PROJECT PERFORMANCE ASSESSMENT REPORT

ARAB REPUBLIC OF EGYPT

Integrated Irrigation Improvement and Management Project and Farm-Level Irrigation Modernization Project

Report No. 173462
JULY 5, 2022

IEG
INDEPENDENT EVALUATION GROUP

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Arab Republic of Egypt

Integrated Irrigation Improvement and Management Project (IBRD-72910)

Farm-Level Irrigation Modernization Project (IBRD-79840, TF-13794)

July 5, 2022

Finance, Private Sector, Infrastructure, and Sustainable Development

Independent Evaluation Group

Abbreviations

FIMP	Farm-Level Irrigation Modernization Project
IEG	Independent Evaluation Group
IIIMP	Integrated Irrigation Improvement and Management Project
IWMD	Integrated Water Management District
MALR	Ministry of Agriculture and Land Reclamation
MWRI	Ministry of Water Resources and Irrigation
O&M	operation and maintenance
PMU	Project Management Unit
WUA	Water User Association

All dollar amounts are US dollars unless otherwise indicated.

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This report was prepared by April Connelly and Hassan Wally, who assessed the project in February 2019. The report was peer reviewed by Mahwash Wasiq and panel reviewed by Christopher Nelson. Wilfried Hundertmark provided additional comments on the draft. Vibhuti Narang Khanna, Romayne Pereira, and Viktoriya Yevsyeyeva provided administrative support.

Note: IEG = Independent Evaluation Group; PPAR = Project Performance Assessment Report.

Contents

Boxes

Figures

Appendixes

Data

This is a Project Performance Assessment Report by the Independent Evaluation Group (IEG) of the World Bank Group on the Arab Republic of Egypt Integrated Irrigation Improvement and Management Project (P073977) and the Farm-Level Irrigation Modernization Project (P117745). We discuss this instrument and the methodology for this evaluation in appendix C.

IEG selected these projects for field-based assessment because they were complementary irrigation projects that supported improvements to the irrigation system in the same command areas. Assessing the two projects together allows for a more complete understanding of the results and provides a comprehensive lesson-learning approach beyond looking at either project in isolation. The information gained from this field-based study provides input for IEG's evaluation of the World Bank's support for service delivery in the irrigation sector.

The Integrated Irrigation Improvement and Management Project was approved on May 12, 2005, became effective on May 2, 2006, and closed on March 31, 2016. The Farm-Level Irrigation Modernization Project was approved on December 14, 2010, became effective on July 10, 2012, and closed on December 31, 2017.

This report presents findings based on a review of the World Bank's project documentation, other relevant materials, and interviews with a range of different stakeholders linked to the program, including government officials, implementing agencies, World Bank staff, other development partners, and civil society. An IEG mission visited Cairo and project sites (Beheira, and Gharbia and Kafr El-Sheikh Governorates) February 10–21, 2019.

IEG gratefully acknowledges the logistical assistance and support of the Ministry of International Cooperation, the Ministry of Water Resources and Irrigation, the Ministry of Agriculture and Land Reclamation, and the staff in the World Bank Cairo office, particularly Ms. Heba Yaken, Ms. Ingy Awad, and Ms. Enas Mahmoud, who provided invaluable assistance before, during, and after the mission.

Following standard IEG procedure, copies of the draft Project Performance Assessment Report were shared with relevant government officials for their review and comment; no comments were received.

The Arab Republic of Egypt—Egypt Integrated Irrigation Improvement and Management Project (P073977)

Basic Data

Country	Egypt, Arab Rep.	World Bank financing commitment	$120.00 (millions)
Global Practice	Water	Actual project cost	$118.56 (millions)
Project name	Integrated Irrigation Improvement and Management Project	Expected project total cost	$300.00 (millions)
Project ID	P073977	Actual amount disbursed	$249.91(millions)
Financing instrument	Specific investment loan	Environmental assessment category	B
Financing source	IBRD-72910		

Dates

Event	Original Date	Actual Date
Approval	12/05/2005	12/05/2005
Effectiveness	02/05/2006	02/05/2006
Restructuring	14/10/2012	14/10/2012
	31/03/2014	31/03/2014
	17/01/2016	17/01/2016
Mid-Term Review	29/02/2012	05/06/2012
Closing	31/03/2014	31/03/2016

Key Staff Responsible

Management	Appraisal	Completion
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The Arab Republic of Egypt—Egypt Farm-Level Irrigation Modernization Project (P117745)

Basic Data

Country	Egypt, Arab Rep.	World Bank financing commitment	$103.87 (millions)
Global Practice	Water	Actual project cost	$156.60 (millions)
Project name	Farm-Level Irrigation Modernization Project	Expected project total cost	$183.87 (millions)
Project ID	P117745	Actual amount disbursed	$100.00 (millions)

Country	Egypt, Arab Rep.	World Bank financing commitment	$103.87 (millions)
Financing instrument	Investment project financing	Environmental assessment category	B
Financing source	IBRD-79840, TF-13794		

Dates

Event	Original Date	Actual Date
Approval	14/12/2010	14/12/2010
Effectiveness	10/07/2012	10/07/2012
Restructuring	21/06/2016	21/06/2016
	31/05/2017	31/05/2017
Mid-Term Review	09/06/2015	09/06/2015
Closing	30/06/2016	31/12/2017

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Summary

The Arab Republic of Egypt depends almost exclusively on the Nile River for its water supply, and it shares the river with 10 other upstream countries. Ninety percent of the Egyptian population is located on 5 percent of land along the banks of the Nile, as is most of the country's agriculture production. Irrigation is a critical input for agriculture production and is the largest user of water in the Egyptian economy, accounting for 85 percent of freshwater withdrawals. Over time, Egypt has moved from a situation of relative water abundance to water scarcity. Fueled by population pressures, demand for water is growing while the options for increasing supply are limited.

The Nile Delta is irrigated by a dense system of interconnected waterways, notable for the scale and complexity of the distribution network. The interconnectedness of waterways creates challenges for managing the distribution of water across the system. Users at the tail end of canals are at a disadvantage and receive relatively low amounts of irrigation water compared with users at the head of the main and branch canals.

Responding to the need to address distribution issues and improve the sustainability and productivity of water use in the face of increased water scarcity, the Ministry of Water Resources and Irrigation (MWRI) initiated an irrigation improvement program, supported by a series of successive donor-funded projects. The program aimed to improve distribution of water across users and lay the foundation for implementing integrated water management with the greater participation of water users. To achieve these goals, it employed a combined package of technical and institutional innovations that was adapted over time.

The projects assessed in this report built on the experience of earlier irrigation improvement projects but sought for the first time to improve performance at all levels of the irrigation network, including the farm level. The Integrated Irrigation Improvement and Management Project (IIIMP) financed investments to improve the main, branch (secondary), and *mesqa* (tertiary) canals. It also included a small pilot to improve *marwa* (quaternary or farm-level) canals, and the pilot was subsequently scaled up by the Farm-Level Irrigation Modernization Project (FIMP).

The development objective of IIIMP was "to increase the efficiency of irrigated agriculture water use and services." It was implemented by the MWRI. The development objective of FIMP was "to increase agricultural profitability and improve equity in access to higher-quality water for small-scale farmers (in the project area)." The project later dropped "increasing agricultural profitability" from its objectives as part of a formal restructuring. FIMP was implemented by the Ministry of Agriculture and Land

Reclamation. Independent Evaluation Group project ratings are described in appendix A.

Results

Through a systematic approach to infrastructure rehabilitation that included all related tiers of the system, the projects generated positive results in improving equity of water distribution between head and tail users, reducing operating costs, and reducing the time required to irrigate, among other benefits. Improvements to the mesqa-level canals raised the ratio of water availability between head and tail users to 75 percent (compared with a baseline of 50 percent). Marwa-level improvements resulted in 84.5 percent water availability ratio, and the use of drainage water by irrigators at the tail end of marwa canals was reduced by 95 percent. Converting from individual diesel pumps to a single-point electric pumping station for lifting water from the branch canals into mesqa canals reduced pumping costs by an average of 50 percent under IIIMP and 46 percent under FIMP. Marwa system improvements also led to a 37 percent reduction in the time required for farmers to irrigate their fields. Conversion from open canals to an underground piped distribution system improved water quality by eliminating contamination from illegal dumping and had the added benefit of increasing the area available for cultivation. Structural improvements to the main canals also generated benefits for nonirrigation users by improving conditions for the supply of drinking water to the city of Alexandria and by improving the condition of roads along the main canal.

Although the projects effectively improved water delivery, they were less successful in driving a change in farmers' behaviors, such as in agricultural practices and on-farm water management. Providing farmers with greater access to quality water and more predictable delivery was expected to enable them to adopt new water management and agricultural practices at the field level and lead to greater water productivity, higher yields, and a shift to higher-value crops. The projects provided training and demonstration activities, but this did not change behavior or lead to crop diversification, an implicit goal of FIMP, which required more time than a single project cycle.

The projects had limited impact on water scarcity at a basin level. Although it is plausible that mesqa and marwa infrastructure improvements reduced field-level water loss, the projects had little impact on water savings for the system at a basin level. One of the expectations of the overall irrigation improvement model, though not part of the stated project development objectives, is that improvements in the management of the system will contribute to water savings, allowing the system to meet the demands of users under increasing constraints. The conversion from open canals to a piped distribution system led to a reduction in the overall water requirements at the mesqa

and marwa levels, but no meters or measuring devices were installed to provide data on the actual amount of water used by the farmers. Efficiency improvements at the farm scale, however, do not necessarily mean that water has been saved at a basin level. The global water use efficiency of the Nile delta system as a whole is relatively high even before improvement, with little scope for further gains, as water lost from one point in the system returns to the river or drainage canals and is used by other users downstream.

Project efforts to reform the institutional structure for managing irrigation and drainage services had mixed results. IIIMP supported institutional reforms aimed at redefining the role of public sector water delivery agencies and laying the foundation to implement participatory integrated water management. The project's capacity-building component supported establishing, expanding, and upscaling Water User Associations (WUAs) at the tertiary (mesqa) and secondary (branch) levels of the irrigation and drainage system; establishing water boards at the branch level, and their subsequent federation into higher-level District Water Boards. Within the MWRI, the project supported creating Integrated Water Management Districts, intended to integrate previously disparate efforts of local district agencies responsible for system improvement and management. Integrating the various agencies within the ministry was expected to reduce fragmentation in the delivery of services at the district level, where the ministry interfaces with farmers.

IIIMP succeeded in transferring management of the system to WUAs at the mesqa level, but efforts to upscale the participation of water user organizations at higher levels of the irrigation system stalled. Mesqa WUAs were successfully established and took over managing the improved mesqa infrastructure, operating collective pumping stations, scheduling irrigation turns, and collecting and managing fees for operation and maintenance. By contrast, water user organizations at the branch and district levels were also established to manage, operate, and maintain the branch canals jointly with the MWRI, but to date, they do not play a role in managing the system and function largely on paper. Several factors explain the difference in these results. First, mesqa WUAs are recognized entities under the existing 1994 WUA law, giving them legal authority to collect fees and providing them with legitimacy in the eyes of farmers and government agencies. By contrast, branch WUAs and District Water Boards were established under ministerial decree, a more tenuous legal situation. Second, the key technology implemented by the projects at the mesqa level (replacing individual pumps with a collective pumping station) makes cooperation necessary. This is not the case at the branch level and above. Third, collective action at the mesqa level and below is facilitated by building on the preexisting mesqa organizational system (history and culture of communal social practices) and its strengths. Mesqa canals also cover a

smaller area and are owned by the farmers. At the scale of the branch canal or district level, there are no preexisting communal ties to build on.

Measures to integrate irrigation and drainage agencies within the MWRI into a single unit at the district level were unsuccessful. Integrated Water Management Districts were established as planned under IIIMP, but after the project closed, each agency reverted to operating as a separate entity. Project design did not incentivize integration of the various district agencies beyond locating them in the same building. Interviews with other stakeholders and a reading of the literature indicate that the project insufficiently addressed historical differences in salary structure between irrigation engineers and drainage engineers and lacked other institutional incentives to foster integration.

What Features of Project Design and Implementation Worked Well, and Why?

A positive feature in the design of both projects was to intentionally involve farmers in the planning and design process of mesqa and marwa improvements, increasing ownership among beneficiaries and enhancing sustainability. The trade-offs were that it lengthened the implementation time to accommodate requests for changes to design, and it was hard to convince farmers to participate before they saw the benefits from other improved areas. Some farmers have been unable to participate in these projects because a key condition for mesqa and marwa selection is that every farmer in the area targeted for improvement must approve.

Combining mesqa- and marwa-level infrastructure improvement into a single procurement package under FIMP led to a more cost-efficient design and enhanced compatibility in the design of the two systems.

What Features of Project Design and Implementation Did Not Work Well, and Why?

Both projects lacked detailed engineering plans and feasibility studies for work at appraisal, resulting in underestimated costs of mesqa and marwa improvements. This contributed to the slow uptake of project activities by farmers initially. Both projects also lacked a sufficiently nuanced understanding of what would drive behavioral change.

IIIMP planned to pilot the use of a continuous-flow irrigation model in two branch canals, but this was dropped during implementation when it proved to be incompatible with the local context. Its promotion raised expectations, and its subsequent abandonment harmed the project's reputation because farmers felt misled.

Both projects encountered problems with procurement that led to delays in civil works. In addition, FIMP lacked contractual provisions to address changes in the exchange rate, and this negatively affected construction progress after devaluation of the Egyptian pound against the US dollar.

Lack of adequate interagency coordination mechanisms also affected the projects. Intended synergies between IIIMP and FIMP were not maximized because of insufficient coordination between the MWRI and the Ministry of Agriculture and Land Reclamation, the implementing agencies for the respective projects. Cross-agency coordination challenges also contributed to difficulties establishing connections to the electricity grid to allow for the conversion from diesel to electric pumps, delaying mesqa improvement works. IIIMP lacked adequate coordination mechanisms between the MWRI, the Ministry of Environment, and the Ministry of Health, impeding implementation of environmental activities envisioned at appraisal.

Frequent ministerial turnovers after the Arab Spring and lack of decision-making by several government officials at that time also had an impact on implementation of the IIIMP.

Lessons

This assessment offers the following lessons:

- **Irrigation improvement efforts in irrigation systems that are organized along a hierarchiacal canal network (such as the Nile Delta's) can realize greater impact by applying a systematic approach to rehabilitation,** as was done through these two projects, as opposed to addressing different levels of the canal system in isolation. But this requires improved institutional integration to be effective.

- **Efficient implementation of irrigation improvement works requires coordinating and sequencing activities that fall under the mandate of many different entities that are often beyond the authority of the project implementing agency.** Arrangements with other entities need to be agreed on and formalized before commencing with work and should ensure that each entity is accountable for achieving results within the project time line.

- **Effecting behavior changes in on-farm water use, agronomic practices, and diversification to higher-value crops requires support beyond improvements to the irrigation water delivery system.** Such changes are incremental and may not be feasible in a single operation.

- **Successfully reforming the institutions that manage irrigation and drainage services, both water users and government agencies, requires greater attention to incentives for collaboration.** The ability of water user organizations to play an effective role in water management depends in part on the incentives for collective action. Transfer of management functions to WUAs at higher levels of

the system, where responsibility will be shared with government agencies, requires clearly defined roles and responsibilities of each party. Reforms within government agencies also require attention to incentives to overcome the status quo.

- **In a context such as the Nile Delta, where overall efficiency of the irrigation system is already high, there is little scope for addressing water savings at the basin level through infrastructure improvement.** In such contexts water scarcity must be addressed through an allocation mechanism that operates within constraints of the system.

Oscar Calvo-Gonzalez
Director, Human Development and Economic Management
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1. Background, Context, and Design

1.1 This Project Performance Assessment Report reviews the experience and achievements of two complementary irrigation projects targeting the same irrigation command area in the Arab Republic of Egypt. Collectively, these projects made improvements to the entire irrigation system from the highest level of main distribution canals down to the field level. The projects built on the experience of a series of previously delivered irrigation improvement projects that modernized discrete segments of the irrigation system with a combined package of engineering and institutional innovations. For the first time, the irrigation improvement package extended to the distribution system in its entirety.

Water Context in the Arab Republic of Egypt

1.2 Egypt depends almost exclusively on the Nile River for its water supply, and it shares the river with 10 other upstream countries. Ninety percent of the Egyptian population is located on 5 percent of land along the banks of the Nile, as is most of the country's agriculture production. Irrigation is a critical input for agriculture production and is the largest user of water in the Egyptian economy, accounting for 85 percent of freshwater withdrawals.

