm not sure exactly how to say it, but technically I think the GHS Activity did end in 2015. MCC transferred all of its money upfront, so no MCC resources were disbursed after the compact end. You could also make it clear that these outputs were ACED outputs, not only attributed to GHS.	In that case, we propose to remove the footnote and note in the text that we are referring to ACED outputs (to which GHS contributed) by the end of the Compact.

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29	13	Can more information be provided about what the technical assistance and training covered for GHS here? And how intensive the training and TA were?	We have added more information about the different activities undertaken as part of the GHS Activity in a footnote. Our references did not include specific information on the intensity of training and technical assistance; that said, our understanding is that there was quite a range of intensity across these activities--for example, the contrast between a single training seminar and an international study tour--and that most ACED participants in these systems attended training seminars, with a smaller number of participants undertaking more intensive activities.
30	13	Can you include the female/male breakdown for enterprises?	We have added this.
31	13	Can you include the breakdown of female (7) /male (55) loan borrowers since we have it in the closeout ITT? Do we have the breakdown of how many facilities were in the project areas vs. outside?	We have added this.
32	13	Could you include the closeout ITT numbers for hire purchase agreements too?	We have added this.
33	General	It would be helpful to include a map of all of the activities and where they took place. I think I remember you having a map like that - if it's easy to include, I think it would be helpful to show how much of AAF/GHS took place outside of the ISRA/CISRA areas.	Good idea. We have added maps in the response to EQ #1.
34	15	Footnote #7 is the first time the FOS from 2013-2014 was mentioned (unless I missed it somewhere). Seems like it should have been included in the data source discussion earlier along with basic info about it like the sample.	We now introduce the Farm Operator Survey when we discuss the pre-post design (in Chapter III).
35	15	It might be worth putting the info in footnote #7 in the text since it's really interesting. However, if you don't want to make that direct comparison, then it's fine to leave it.	We would prefer to leave this as a footnote. Given the small sample sizes for these indicators in the 2013-2014 FOS, it might be best not to overemphasize the quantitative comparison with the indicators from the Water User Survey.
36	18	There's no mention of the potential impact of covid-19/global recession/war in Ukraine and how they might have impacted 2021 numbers. Even if these events didn't have much of an impact on 2021, it would be helpful to include what information was gathered about this in case readers wonder about it. (I now see this comes later. Perhaps just a sentence in this section could be added?)	We have added a sentence to refer to the later findings.
37	32	EQ #2 - this section doesn't mention that there were farmers who benefited outside of the rehabilitated systems from GHS and AAF. I feel like to be complete, there should at least be a mention of them.	We revised the response to EQ #2 to note that the “GHS and AAF Activities also separately affected many farmers elsewhere in Moldova.”
38	34	Last paragraph, could you include the average or median age of water users? I'm curious to know what it is.	We have added this to the text.
39	37	Can any statements be made about labor comparing the actual 2020 numbers to the baseline/target in the M&E Plan? The indicator in the M&E Plan is “wage bill paid to labor per hectare.” Baseline from 2009 was $40, baseline from 2013 was $64, and the original Year 5 target was $180. (I'm wondering now if you don't want to put this in the body of the report if you would prefer to have an annex comparing actuals to indicators in the M&E Plan?)	We have added an appendix focused on the M&E indicators.

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40	41	What does “commitment to irrigation” mean? Can this finding be more specific? It reads as though these are HVA farmers and exporters, maybe just say that instead of commitment to irrigation which is pretty vague.	We have edited the text in response to EQ #4 to clarify.
41	41	What did non-users say were the main barriers to HVA production in the interviews? Was it the same as water users and WUA directors?	As noted above, for the non-users we interviewed, we generally did not ask them directly why they did not cultivate HVA crops (in part because some of them did). Rather, we asked them why they did not irrigate in 2020, despite the drought. They consistently pointed to a lack of equipment as a key reason, though some also mentioned a lack of resources to pay for irrigation water and other inputs. We have added this to the text in the response to EQ #4. During these interviews, some non-users did mention the reasons why they and/or other farmers did not cultivate more HVA crops--a lack of labor was the most common reason. We have also added that to the text in the response to EQ #4.
42	43	The former MCA-Moldova project director pointed this out in his remarks; however, I wonder if it would help to show population numbers (of working age?) of Moldova and rural areas over the evaluation period in this section on the lack of farm labor?	We were able to obtain population estimates overall but did not identify sources that show the population in rural areas. We added a paragraph discussing these contextual factors at the end of the response to EQ #4.
43	51	Along similar lines of comments from the former MCA-Moldova M&E Director, it would be interesting to know - what was the reason for so many WUA members joining in earlier years - did they intend to irrigate or did they not understand what the WUA was for?	Our understanding is that farmers joined the WUAs initially to meet the numbers required (50 percent of farmers plus one) to establish the WUA and benefit from system rehabilitation. They were being offered a large free investment in their community that had the potential to improve their wellbeing, directly through irrigation and/or indirectly through increased land prices. Once the systems were rehabilitated, farmers' good intentions to irrigate did not translate into practice given constraints like market access issues, lack of labor, the cost of irrigation, and so on. It's also possible that many farmers joined to benefit from increased land values (even if they did not plan to sell their land in the near future) and never had any genuine intention to irrigate. We have added some text about this under EQ #6, where we talk about changes in membership. This all goes back to one of the key lessons--there was no mechanism to assess farmers' true commitment to irrigation.