1.3 Over time, Egypt has moved from a situation of relative water abundance to water scarcity. Fueled by population pressures, demand for water is growing while the options for increasing supply are limited. The population of Egypt has grown from 75 million in 2005 to 95 million in 2016, exerting considerable pressure on the quantity and quality of the water resource and affecting water and food security and the environment.[1] Climate change models predict increased water constraints. In the face of water scarcity, Egypt faces the strategic challenge of improving the productivity and sustainability of water use rather than augmenting water supply (World Bank 2005b).

Nile Delta Irrigation System

1.4 The Nile Delta is irrigated by a dense system of interconnected waterways, notable for the scale (providing water across an area of more than 2 million hectares) and complexity of the distribution network. The structure of the distribution network involves successive levels of canals comprising the main feeders from the river to main (primary) canals, branch (secondary) canals, *mesqa* (tertiary) canals, and *marwa* (quaternary) canals or field ditches (see box 1.1). Main and branch canals are publicly owned and are managed and maintained by the Ministry of Water Resources and Irrigation (MWRI). Mesqa and marwa canals are located on private land and are owned,

operated, and maintained by farmers (Molle et al. 2015). Irrigation canals are complemented by a parallel drainage network.

1.5 The interconnectedness of waterways creates challenges for managing the distribution of water across the system. Waterways at all levels of the irrigation network are interconnected, including between irrigation canals and drainage channels. This complicates water management because actions at one level of the system affect the others, and hydraulic characteristics are in flux. Managers must contend with uncertainly of both supply (inflow into each canal depends on upstream conditions) and demand (influenced by cropping patterns and how much water farmers are abstracting at the field level; Molle et al. 2015). Users located at the tail end of canals are at a disadvantage and receive relatively low amounts of irrigation water compared with users located at the head of the main and branch canals. To overcome shortages, tail end users often irrigate with untreated drainage water.

Box 1.1. Water Distribution across the Irrigation Network and Associated Challenges

Water distribution in the Arab Republic of Egypt can be categorized into three levels.

The first level is at the main canals, where water is running continuously and distributed among irrigation directorates on a volumetric basis. Irrigation directorates are obligated to satisfy certain quotas on the main canals. The first level is the most important level for optimal allocation of water resources throughout the country.[a] Management of the system at this level is completely under the domain of the Ministry of Water Resources and Irrigation.

The second level is the distribution of water among branch canals within the same irrigation directorate, which is done on a rotational basis (typically, 5 days on and 5 days off in summer, and 5 days on and 10 days off in winter). The combined effect of deterioration of the main and branch canal network, a lack of ability to control farmers' consumption, and the need to satisfy certain quotas on the main canals results in unreliable distribution of water in branch canals. Water supply at branch canals is adjusted frequently to solve problems at the tail end or to maintain required flow in the main canal, which makes it difficult to ensure rotation schedules. Operation of the branch canals is under the domain of the Ministry of Water Resources and Irrigation.

The third level is distribution among the *mesqa* canals, which connect the branch canals to the *marwa* canals (field ditches). Mesqa canals are the collective property of all farmers who use them. Marwa canals are the private property of individual farmers. The operation, management, and maintenance at the mesqa level and below are the responsibility of farmers. At this level, the government has almost no role in water management, and water distribution depends mainly on water consumption by the farmers.

The availability of water in branch canals is often insufficient to feed all mesqa canals. The rotation in branch canals is biased toward those at the head end of the system. Mesqa canals at the head of the branch canal take more water than they are entitled to because farmers are never sure when it will be available again, which puts the branch canals at the tail end of the system and farmers at the end of mesqa canals at a disadvantage (KfW 2018).

Branch canals deliver water below ground level, requiring that farmers lift water onto the mesqa canal with the use of a pump. Farmers have the right to lift water at any time during their "on" period of the rotation. Traditionally, lifting water to the mesqa canal was done by animal-driven waterwheel (the *saqia*), which was collectively operated. Farmers' capacity to extract water by saquia was limited by the need to share with several other farmers and the restrictions of canal rotation. This meant farmers were constrained in when and how long they could irrigate. The saqia was also licensed by the MWRI. In the 1970s, farmers began replacing the saqia with mobile, individually operated diesel pumps. By the end of the 1990s, the saquia almost completely passed out of use in the delta. The shift to individual diesel pumps was unplanned and unregulated. The adoption of induvial pumps removed the water lifting constraints of the saqia. Irrigation districts also lost the ability to exercise control over water consumption, and inequality between upstream and downstream users within mesqas intensified.

Sources: Adapted from El Gamal 2019 Gouda 2016; KfW 2018.

Note: a. Municipal and industrial water requirements have the highest priority in Egypt. However, these requirements are small relative to the agricultural sector.

1.6 Responding to the need to address distribution issues and improve the sustainability and productivity of water use in the face of increased water scarcity, the MWRI initiated the Irrigation Improvement Program, supported by a series of successive donor-funded projects. The program aimed to improve distribution of water among users and lay the foundation for implementing integrated water management with greater participation of water users. To achieve these goals, the projects employed a combined package of technical and institutional innovations that was adapted over time. The leadership of the MWRI was also concerned with the high costs of government water programs and viewed institutional reforms as a way to bring the voice of beneficiaries into the water management domain and reduce the impact of water management costs on the government budget.

1.7 The two projects assessed by this report built on earlier efforts of the Irrigation Improvement Program that targeted various segments of the irrigation system, including the World Bank interventions outlined in box 1.2, but for the first time, the irrigation improvement package was extended to cover the whole irrigation system, including quaternary (on-farm) canals.

Box 1.2. Recent History of World Bank Engagements in the Irrigation and Drainage Sector in Egypt

The Integrated Irrigation Improvement and Management Project was the latest in a series of several consecutive World Bank projects that supported development of irrigation and drainage in the Arab Republic of Egypt over more than 25 years. Prior projects included the National Drainage Project, which became effective in 1991 and closed 10 years later. The main objective of this project was to increase agricultural productivity on about 720,000 feddans (about 300,000 hectares) by establishing good drainage conditions and evacuating excess water from the area. The Irrigation Improvement Project, which became effective in 1995 and closed in 2006, was the World Bank's first project to finance Egypt's Irrigation Improvement Program. The project underscored the importance of increasing the efficiency of water use and reliability of water services. The Integrated Irrigation Improvement and Management Project was conceived as a successor of these two projects, as it aimed to integrate the administration and performance of the irrigation and drainage subsectors. Technically, this project and its predecessors made fundamental interventions at several levels of the irrigation system that have profoundly changed the way water is managed and delivered from one level to another.

Sources: Ministry of Water Resources and Irrigation; World Bank 2010.

1.8 The first project, the Integrated Irrigation Improvement Management Project (IIIMP), financed investments to improve the main, branch, and mesqa canals and included a small pilot to improve marwa canals. This project was implemented by the MWRI. The development objective of IIIMP was "to increase the efficiency of irrigated agriculture water use and services." IIIMP was designed with five components:

- Component 1**.** Improved and Integrated Water Management. This component financed irrigation and drainage rehabilitation, improvement, and modernization at all levels of the selected command areas.

- Component 2**.** Improved On-Farm Water Management. This component comprised (i) adaptive research programs for regional water and land management, (ii) on-farm water control and irrigated agriculture practice demonstrations, and (iii) strengthened irrigation advisory and production support services for irrigation.

- Component 3. Institutional Development and Capacity Building. This component supported establishing, expanding, and scaling up water user organization functions at tertiary and secondary irrigation levels and drainage hydraulic units throughout the selected command areas. It also supported establishing and mainstreaming Integrated Water Management Districts (IWMDs) within the MWRI.

- Component 4. Project Management Coordination and Integration. This component would support the management and coordination entities, functions

and activities needed for effective planning, implementation and commissioning of irrigation and drainage improvements on the basis of full command areas.

- Component 5. Environmental Mainstreaming. This component supported implementing an environmental management plan to demonstrate how improvements in water quality could be achieved by addressing threats to water quality. Such threats include domestic sewage discharges into irrigation systems and improper disposal of municipal solid wastes.

1.9 The second project, the Farm-Level Irrigation Modernization Project (FIMP), scaled up the marwa pilot improvements carried out under IIIMP. This project was implemented by the Ministry of Agriculture and Land Reclamation (MALR). The development objective of FIMP was "to increase agricultural profitability and improve equity in access to higher-quality water for small-scale farmers (in the project area)." The project later dropped "increasing agricultural profitability" from its objectives as part of a formal restructuring when it became apparent that this was unrealistic under the project time frame (discussed further in chapter 2, Results: What Didn't Work). FIMP was designed with two components:

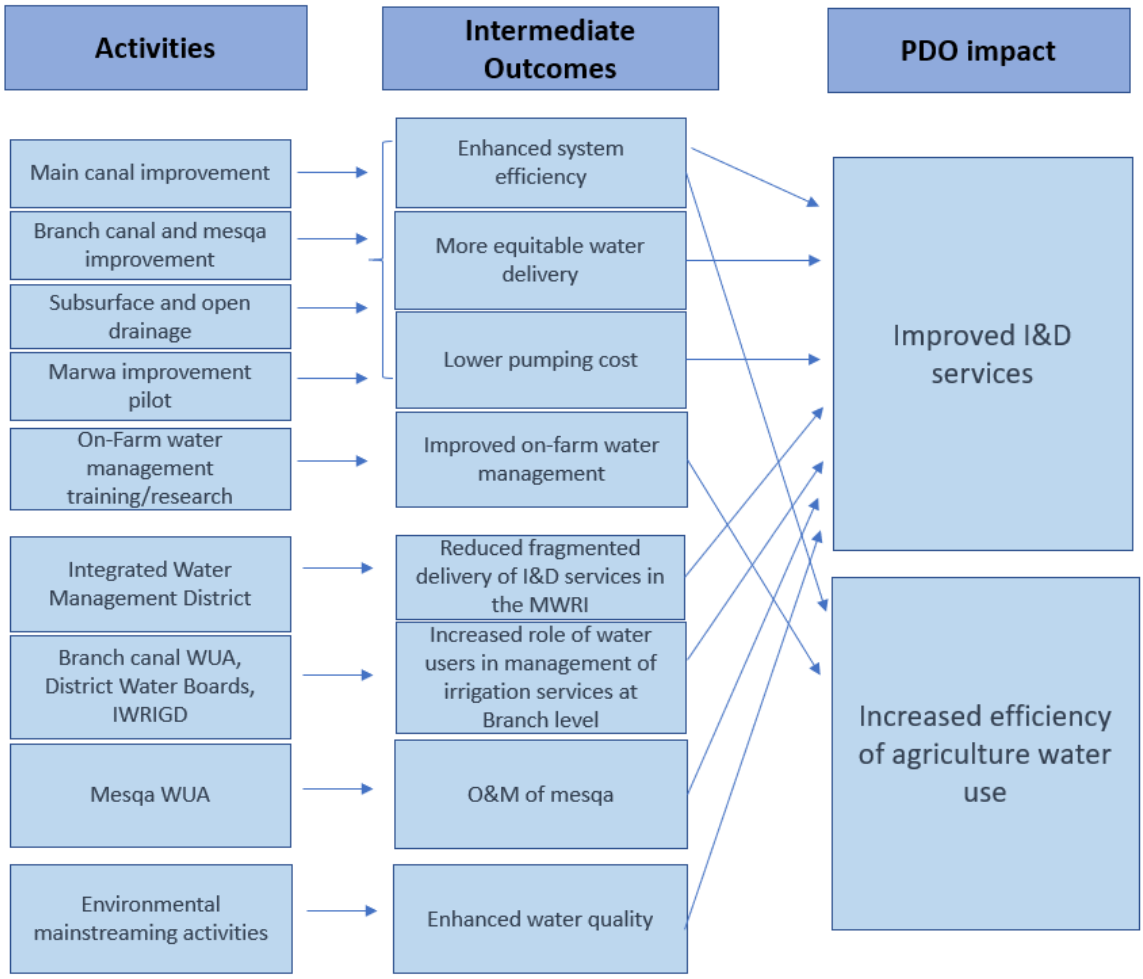
- Component 1. Marwa and Farm-Level Irrigation Improvements. This component supported marwa and other farm-level modernization activities on 200,000 feddans (84,000 hectares) in three irrigation command areas in the old lands in the Nile Delta (Mahmoudia, Manaifa, and Meet Yazid).[2] Activities included (i) marwa and off-farm improvements transforming open marwa canals to low-pressure distribution systems and upgrading mesqa pump stations; (ii) remodeling pump stations from diesel to electric pumps and installing dedicated rural electric power grids; (iii) farm-level improvements, such as laser land leveling, deep plowing, applying gypsum, reshaping field drains, and using flexible hose systems; (iv) capacity building for use and maintenance of mesqa- and marwa-level works and land improvement activities; and (v) conducting field surveys.

- Component 2. Farm-Level Technology Modernization. This component aimed at enhancing farmer knowledge of improved irrigation and associated land improvement and crop production technologies. Activities included: (i) increasing farmer awareness of marwa improvements; (ii) demonstrating improved marwa and farm-level irrigation systems, on-farm water management, and associated land improvement and agronomic practices for field and horticultural crops; (iii) training lead farmers and extension staff in irrigation management and associated practices; (iv) improving extension delivery through mass media broadcasting, increasing outreach of the MALR's interactive web-

based extension information networks; and (v) providing support for implementation, monitoring and evaluation activities, and environmental monitoring.

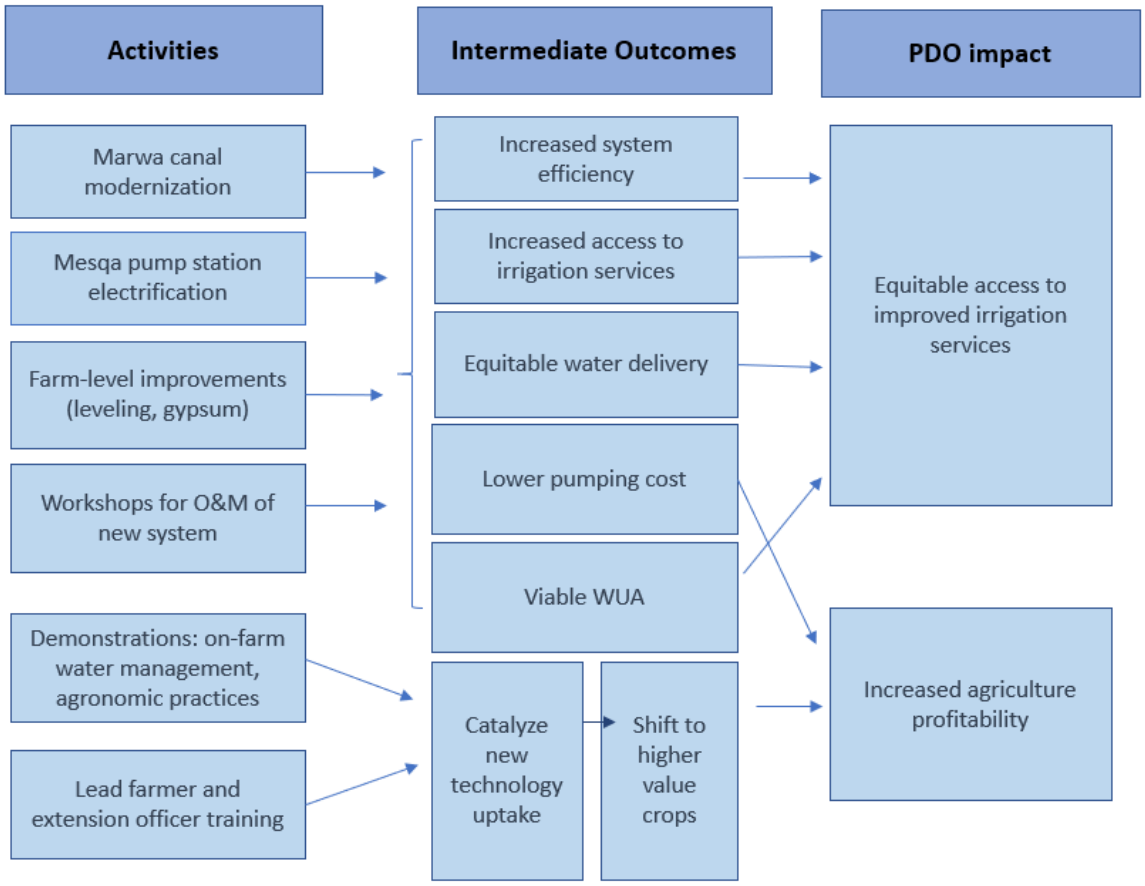
1.10 Figures 1.1 and 1.2 illustrate each project's theory of change as reconstructed by the Independent Evaluation Group (IEG) based on the Project Appraisal Documents.

Figure 1.1. Simplified Theory of Change of the Integrated Irrigation Improvement and Management Project



Source: Independent Evaluation Group, based on Project Appraisal Document (World Bank 2005b).
Note: I&D = irrigation and drainage; IWRIGD = Integrated Water Resources and Irrigation General Directorate; MWRI = Ministry of Water Resources and Irrigation; O&M = operation and maintenance; PDO = project development objective; WUA = Water User Association.

Figure 1.2. Simplified Theory of Change of the Farm-Level Irrigation Modernization Project



Source: Independent Evaluation Group based on Project Appraisal Document (World Bank 2010).
Note: O&M = operation and maintenance; PDO = project development objective; WUA = Water User Association.

2. What Worked, What Didn't Work, and Why?

Results: What Worked

2.1 The projects' application of a systematic approach to rehabilitating all related tiers of the system generated many positive results: improving equity of water distribution between head-end and tail-end users, reducing operating costs and the time required to irrigate, improving environmental conditions at the field level, and other nonquantified benefits (increasing the area available for productive use, enhancing supply of water to nonirrigation users). Collectively, the interventions made under IIIMP and its predecessor project changed the way that water is delivered from one level to another. FIMP extended this to the field level. The results of IIIMP and FIMP were primarily reported at the mesqa level and below, where they were most visible.

2.2 **Greater equity in water distribution.** Improvements to the mesqa-level canals under IIIMP increased the ratio of water availability between head and tail users to 75 percent (compared with a baseline of 50 percent) and reached 87 percent by December 2018, at the closure of the KfW cofinanced loan. A beneficiary survey carried out by MWRI at the close of IIIMP indicated that 95 percent of farmers perceived that irrigation improvements carried out under IIIMP enhanced equity along the branch canals, and 98 percent perceived that the project enhanced equity on mesqa canals. The KfW completion report noted that although water shortages continue to be observed at times at the tail end of branch canals, the technical improvements to the mesqa (collective pumping station and piped distribution) made it possible to work with lower water levels and irrigate the tail end of the mesqa area (KfW 2018).

2.3 Interviews with government officials and farmers carried out by the IEG assessment mission provide further granularity on how the project interventions contributed to greater equity in water distribution. First, IIIMP supported rehabilitation works along the main canals of Mahmoudia and Meet Yazid. Most critical of these rehabilitation works was repairing a ship lock gate at the entrance of Mahmoudia canal. According to irrigation officials, this gate leaked water back into the Rosetta Nile branch. As a result, the optimal water level in the canal could not be established at the head end. This situation was compounded by the existence of poor sections (for example, sections that became too wide) along the canal that resulted in chronic water shortage at the tail end of the canal.

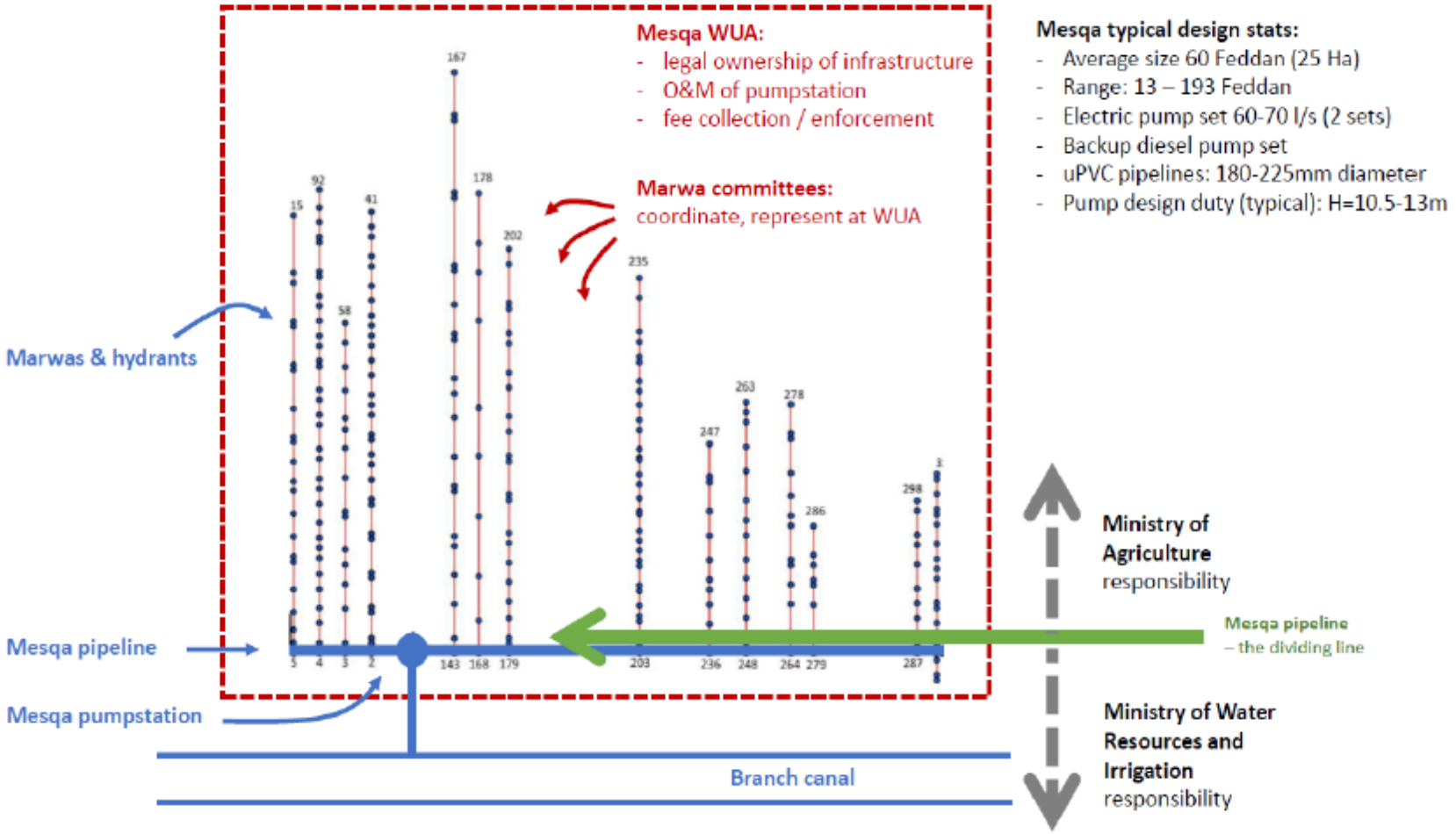
2.4 A similar situation existed at the beginning of Meet Yazid canal where two sections of weak embankments resulted in below-optimal water levels at the head end. Irrigation officials explained that they could not risk raising the water level because they feared that the embankments would collapse, and the water would flow into a parallel water drainage canal. If that happened, widespread flooding to residential and agricultural areas would occur because the pumping stations at the tail end of the drainage canal would be overwhelmed, and water would flood wide areas along the drainage canal.

2.5 For 30 years before the IIIMP intervention, the Meet Yazid canal had suboptimal water levels at the head end. This resulted in chronic shortages at the tail end, with farmers in these areas totally relying on drainage water to irrigate their fields. IIIMP addressed these concerns, among other rehabilitation works (including U-shaped sections on Meet Yazid) along both canals. These improvements, combined with other rehabilitation of control gates on branch canals, increased the water level at the head of each branch canal, and consequently water supply to the tail end increased. An irrigation official explained that before IIIMP, the situation at the Mahmoudia tail end was critical because the water level dropped below the intake level of the municipal

water treatment plant that supplies the city of Alexandria. The same official explained that after the rehabilitation works along Mahmoudia under IIIMP, complaints from tail-end users of Mahmoudia decreased by 96 percent. Irrigation officials also informed the mission that 15,000 feddans (6,300 hectares) at the tail end of Meet Yazid used to suffer from lack of irrigation water during peak summer demand time in August. After the project-supported rehabilitation, these areas now receive a higher share of irrigation water and rely less on polluted drainage water to water their crops.

2.6 Additionally, IIIMP supported modernization of mesqa canals, replacing the traditional open mesqa canals with underground pipes that deliver water to the various marwa canals along the mesqa line (figure 2.1). A single-point electric pumping station at the head of the mesqa to draw water from the branch canal replaced numerous individual diesel pumps. Under the project, farmers benefiting from the same mesqa canal formed a mesqa Water User Association (WUA) to manage and organize the mesqa irrigation. In most cases, farmers also chose a pump operator who was responsible for operating the collective pump station at the head of the mesqa. The WUA would collect operation and maintenance (O&M) fees from the farmers and ensure coordination among all water beneficiaries along the mesqa canal. In addition, the upstream rehabilitation of branch and main canal sections improved the availability of irrigation water, which allowed better equity between head and tail mesqas along the same branch canal.

Figure 2.1. Schematic of Mesqa- and Marwa-Level Improvements



Source: World Bank 2018b.
Note: ha = hectare; O&M = operation and maintenance; uPVC = unplasticized polyvinyl chloride; WUA = Water User Association.

2.7 **More reliable water delivery at the field level.** Switching from diesel to electric pumps improved the reliability and reach of water delivery. Neither project measured reliability in water delivery, but farmers interviewed by the IEG mission reported that under the modernized system, irrigation water at the field level is more reliable. Water fluctuations and unpredictability have decreased, leading to fewer conflicts among farmers. Under the old system, periods of water shortages affected head-end and tail-end farmers to different degrees. With the improved system, some tail areas still experience shortages, but farmers noted they do not last as long, and the entire mesqa is affected equally. Farmers noted that shortages in irrigation water during peak summer months before the project could last up to 25 days; after the project, shortages were either totally absent or in the range of 10–12 days in tail areas. The availability of irrigation water allowed farmers to water their crops at the optimal intervals and avoid water stress during critical times of the growth cycle. Farmers reported that this had positive impacts on yields, particularly for summer crops. Rice farmers in Kafr El-Sheikh Governorate claimed to achieve 4.25 tons of rice per feddan after irrigation improvements. Farmer estimates of productivity before the project was between 1 and 2 tons per feddan.

2.8 **Reduced pumping and operating costs and the time required for field-level irrigation activities.** Converting from individual diesel pumps to a single-point electric pumping station resulted in a reduction in pumping costs by 50 percent under IIIMP and 46 percent under FIMP. IIIMP reported that on average, operational costs for irrigation (including labor) dropped by 4 percent for summer crops (cotton and maize), 4 percent for winter crops (wheat and sugar beet), and approximately 6 percent for rice. FIMP reported a 31 percent reduction in O&M costs because of the change from diesel to electric pumps and from open earthen to modernized marwa canals, which reduced the time and labor required for field-level irrigation activities.

2.9 The project completion report for FIMP reported that the time required for field-level irrigation activities was reduced by 37 percent, a result of higher flows at the point of release into the fields. The larger discharge of the new pumps provided a larger irrigation stream size, which together with the savings of the time used to move individual pumps to and from fields, resulted in less overall time required to irrigate (World Bank 2018b).

2.10 Anecdotal evidence reported to the IEG mission shed further light on how the marwa improvements reduced time and labor required to irrigate. Farmers noted that under the old system, water at the field level flowed through open earthen channels that filled with weeds, slowing the flow of water. In addition, before each irrigation, they had to make sure that there were no breaks in the earthen marwa channels that would flood

other fields. This process of weeding and checking for breaks was labor intensive. The new system eliminated the time and costs incurred for weed control and maintenance of the earthen canals. Under the new system, clean water flows fast as soon as the valve on the famer's land is opened. Farmers explained that the time required to water each feddan decreased from an average of five to six hours under the old system to two to three hours under the improved system. The time saved could be used by farmers to attend to other productive activities. Anecdotal reports to the IEG mission indicated that farmers also appreciate that they can now irrigate without getting dirty. Women farmers reported that the reduction in effort, together with the fact that they can now irrigate without getting dirty, has enabled them to participate more in irrigation activities.

2.11 **Improved environmental conditions and reduced exposure to contamination.** Conversion from open canals to a piped distribution system improved water quality by eliminating contamination from illegal dumping and reducing tail-end farmers' need to pump water from drainage canals. Drainage works also reduced waterlogging and salinization. An environmental assessment carried out by FIMP after the marwa works were completed showed that the water was free from parasites and pesticides and that macro, micro, and heavy metals were below critical limits.

2.12 **Land savings.** Covering open canals in farmers' fields with an underground piped system had the added benefit of increasing the area available for cultivation, as the new buried system requires less land. A technical report prepared for FIMP indicated that 2 to 3 percent of additional cropping area was recovered by filling the old open mesqa and marwa canals with the new piped system.

2.13 Structural improvements to the main canals under IIIMP also benefited nonirrigation water users by improving the conditions for supplying water to the city of Alexandria and improving roads. Dredging the canals and rehabilitating water control structures improved the hydraulic functioning and capacity of the canals, benefiting drinking water supplies (improved safety and reliability). As noted, previous water levels at the tail end of the Mahmoudia canal prevented the main water treatment plant from operating on a consistent basis, and this problem was solved by IIIMP improvements to the main canal. Structural improvements to the main canals also strengthened collapsing embankments, which improved the conditions of the roads along the canals.

2.14 Efforts to reform the institutional structure for managing irrigation and drainage services had variable results at different levels. IIIMP supported institutional reforms aimed at redefining the role of public sector water delivery agencies and laying the foundation to implement participatory integrated water management, in which water management would be carried out through regular consultation with WUAs under

appropriate institutional and cost-sharing arrangements. The project's capacity-building component supported the establishment and expansion of WUAs at the tertiary (mesqa) level, a practice supported by the government since the early 1990s. The project also supported the formation of WUAs at the branch level to manage, operate, and maintain the branch canals jointly with the MWRI. In addition, the project established water boards at the branch and district levels to ensure that users had a voice in water management decision-making. Within the ministry, the project supported the creation of IWMDs to integrate previously disparate district agencies responsible for system improvement and management. This integration was expected to reduce fragmentation in the delivery of services. The IWMD would be responsible for scheduling the preset quota of water for the district, and eventually, this would be done in consultation with the newly created District Water Boards.

2.15 The project succeeded in increasing water users' participation in irrigation management at the mesqa level and below, but it made little progress at the branch and district levels. This section discusses the positive experience at the mesqa level. The experience at the branch and district levels is discussed in the section Results: What Didn't Work. Mesqa WUAs were successfully established to manage water at the tertiary level and took over managing the improved mesqa infrastructure, operating collective pumping stations, scheduling irrigation turns, and collecting and managing fees for O&M.[3] WUAs visited by the IEG mission reported that they have been able to collect sufficient fees from farmers to cover operating costs and have been able to maintain the system.

2.16 Several factors contributed to the success of establishing functional WUAs at the mesqa level. First, mesqa WUAs are formally recognized entities under the existing 1994 WUA law, giving them legal authority to collect fees and providing them with legitimacy in the eyes of farmers and government agencies. Second, the key technology innovation at the mesqa level (replacing individual pumps with a shared pumping station) makes cooperation necessary, which is not the case at the branch level and above. Third, collective action at the mesqa level builds on the preexisting organizational system along the mesqa canal (history and culture of communal social practices), whereas traditional communal ties do not exist at the larger scales. As noted in box 1.1, before the adoption of individual diesel pumps, traditional water management practices at the mesqa level relied on collective action. Farmers along the mesqa canal shared a collective waterwheel and formed what was called a *saqia* ring, with a leader who was responsible for managing the mesqa irrigation schedule and resolving conflicts. Village elders also played a role in resolving disputes over irrigation turns. Under the new system, WUA members and the pump operator tend to have high social status and high levels of trust from local communities with respect to financial

management and conflict resolution. Farmers report that the strong social interdependence of communities along the mesqa canal contributes to a high rate of fee collection (World Bank 2018a).[4] This contrasts with the experience in other countries, where the establishment of water user organizations has undermined traditional social arrangements with poor results.

2.17 The FIMP experience suggests that the size of the mesqa area also influences effective collective action at the mesqa level. FIMP areas ranged in size from 13 to 193 feddans (5.5–81 hectares). A World Bank 2018 report found that smaller mesqa areas have greater operability than large mesqa areas as they are more socially cohesive and technically manageable. Contractors working on the project experienced less divergence in farmer views and fewer objections during construction. This was attributed to the strength of family relationships typical of smaller land areas, relationships that diminish or disappear with increased mesqa size. This finding was also relayed to the IEG mission in interviews with both farmers and contractors. Farmers in one mesqa area interviewed by IEG reported that out of 10 marwas, 1 was not functioning because it was too big, and there was intractable infighting of families.