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44	General	Overall, the Final Evaluation Report is a consistent work, reflecting the detailed and multidimensional impact of the Compact TAP project. At the same time, we have to agree with most of the trends, findings, and conclusions reflected in this report. Unfortunately, these trends did not meet also the expectations of the Moldovan Government due to a multitude of circumstances that occurred in the country after the launch and implementation of the Compact Project. The outcomes need to be analyzed in a complex and dynamic way because they are interdependent in many cases. For example, we could refer to the abolition of the EU visa requirement for Moldovan citizens and the intensification of labor migration. The liberalized access to European labor markets and welfare opportunities (others than agricultural activities) were decisive in comparison to those seen and expected by beneficiaries before the Compact Project intervention. As a result, we've seen an intensification of land consolidation processes and a decrease in the number of beneficiaries in CIS service areas. The land consolidation process is appreciated in the report like a negative one. However, in our opinion, large, consolidated areas permit farmers to practice efficient agriculture that meets market requirements regarding the quantity and quality of the products. Thus, we see the consolidation as a positive process and believe that this catalyzes new investments in irrigable crops or multi-year plantations, infrastructure and irrigation equipment, post-harvest facilities and storage, etc. Under these circumstances, it remains clear to us that the Compact investments in the THVA project are sustainable and mitigate the effects of climate change and also increase the well-being of citizens in the areas of intervention. At the same time, there are findings where our opinion and comments provided below could contribute to a better understanding of the situation and its genesis. There are also some divergences with SDA Moldova data, the discussion of which may help to improve the Final Report.	We appreciate the reviewer's thoughtful comments on the draft report and are pleased with their overall agreement with the findings. Another reviewer made a similar comment about the changing context in Moldova since the Project was designed, with small-scale agriculture becoming less attractive (comment #83). We agree that this is an important point, and we have added a brief discussion to the executive summary, discussion of barriers (EQ #4), and the conclusion. Regarding land consolidation, we agree that there are positive benefits in terms of agricultural production, which we highlighted in the introduction to EQ #3. However, land consolidation also implies that the direct beneficiaries of irrigation through the rehabilitated systems are both fewer in number and better-off (larger farmers) than initially expected by MCC.
45	x	*"Targeted all 315 farmers who pumped irrigation water through the 10 Project systems in the 2020 agricultural season."* According to SDA Moldova, in the Table ES.1. Principal data sources for the final THVA Project evaluation (Water User Survey 2020 season) should be reflected 319 farmers instead of 315. These changes should be made to the entire content of the report (ex. page xiv, 10, 16, 33, 36 and 70).	The number of 315 water users was calculated based on lists of names provided to us by the WUAs. It is possible that there were small reporting errors in these numbers or those reported to SDA-Moldova. However, the discrepancy between the two numbers is very small (a deviation of only about one percent). Therefore, we prefer to retain the number currently reported, which was the basis of the sample for the Water User Survey. We have added a table note to Table C.1 to note this discrepancy.

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46	xi	*"However, in the 10 rehabilitated systems, the Project is unlikely to have met its other objective, which was to "increase rural incomes by stimulating growth in irrigated HVA," given that it did not achieve most of the key related outcomes expected in the project logic. Although the Project led to increases in irrigation use and HVA cultivation, the transition to irrigated HVA crops in the rehabilitated systems did not occur to the extent envisaged and the Project's investments in those systems benefitted only a small number of water users.* ***As a result, the Project is unlikely to have been economically justified.****"* We cannot fully agree with the highlighted conclusion and the categorical way in which it is formulated. As mentioned above in the "Generalities" section, during the implementation of the Compact Program, occurred several phenomena that were not identified as risks at the development stage of the expected project indicators. In this regard, some expected indicators were too optimistic. Here, we refer not only to changes in the national and international context (economic situation, abolition of the EU visa requirement, embargoes on traditional markets, the Covid pandemic, etc.) but also to the specific aspects of project implementation. Referring to the specific aspects, first of all, we could mention that the Compact Program did not have a distinct activity related to the transition of farmers to the cultivation of HVA crops in the intervention areas. This activity constituted a minor component of another project implemented by USAID - The Agricultural Competitiveness and Enterprise Development Project, whose target group was much larger, covering the whole country. The mentioned project also targeted specific value chains and value-added crops (apples, grapes, tomatoes) for which most farmers in CIS areas were not yet ready and required considerable investments. Secondly, analyzing a set of indicators (irrigated areas and pumped water volumes) it should be taken into consideration that Compact CIS are pressurized systems. These systems' particularities require the presence of sufficient irrigation equipment, corresponding to the different types of irrigation. At the end of the Compact Program and in the following period, SDA Moldova granted to the WUAs some irrigation equipment, but this was not sufficient or applicable to different crops throughout the irrigation season. The lack or the insufficiency of irrigation equipment was mentioned by the respondents as well, and the most affected were the small users, from whom the Donor expected to achieve very high result indicators.	We agree with the points made here about the changing context and barriers to transitioning to HVA and have highlighted many of them in the report. We also describe in the report that, despite these challenges, the Project had positive effects such as establishing sustainable WUAs, leading to the broader adoption of the WUA model throughout Moldova and increasing profitability for some (mostly larger) farmers. This statement about the Project not being economically justified was in the specific context of MCC's CBA model. Given that the transition to HVA has been slower and less widespread than expected, the predicted benefit streams in that model would not have justified the Project's costs in terms of the calculated economic rate of return (ERR). We have edited the text to make it clear that this statement refers to the CBA model. The CBA model is being updated separately by MCC based on the information from the evaluation and will provide an updated evaluation-based ERR.

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46 (cont.)	xi	However, SDA Moldova attests, overall, the ability of WUAs to keep the systems operational and to provide qualitative irrigation services, which allows the extension of the HVA crops area. We also note that large-scale farmers in Compact service areas are principal beneficiaries that are continuing to invest in high-value crops, land consolidation, and appropriate irrigation equipment. The cost of these investments is significant and not all Compact beneficiaries can afford it. For example, in the Compact CIS, only the area under orchards increased by about 1,000 ha, where the average cost of investment in these plantations was about 30,000 Euro/ha. As a result, the limited financial possibilities of small farmers to invest or to access additional financial resources led them to choose other economic opportunities, lease their land and/or abandon farming. Thus, the conclusion that the project is not economically justified we appreciate as premature, given the cost of the investment required to switch to the cultivation of HVA crops. At the same time, compared to expectations, the small number of users who have benefited from the Compact investments is a logical evolution in the context of other processes reflected above.	
47	xv	*"The median land rental price in the rehabilitated systems increased by more than 50 percent since rehabilitation, and sales prices also increased substantially; external factors likely drove most of the increase in rental prices, but the* ***Project might have contributed to the increase in sales prices.****"* We cannot fully agree with the highlighted statement. We do not know the original survey data, but we should note that in most of the Compact CIS service areas, both - land rental and sales prices have increased significantly. We believe that the project has a particular and predominant contribution to the increase of these indicators. The price gap between irrigable and non-irrigable land in most intervention areas is at least 30-50% higher. Certainly, increases have been attested on both categories of land (in irrigable and non-irrigable areas), but these evolutions were proportional, and the difference exists. At the same time, we must admit that in some CIS areas, there are practices where users rent out all their land, both irrigable and non-irrigable, at the same price. These practices often result from the intention of small landowners to solve the problem in a complex way by leasing all the owned land at once. In these cases, lessees offer a medium rental price and use non-irrigable plots as exchange funds for land consolidation.	The statement in the report about land sales prices was based largely on qualitative data because we do not have good estimates of these prices from the data we collected. (The evaluation was not designed to collect such estimates.) In interviews, local stakeholders perceived that land sales prices had increased throughout Moldova, but more so in the Project systems because the Project increased the long-term value of the land. For rental prices, we have more precise data from the Water User Survey in the Project systems and relatively consistent estimates from interviews with farmers and WUA directors in comparison systems. These data suggest that the typical (median) land rental price was not very different between Project systems and comparison systems. As we note in the report, that does not rule out that some farmers in Project systems might have benefitted from increased land rental prices, but on average this effect appears to be small based on the data we collected. This is consistent with the suggestion here and in the next comment that rental prices might not always have been responsive to the increased access to irrigation.