Results: What Didn't Work

2.18 The projects effectively improved water delivery, but they were less successful in driving changes in on-farm water management and agricultural practices. Providing farmers with greater access to quality water and more predictable delivery was expected to enable them to change their water use and agricultural practices at the field level. This was expected to lead to greater water productivity, higher yields, and diversification to higher-value crops. However, the projects' support for these goals was limited to training and demonstration activities to raise awareness of new agronomic practices and more efficient on-farm irrigation practices. These efforts were not enough on their own to lead to the expected changes in behavior.

2.19 With respect to changing irrigation practices, both projects lacked support for specialists to provide training in improved water use on the farm, beyond research demonstration plots. Agriculture extension services in Egypt focus on crop and livestock production and do not have expertise in operating the irrigation system efficiently. IIIMP supported on-farm water management through water and crop management research activities, but these were significantly scaled back during implementation. In 2014, systematic rice intensification research activities were transferred to another World Bank–financed project (Enhanced Water Resources Management Project). The controlled drainage pilot resulted in a 32 percent reduction in the amount of irrigation water applied on pilot plots, but the pilot was discontinued because of implementation challenges (application was costly, a high number of stakeholders needed to be trained,

and farmers were reluctant to agree to a controlled manhole system). The project completion report for IIIMP noted that farmers need time to adjust to new water delivery, as water productivity requires farmers to change their practices to reflect reliability of water (World Bank 2016). This may take longer than a single project time frame.[5] The IEG mission observed that flood irrigation was still the predominant practice, and farmers still overwater their fields.

2.20 Diversifying to higher-value crops was one of the ways that FIMP aimed to achieve the project development objective of increased farm profitability. The Mid-Term Review of the project found that diversification required support for access to finance and markets, which the project did provide, and it required more time than a single project cycle. The project was restructured, dropping increased farm profitability from its objectives. Originally, FIMP aimed to introduce modern irrigation technologies such as low-head bubblers on 10,000 hectares. These technologies were expected to catalyze a shift to higher-value crops on about 12,000 hectares. These targets were found to be unrealistic, as the shift in both technology and crop type depended on factors external to the project (farmer attitudes, local financing for irrigation equipment, markets, and production knowledge).[6] The strategy shifted, establishing "lead farmers" on 200 feddans (84 hectares) for demonstration purposes, linked to the farmer field school approach (World Bank 2018b). At project closure, 100 hectares were planted with higher-value crops on demonstration plots. But there were minimal changes in cropping patterns in nondemonstration plots. In addition to providing adequate capacity support and inputs, a deeper understanding of the drivers and constraints to crop diversification is also needed. In some project areas, soil salinity is a constraint to crop diversification. A study on cropping decisions of farmers in the Nile Delta found that cropping choices are determined by factors beyond water availability and economic profitability, and that interventions and policies seeking to influence a change in cropping patterns need a more thorough understanding of the factors driving farmers' rationales (Ghazouani et al. 2014).

2.21 The projects had limited impact on water savings. Although it is plausible that infrastructure improvements at the mesqa and marwa levels reduced field-level water loss, the projects had little impact on water savings for the system at large. One of the expectations of the overall irrigation improvement model, though not part of the project's stated development objectives, was that improvements in the management of the system would contribute to water savings[7], allowing the system to meet the demands of more users under increasingly constrained supply. The conversion from open canals to a piped distribution system led to a reduction in the overall water requirements at the mesqa and marwa levels.[8] However, no meters or measuring devices were installed to provide data on the actual amount of water used by the

farmers (World Bank 2018a), and thus there was no mechanism for measuring efficiency improvements. Moreover, the literature notes that even when efficiency improvements are made within the boundary of local programs, this does not necessarily mean that water has been saved at a basin level (El Gamal 2019; Grafton et. al 2018, Molle 2019; Perry 2017). Farmers often use the water that is "saved" locally to expand cultivation or may switch to crops that demand more water. Moreover, the nature of the irrigation system of the Nile River is somewhat unique as water lost from one point returns to the system and is reused by other farmers downstream.[9] Because of this reuse[10], the global water use efficiency of the system is relatively high[11], even before system improvement, with minimum scope for further gains.

2.22 Efforts to upscale the participation of water user organizations at the branch and district levels stalled. IIIMP established WUAs at the branch and district levels, but as of the date of the IEG assessment mission, they do not play a role in managing the system. Several factors contributed to this limited result. First, branch WUAs and District Water Boards were established under ministerial decree, which has a more tenuous legal status than the water law that recognizes mesqa WUAs. This status limits their ability to enforce rules, charge for O&M, or collect fees (Molle et al. 2019, citing Gouda 2016). Formal legal status of branch WUAs and District Water Boards is being considered under a new draft water law, but the law was still pending approval at the time of the assessment mission. Until the new law is approved, the organizations at the branch and district levels are left without a function.

2.23 Without a law that spells out their role, mandate, and responsibilities, branch- and district-level water user organizations have a limited role to play in managing the irrigation system, and their inclusion in water management activities depends on MWRI district staff. The literature and interviews during the IEG mission indicate that after the Arab Spring, some water boards were perceived as overstepping their mandate and attempted to use their position to petition local government to address issues other than irrigation in an aggressive manner, dampening the interest of district government officials in engaging with these groups or strengthening them further.[12] Branch WUAs and District Water Boards are also intended to facilitate dialogue between the users and the MWRI, but the tenuous legal status and current lack of tangible function also limit the legitimacy of these institutions in the eyes of farmers. Anecdotal evidence reported in the literature and in IEG interviews with farmers suggests that it is common for farmers to bypass them and take their concerns directly to the district irrigation office instead. Moreover, some of the factors that encourage cooperation among water users at the mesqa level are not present at the branch and district levels.

2.24 Measures to integrate the disparate irrigation and drainage agencies within MWRI into a single unit at the district level were unsuccessful. IWMDs were established

as planned under IIIMP, but after the project closed, these agencies reverted to operating as separate entities with their own chain of command and workflow. The project design lacked adequate attention to incentives to integrate the workflow of the various district agencies beyond combining them in the same building. Interviews with stakeholders indicate that historical differences in salary structure between irrigation engineers and drainage engineers needed to be addressed, and institutional incentives to foster integration were lacking. The appetite for implementing integrated water management within the ministry—a key rationale for the institutional reforms promoted under IIIMP—also appears to have changed over time. This was a priority for the ministry at the time IIIMP was under preparation. In 2002, the ministry established an institutional reform unit to support a shift toward integrated water management, and in 2005, the unit developed a water management action plan. In 2010, the institutional reform unit was disbanded. KfW, a cofinancier of IIIMP, noted in its completion report that "the Ministry is hesitant to continue with the establishment of IWMDs and has temporarily put a stop to developing and strengthening these entities" (KfW 2018).

Design and Preparation: What Worked

2.25 Intentionally involving farmers in the planning and design process of mesqa and marwa improvements increased ownership among beneficiaries and enhanced sustainability. Mesqa canals and the downstream marwa distribution works are owned, managed, and maintained by the farmers themselves. Under both projects, the government was responsible for construction of mesqa pumping stations and improved mesqa and marwa water distribution systems; the improved infrastructure was transferred to farmers on completion, and the beneficiaries took full responsibility for O&M. Under Egyptian law, each individual beneficiary is required to repay the capital cost through increased land tax. As a condition for initiating construction, farmers had to agree to the technical designs and installation works on their lands. Accommodating farmers' design preferences and including them in the construction process was an essential element of design.

2.26 Under IIIMP, the establishment of a viable WUA was a condition for mesqa improvement. Through WUAs, farmers were involved in all stages of development of the mesqa contracts, including the design layout, and could request changes to design once construction started if the request was technically sound and financially viable. Completed infrastructure was handed over to the mesqa WUA. The Irrigation Advisory Service in the MWRI was charged with the farmer consultation process,[13] comprising five stages.[14] The Irrigation Advisory Service was also responsible for formal registration of the WUA.

2.27 FIMP used WUAs that were already established through IIIMP or earlier irrigation improvement projects. In addition to working with mesqa-level WUAs, the project created marwa committees as an institutional vehicle for channeling farmer demands and ensuring their active participation in planning and implementing improved marwa works.[15] To improve a marwa, farmers had to collectively decide and agree on where to locate it and where to put the field turnouts. Farmers signed off on key stages of the final design,[16] checked implementation progress, and cosigned construction payment approvals. This process amplified ownership and ensured that the works reflected specific needs. Farmers also had the opportunity to work for the contractors in constructing the works, gaining knowledge in how to repair damaged works. The construction process was therefore responsive to individual farmer preferences and ensured that the water users and landowners were completely satisfied with the layout. The position of the buried marwa, the precise location of each of the outlet hydrants or valves, the number of hydrants per plot, and the minimum pipe sizes were all determined by the users (the Project Management Unit [PMU] changed the hydraulic design of the marwa pipes from 160 millimeters to 180 millimeters on farmers' request). In addition, on-farm improvements, such as laser land leveling, could be undertaken only if there was farmer demand for them. A beneficiary survey carried out at the end of FIMP found a high level of satisfaction (91 percent) with the level of farmer involvement.

2.28 Another positive design feature of FIMP was to combine mesqa- and marwa-level infrastructure improvement works into a single procurement package. This led to a more cost-efficient design and enhanced compatibility in the design of the two systems.

Design and Preparation: What Didn't Work

2.29 Although involving farmers in planning improvements enhances ownership, the trade-off for this degree of farmer engagement is the required implementation time to accommodate requests for changes to design. It can also be challenging to convince farmers to participate before they observe benefits from other improved areas. Mesqa canal construction under IIIMP suffered numerous delays because of farmer demands for changes to the agreed designs and additional works. Most farmers could not read construction drawings, so the scope of works was apparent only after construction began. Request for changes to design during the FIMP's implementation was delayed initially because some farmers objected to the civil works proceeding at all. They were skeptical about the benefits of the buried marwas until they started observing the results in other improved areas. Farmers also caused delays for technical reasons, such as demanding greater-diameter marwa pipes, relocated or additional outlets, extensions to marwa canals, and so on. These demands required a negotiation process with farmers and technical and contractual adjustments.

2.30 Some farmers were unable to participate in the projects because a key condition for mesqa and marwa selection was that every farmer along the canal targeted for improvement had to agree to have works carried out on their land. Refusal by a single farmer could keep their entire mesqa or marwa area from participating. During the IEG field visits, the mission was approached by multiple farmers who complained that they wanted to participate in the project but had been unable to do so because one farmer in their mesqa area refused to sign on.

2.31 Both projects lacked detailed engineering plans and feasibility studies for work at appraisal, resulting in underestimated costs of mesqa and marwa improvements. IIIMP estimated costs of the mesqa-level works—the largest component in the project—from one pilot, as opposed to sampling needs at different locations. This resulted in underestimating mesqa improvement costs by about 15 percent. Designs for the pumps and pump houses had to be revised to reduce the overall cost before implementation proceeded so that farmers were not deterred.[17] Lack of engineering feasibility studies at appraisal of FIMP resulted in an underestimation of the costs of mesqa and marwa improvements by 13.5 percent.

2.32 The procurement processes established at design under both projects contributed to significant bottlenecks in civil works construction until new approaches were adopted. Under IIIMP, smaller procurement packages were used initially for specialized civil works, but they did not appeal to the best-quality contractors. The lesson highlighted by the Implementation Completion and Results Report was that a project with specialized works needs to be packaged in larger procurement packages that would maintain the high standards for contractors for all packages (World Bank 2016). Smaller local contractors would be employed through subcontracting. The PMU would then have to monitor fewer and more reliable contractors, bringing down project costs.

2.33 The initial approach for procuring civil works under FIMP proved difficult to implement at scale and was initially a significant bottleneck to implementing mesqa and marwa improvement. Under the "force account" approach, the PMU used MALR staff, workers, and equipment, and it directly procured project inputs such as parts, transport, storage, and pipeline and pump station installation. The approach was initially appealing because it provided the opportunity to involve local communities in construction. In addition, the Executive Authority for Land Improvement has specialized employees in soil, civil, and mechanical engineering and is equipped with tractors, excavators, and other heavy machinery for soil improvements. Force account had been used successfully for IIIMP's marwa improvement pilot, which covered a relatively small area (5,600 feddans or 2,350 hectares). However, it proved problematic to implement at scale on the larger FIMP area (190,000 feddans or 80,000 hectares), as the total scale of works and the required level of quality and cost control surpassed the

capacity of the PMU. When the initial small-scale approaches proved inadequate for the pace and scale of implementation, the project adopted standard contracting processes, which combined marwa and pump station rehabilitation works under one package that was tendered to medium-scale contractors. Thereafter, contract implementation rapidly improved.[18] In 2016, the project also hired a firm that was responsible for construction supervision and quality control that expedited implementation and enhanced the quality of construction works.

2.34 The contracts for civil works under FIMP also lacked a provision to allow for price adjustments, leading to a temporary halt in works after devaluation of the Egyptian currency. On November 3, 2016, the government decided to remove currency controls, leading to a major devaluation of the Egyptian pound against the US dollar that tripled the steel price and increased costs for fuel and unplasticized polyvinyl chloride pipes. Variation orders were not permitted under the International Bank for Reconstruction and Development loan because none of the contracts included clauses for price adjustment because of currency depreciation. Contractors were not able to absorb the resulting price increases of materials and labor and stopped work, except for the few activities unaffected by the price increases. The project cofinancier, Agence Française de Développement, which had more funding flexibility, stepped in and funded compensation payments out of its loan. By contrast, the devaluation had a positive impact on IIIMP, which experienced a significant windfall because all construction costs were disbursed in Egyptian pounds.

Implementation and Supervision

2.35 Although the projects were designed to complement one another, potential synergies were not maximized because coordination between the MWRI and the MALR was problematic. Administrative jurisdiction across the irrigation command area is divided between the MWRI, which is responsible for main and branch canals and mesqa canals, and the MALR, which is responsible for marwas and on-farm activities. FIMP was the first irrigation project implemented by the MALR. The two ministries were expected to coordinate at the intersection of the marwa and mesqa levels. The MWRI was to play a supporting role to FIMP through its responsibility for (i) ensuring distribution of water from main and branch canals to the mesqa pumping stations, (ii) modifying the intakes for mesqa pump stations if they were too low to allow effective water pumping into the marwa areas, and (iii) providing permits needed by municipal authorities and the electricity company for connecting new electrical pumps to the grid (World Bank 2018a). In practice, the potential synergies between the two ministries were not fully maximized. One irrigation consultant noted that while the MWRI has technical expertise and equipment that gives it a comparative advantage in implementing infrastructure improvements, FIMP was not able to access this because of institutional

turf battles. A World Bank report detailing the FIMP experience also found that the absence of coordination made it impossible for larger mesqa areas to be modified to a smaller, more manageable size because that requires the involvement of the MWRI (World Bank 2018a). Conversely, officials explained that formal coordination with the MALR could have played a positive role in convincing farmers to modernize their mesqa canals under IIIMP, since the MALR deals closely with individual farmers through extension services. Moreover, because the MALR is also more adept at interacting with farmers, they could have provided support to irrigation improvement projects on farms to help maximize the impact from improved distribution of irrigation water. That said, the PMU directors of IIIMP and FIMP were able to work together successfully because of their personal relationship. However, as this coordination was based on personality, both directors expressed concern that there is a need for a stronger formal coordination mechanism built into project design.

2.36 IIIMP also lacked adequate coordinating mechanisms among the MWRI, the Ministry of Environment, and the Ministry of Health to adequately implement environmental management activities envisioned at appraisal. IIIMP included environmental mainstreaming activities, and it aimed to address threats to water quality posed by domestic sewage discharges into the irrigation system and improper disposal of municipal solid wastes. However, the envisioned activities were not realized because they were beyond the mandate of MWRI and the scope of the project development objective, which was focused on irrigation and drainage. Following the Mid-Term Review, support for environmental mainstreaming activities was transferred to the Enhanced Water Resources Management Project funded by the Global Environment Facility. This project, although implemented by the same ministry, had a broader mandate and stronger coordination ties with other agencies. Its project development objective was "to pilot integrated water resources management in the Nile Delta and to enhance the knowledge and capacity of water sector institutions for integrated water resources management." Its PMU benefited from strong collaboration arrangements with the Holding Company for Water and Wastewater under the Ministry of Housing and Urban Development and the Egyptian Environmental Affairs Agency. Moreover, by design, the Enhanced Water Resources Management Project had links to other ongoing projects (funded by the World Bank and other donors) aimed at improving water management in the Nile Delta. These linked projects shared budgets and technical specialists and had common stakeholders and project areas.