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48	xv	*"Overall, we cannot rule out that some **farmers** in rehabilitated systems received higher land rental prices because of the Project, but on average these effects appear to be small relative to the effects of external factors."* In our opinion, the word "farmers" should be replaced with "landowner," because they are the primary beneficiary. Concerning the project impact on the rental price, we refer to comment 4, above. We also disagree that the report was limited to examining only the rental price of the land, ignoring the sale price of the land, which reduces the project impact. Contrary to the expectations, in some CIS the rental price of irrigable and non-irrigable land does not differ significantly, due to the reason we mentioned above. The situation is different for the sale price of irrigable land. For example, in the area served by CIS Grozești, the sale price of irrigable land is about 65000 lei/ha, compared to 25000 lei/ha for non-irrigable land. The increase of this indicator, among other factors, was directly influenced by the availability of irrigation infrastructure and the direct interest of the farmers to lease irrigable lands.	Thank you for this suggestion; we have replaced the word "farmers" with "landowners." Please see the response above regarding rental and sales prices. The evaluation was not designed to capture precise estimates of sales prices because sales are much less common than rentals and some sales might have taken place many years ago (and therefore would be subject to recall error). The evaluation did not collect these data because there would be too few recent sales transactions to draw conclusions. In interviews, farmers' and WUA directors' estimates of sales prices and how they had changed over time varied wildly even within the same system, making it challenging to draw stronger conclusions about these prices. Nevertheless, we concluded that the Project likely contributed to increases in land sales prices in Project systems based on qualitative data.
49	xviii	*"Although the Compact ended before most of these WUAs were formed, the THVA Project supported their formation by: (1) developing the WUA Law, under which all WUAs were established; (2) enabling the management of non-Project WUAs to engage with and learn from Project WUAs; and (3) leading to the establishment of SDA-Moldova, which played a critical role in helping non-Project WUAs navigate the **establishment and management** transfer processes."* Additionally, as a replication of the Compact experience, SDA Moldova provided newly established WUAs with consultancy and technical support in organizing, launching, and carrying out the current activity.	Thank you; we have revised the text accordingly.
50	xix, 41, Key findings	*"As discussed under EQ #1, the area irrigated in the rehabilitated systems—which is directly connected to the estimated benefits of the Project—**has fallen short of the Compact Closeout CBA projections**. There has also been much greater fluctuation in the area irrigated from year to year than anticipated. Overall, whereas the CBA model projected that irrigated area would increase rapidly after the end of the Compact and be sustained at a high level, in practice; it increased more gradually initially and even decreased substantially more recently. **This suggests that the Project ERR is likely lower than that estimated by MCC at Compact Closeout.**"*	We agree with many of the points made here and discuss them in the report. For example, we discuss the sensitivity to rainfall, issues with lack of equipment, and the need for a more tailored and focused approach to support the transition to HVA (which is one of the key lessons under EQ #7).

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50 (cont.)	46, Key findings	*"The **AAF Activity had limited effects on water users in the rehabilitated systems** and it is **unlikely that GHS trainings led many water users to transition to irrigated HVA production**."* While we do not dispute the overall conclusion on the ERR, we believe that the Compact Closeout CBA projections related to the gradual increase in the irrigated area were too optimistic. We will try to list some factors that were missed, including: • Rainfall and their periodicity, which directly affects the irrigated area indicator, as well as the volumes of water pumped for irrigation; • The availability of appropriate equipment for different types of irrigation and crop irrigated through the season; • The cost of investing in high-value crops, including orchards; • Exceptional and unpredictable situations such as embargoes or pandemic situations, which restricted movement and significantly reduced access to internal and external markets, etc. Also, it would be better if some project activities and the timeline for their implementation were different. First of all, we would like to mention the lack of a dedicated activity aimed to stimulate the transition to HVA crops in Compact CIS command areas. Secondly, we refer to the Access to Finance Activity (AFA), which has been running since 2012, well before the completion of the CIS Compact rehabilitation. The need to access financing for farm business development in CIS Compact areas (irrigation equipment, post-harvest, processing facilities, etc.), in our opinion, emerged only after rehabilitation. Moreover, the geography of the AFA was extended over the whole country, which made agricultural investments in the CIS Compact areas to be limited or not requested, as premature. As a result, after 2015 many farmers in the Compact areas continued to grow irrigated value-added crops, but the areas farmed and the quantities of yields (mainly vegetables) were in most cases adapted to existing storage capacities and the current local market consumption. For example, in the 2020 agriculture season, most farmers had good yields of cabbage, potatoes, and so on. However, due to a lack of storage facilities and market opportunities (pandemic year), they had to abandon most of the products in the field. Obviously, the farmers' losses in 2020 also affected their interest to cultivate HVA in 2021, which was a pandemic one.	(see previous page)
51	4	*"WUAs collect annual membership fees from members **based on the area of land that they cultivate**, as well as irrigation fees based on the volume pumped."* We propose the following text in the Report: WUAs collect annual membership fees from members based on the area of land that they owns or hold lease rights within the Service Area, as well as irrigation fees based on the volume of the delivered water.	Thank you; we have revised the text accordingly.