2.37 Cross-agency coordination challenges also played a role in the difficulty in establishing connections to the electricity grid to allow for the conversion from diesel to electric pumps at the mesqa pumping stations. This process required extending overhead electrical wires from the pumping station to the existing electricity grid and

was not under the authority of either project's implementing agency. Some electric poles had to be erected on private lands, and a compensation mechanism had to be established to compensate farmers for using their land and damaging their crops when installing the electrical poles. Several bottlenecks were encountered in this process. First, establishing a new connection to the grid required multiple approvals from different institutions (local municipalities, MWRI, the Ministry of Electricity and Energy, and the Road and Bridge Authority, among others) to allow the work to proceed. Securing approvals was time consuming, at times requiring more than six months. Second, a delay stemmed from lack of clarity on who pays for the cost of electrification. This was resolved in 2013, after "a formal decision was made by the MWRI in conjunction with the Ministry of Finance that the costs of the electricity networks should be included in the mesqa infrastructure cost-recovery arrangements made with farmers, with repayments to be made over 15 years" (World Bank 2016). Third, electricity distribution in Egypt is under the mandate of public electricity distribution companies that are responsible for the development and O&M of electricity distribution. Awarding contracts to these companies directly with World Bank funds was problematic because it was against the World Bank's guidelines. This issue was resolved by paying the electricity companies through the local fund. In some instances, electrification could not proceed because a farmer might refuse to grant approval for establishing an overhead line over their lot. This situation required technical modifications to find alternative routes or resort to subsurface electrical lines. In addition, passing overhead lines over roads required extra permits, which added more delays to an already lengthy process.

2.38 The IIIMP team explained to IEG that a ministerial agreement between the MWRI and the Ministry of Electricity and Energy was sought before the project became effective, and follow-up meetings were held with the Ministry of Electricity and Energy but were not successful because those agencies were not accountable for the project loan. The Implementation Completion and Results Report recommended that future projects be structured with a separate loan in parallel with the Ministry of Electricity and Energy to provide for electricity networks in future areas of mesqa improvement (World Bank 2016). The PMU directors of both projects reiterated this point to the IEG mission. The cofinancier's completion report further concluded that the whole approach to the electrification of pump stations needs to be reassessed on future mesqa improvement projects to ensure that the electrification program keeps pace with the mesqa improvement works. It suggested that one possible solution would be to involve the Ministry of Electricity and Energy as a joint executing agency in future irrigation improvement projects to ensure coordination between mesqa development and the associated power supply (KfW 2018).

2.39 Frequent ministerial turnovers after the Arab Spring and lack of decision-making by several government officials at that time also had an impact on implementation of the IIIMP. The promotion and then abandonment of pilots to convert branch canals to continuous flow harmed IIIMP's reputation.[19] A key innovation piloted under IIIMP was to change the mode of operation of branch canals from a rotational system, in which water is delivered to the canal every few weeks, to a system that delivers water continuously to each branch canal in accordance with predetermined volumetric water allocations. During implementation, continuous flow was found to be incompatible with the incentives at the farm level, and it was eventually abandoned. The IEG mission was informed from discussions with irrigation officials that the continuous-flow model was abandoned because (i) the amount of irrigation water available would not support continuous flow across all command areas, (ii) the design of the canals needed to be modified, and (iii) irrigation management would be difficult and require monitoring devices that were unpopular among farmers. Irrigation officials also explained that when the continuous-flow pilot was implemented in one area, farmers abused water usage, and rice areas increased from 40 percent to 90 percent of the command area. Project beneficiaries reported to the IEG mission that the project's promotion of the benefits of continuous flow was used to encourage farmers to participate in the project, and when it did not materialize, it raised suspicions among some participants, who felt misled. KfW also raised the issue in the cofinancier's comments to the World Bank Implementation Completion and Results Report and in KfW's own completion report, finalized in 2018.

3. Lessons

3.1 Review of the two projects highlights the following lessons.

3.2 **Irrigation improvement efforts in irrigation systems that are organized along a hierarchical canal network (such as the Nile Delta's) can realize greater impact by applying a systematic approach to rehabilitation, as was done through these two projects, as opposed to addressing different levels of the canal system in isolation. But this requires improved institutional integration to be effective**. In a system such as that of the Nile Delta, if one level does not harmonize, the entire system is at risk for failure. In this case, project achievements were most visible at the lowest levels, where mesqa and marwa improvements took place, but this was only possible where improvements had already been completed upstream. Addressing the system in a comprehensive manner requires attention to sequencing (upstream improvements needed before downstream improvements can be done). Project experience highlights the need for mechanisms to ensure adequate coordination across different agencies responsible for managing the system at different levels.

3.3 **Efficient implementation of irrigation improvement works requires coordinating and sequencing activities that fall under the mandate of many different entities that are often beyond the authority of the project implementing agency.** Mechanisms for cross entity coordination need to be agreed on and formalized before commencing with work and should ensure that each entity is accountable for achieving results within the project time-line.

3.4 **Effecting behavior changes in on-farm water use, agronomic practices, and diversification to higher-value crops requires support beyond improvements to the irrigation water delivery system.** Such changes are incremental and may not be feasible in a single operation. Additional support is needed to provide farmers with access to finance to acquire adequate inputs and improve their access to markets. It also involves inducing behavior change, which is incremental and not feasible in a single operation. The time required to induce such changes is beyond a single project cycle and needs to be coordinated and sequenced appropriately with improvements to the water delivery system.

3.5 **Successfully reforming the institutions that manage irrigation and drainage services, both water users and government agencies, requires greater attention to incentives for collaboration**. The ability of water user organizations to play an effective role in water management depends in part on the incentives for collective action. Transfer of management functions to WUAs at higher levels of the system, where responsibility will be shared with government agencies, requires clearly defined roles and responsibilities of each party. Reforms within government agencies also require attention to incentives to overcome the status quo.

3.6 **In a context such as the Nile Delta, where overall efficiency of the irrigation system is already high, there is little scope for addressing water scarcity through irrigation improvement projects alone.** Instead, water scarcity must be addressed through a quota or other allocation mechanism that operates within constraints of the system.

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[1] Population growth has decreased the per capita quota of water supply from 2,251 cubic meters in the 1960s to 1,122 cubic meters in the 1990s (with some estimates as low as 600 cubic meters).

[2] A feddan is an Egyptian unit of land area that is equivalent to 1.038 acres.

[3] In Egypt, fees are not assigned to water. Mesqa Water User Associations (WUAs) charge a fee for the electricity consumption of the pumping station, the pumping station operator's salary,

and maintenance of the system. Each mesqa WUA determines its own fee level and collection method.

[4] Other factors reported to contribute to the high collection rates are the high productivity in the Nile Delta and government agriculture subsidies that make irrigation more affordable, and the introduction of smart cards for electricity payments for pump operation.

[5] A World Bank technical report on the Farm-Level Irrigation Modernization Project suggests that such changes will take time, noting that "it is reasonable to assume that once the farmers have some experience with the piped marwas, then with some extension services and training they may see the advantages of drip or bubbler irrigation systems."

[6] A report prepared on the experience of the Farm-Level Irrigation Modernization Project reported that "for horticultural crops, a suitable area of land and access to finance and markets are needed, over and above better water access through improved marwas. Moreover, the costs and required land area needed for installing drip irrigation networks for fruits and other horticultural crops was deemed unsuitable for Egyptian smallholder farmers. Specifically, the filtering of water required for drip irrigation was likely to bring rather heavy costs for the equipment itself and required larger pumps and higher energy costs to provide the pressure needed for filtration" (World Bank 2018a).

[7] Egypt's National Water Resources Plan 2037 depicts an increase in the overall water use efficiency from 78 percent to 84 percent through a combination of irrigation system modernization and water reuse.

[8] These reduced water requirements resulted from less seepage, fewer water applications, and generally shorter irrigation periods at each application.

[9] Egypt is a unique irrigation environment. More than 95 percent of the country's water resources come from the Nile as inflow from upstream catchments; rainfall is negligible. Hydrologically, this makes analysis of water use relatively simple: all return flows from excess irrigation applications go either to groundwater (which is in equilibrium in the surface-irrigated areas and overdrafted in newly developed areas in the western delta) or back via the drains to the surface system, except at the northern interface with the Mediterranean. Egypt is thus a classic example of recoverable flows, and "on-farm efficiency" is of modest relevance to water saving (Perry, Steduto, and Karajeh 2017).

[10] Drainage water from irrigated fields is reinjected into the distribution system at different locations in the Nile Delta. This reuse substantially increases the overall efficiency of the delta's water use. However, it is a process that merely facilitates water distribution across a long, ramified, and complex network. Reuse adds water locally and is therefore important for local managers, but it does not add water to the delta per se and therefore does not alter the overall macro-level water balance (Molle 2018).

[11] Some estimate the Nile Delta's overall efficiency at 93 percent (Molle 2018).

[12] Independent Evaluation Group interviews suggest that the absence of a law governing District Water Boards and branch WUAs, and spelling out their roles, mandates, and responsibilities, created confusion among members of these organizations about the limits of their mandate.

[13] Under the Irrigation and Drainage Law 213 of 1994, the Irrigation Improvement Sector is mandated to establish and build the capacity of mesqa WUAs. The Irrigation Advisory Service is a section within the Irrigation Improvement Sector.

[14] (i) The Irrigation Advisory Service undertakes the initial farm surveys to determine who owns which plot, from where it receives water, and the cropping pattern. (ii) These data are plotted on a satellite image to define each mesqa command area. Any particular social or operational anomalies in terms of land ownership, water rights, and so on are noted and the information passed to the Irrigation Improvement Sector design unit in the governorate office. (iii) Preliminary designs are prepared showing the location of the intake, pump house, and sump; alignment of pipelines; and position of the valves. (iv) The designs are then discussed with the farmers in the field and if necessary revised to obtain a consensus, which is acceptable to the farmers and is also technically and financially viable. (v) The separate mesqa designs are then consolidated into packages for tendering (KfW 2018).

[15] The marwa committee is composed of water users, be they landowners or tenants, and is headed by a chair who represents its members both to the project staff in matters related to marwa improvements and training and to the WUAs for matters related to irrigation infrastructure at the mesqa level. Often, the chair of the marwa committee is a member of the WUA committee.

[16] The original designs for the marwas and the planned position of all the outlet valves are based on the Project Management Unit and the extension staff holding several meetings with the water users, who agree to the interventions and sign an agreement for the project to proceed.

[17] The cost of mesqa modernization is paid by beneficiary farmers over 20 years interest free through a collection system connected to land property tax.

[18] Work contracts of significant size (minimum $5 million to $10 million) executed by competent commercial contractors achieved rapid and acceptable results. Sixty percent of the work was completed in the last 25 percent of the project duration, and 37 percent of that was achieved in the last seven months.

[19] The concept of continuous flow as an alternative to the rotational system was introduced to Egypt in the late 1970s, when researchers began to view the rotational system as wasteful. Continuous flow was also intended to improve water delivery services to the farmers by providing a more reliable and flexible supply of water at the point of abstraction, and it was expected to make the system more suited to growing high-value crops. It also enhances the effective night storage capacity of the canals and therefore reduces the cost of improved mesqa systems.

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Appendix A. Ratings

The Arab Republic of Egypt—Egypt Integrated Irrigation Improvement and Management Project (P073977)

Table A.1. ICR, ICR Review, and PPAR Ratings

Indicator	ICR	ICR Review	PPAR
Outcome	Moderately satisfactory	Moderately satisfactory	Moderately satisfactory
Risk to development outcome	Modest	Modest	Modest
Bank performance	Moderately satisfactory	Moderately satisfactory	Moderately satisfactory
Borrower performance	Moderately satisfactory	Moderately satisfactory	Moderately satisfactory

Sources: World Bank 2016, 2017.
Note: The ICR is a self-evaluation by the responsible Global Practice. The ICR Review is an intermediate Independent Evaluation Group product that seeks to independently validate the findings of the ICR. ICR = Implementation Completion and Results Report; PPAR = Project Performance Assessment Report.

The Integrated Irrigation Improvement and Management Project (IIIMP) was expected to close on March 31, 2014. The actual closing date was two years later on March 31, 2016. The delay was mainly due to political unrest in the Arab Republic of Egypt between January 2011 and June 2013, which affected the implementation of the project.

The project was restructured three times, all level 2. The first restructuring was carried out on October 14, 2012, when the disbursed amount was $43.30 million. The restructuring was done to increase the percentage of expenditures to be financed under the loan from 70 percent to 90 percent, reallocate the loan proceeds among categories of expenditures, and amend Schedule 4, Section III-I of the loan agreement based on the revised procurement plan, to identify the number of contracts subject to the World Bank's prior review. The second restructuring was on March 31, 2014, when the disbursed amount was $65.99 million, to extend the loan closing date from March 31, 2014, to March 30, 2016, reallocate loan proceeds among different categories of expenditures, and improve the results framework. The third restructuring was on January 17, 2016, when the disbursed amount was $101.96 million, to reallocate the loan proceeds among different categories of expenditures to help finance procurement of emergency pumps and spare parts for large pumping stations to ensure sustainability of investments under the project.

1. Relevance of the Objectives and Design

Objectives

The project development objective (PDO), which remained unchanged throughout the project, was as follows: To assist the Ministry of Water Resources and Irrigation (MWRI)

in improving the management of irrigation and drainage in the project area, to increase the efficiency of irrigated agriculture water use and services.

Relevance of the Objectives

The project's objectives were and remain in line with the government's priorities for the irrigation sector. At the time of project appraisal, the efforts of the government of Egypt focused on increasing economic growth through improvements in management of water resources and agricultural productivity. The government's Integrated Water Resources Management Plan (MWRI; 2005) aimed to increase water productivity, integrate the fragmented water-related agencies, and empower Water User Associations (WUAs) through capacity building. The government's Strategy of Sustainable Agricultural Development: Towards 2030 also featured enhancing productivity of water in agriculture as one of its main objectives. One of the main components of this strategy was to develop a national irrigation and modernization program that gradually improved the efficiency of water conveyance and distribution systems (World Bank 2010).

The project objectives remain relevant to the new National Water Resources Plan (2017–37), which was in draft form at the time of the Independent Evaluation Group (IEG) assessment mission. Irrigation officials informed the IEG mission that investments in the rehabilitation of irrigation infrastructure continues to be a priority to the MWRI, including increasing the role of beneficiaries in managing the irrigation system. The government is currently engaging other donors (Agence Française de Développement [AFD], International Fund for Agricultural Development, Food and Agriculture Organization, and Organization of the Petroleum Exporting Countries) to finance irrigation improvement operations with a focus on modernization of *mesqa* (tertiary) and *marwa* (quaternary) canals. The minister expects eventual investments in the National Water Resources Plan to double the planned 900 billion Egyptian pounds (LE 900 billion). The MWRI will contribute LE 240 billion (27 percent) to the National Water Resources Plan. The government will also allocate LE 70 billion of the initiative toward solving Egypt's water shortage crisis.

Relevance of objectives is rated **substantial.**

Relevance of the Design

Neither the Project Appraisal Document (PAD) nor the Implementation Completion and Results Report (ICR) included an explicit theory of change, which was not a requirement at that time. The results framework prepared at design did not provide clear links among project inputs, outputs, and expected outcomes, and it was later modified during implementation. Nonetheless, the detailed project description in annex 4 of the PAD

provided a good explanation of what the project intended to do and how the supported activities would contribute to the stated goals.

The project was designed to achieve the PDO in the following ways:

The project aimed to enhance the efficiency of irrigated agriculture water use with support for both on-farm and off-farm activities. Off-farm activities focused on piloting the continuous-flow irrigation model in a few branch canals in the project area rather than the rotational-flow model. Continuous flow was expected to allow for water savings while permitting crops to be irrigated more efficiently. On-farm irrigation improvements included on-farm water control and irrigated agriculture practice demonstrations (for example, demonstrating and training farmers in on-farm water management techniques, including proper irrigation scheduling), support to adaptive research programs focused on water management and productivity, and strengthened irrigation advisory and production support services.

The project was designed to increase the efficiency of irrigation services through a combination of activities. First, support for structural improvements of the main (primary) and branch (secondary) canals aimed to increase the hydraulic capacity of the system and deliver more water to the mesqa canals. Second, at the field level, open mesqa canals would be replaced with subsurface unplasticized polyvinyl chloride pipes. In addition, each modernized mesqa canal would get an electric pumping station to draw water from the branch canal. This was expected to reduce pumping costs compared with use of multiple individual diesel pumps. Mesqa modernization in combination with upstream rehabilitation was expected to improve the equity of water distribution along the mesqa canals, where head-end users were favored at the expense of tail-end users. Third, design also would support open and subsurface drainage network improvements to increase the efficiency of services and decrease waterlogging in project areas. Fourth, to improve the efficiency of services at the institutional level, the design aimed to address the institutional arrangements for individual mesqa operation through supporting WUAs and supporting relevant changes and strengthening for all the relevant institutions on which the mesqa-level WUAs depended. These activities were relevant to ensuring the sustainability of project investments. Fifth, to improve water quality, an additional constraint to use, the design would support an environmental management plan that aimed to address threats to water quality posed by domestic sewage discharges into the irrigation system and improper disposal of municipal solid wastes.