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52	5	*"**The Project was expected to have 112,000 beneficiaries**, including farming households irrigating through the rehabilitated systems, individuals employed in seasonal labor (who would benefit from higher wages due to greater demand for labor), and landowners (who would benefit from increased rental income and land values due to increased land productivity)."* We believe that the expectations of 112,000 project beneficiaries were too optimistic. Contrary to these assumptions, due mainly to the migration and land consolidation processes, the dynamic of this indicator was negative. For example, according to SDA Moldova data, compared to 2013, the number of landowners in the service area decreased from about 18.5 thousand to about 13.2 thousand natural or legal persons. At the same time, farmers in the service areas face a shortage of local skilled employees, even at competitive wages. The situation in the CIS Blindești service area is relevant to the case. The strawberry producers employ in the harvesting season about 700 laborers per day, brought from 5 districts adjacent to the Ungheni district, from a distance at least 50 km, being forced to support additional considerable transportation costs.	In response to another reviewer's comment, we have expanded the text about the number of expected beneficiaries. We agree that this expectation was overly optimistic. We also highlight the phenomenon of land consolidation and the challenges around rural labor in the report.
53	13	*"**AAF Activity.** The Activity provided loans worth 11.7 million dollars (79 percent of the target) to 62 borrowers (83 percent of the target) throughout Moldova, funding post-harvest infrastructure with a total capacity of 20,705 metric tons (double the target)."* According to SDA Moldova data the correct figures are the following: **AAF Activity.** The Activity provided loans worth 12.4 million dollars (83 percent of the target) to 66 borrowers (88 percent of the target) throughout Moldova, funding post-harvest infrastructure with a total capacity of 39,000 metric tons (quadruple the target).	The indicators we provided are from MCC's Closeout indicator tracking table; MCC requested that we focus on those end-of-Compact statistics in this section. Note from MCC: MCC has a policy that we use the final Indicator Tracking Table (ITT) numbers for external reporting. Unfortunately, some of these results were not completed at compact end date (CED) so they couldn't be fully captured in the final ITT. The 62 borrowers differs from the 66 borrowers reported on in the closeout Results Statements. The 66 refers to the borrowers that had been approved for loans by MCA-Moldova at the compact end date (CED), whereas the 62 recorded in the ITT refers to the loan borrowers who had actually signed loan agreements with PFIs as of CED (same for value of loans). The capacity differs from the more than 39,000 tons of cold-storage capacities that were reported on in the closeout Results Statements. This is because the 39,000 was measuring the intent of the loan borrower when obtaining the loan, whereas the 20,705 tons of cold-storage capacities recorded in the ITT reflects what was actually built as of the Compact End Date.

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54	--	*"The number of water users decreased substantially to 183 users in 2021."* According to SDA Moldova data the correct figure is the following: The number of water users decreased substantially to 182 users in 2021.	The number of 183 water users was calculated based on lists of names provided to us by the WUAs. It is possible that there were some small reporting errors in these numbers or those reported to SDA-Moldova. However, the discrepancy is very small (a deviation of only one user). Therefore, we prefer to retain the number currently reported, to maintain consistency of data sources across indicators. We have added a table note to Table C.1 to note this discrepancy.
55	35	*"The prevalence of small farmers among water users in 2020 confirms that smaller farmers can irrigate through the rehabilitated systems. However, for small farmers to irrigate, they must coordinate because the rehabilitated systems were designed to provide large volumes of water, which limits the ability of small farms to irrigate independently (Borkum et al. 2018)."* We believe that this finding can be referred to the lessons learned. In the future, similar projects would benefit from considering the possibility of combining gravity and pressurized irrigation in some cases. In particular, this is relevant for systems where there are a vast number of small users and where the terrain configuration and elevation would allow the use of gravity irrigation. In our opinion, such solutions would increase the area under irrigation and the efficiency of CIS having this possibility. Experience has shown that some WUAs (Ex. Prutenii II, Cosnita, Criuleni) attracted additional investments, including from SDA Moldova funds, and adapted systems for partial use of gravity irrigation in the post-Compact period.	We note in the report that "in systems in which the water is pumped to a basin and then transported to hydrants using gravity, cooperation is not necessary because water is readily available at in-field hydrants without further pumping." We have added some text under the first lesson under EQ #7 to note this idea as one possible approach to system-specific tailoring of the Project.
56	38	*"In Blindesti and Leova Sud, consolidation by large farms mainly occurred before system rehabilitation, although it has increased slightly since then."* We disagree with this statement. For example, according to SDA Moldova data, in the CIS "Leova Sud" land consolidation took place, especially in the post-Compact period and the increase was significant one. The area owned by the largest farmer mentioned in the report doubled from approximately 370 ha in 2015 to approximately 740 ha in 2020. Moreover, it should be mentioned that in systems where some large farmers have strong interest in massive land consolidation, they artificially maintain a low level of irrigation and offers a small rent payment. This fact determines a small price for acquisition or renting of land by the interested farmers. An eloquent example is CIS Leova Sud, where one farmer through 2KR Program, brought four pieces of irrigation equipment and does not use it for several years. On the other hand, between the periods (2018 – 2019), he consolidated (purchased/leased) most of the land in the service area.	We agree that consolidation has increased since rehabilitation. However, compared to many other systems, data from the 2013-2014 Farm Operator Survey suggest that Blindesti and Leova Sud were comparatively consolidated in the 2013 season. We made slight revisions to the text to clarify. In Leova Sud in particular, our understanding is that since rehabilitation, a single large farmer has taken over land previously operated by the other three large farmers in the system. That is, the land was already consolidated by large farmers before rehabilitation but became further consolidated under a single farmer.

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57	70–78	*Appendix C. Findings from WUA administrative data.* Revised Appendix C2-C9 following SDA Moldova data are attached.	Thank you for carefully reviewing these data. Our responses are as follows: • Table C.1: As noted above, we prefer to retain the current numbers of water users we report for consistency with the Water User Survey sample frame. We have noted the small discrepancies with SDA-Moldova's numbers for 2020 and 2021 in a table note. • Table C.5: For 2018, we are unable to fully resolve the small discrepancies across different data sources. The total area irrigated was 1,781ha according to WUA administrative data, 1,770ha according to SDA-Moldova's 2018 annual report (which does not provide a breakdown by system), and 1,794ha according to discussions with the reviewer. Given that these discrepancies are small and do not substantively affect the findings, we prefer to retain the current numbers from the administrative data. We note the discrepancy in a table note. For 2019 and 2021, the small discrepancies with SDA-Moldova's data for specific systems are likely due to rounding. However, the totals are consistent with those in SDA-Moldova's annual reports, and we have therefore not adjusted the numbers for those years. • Table C.6: Based on discussions with the reviewer, it appears that the discrepancies might be due to differences in the timing of data collection. We have adjusted the numbers to reflect SDA-Moldova's data, which are based on official WUA reports following the annual General Assembly. • Table C.8: We correct an arithmetic error for total revenues Cosnita in 2017. • Table C.9: Based on discussions with the reviewer, it appears that WUAs might have misunderstood our question about reserve fund balances. We have adjusted the numbers to reflect SDA-Moldova's data, which are based on official WUA accounts.
58	General	I went through the report and found it to be very well written, thorough and nicely formatted. I rarely see reports that are this well written. It is good to see statements and conclusions that appear to be supported by hard data. I applaud MCC for having the courage to make these kinds of investments in the Republic of Moldova through the THVA Project. I believe it is a significant contribution to the country's development and that some of the benefits will not be seen for years to come. We see how long it took for countries like the Netherlands and Spain (two examples) to figure out irrigation, drainage, and system management: literally centuries.	Thank you!
59	7	*"...could lead to the loss of WUA revenue and eventual degradation of irrigation infrastructure."*	These studies (de Fraiture et al., 2014, and Turiansky, 2019) do not explicitly discuss WUA revenue, so we have not revised the text. However, based on other studies, we agree that poor cost recovery appears to be an issue for many WUAs.

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60	7	I managed a USAID project in Senegal from 2016–2022 and I can say that infrastructure of all types is typically unmaintained—it tends to be used without any preventive maintenance until something breaks.	Thank you for sharing this experience that supports the discussion of maintenance challenges.
61	13	I would note that the initial CISRA procurement failed and several months were lost, followed by many contractual problems with a loosely-affiliated joint venture. This resulted in irrigation system rehabilitation delays and compromised the ability of WUAs to benefit from project support until the final few months of the Compact.	Thank you. We have added a sentence in the introduction to indicate that construction was delayed, which is important for interpreting some of the later findings.
62	15	Not sure what you mean by "equipment replacement and regular maintenance checks"; what equipment are you referring to, and how do maintenance checks prevent clogging? Maintenance checks are fine, but need to be followed up by implementation of maintenance tasks.	Thank you; this is a good point. We have replaced "maintenance checks" with "maintenance work."
63	15	*"Therefore, maintaining the drainage system implies additional costs..."*	Both maintenance and use of the drainage system (which requires pumping) imply additional costs for the WUA; we have adjusted the text accordingly.
64	23	In the box, is "calibrated/calibration" the right word (right translation)? I do not believe readers will understand what this is supposed to mean.	We reconfirmed the translation, which appears to be correct. By calibration, the respondent is referring to the organization of produce by size, appearance, and quality to make the package more presentable and uniform. We have adjusted the quote to clarify the meaning.
65	63	*"common platforms for water management ... have not been sustained"*: this is not surprising, as the software is rather sophisticated and annual licensing is very expensive. But if Moldova wants to join the EU, they will have to invest in this kind of thing to meet membership requirements.	We agree. As mentioned elsewhere in this section, Moldova is now attempting to implement the EU's water framework directive, which requires monitoring 45 water quality parameters; this task was included in and funded as part of the second RBM plans.
66	65	Last bullet point: I fully agree with this, as you must know based on our online call several weeks ago! Also, perhaps change to "...these new organizations to function independently by the end of..."; or, "...these new organizations to become self-sufficient by the end of..."	Thank you; we have revised the text to say, "…for these new organizations to be self-sufficient by the end of the project."
67	14	*"1. Irrigation system functionality"* I counted five systems that encountered significant equipment failures and were able to resolve them with the SDA's technical and financial support. The framing of conclusions at the beginning of this paragraph is somewhat biased in light of these findings. Maybe consider rephrasing it? For example - Despite some fairly serious failures encountered by several systems, all of them were able to continue to operate normally? Furthermore, as the text goes and in the conclusion (B. Implications), you highlight the relevance of post-project organization (SDA) in supporting the normal business of associations.	We believe that the current statement in the report is accurate. As noted in the report, there were only three systems in which WUA directors perceived the functionality issues as severe (Roscani, Cosnita, Puhaceni), and even in these systems only certain parts of the system were affected. We revised the summary point (in bold) to highlight the importance of SDA's support, as described in the second and third paragraphs.
68	15	*"No additional irrigation modules were completed in Chircani-Zirnesti between 2018 and 2021."* An excellent concept of rehabilitation for testing, which was implemented in a not very appropriate place. Is it possible to draw the attention of the readership to the fact that 13 modules account for 19 members (2021) of the association?	This section is focused on the functionality of the systems, which include the 13 functional modules in Chircani-Zirnesti. Later, we discuss the limited number of members and users in this system, and how it is one of the lowest-use systems (comprising mostly of large non-HVA producers who are not interested in irrigating regularly). In the response to EQ #2, we also added a sentence highlighting the small number of users in most systems.