The design had three notable shortcomings. First, the project promoted the use of the continuous-flow irrigation model, which was found to be of limited benefit to farmers and incompatible with incentives at the farm level; the approach was eventually

abandoned (see chapter 2, Implementation and Supervision for further details). Second, there was lack of attention to the coordination mechanisms needed to adequately implement the environmental management plan among the MWRI, the Ministry of Environment, and the Ministry of Health, among other governmental institutions. Third, part of the project's institutional reforms aimed to reduce fragmentation among the many MWRI agencies, but the design lacked attention to incentives to integrate the workflow of different agencies under MWRI beyond combining them in the same building.

Relevance of design is rated **modest.**

2. Efficacy

Subobjective 1: Improve management of irrigation and drainage to increase efficiency of irrigated agriculture water use.

As noted in the previous discussion of design relevance, the efficiency of irrigated agriculture water use was expected to increase through two main activities: the promotion of the continuous-flow irrigation model in branch and mesqa canals rather than the rotational-flow model, and improved on-farm water management. During implementation, promotion of the continuous-flow model was dropped, and activities under component 2 were scaled back (component 2 had a disbursement rate of 13 percent—$0.58 million at completion compared with $4.62 million at appraisal), with the activities supporting adaptive research and irrigation advisory support services transferred, in January 2014, to the Enhanced Water Resources Management Project funded by the Global Environment Facility.

Outputs

Continuous Flow

This activity was dropped.

Outputs Associated with Improved On-Farm Water Management

Water Crop Management Adaptive Research

- Adaptive research for system of rice intensification: The Project Management Unit (PMU) selected 80 feddans (34 hectares) to pilot the rice intensification system in the Nekla command area. In January 2014, the system's research activities were transferred to another World Bank–financed project (Enhanced Water Resources Management Project, implemented January 2014–March 2017).

- Investigations for water management under controlled drainage: An area of 300 feddans (126 hectares) of controlled drainage was piloted, and farmers were trained in El Baradei area, resulting in a 32 percent reduction in applied irrigation water quantities on pilot plots. However, the pilot was discontinued because of implementation challenges (costly application, high number of stakeholders to be trained, and farmers reluctant to agree to the controlled manhole system). This activity was also taken over by the Enhanced Water Resources Management Project in January 2014.

Strengthening of Irrigation Advisory Support Services

- This aspect included setting up a number of continuous-flow pilot areas and training the relevant WUAs and branch canal WUAs and the MWRI staff in preparing them for continuous-flow irrigation as an alternative to rotational flow. This activity was also taken over by the Enhanced Water Resources Management Project in January 2014.

- Other activities included capacity building (training-for-trainers courses) for the Irrigation Advisory Service and the Central Department for Irrigation Advisory Services extension staff in coordination with the MWRI Training Center.

On-Farm Demonstrations

- The project carried out a pilot to improve irrigation systems at the farm level. The pilot area (4,500 feddans or 1,890 hectares) was used to demonstrate improved marwa infrastructure development and laser land leveling in improved mesqa areas. Farmer excursions were also organized to show farmers the benefits of such improvements. In total, 7,000 feddans (2,940 hectares) of laser land leveling was implemented.

Outcomes

According to the ICR, the project provided the target area of 193,750 hectares with improved irrigation, drainage infrastructure, or both that benefited 476,662 water users, exceeding the target of 360,612. Improved irrigation services (the second part of the project objective, assessed in the next section) was expected to translate into increases in yield and water productivity at the farm level.

Efficiency of irrigated agriculture water use was assessed through a proxy indicator that measured water productivity defined as cubic meters per hectare per crop cycle (for main crops—that is, wheat, cotton, rice, maize, and berseem). According to the ICR, water productivity increased by 15 percent, which represented 75 percent of the original target of 20 percent.

Efficacy of subobjective 1 is rated **modest.**

Subobjective 2: Improve management of irrigation and drainage to increase efficiency of irrigated agriculture services.

The PAD did not include a clear definition of what was meant by "irrigation efficiency." This issue was also highlighted in the ICR. Based on the review of the PAD and ICR and on discussions with the project team, IEG understands this objective to mean improving equity in access to irrigation services through improved distribution between head-end and tail-end users.

As discussed in section 1 of this appendix under Relevance of the Design, the project planned to achieve this objective through a combination of infrastructure improvements and institutional reform activities. Insitutional reforms included those within the MWRI (through developing and applying an integrated approach to planning, implementing, and managing irrigation and drainage improvements by supporting better integration of MWRI departments at the command area and district levels) and activities designed to increase participation of water users in the management of the system. Reform of the water resources management institutions in the project area was intended to enhance their capability of eventually adopting integrated water resources management.

Outputs

Rehabilitation of Infrastructure

- **Main canal improvement.** Twenty-seven contracts were completed for works carried out on the Mahmoudia and Meet Yazid main canals.
- **Branch canal improvement.** A total of 445 kilometers of branch canals were upgraded, and 43 branch canals, which served the mesqas selected for upgrading, were rehabilitated. Also, 28 ultrasonic flow measurement systems were installed on the main and branch canals.
- **Mesqa canal improvement.** A total of 85,347 feddans (compared with a target of 85,000 feddans or 35,700 hectares) were completed, with works including intakes from the branch canal, gravity pipelines to the concrete pump sump, pump house with electric pump units and a standby diesel pump, suction and delivery pipework, electrical fittings including a meter, and a buried unplasticized polyvinyl chloride pipe distribution network.
- **Marwa canal improvement pilot.** A total of 24,546 feddans of marwa canals were developed compared with a target of 30,000 feddans (12,600 hectares). This

work formed the basis of what became the Farm-Level Irrigation Modernization Project (FIMP).

- **Drainage works.** A total of 92,085 feddans were provided with either new or rehabilitated drainage systems, representing about 78 percent of the original target of 118,760 feddans (49,880 hectares).

Institutional Support

- **Mesqa-level WUAs.** A total of 1,162 WUAs were fully operational at project closure compared with a target of 1,530 WUAs. According to the ICR, this shortcoming was due to delays in installing electrical pumps. As of December 2018, when the KfW report was carried out, 1,672 WUAs were operational.
- **Branch canal WUAs**. The target was met: 308 WUAs were established. Also, 208 training courses were provided to strengthen the capacity of members.
- **District Water Boards.** Nine District Water Boards were established (target of nine).
- **Integrated Water Resources and Irrigation General Directorates.** Three Integrated Water Resources and Irrigation General Directorates were established in three governorates (Beheira, Gharbia, and Kafr El-Sheikh).
- **Integrated Water Management Districts.** Twenty-two were established (target of 22) as a mechanism for integrating disparate MWRI agency responsibilities for operation and maintenance of irrigation and drainage systems at the district level.

Environmental Management

Awareness campaigns were provided to board members of 56 branch canal WUAs and 1,668 mesqa-level WUAs, with 11,140 direct beneficiaries receiving education related to proper sewage and solid waste disposal and water quality impacts.

Outcomes

At project completion, the target area of 193,750 hectares had improved irrigation, drainage infrastructure, or both that benefited 476,662 water users, exceeding the target of 360,612. The World Bank ICR indicated that as a result of infrastructure rehabilitation and modernization, equity of water distribution improved (World Bank 2016): the ratio of water availability (in cubic meters per hour) measured at head and tail reached 75 percent (target of 75 percent and baseline of 50 percent).

These results were in line with KfW's final report for IIIMP. KfW completed its cofinanced activities in December 2018, and its assessment found that within the Mahmoudia command area, average water productivity for summer rice between the head and tail end are similar (0.60 and 0.58 kilograms per cubic meter, respectively), suggesting higher levels of equity. Within the Mit Yazid command area, average water productivity is slightly higher at the head than at the tail end (0.74 and 0.65 kilograms per cubic meter, respectively). Within the Mahmoudia command area, average water productivity for winter wheat between the head and tail end are similar (1.25 and 1.24 kilograms per cubic meter, respectively), again suggesting high levels of equity. Higher levels of equity were also present within the Mit Yazid command area (interestingly, water productivity at the tail end is slightly higher—1.42 compared with 1.36 kilograms per cubic meter at the head; KfW 2018).

According to a beneficiary survey carried out on completion of the World Bank loan, 91 percent of beneficiary farmers reported improved access to adequate water and drainage services. This exceeded the target of 50 percent. A subsequent survey, the results of which were reported in the KfW completion report in December 2018, found that 98 percent of farmers surveyed believed that irrigation improvements at the mesqa level enhanced equity.

Irrigation costs at the mesqa level were also reduced from LE 300 per 1,000 cubic meters to LE 150 per 1,000 cubic meters (with a target LE 100 per 1,000 cubic meters). The lower costs were the result of reduced pumping costs (from switching from diesel to electric power) and reduced labor costs. The target was not met because of the delays in installing electricity to all of the pumping stations installed by the project, which resulted in fewer stations being converted to electric pumps than anticipated. Improvements in equity, costs, and reliability were also reported anecdotally to IEG during its field assessment. See chapter 2 of the main report, Results: What Worked, for a detailed discussion of how improved services and greater equity were achieved.

Efficacy of subobjective 2 is rated **substantial.**

3. Efficiency

IEG's ICR Review thoroughly reviewed the efficiency assessment presented in the project completion report and concluded that efficiency was modest. This was due to lower ex post economic rate of return (ERR; 12.2 percent) compared with appraisal (20.5 percent). Project costs for mesqa and marwa improvement were underestimated, so the project spent half of the budgeted amount covering an area smaller than originally planned with improved mesqas and marwas. There were also a number of administrative inefficiencies. The project was delayed by two years because of

circumstances beyond its control, a consequence of political instability associated with the Arab Spring. Some implementation delays stemmed from limited implementation capacity of domestic contractors and technical issues in preparing procurement contracts. There were also delays at the mesqa level resulting from the need for a majority of farmers to accept the design of the proposed works. The Project Performance Assessment Report mission did not find any new information that would change the ICR Review efficiency assessment.

Efficiency is rated **modest.**

4. Outcome

Based on modest relevance of design, substantial overall efficacy, and modest efficiency, the overall outcome for the project is rated **moderately satisfactory.**

5. Risk to Development Outcome

The project's development outcomes face the following risks.

Operation and maintenance of the main and branch canals remain the responsibility of the MWRI. The amount of financial resources allocated by the government to support project-related activities after the completion of the project was not reported in the ICR. That said, over the years, the government has demonstrated commitment through annual budget allocations to maintain the irrigation and drainage infrastructure, as both are critical elements for sustaining agricultural productivity in the country. This was confirmed by IEG's discussions with irrigation officials, who explained that MWRI has an annual budget allocation for rehabilitation and maintenance of irrigation infrastructure. However, because of the extensive irrigation and drainage network, cooperation with international donors will continue in this area.

District Water Boards and branch canal WUAs are at risk from lack of adequate legal backing. The entities were established under the project by ministerial decree, and at project closure, their formal legal status was being considered under the new draft water law. At the time of the assessment mission, the draft water law was still pending approval.

The sustainability of the development outcome at the mesqa and farm levels is directly related to the success of the newly established WUAs in managing the project investments in irrigation infrastructure. WUAs at the mesqa level are backed by law. Those visited by the IEG mission reported that to date, they have been able to collect sufficient fees from farmers to cover operating costs and have been able to maintain the system.

That said, the project completion report for IIIMP highlights that sustainability beyond maintenance of works has not been fully addressed because there is no institutional mechanism to support farmers or WUAs outside of projects. WUAs at both the mesqa and branch levels need further capacity building and specialized training to use the water well. In theory, agricultural extension is available from the Ministry of Agriculture and Land Reclamation (MALR), but that institution tends to focus on crop and livestock production, not on the particular skills needed to operate an irrigation system efficiently.

To sustain the benefits of the project at the mesqa level, the government also needs to follow up on electrification of the remaining (diesel) pumps to ensure that farmers benefit from more affordable and reliable service. The mission was informed that electrification efforts are continuing after project completion.

Law 213 of 1994 provides for recovery of mesqa improvement costs from the landowners benefiting from such investments. The costs of pump sets are repaid within three years, while repayment of the cost of civil works takes place over 20 years. Costs are repaid without interest. Collection of the installments is the responsibility of the Land Tax Authority. After deduction of fees for the Land Tax Authority and Irrigation Improvement Sector, the amount collected is paid into a revolving fund, which is intended to be used for further mesqa improvement. Until 2013, arrangements to start the cost recovery were delayed while a decision was awaited as to whether the costs of electrification should also be included. During the summer of 2013, a formal decision was made by the MWRI in conjunction with the Ministry of Finance that the costs of the electricity networks should be factored into the cost recovery, with repayments to be made over 15 years. The IEG mission was informed that cost recovery was low, ranging between 20 and 30 percent, and that new owners of lots with modernized mesqa canals refused to pay cost recovery installments because they did not sign any papers obliging them to pay; these papers were signed by previous owners. This is a serious problem that needs to be legally addressed. One solution could be adding the costs of modernization as a lien on the title of land independent of the owner.

Risk to development outcome is assessed as **modest.**

6. Bank Performance

Quality at Entry

IEG's review of the ICR included a solid assessment of quality at entry; the main points of that assessment are repeated here. The mission did not find any new information that would change that assessment.

The project built on the World Bank's long and successful partnership with the MWRI in the irrigation and drainage sector in Egypt. Long-term collaboration with KfW and the Netherlands Development Cooperation was also beneficial in promoting a common donor vision for institutional change.

Design benefited from the lessons and experience of previous World Bank operations in the country, particularly the Irrigation Improvement Project, the National Drainage Project, and the Pumping Stations Rehabilitation Project. Notable lessons reflected in the design included the following: the need to address integration of fragmented water delivery agencies and the modernization of irrigation and drainage systems to deliver water services for agriculture and other sectors; electrification of pumps in the design of new mesqa systems to reduce costs of irrigation; investments in on-farm water management programs, such as demonstrations to farmers about efficient water management techniques; and establishment and empowerment of WUAs.

However, design suffered from several notable shortcomings. First, it aimed to promote continuous-flow irrigation (which ultimately failed) rather than the traditionally practiced rotational flow. The suitability of continuous flow to local conditions should have been carefully assessed before implementation. Second, detailed studies of the canal systems were needed before major civil works contracts could be awarded, but these studies were unavailable at entry. Third, the design did not include detailed surveys, feasibility studies, and engineering designs to accurately assess costs of the mesqa-level work. This resulted in underestimating costs by about 15 percent. Fourth, the design sought to address environmental issues that were beyond the mandate of the implementing agency and required adequate coordination with relevant ministries and government agencies. This necessary coordination was not reflected in the project design. Fifth, the design lacked details on the roles and responsibilities of the different water organizations supported by the project. There was no clear mechanism laid out in the design to explain how these organizations would work together to improve the efficiency of service delivery. Sixth, multiple key risks were identified at appraisal, but the proposed mitigation measures were insufficient, and the identified risks still caused implementation delays. The provision of electrical lines for mesqa pump stations was considered a moderate risk. However, during implementation, it became the main reason for not achieving the target number of operational WUAs. Finally, monitoring and evaluation (M&E) suffered from some design shortcomings.

Quality at entry is rated **moderately unsatisfactory.**

Quality of Supervision

The project was implemented under a challenging political environment that extended from 2011 through 2013. The World Bank supervised the project regularly throughout

the implementation period, and supervision missions included a relevant skill mix. The World Bank was proactive during the implementation of the project. It was able to rectify the problems that arose because of a lack of detailed engineering designs on large civil works, and it reviewed mesqa-level designs in a bid to control costs. Supervision demonstrated flexibility and adaptive decision-making by dropping the continuous-flow irrigation model when it became evident that it was not applicable under local Egyptian conditions. World Bank supervision helped the government to restructure the project and get implementation back on track after significant delays caused by political turmoil and helped modify the results framework to better capture the project's outcomes. The Mid-Term Review was carried out five years later than originally planned to allow for enough evidence on implementation in light of the various implementation delays from political turmoil and slow uptake of mesqa improvements. The IEG mission was informed by PMU staff, including the director and his deputy, and also by other irrigation officials that the World Bank expertise in general was highly appreciated. Despite multiple changes in task team leaders over the course of the project, counterparts felt that all task team leaders were proactive and solution oriented. However, they emphasized that the project benefited most when the task team leader was an experienced irrigation specialist with a high level of technical knowledge of the sector and its issues and who was able to provide exceptional troubleshooting of technical issues. This comment was reiterated by officials at the Ministry of International Cooperation.