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69	16	*"Overall, these findings suggest that the WUAs are managing the rehabilitated systems well, contributing to a substantial improvement in the availability of affordable irrigation water."* The reduction in the total number of members of the associations from over 11,000 in 2015 to 650 in 2021 scarcely supports this conclusion.	This section is focused on whether the provision of water to members is well-managed. We believe that this statement is accurate, as water is readily available to those members who demand it. We view the decrease in the number of members a separate issue, which we address later in the report.
70	16	*"More intensive use of the rehabilitated systems should be reflected in a greater volume pumped, more water users, and a larger area irrigated."* I would not characterize this as intensive growth. Extensive? This is most likely due to an increase in the number of non-HVA crops consumers during dry season, resulting in an increase in the volume of water pumped. However, the average increase in the volume of water consumed per hectare of irrigated land in 2020 was just 8%. What do you think?	Thank you; this is a good point. "More extensive use" is a more precise description; we have revised the text accordingly.
71	21	*"Most water users who irrigated HVA crops in 2020 had experience cultivating the same crops before rehabilitation, suggesting that the transition to HVA crops was more limited than expected."* Don't you think that the collapse in the number of regular members of associations (a 17-fold reduction in the period from 2015-2021), some of whom were also expected to switch to the cultivation of HVA crops, could be another factor contributing to the extremely low rates of transition?	We agree and have adjusted the text accordingly.
72	24	*"Farmers also identified several constraints to working with domestic retail chains…."* I would add - The logistics of imported products are well-organized, which allows coordination with local wholesalers and supermarkets. In addition, Moldovan producers have been unable to arrange the delivery of their products to local retail chains.	The specific domestic retail chain we interviewed mostly relied on imports only when Moldovan produce was not available, although farmers we interviewed mentioned import competition in the context of dampening prices for HVA produce (as mentioned elsewhere in the report). The domestic retail chain also has its own logistics centers for collating produce from farmers in different parts of Moldova, so the lack of access to cold storage (to preserve produce until it can be sold to the retailer) was cited as a challenge rather than the transportation itself.
73	30	*"Less than one-third of water users participated in any type of GHS training; any impacts of training on improved practice adoption in the rehabilitated systems are unlikely to be widespread."* Does this suggest that the training program was developed without taking the participants' needs and requirements into account (training needs assessment)? Have other members of the associations or local farmers who are not members of the association shown interest in these trainings?	We did not ask water users about their perceptions of GHS trainings, which were conducted many years ago, so cannot comment on their alignment with respondents' needs. What we can say is that the overall reach of these trainings was limited and therefore unlikely to have driven changes in the systems, even though the numbers trained were aligned with program targets.
74	33	*Footnote 19.* In fact, the list of beneficiaries is far broader than "water users" and includes additional beneficiary categories. Please recheck the definition of THVA beneficiary in the Post-Compact M&E Plan - Chapter 1.5. Program Beneficiaries.	We have described the full set of expected beneficiaries in the introductory chapter; in this section we are focusing on water users, the beneficiaries who drove Project benefits in the CBA model.

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75	42	*"Commitment to irrigation."* This appears to be the most critical factor in this context. Considering a steady decline in the total number of members of all associations, the number of water users remained nearly stable during the study period. That is, people who formed the association in order to get irrigation benefits either left the association after CIS rehabilitation or are not interested in the services provided by the association. I would say that commitment is also heavily influenced by considerable limits on small farms' ability to engage in irrigation autonomously (as described on page 35) + the necessity to pay expensive (as they perceive) membership fees (page 51)+limited interest in HVA crop cultivation.	We agree with the reviewer.
76	48	*"...although a comprehensive rehabilitation (like CISRA) might not be economically viable"* Is there any data to compare the cost of rehabilitation per hectare for comparable projects? According to the Final Program Review (2015) of the Compact Moldova, rehabilitation turned out to be fairly expensive, with average costs of about US$ 7,000 per hectare, and one scheme costing more than US$ 13,000 per hectare.	While this type of comparison is possible, comparisons of estimates of cost per hectare can be challenging to interpret because there is vast heterogeneity in irrigation schemes (country, system type/design, rehabilitation versus new construction, scale, etc.).
77	48	*"The AAF Activity had limited effects on water users in the rehabilitated systems."* According to the Final Program Review (2015), the largest beneficiaries of AAF funds were the districts of Straseni and Briceni, both of which are located outside of the ISRA/CISRA intervention area.	In the response to EQ #1, we have added more information about where the AAF-funded infrastructure was constructed.
78	51	*"The number of WUA members has stabilized over the past few seasons."* Please pay attention to the fact that in the first four years following the project's completion, the total number of members of 10 associations declined by more than half each year, and this figure only stabilized at 650 persons by 2020. I think it is just impossible to ignore the 17-fold decline in the overall number of members of the ten associations.	In the response to EQ #6, we have more explicitly discussed the decline in WUA membership.
79	51	*"WUAs are likely to be more sustainable if they have a stable base of fee-paying members. Exclusion of large numbers of members for non-payment of fees was common in previous years."* The expulsion from the associations of members who did not pay membership fees resulted in many of them leaving with their cultivated lands, so decreasing the proportion of cultivated land owned by association members. This pushes management to increase membership fees or incorporate a part of fixed costs into the cost of water. The limited command area coverage by irrigation may also jeopardize WUA's long-term sustainability. Was this particular aspect covered in the research?	As described in the report, WUAs have adjusted to the reality of many of the initial members not paying their fees--and inconsistent irrigation use by the remaining members--by adjusting their membership fees (and, in some cases, irrigation fees) to achieve financial sustainably despite these constraints.

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80	58	*"System rehabilitation and irrigation management transfer addressed a major constraint to cultivating HVA crops."* Indeed, the management transfer is the component of the project that most effectively solved the problem with the cultivation of HVA crops. Regarding CISRA, I would add that it was vital to consider the fact that these systems were originally designed and constructed in Soviet times to irrigate fields of tens of hectares of land cultivated by collective farms. The use of the same structural design with the same capacities under conditions of ultra-fragmentation of plots, the presence of different types of farms, and a variegated crop pattern is an entirely different case. This is supported by the fact that the new WUAs have successfully adopted and used the management transfer and can continue to function in some capacity without requiring significant investments in system rehabilitation.	We have added text to emphasize the issue of land fragmentation under EQ #2, where we discuss irrigation by small farmers.
81	59	*"Many farmers did not follow through on their stated commitment to become active WUA members; future projects could consider ways to assess and encourage farmers' commitment, such as requiring an up-front payment."* A good idea, but there was a risk that the number of "expressions of interest" would be so low that rehabilitation would be financially unsustainable even at this early stage of implementation.	In some places, it may be that there would be few expressions of interest; in that case, it might make sense to reassess the plan.
82	65	*"Develop a clear, location-specific theory of how envisaged changes in irrigation use and cropping patterns might occur and design additional tailored interventions to support those changes, which might include targeting specific types of farmers or geographies."* Not only types of farmers or geographies. I would also add such an important element as the technologies used for cultivating agricultural crops. Irrigation is just one component of the extensive and complex technological process involved in crop production. So, it's not enough to just pick one technological process and ignore the others if you want to get great outcomes. As a result, before beginning such a project, it is essential to be certain that irrigation is the weakest link in the technological process of this particular group of farmers. In our case, it turned out that for the absolute majority of beneficiary farmers, all links of the technological process are weak. As a result, while we were successful in providing modern irrigation equipment to farmers who were expected to benefit from it, we discovered that it was insufficient for achieving the shift to HVA crop production.	We agree. Interventions to address these broader constraints might need to be tailored by farmer/geography. We have adjusted the text to clarify.