Quality of supervision is rated **satisfactory.**

Overall Bank performance is rated **moderately satisfactory.**

7. Borrower Performance

IEG's review of the ICR included a thorough assessment of borrower performance; the main points of that assessment are repeated here. The mission did not find any new information that would change the conclusion of that assessment.

Government Performance

As reported in the project ICR, government commitment to and ownership of the project was demonstrated by it providing counterpart funding as planned, supporting implementation arrangements (including appointment of key officials), and being available to the World Bank missions consistently. The government also initiated restructuring requests accordingly. The project team further elaborated that given the importance of the irrigation and drainage systems, the government was expected to continue making the necessary resources available to ensure sustainability of the project. The ICR did not elaborate on the government's strategy to continue building the

capacity of the newly established WUAs, without which the benefits and the ownership dimensions of the project could decline over time. The IEG mission inquired about this point and was informed by irrigation officials that the MWRI was committed to increasing the role of beneficiaries in managing the irrigation system in Egypt. They explained that a comprehensive irrigation law was being reviewed by the Agriculture and Irrigation Committee within the Egyptian Parliament that would provide formal legal backing to branch WUAs and District Water Boards. There is no indication of when the law is expected to be finalized, approved, and adopted. It includes controversial issues such as water rights. The experience of other countries indicates that finalizing such laws is a long-term process. There is little indication of any other strategy to support these entities in the meantime. Finally, the government could have provided more support at higher levels to speed up the electrification of the pumps as originally planned.

Government performance is rated **moderately satisfactory.**

Implementing Agency Performance

The MWRI was responsible for implementation of the project through a dedicated PMU housed within MWRI in Cairo. The PMU was responsible for integrated planning, financial management, budget control, procurement of goods and services, monitoring and coordination of project activities, and overall technical and progress reporting. The ICR highlighted that implementation of the physical dimensions of the project was managed by technical units within the MWRI. Although implementation was slow at the beginning of the project, it improved in the last four years. This was possible because the technical departments within the MWRI become more focused and showed better management of contracts, which ensured that works were completed according to schedule. However, the implementing agency could have provided more support to ensure safeguard compliance on the electrical contracts earlier in implementation; this was resolved only during the final stages of the project. According to the ICR, earlier detection could have helped ensure timely completion of the electrical contracts and better results on operationalization of the mesqa-level WUAs.

Implementing agency performance is rated **moderately satisfactory.**

Together, government and implementing agency performance led to a borrower performance rating of **moderately satisfactory.**

8. Quality of Monitoring and Evaluation

Design

M&E activities were the overall responsibility of the PMU at the MWRI. Other technical agencies within the MWRI were also involved in M&E. Activities of these agencies were coordinated by the PMU. The PMU had an M&E section with one M&E specialist, and a short-term international consultant provided support for M&E activities. The original results framework included three outcome indicators to assess the PDO. The first indicator, "volume of water used for given level of agricultural production (m^3 [cubic meters] per hectare per crop)," and the second indicator, "difference between land productivity (tons per hectare) between head and tail end farmers," were relevant and directly related to the PDO. However, the third indicator, "value of land (compared with non-project neighboring command area),"was not relevant because the value of land could be influenced substantially by factors extraneous to the project. Hence, it was later dropped. The results framework also included 16 intermediate outcome indicators to assess different activities under the project's five components (listed in chapter 1, Nile Delta Irrigation System). Although these indicators were relevant, specifications of (intermediate and end) targets were not provided in the PAD. Also, measuring some of them proved challenging. For example, for "tons of solid wastes collected and safely disposed to (pilot) landfills," there were no indicators to assess improvements in drainage, even though the project was expected to perform a sizable rehabilitation of the drainage systems. Assessment of water table and soil salinity levels before and after rehabilitation in project areas would have provided valuable input on the impact of the project.

Three core sector indicators were added at the 2014 restructuring of the results framework: area provided with improved irrigation and drainage services; water users provided with new or improved irrigation and drainage services (male, female); and operational WUAs created or strengthened. Units of measurement for the first two outcome indicators were also changed. The unit for water productivity indicator was changed from cubic meters per hectares crop cycle to water productivity increase (in percentage) for main crops because the new unit better reflected the PDO of "efficiency of irrigated agriculture water use," for example, when higher-value or higher-water-use crops were introduced by the farmer. However, given that a switch to higher-value crops requires support beyond the project's scope, the assumption that the project would induce crop diversification was overly ambitious. The unit to measure equity within a mesqa area was changed from "difference between land productivity (tons per hectare) between head and tail end farmers" to "ratio of water availability."

Implementation

The PMU used various sources of data. Some of the project-specific data were obtained from the Water Management Research Institute, agricultural cooperatives, the Irrigation Improvement Sector, and the MALR. The PMU used data from these sources, surveys of WUAs, and regular PMU reports to prepare the annual M&E reports. The project team indicated that some of the data were verified by field visits and reviews of the irrigation water distribution network. According to the ICR, Excel spreadsheets were used to generate monthly tabulated or graphic physical progress of the project. However, the ICR did not report on many physical targets relating to main canal rehabilitation as envisioned in the PAD.

Use

The ICR provided limited coverage on use of information. The PMU used the monthly progress reports to adjust the overall planning activities and financial forecasts and take action regarding poor performance of contractors. Information from the Mid-Term Review was used to address the earlier problems in the design of the results framework by dropping some indicators, revising others, and adding new ones.

Because of design shortcomings and implementation weaknesses, quality of M&E is rated **modest.**

The Arab Republic of Egypt—Egypt Farm-Level Irrigation Modernization Project (P117745)

Table A.2. ICR, ICR Review, and PPAR Ratings

Indicator	ICR	ICR Review	PPAR
Outcome	Moderately satisfactory	Moderately satisfactory	Moderately satisfactory
Risk to development outcome	Modest	Modest	Modest
Bank performance	Moderately satisfactory	Moderately satisfactory	Moderately satisfactory

Sources: World Bank 2018b, 2018c.
Note: The ICR is a self-evaluation by the responsible Global Practice. The ICR Review is an intermediate Independent Evaluation Group product that seeks to independently validate the findings of the ICR. ICR = Implementation Completion and Results Report; PPAR = Project Performance Assessment Report.

The FIMP was restructured twice. The first was a level 1 restructuring on June 21, 2016, when the amount disbursed was $40.62 million. Changes included the following: (i) Revising the original PDO. The original PDO of increasing agricultural profitability was unrealistic with respect to the project time lines. The original PDO focused on the long-term impact of the project. Although the project activities were expected to lay the foundation for the long-term goal, such a goal could only be achieved after project closing, when the civil and electricity works were complete, and the farmers adopted the new techniques based on observation of the lead farmers. (ii) Scaling down the targets for activities associated with introducing modern irrigation technologies. Shifts in both technology and crop type depended on factors external to the project (such as farmer attitudes, local financing for irrigation equipment, and access to markets). (iii) Replacing the "force account" mechanism (an approach that entails financing and administering community-based construction activities) with an approach of clustered medium-scale contracts by commercial contractors. This change was necessary in view of the limited capacity within the MALR and the PMU to administer small contracts. (iv) Triggering the Involuntary Resettlement Safeguard (discussed in appendix B). (v) Extending the closing date. An extension of 18 months allowed completion of ongoing activities that had been subject to delays associated with implementing the force account approach.

The second restructuring, a level 2 restructuring on May 31, 2017, when the amount disbursed was $58.59 million, addressed the effects of the depreciation of the Egyptian pound relative to the US dollar. The depreciation increased the cost of inputs and slowed progress on physical works, as contractors could no longer cover their costs. The restructuring allowed the International Bank for Reconstruction and Development to increase its share of financing from 60 percent to 90 percent for physical works and from 60 percent to 100 percent for consulting services. This change enabled AFD to cover the cost of variation orders on affected contracts (which the World Bank was not authorized

to do as the World Bank financing for the project did not include contingency provisions for price changes).

9. Relevance of the Objectives and Design

Objectives

FIMP was restructured during implementation, and its PDO was revised. Accordingly, IEG has applied the split rating methodology to assessment of this project, whereby the relevance of objectives and the efficacy are assessed twice against the original and revised objectives. The final outcome rating is derived using a weighted average according to the amount of the loan commitment. The two PDOs are as follows:

- Original PDO: To increase agricultural profitability and improve equity in access to higher-quality water for small-scale farmers in the command areas of Mahmoudia, Manaifa, and Meet Yazid located in the Nile Delta.
- Revised PDO: To increase access to improved irrigation systems in the project areas of Mahmoudia, Manaifa, and Meet Yazid located in the Nile Delta, in an equitable manner.

Relevance of the Objectives

Both the original and revised PDOs were relevant to the government's strategy for the agriculture sector. The agricultural sector remained vital for raising rural incomes as this sector provided employment for about 30 percent of the workforce. In the years before appraisal, agricultural productivity remained below potential. The issues facing the agricultural sector included (i) water scarcity (there are both limited freshwater resources and increasing demand for water resources because of population growth, agricultural expansion, and industrial development); (ii) food security (about 40 percent of Egypt's food requirements are met through imports); and (iii) climate change factors (climate change models project an increasing probability of severe weather events that would increase volatility and decrease production of key crops).

FIMP's original and revised objectives are consistent with the priorities outlined in the government's Strategy of Sustainable Agricultural Development: Towards 2030. One of the strategy's main pillars is to support a national irrigation modernization program targeting 5 million feddans (2.1 million hectares) of old lands. This program was expected to gradually improve the efficiency of water conveyance and distribution systems and the efficiency of on-farm irrigation systems, with the goal of increasing farm-level efficiencies from 50 percent to 80 percent by 2030. FIMP was considered a first phase contributing to this pillar of the strategy.

The IEG mission was informed that in 2017, the governor of Beheira Governorate officially requested the prime minister's office to extend the coverage of FIMP activities to cover all agricultural lands within Beheira (total cultivated area in Beheira is approximately 1 million feddans or 420,000 hectares). Also, in several instances during field visits to the project areas, the mission was approached by farmers who did not participate in the project, requesting the application of modern irrigation promoted by FIMP on their lands. These farmers explained that they wanted the same benefits that their neighbors got, namely cost and time savings with regard to irrigation and more equitable irrigation along the mesqa and marwa canals. FIMP's PMU director explained that the project's experience is being replicated under several pilots in the Nile Delta and in southern (upper) Egypt. Funding for these pilots is through the Organization of the Petroleum Exporting Countries Fund for Internatinoal Development and the International Fund for Agricultural Development. The goal is to achieve national coverage of 5 million feddans (2.1 million hectares) by 2030.

Both versions of the PDO were also well aligned with the World Bank strategy for Egypt. The Country Assistance Strategy for 2006–11 highlighted the need to improve the management and efficiency of water and land resources. The Interim Strategy Note for 2012–14 identified the need to develop coherent policies in water supply through local participation. The World Bank's current Country Partnership Framework for 2015–19 underscored the need to increase agricultural productivity and off-farm employment through policy reforms, better connective infrastructure, efficient water allocation systems, and improved agricultural and agro-industrial logistics. The second focus area of the Country Partnership Framework identified the need to improve "opportunities for private sector job creation" through "enhancing access to improved agricultural and irrigation services" (World Bank 2015, 53).

Relevance of Original Project Development Objective

Despite the relevance to government and World Bank strategies, the original PDO, which included the objective of increasing agricultural profitability, focused on the long-term project impact. It was unrealistic regarding the project time lines and insufficiently aligned with the project components. The theory of change for this part of the objective was too ambitious, and the conceptualization of how the two parts of the project work together was unfounded. The project activities were expected to lay the foundation for these long-term goals, but they could only be achieved after project closing as farmers gradually adopted the new techniques based on the observation of gains made by the lead farmers. Diversification to higher-value crops would also require attention to market links, which was beyond the project's scope.

Relevance of the original objective is rated **modest.**

Relevance of Revised Project Development Objective

The revised objective dropped the part of the PDO associated with increasing agricultural profitability and focused on increasing access to improved irrigation systems in an equitable manner in the project area. The revised objective remained consistent with the strategies noted but was more realistic in what could be achieved within the implementation time frame of the project.

Relevance of the revised objective is rated **substantial.**

10. Efficacy

Subobjective 1: To increase agricultural profitability in the command areas of Mahmoudia, Manaifa, and Meet Yazid located in the Nile Delta.

Outputs Relevant to Subobjective 1

- A total area of 155,362 feddans (65,252 hectares) of irrigation infrastructure was modernized by project closure (including modernizing marwa hydraulic systems with pipelines or lined canals), compared with the target of 190,500 feddans (80,000 hectares).

- Electric pumps installed under the projected benefited 155,300 feddans (65,200 hectares): 104,834 feddans (44,030 hectares) in Beheira and 50,466 feddans (21,196 hectares) in Kafr El-Sheikh. This exceeded both the original and revised targets of 130,000 and 155,000 feddans (54,600 and 65,100 hectares), respectively.

- A total of 7,534 farmers were trained on aspects of pump operations (including pump activation, operational butterfly valve settings, and electric- and diesel-motor maintenance), compared with the target of 7,500 farmers.

- Fifteen technologies were demonstrated in the project areas, as targeted. The technologies included (i) community composting, (ii) silage, (iii) fodder from rice straw, (iv) on-farm irrigation improvements by buried pipe, (v) on-farm irrigation improvements by lined marwa canals, (vi) use of an electronic complaint system, (vii) regular transplant of rice by rope, (viii) system of rice intensification, (ix) laser land leveling, (x) deep plowing, (xi) adding gypsum to soil, (xii) use of different rice varieties in farmer field schools, (xiii) use of card payment for electricity supply, (xiv) raised beds, and (xv) modern irrigation for horticulture in old land.

Outcomes Relevant to Subobjective 1

- Farmers' costs for pumping water into mesqa canals (as a result of the switch from diesel to electric pumps) decreased by 46 percent at project closure. This exceeded the target of 30 percent. The time required for field-level irrigation activities was reduced by 37 percent, compared with the target of 20 percent.

- The ICR reported agricultural output (in Egyptian pounds per feddan) from the main irrigated crops increased by 30.9 percent in the project areas, exceeding the original target of 10 percent. These data were based on annual yield measurements in 2015, 2016, and 2017.

- Higher-value horticultural crops were planted in 1,218 feddans (512 hectares) at project closure, below the original target of 12,000 feddans (5,040 hectares) but above the revised target of 100 feddans (42 hectares). The project did not include a baseline, so it is not clear how many feddans had been planted with higher-value horticulture crops before the project. The ICR concluded that the shift to higher-value horticultural crops could not be attributed to the project, as promoting a shift to higher-value horticultural crops required completion of the marwa-level modernization first and also required support for activities that the project did not provide (access to credit and markets). Moreover, the project's approach to promoting changes in crops was through demonstrations and farmer field schools. It would require a longer time line than the project period for farmers to gradually adopt practices observed from lead farmers.

Subobjective 2: To improve equity in access to higher-quality water (original PDO); increase access to improved irrigation systems in an equitable manner (revised PDO).

The project intended to achieve this goal by modernizing the hydraulic system at the mesqa and marwa levels. Infrastructure improvements would replace individual pumps at the mesqa level with a single electric pump and replace the traditional open mesqa and marwa channels with a piped subsurface system. These improvements would improve the speed and efficiency of water conveyance to the fields and enhance the equity of irrigation water distribution between head- and tail-end users. The improvements would also ensure that tail-end farmers would be served with greater access to higher-quality water, reducing their dependence on the reuse of drainage water. The piped marwa system was also expected to facilitate subsequent investment by farmers in the simpler forms of localized irrigation (specifically low-head bubblers), which would be very useful for eventual switching to higher-value cropping, especially horticultural crops (World Bank 2010, 12).

Outputs Relevant to Subobjective 2

- A total of 197,663 water users (including landowners and tenant farmers) had access to improved irrigation and drainage services by project closure. This represented a 41 percent increase relative to the target of 140,000 water users. Gender-disaggregated data obtained from a sample survey undertaken by extension focal point officers showed that 15,813 female water users had access to improved irrigation and drainage services at project closure. This represented a 13 percent increase relative to the target of 14,000 female water users.

- A total area of 65,252 hectares of irrigation infrastructure was modernized (including modernizing marwa hydraulic systems with pipelines or lined canals) at closure, compared with the target of 80,000 hectares.