No.	Page	Comment	Evaluator Response
83	x, xiii, Findings, and other pages	**GENERAL COMMENT** A much slower transition to irrigated agriculture and THVA production noted and reflected in the study. As also mentioned in the report but under a bit different angle, the external factors had a major impact on the project results. In essence, this also explains the more modest results than the ones initially expected when referring to transition to THVA and irrigated agriculture. Please note that we are dealing with absolutely two different socio-economic contexts if we discuss the situation at the project development stage and after the project implementation. At the development stage we had many farmers willing to identify themself with and be part of the project and after that we notice a sharp decrease of that number. And the cause of it is: *Development stage including implementation period:* Most of them were small farms including many households with small plots. At the development stage for them the irrigation was foreseen and could have been a good boost for increasing the family's income as other opportunities to earn were very limited for the rural population. The alternatives at that stage were: a) emigration, but that was very expensive and problematic and far fewer people could afford that luxury than now (also the age of emigrated categories were much restrained than now); b) public service – better and stable remuneration than in traditional agriculture, although in rural area this was always a limited opportunity only to a few residents; c) commuting to neighboring towns and cities – better remuneration than what one could get in the rural area but it has drawbacks such as transportation cost and time consuming and still not as promising as what irrigated agriculture could have offered (this refers to public service too). Here are the economic reasons that justifies the saying above: • Average annual salary in 2009 was around 2637 MDL x 12 months =31,644 MDL • Average net profit per 1 ha of vegetable could be around ~ 45,000 MDL (case of sweet pepper this hasn't change too much since then) • A small farm or a household with 3 ha could earn x 45,000MDL = 135,000 MDL	We have incorporated the key points about the changing context in Moldova in the executive summary, discussion of barriers (EQ #4), and the conclusion.

No.	Page	Comment	Evaluator Response
83 (cont.)	x, xiii, Findings, and other pages	*Post Compact Stage:* After the liberalization of visa regime with the EU, Moldovans got the right to free movement and stay on EU territory (limitation to 90 days per one entry), also many Moldovans hold Romanian citizenship for whom the conditions of stay and even official employment within the EU are much more relaxed. At the same time, the European Community has also relaxed the legislation regarding the employment of expats, specifically for certain fields that lack the labor force, especially for seasonal jobs, agriculture, construction, and transportation services. All that has produced a considerable drain of the labor force from Moldova and if previously only certain age groups emigrated, now there is an exodus in all segments. Furthermore, if previously the emigration in search of a job, was a very expensive, arduous, and risky process, currently it is done very simple, without risks, without costs and with possibilities of official employment. In this context, the remuneration offered in the EU is incommensurable with the possibilities that can be offered by the irrigation agriculture to small producers and households. Hence, many of them prefer to work for a few months a year outside the country, abandoning their own agricultural land (most often cultivating corn) but earning two, three or even more folds more than practicing even HVA production (which for a small farmer needs a consistent investment to be done and that bears risks). Another important and essential factor to be considered was the significant increase in remuneration in all sectors of the Moldovan economy, which also makes the activity of THVA or of the irrigated agriculture on small areas unattractive. Here are the economic reasons that justifies the saying above: • Average remuneration obtained in EU (NL case for a seasonal work) 1500EURO/per month x 4 months = 6,000 EURO = 120,000 MDL (many working more than 4 months) • Present Average Remuneration in Moldova ~10,000 MDL/months x 12 months =~120,000 MDL • A small producer or a household with 3 hectares of HVA can earn almost the same but working twice more time, significantly investing (in inputs and also in on farm irrigation equipment), and bearing many risks (weather, phytosanitary, markets, political context, etc.) Therefore, the further typology of an THVA producer within the irrigation perimeters will be the large and medium operators who have more endurance and can better confront the market and socio-economic situation. (to increase irrigated ag - need for land consolidation and producers cooperation, Need to attract other business operators).	(see previous page)

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84	xviii	*"Project WUAs also continue to rely on SDA-Moldova for legal, accounting, and technical* ***and financial support through 2022,*** *seven seasons after rehabilitation was completed".* Although if they counted or still counting on SDA Moldova financial support that was / or still is only seeking for additional investment in infrastructure, irrigation or in other equipment. It is worth mentioning that from foundation to present, all WUAs have financed their operational activity from own collected funds. They also did so throughout the construction period, along a period of more than 3 years without water delivery before the commissioning of the irrigation systems.	This is an important clarification and we have adjusted the text accordingly.
85	xix	*"Implement mechanisms that increase the commitment of farmers to participate in new farmer organizations like WUAs such as requiring farmers to make an affordable up-front financial investment before the project moves forward."* We need also to consider that there is a major difference between pressurized and gravity irrigation systems, where usually farmers may not need on-farm irrigation equipment, Therefore, in pressurized irrigation systems with non-flat and hilly complicated landscape *(most typical for Moldova),* the transition to irrigated agriculture will be a much slower process due to investment needs in on-farm irrigation equipment, which is quite an investment *(sometimes even commensurate with the cost/ha of the rehabilitated water supply system)* and burdensome, specifically when we talk about small farms. It is an important fact to be considered when planning for new pressurized irrigation projects *(One of the aspects that was not given much consideration at the project design stage)*. Also, see below the comment referred to page 44, which complement this one with more details.	We cannot rule out that increased provision of free or low-cost on-farm equipment to farmers would have increased the affordability of irrigation in the pressurized rehabilitated systems. However, a lack of access to markets and limited rural labor were consistently cited by farmers and other stakeholders as critical constraints to irrigating and transitioning to HVA crops, which irrigation equipment would not address. Further, there has been excess capacity for WUA-provided equipment services (except in the 2020 drought year), and purchase of on-farm irrigation equipment through the 2KR hire-purchase facility in the 10 systems has been limited. This suggests that many farmers are not taking advantage of existing (relatively) affordable equipment options.
86	xiii	*"Common Platforms 2 and 3, which were designed to collate information from four institutions related to water management and make the information visible across them, fell out of use soon after the Compact due to turnover of trained staff and limited incentives for remaining staff to update and maintain the systems."* To some extent the statement is correct, but we should also consider the fact that after the Compact end there were several reorganizations provided on the ministerial level as well as within its subordinated institutions that were also leading to that. Nevertheless, with reference to the Platform 2 and 3, following the reorganization process it was decided to collate and consolidate the information from the four institutions related to water management into one single platform named "Waters Cadaster" placed under the management of the Water Management Basin Directorate. There is still a chance that those platforms may come back within the framework of the "Waters Cadaster" - here is the link to their web site https://csa.gov.md	Thank you for sharing this update.

No.	Page	Comment	Evaluator Response
87	23–24	*"Further, these respondents perceived that there had been a decrease in the purchasing power of Moldovan consumers over the past decade—in part due to migration of working-age people and high inflation—that has led to reduced domestic demand."* This perception is contradictory to the reality that exists, and the reason is probably because of the following. The internal market for fresh fruit and vegetables has always been very small compared to the quantities produced, therefore the only sustainable solution in conditions of increased production is the orientation and increase of the export capacities of producers. It is certain that in recent years *(specifically the last decade)* the internal production, especially of fruits, has considerably increased *(more than 200% - as per official statistics, in reality is much more),* respectively, part of that produce is sold on the local market, although the volume of the market has not changed significantly, the supply has increased far above its size, hence a fiercer competition and the perception that the purchasing power of Moldovan consumers has decreased. As per economic analysis done by Veaceslav Ionita, Expert in economic policies from IDIS "Viitorul", if comparing the 1990 or 1991, the years before the economic collapse, then in the last decade, the purchasing power of Moldovan consumers has increased by 1.6-1.9 times comparing only the wages. Nevertheless, the wages are not the only source of revenue and as per his estimations in 2020 the Moldovan consumer could buy 2.6 times more than in 1991. Another indirect indication that proves that the purchasing power has significantly increased in recent years, it is the number of new retail networks entering Moldovan market as well as the number of outlets opened (Linela a national chain of supermarkets with more than 145 units opened around the country. Kaufland with 8 units, Metro Cash&Carry with 4 units, N1, Fourchette, and others).	Thank you for this explanation; we have removed this sentence from the report.

No.	Page	Comment	Evaluator Response
88	44	Almost all Project WUAs offer their members the opportunity to rent irrigation equipment services ***(comprising equipment, such as hoses and sprinklers, and workers to operate it);*** *the equipment was provided to the WUAs by the Project, and SDA-Moldova has provided some additional equipment since the end of the Compact.* In fact, we are not talking about hoses and sprinklers as mentioned here, it is about on-farm irrigation equipment which is much more costly and not quite affordable to small farmers. This should be a lesson learned for all future pressurized irrigation projects that there would be no expected success unless the number of available on-farm irrigation equipment is provided in the quantity and capacity that could fit at least the minimum of pump's discharging capacity that allows it to operate within the efficiency limits. By not ensuring this, there is a huge risk that pumping stations will be abandoned, though some of them (producers) would have on-farm irrigation equipment in place. Hence, the number of already available on-farm irrigation equipment could be an indicator to decide to go or not with selection of a pressurized irrigation system for a future project.	Please see the response to comment #85 above.
89	--	Indeed, the process of transition to irrigated agriculture is a slower process than expected, and it is because the THVA production require enormous investments, nevertheless there are large investments within or in the proximity of some of the rehabilitated perimeters, catalyzed after the project implementation that have or may have a significant economic effect later. It would have been good to have a section that would show what were the investments catalyzed after the rehabilitation. For example, in Jora de Jos, Cosnita, Criuleni, Roscani we are talking about dozens, or hundreds of hectares of perennial crops planted, the value of the investments could be commensurable with the investments in those irrigation systems. In Jora, Criuleni and Cosnita farmers have invested in cold storages. In Cosnita for example the farmers have procured around 45 units hose-reel irrigation equipment (each cost between 17-25, ths. $US). Also, the other investment from Blindesti and Grozesti.	We agree that there have been some important additional HVA-related investments by farmers in the systems, although the overall transition has been slower than expected. For example, as mentioned in the report, there were about 100 water users in 2020 who had entered the systems/invested in them since rehabilitation; these included some of the largest water users. Further, more than 1,000 hectares of apples and other orchard crops were irrigated across the 10 systems in 2020. We estimate that, among water users irrigating these crops in 2020, more than two-thirds did not cultivate them in the system before 2015. This suggests that there were substantial new investments in orchards after rehabilitation, in addition to investments in other new crops like sugar beets in Grozesti and strawberries in Blindesti.
90	x, 2	*"CISRA and the WUA-related component of ISRA targeted 10 centralized irrigation systems located along the Prut River (Blindesti, Grozesti, Leova Sud, and Chircani-Zirnesti) and the Nistru River (Lopatna, Jora de Jos, Criuleni, Cosnita, Puhaceni, and Roscani).[1]"* *"[1] The Project originally targeted 11 systems, and established a WUA in the 11th system, Cahul. However, MCC decided not to rehabilitate this system given drainage issues, and this WUA was largely dormant during the Compact."* In our opinion, the main reason not to rehabilitate Cahul CDS was the revised approach to the Compact CIS rehabilitation. It presumed 10 CIS complete rehabilitation and, consequently, the lack of funds for Cahul's CDS rehabilitation.	We have modified the text accordingly.

No.	Page	Comment	Evaluator Response
91	5	*"Two rehabilitated systems were completed before the 2015 agricultural season and the other eight systems were completed during the 2015 season; rehabilitation was originally planned to be completed earlier in the Compact,* ***but was delayed by procurement challenges****. (Figure I.2 shows examples of rehabilitated infrastructure in these systems.)"* With respect to the evaluator's opinion, we suggest the following text: "but was delayed taking into consideration the need for redesign and procurement challenges."	We have modified the text accordingly.

Appendix H. Evaluation gender type

MCC categorizes its evaluations into the following gender type categories:

Type 1 – Gender is and/or was part of the logic and evaluation design of the program being evaluated.

Type 2 – Gender is and/or was not part of the logic of the program being evaluated, but the evaluation design incorporates gender issues (for example, in the evaluation questions or data collection methods).,

Type 3 – Gender is/was not part of the logic or evaluation design of the program being evaluated, but sex-disaggregated data will be or were collected.

Type 4 – Gender is and/or was not part of the logic or evaluation design of the program being evaluated, and sex-disaggregated data will not be nor were not collected.

Not applicable (N/A) – This applies if interventions will not be evaluated or if an evaluation is canceled before an evaluation design report has been approved.

At the time of final evaluation report completion, MCC has determined the THVA evaluation's gender type to be **Type 3** based on the definitions above. The project logic does not include gender nor was it part of the evaluation design, but sex-disaggregated data were collected from water users.

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