- Electric pump installed under the projected benefited 155,300 feddans (104,834 feddans in Beheira and 50,466 feddans in Kafr El-Sheikh). This exceeded both the original and revised targets of 130,000 and 155,000, respectively.

Outcomes Relevant to Subobjective 2

- The main indicator the project used to measure equity among water users was the ratio of water availability (in cubic meters per hour) at the tail and head ends of the marwa. At project closure, farmers at the tail end of the marwa received on average 85 percent of the water flow, compared with 50 percent at the baseline. This exceeded the target of 75 percent.

- An additional indication of equity in access to higher-quality water was a reduction in the reuse of drainage water, especially by farmers at the tail end of the marwa canals. At project closure, this was a 95 percent reduction, compared with the target of 50 percent.

- Differences in yields between farmers at the tail end and head end of marwa canals was also reduced by 59 percent, exceeding the project target of 20 percent. However, the ICR noted that this outcome could not be linked to the project improvements alone because crop productivity depends on a number of extraneous factors such as fertilizer application and seed choice. This was a key performance indicator identified at appraisal but dropped during the 2016 restructuring.

Many of the outcomes listed in the project ICR, along with other benefits, were reported to the IEG assessment mission. Farmer interviews during IEG's mission revealed that costs for electric pumps were 60 percent lower than for diesel pumps, even after removing subsidies on electricity. In addition, farmers explained that the time required

to water each feddan decreased from an average of 5–6 hours to 2–3 hours. The time saved could be used by farmers to attend to other productive activities. When asked about their yields under the modernized system, farmers emphasized that irrigation water became more reliable, and equity improved. Farmers noted that, prior to the project, shortages in irrigation water during peak summer months could last up to 25 days; after the project, shortages were either totally absent or in the range of 10–12 days in tail-end areas. The availability of irrigation water allowed farmers to water their crops at the optimal intervals and avoid any water stress during critical times of the growth cycle. This had positive impacts on yields, particularly for summer crops. Rice farmers in Kafr El-Sheikh Governorate claimed to achieve 4.25 tons of rice per feddan after irrigation improvements. Before the project and with water shortages, productivity was between 1 and 2 tons per feddan. Discussions with farmers toward the tail end in Kafr El-Sheikh areas revealed that before the project, they would rely to a large extent on drainage water to irrigate their summer crops, and they explained that farmers at the extreme tail ends did not receive fresh irrigation water at all. After the irrigation improvements, tail-end farmers received a better share of fresh irrigation water and decreased their reliance on drainage water.

Overall Efficacy Rating

The objective of improving agricultural profitability is a long-term goal that could only be fully realized after project closing, as farmers gradually adopt the new techniques based on the observation of gains by the lead farmers. Efficacy of the original PDO, which includes improving agriculture profitability, is therefore rated as modest. The expected outcomes for the subobjective of improving equity in access to higher-quality water for small-scale farmers in the project area were realized or exceeded during the lifetime of the project. Efficacy of the revised PDO, which includes only this part of the objective, is rated as substantial.

Efficacy of the original PDO is rated **modest.**

Efficacy of the revised PDO is rated **substantial.**

11. Efficiency

IEG's review of the ICR concluded that efficiency was substantial, and the main justification of that rating is repeated here. The IEG assessment mission did not find any new information that would result in a revision of that rating.

The ERR calculated at project closure was 22 percent, a high rate of return even though it was lower than the ERR of 29 percent that was estimated at appraisal. The ERR was calculated on the basis of activities associated with the farm-level infrastructure improvement. Other benefits from the project that did not factor into the economic

analysis included environmental benefits because of the reduction of greenhouse gas emissions as a result of switching from diesel to electric pumps, and health benefits to the local population in project areas because of reduced exposure to noxious fumes from diesel pumps. The lower-than-anticipated ERR was attributed to the fact that many civil works were done in the last two years of implementation, delaying the accrual of net benefits. Irrigation improvement costs were also higher than estimated, and some land improvement demonstration activities under component 2 (the number of field crop demonstration sites, area treated with land improvements such as laser land leveling, deep plowing, gypsum application, and so on) had to be reduced.

The project experienced delays in the initial years of implementation. This was a consequence of social unrest during the first three years of implementation, the use of the force account contracting approach, the weak capacity in the MALR and the PMU to process the large volume of small contracts, and the lack of technical assistance at design. Implementation progress accelerated in the later years after the adoption of a different contracting approach and provision of technical assistance. The project was also negatively affected by the lack of arrangements for covering price contingencies in contracts. This caused implementation of civil works to stall after the depreciation of the Egyptian pound relative to the US dollar. This issue was eventually resolved by the supervision team and the PMU in collaboration with AFD, which adjusted the terms of its cofinancing to allow for contribution to civil works.

Efficiency is rated **substantial.**

12. Outcome

Pre-restructuring: Based on modest relevance of objectives, modest efficacy, and substantial efficiency, outcome for the project is rated **moderately unsatisfactory.**

Post-restructuring: Based on substantial relevance of objectives, substantial efficacy, and substantial efficiency, outcome for the project is rated **satisfactory.**

Weighted outcome rating, according to International Bank for Reconstruction and Development disbursement amounts, is as follows:

Amount disbursed at restructuring: $40.62 million out of a total International Bank for Reconstruction and Development disbursement of $100.00 million.

Calculation: 40.62/100 × 3 + 59.38/100 × 5 = 1.22 + 2.97 = 4.19, rounded to 4. A value of 4 corresponds to a moderately satisfactory rating on a 1 to 6 scale (1 = highly unsatisfactory, 2 = unsatisfactory, 3 = moderately unsatisfactory, 4 = moderately satisfactory, 5 = satisfactory, and 6 = highly satisfactory).

Overall outcome rating is **moderately satisfactory.**

13. Risk to Development Outcome

The main risks to the development outcome are linked to the sustainability of the modernized mesqa and marwa canals.

Risk related to sustainability of the piped system is low, as the civil works were not complicated and did not require high-level operational skills from contractors. Technical reports indicate that when installed correctly, the buried uPVC marwa system should not require any maintenance or repairs for up to 25 years. The project included a number of measures to ensure quality of civil works during implementation and correct installation: (i) redirecting irrigation civil works to medium-scale contractors; (ii) hiring specialized quality control and construction supervision consultants (as of mid-2016, after which most of the modernization was implemented); and (iii) the close involvement of beneficiary farmers in the detailed design of marwa improvements and supervision and co-certification of the delivery of equipment and works at the field level.

Beneficiaries interviewed by the IEG mission explained that maintenance was simple, and local capacity was improving when it came to handling repairs. Support for operation and maintenance is further provided by the technical workshops that were established during implementation of the community and small-scale contracting approach. These workshop facilities, maintained at PMU offices in the MALR at the district level, provide the following: a base for mesqa WUA and operator training, technical-training support to small private service centers undertaking pipe and pump repairs, and the production and repair of low-cost alfalfa valves (World Bank 2018b).

Pump operators carry out basic maintenance and repair works for backup diesel units. A technical report on the project noted that in some instances and for all electrical repairs, the WUAs hire a technician from the surrounding area if the operator cannot handle required works. For more complex needs, repair and maintenance centers are scattered in the capital cities of the governorates.

Collection rates by mesqa WUAs are reported to be high and have been sufficient to cover maintenance needs to date. This was further confirmed by the WUAs interviewed by the IEG mission. There is a risk that the government could either reduce or eliminate subsidies for the electricity used in agriculture, which could undermine the cost savings associated with the replaced electric pumps at the mesqa level. The IEG mission was informed that both diesel and electricity subsidies were being significantly reduced. Beneficiary farmers informed the mission that even with the removal of subsidies, electric pumps were more cost efficient and required less maintenance than diesel ones.

Risk to development outcome is rated **modest.**

14. Bank Performance

IEG's review of the ICR included a thorough assessment of Bank performance. The main points of that assessment are repeated here, with updates from information reported to the IEG assessment mission. The mission did not find any new information that would change the conclusion of the earlier assessment.

Quality at Entry

The project was prepared based on the lessons from prior World Bank–financed irrigation modernization projects in Egypt, including the experience of IIIMP, that informed the project's scope and approach. Several risks were identified at appraisal, including high risks associated with poor quality of local materials and workmanship, and procurement delays. Mitigation measures incorporated at design included quality inspection of works by external agencies and training in procurement by a donor agency early in the project life. The arrangements made at appraisal for safeguards and fiduciary compliance were appropriate**.**

However, there was insufficient coordination across expertise within the World Bank at the design stage, and as a result, detailed design and engineering feasibility studies were not carried out for modernization of the system. This negatively affected the project's readiness for implementation and caused delays in implementing the civil works activities. The project was led by the agricultural sector of the World Bank working directly with their counterparts at the MALR. There was little involvement from the water sector team, which had irrigation and drainage technical experts with a long history of engagement with the MWRI in prior World Bank–financed irrigation projects in Egypt.

Several other shortcomings negatively affected quality at entry. First, the original PDO was unrealistic regarding project time lines and the project activities and time frame (given that improvement to the irrigation system is not sufficient on its own for improving agricultural profitability). Second, the design overestimated the capacity of the MALR and the PMU to administer the force account approach. Neither the MALR nor the PMU had the capacity or the required resources to supervise multiple small contractors. These factors contributed to delays in the first three years of implementation, and eventually the approach was modified to rely on a cluster of medium-scale contracts administered by commercial contractors. Third, contracts for civil works did not include provisions for price contingencies. The increase in cost of inputs caused by the depreciation of the Egyptian pound relative to the US dollar caused delays until the issue was resolved by means of arrangements with AFD. Fourth, the

design did not initially include technical assistance activities aimed at providing engineering support to the PMU, and these activities were incorporated three years after project implementation. There were also shortcomings in M&E design.

Quality at entry is rated **moderately unsatisfactory.**

Quality of Supervision

The World Bank team carried out intensive supervision of the project through all stages of implementation and was instrumental in aiding the PMU to overcome many implementation challenges. According to the ICR, the team conducted 31 supervision missions. The supervision team included specialists with expertise in engineering, irrigation, agronomy, extension, and social expertise. The World Bank team arranged for consulting firms to provide technical support to the MALR and the PMU for making the switch from the force account approach, and this helped increase construction activities in the latter years of project implementation. The team also worked with AFD to resolve the issue of cost increases in the wake of the depreciation of Egyptian pound during implementation. Field visits during supervision missions and feedback provided by the team helped monitor project progress and take corrective action (World Bank 2016). Technical audits in response to technical and financial issues provided insights and prompted important technical adjustments. The team also made appropriate arrangements for compliance with additional safeguards triggered during project restructuring. However, given the delays in the initial years of project implementation, the project restructuring, which took place in the fifth year of the project, should have been done earlier. According to the borrower (the Ministry of International Cooperation), the continuity of leadership of the World Bank team was undermined by frequent changes in task team leaders, with seven task team leaders in eight years, from design to project completion. That said, the PMU reported to the IEG mission that the hands-on engagement of the World Bank supervision team throughout the project was instrumental in finding solutions to implementation challenges and is unique among other donors' supervision processes.

Quality of supervision is rated **moderately satisfactory.**

Overall Bank performance rating is **moderately satisfactory.**

15. Quality of Monitoring and Evaluation

Design

Of the five original M&E indicators, three indicators—a 30 percent reduction in irrigation operating costs in Egyptian pounds per feddan; a 50 percent reduction in

drainage water reuse by farmers, especially those at the tail end of marwa canals (with reduction being measured against baseline and nonproject neighboring comparison areas); and establishment of 20,000 active marwa committees—were appropriate for monitoring project performance. However, the two key outcome indicators—a 10 percent increase in agricultural output from the main irrigated crops measured in Egyptian pounds per feddan, and a 20 percent reduction in difference in yields between farmers at the tail and head ends of quaternary canals—were not good measures of the project's achievements, as increase in agricultural output and difference in yield could not be attributed to project activities in the irrigation sector alone.

Implementation

With the change in PDO, the indicator pertaining to increase in agricultural profitability was dropped. Two new core sector indicators were added after the project restructuring—the number of water users (including the number of female beneficiaries) provided with improved irrigation and drainage services, which are relevant to the PDO but insufficient for demonstrating project outcomes. Surveys were carried out in 2016 and 2017 in some areas with a sample of households (including with tail-end farmers at marwas for about 8 percent of the total cropped area) to monitor project performance.

Use

The indicators monitored during implementation were used as a reporting tool to the MALR to address areas where progress was lacking. At closure, the indicators were used for evaluating overall project performance.

Quality of monitoring and evaluation is rated **substantial.**

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Appendix B. Fiduciary, Environmental, and Social Aspects

The Arab Republic of Egypt—Egypt Integrated Irrigation Improvement and Management Project (P073977)

Financial Management

During project preparation, a financial management action plan was agreed on with the borrower and made a condition of effectiveness, to address concerns that the Project Management Unit (PMU) did not have a financial management function in place. In accordance with this plan, financial management was handled by the PMU through an externally hired financial specialist and three accountants seconded from the Finance Department of the Ministry of Water Resources and Irrigation. According to the Implementation Completion and Results Report (ICR; World Bank 2016), the project consistently maintained sound manual and automated accounting records. The quarterly report reviewed interim financial reports, and the annual audited financial statements were consistently received on time and were of acceptable quality. The ICR did not report on the status of external financial audits.

Procurement

The World Bank's Project Appraisal Document reviewed the project's standard bidding documents prepared by sectors of the Ministry of Water Resources and Irrigation and found them adequate for the purpose of the project under national competitive bidding (World Bank 2005, 98). According to the ICR (World Bank 2016, 10, para. 35), civil works contracts were awarded following standard World Bank procurement guidelines. A total of 156 civil works contracts were awarded. In addition, 38 contracts were awarded for the supply of goods and services, the largest contract being for the supply of spare parts for drainage pumping units. Procurement delays stemmed from identifying works and technical issues and preparing detailed designs for bid documents and not from the procurement process itself.

Environmental and Social Safeguards

The project was classified as environmental category B. It triggered two safeguard policies: Environmental Assessment (OP 4.01) and Involuntary Resettlement (OP 4.12). The ICR reported that the government prepared an environmental assessment and an environmental management plan to address both the environmental impacts and external factors (World Bank 2016, 9, para. 31). According to the environmental assessment, the net impact of the project was positive, and the negative impacts were

generally temporary and minor. Most of the envisioned activities under the environmental management plan were not implemented. The ICR did not provide an explicit statement of compliance, but it stated that "overall, the project activities complied with all applicable World Bank policies" and that "there were no associated significant, sensitive, diverse, unprecedented, or irreversible impacts" (World Bank 2016, 8, para. 30). The ICR also reported that a provisional Resettlement Action Plan was completed before project approval (World Bank 2016, 9, para. 32). The project team explained to the Independent Evaluation Group that the need for land during implementation was significantly reduced because the project focused on rehabilitation and improvement of main and branch canals, and there was no new construction.

Project contractors selected the timing of the civil works to minimize crop losses. During project implementation, the need for crop compensation for electrification contracts was identified. This was addressed through a joint World Bank–PMU team to identify the affected persons, assess crop damages, and pay compensation. Payment of all affected persons was swiftly and successfully completed by the end of May 2016. According to the project team, only 78 households were affected by the project. The team also explained that there was a well-established country compensation system in place. Higher-risk contracts, such as siphons and canal bed dredging, were subject to site-specific environmental and social impact assessments and environmental and social management plans (ESMPs).

The Arab Republic of Egypt—Egypt Farm-Level Irrigation Modernization Project (P117745)

Financial Management

An assessment conducted at appraisal to judge the financial management capacity of the implementing agency, the Executive Authority for Land Improvement, rated financial management risk as significant, in view of the lack of staff within the implementing agency who had experience working with World Bank–financed projects. Mitigation measures were incorporated at design, including a review of project reports by an external auditor, and with the mitigation measures, the financial risk was rated as moderate. The ICR notes that financial management during implementation was satisfactory (World Bank 2018, 23). The PMU's financial management team included an experienced financial officer supported by several graduate staff with the required skills. An independent external auditor was appointed to audit the project's annual financial statements, and the audit reports complied with the World Bank's requirements. The task team leader clarified that the final audit was unqualified.

Procurement

An assessment was made at appraisal to judge the procurement management capacity of the Executive Authority for Land Improvement (World Bank 2018, 10). The procurement risk at appraisal was rated as high, in view of the weak capacity within the PMU (World Bank 2010, 10). Mitigation measures to address procurement risks included requiring all contracts to be subject to prior review. A procurement plan was prepared at appraisal, and procurement activities were to be supervised at least twice a year (World Bank 2018, 66). The ICR notes that training was provided to the PMU during implementation, and there were no procurement issues during the project execution period (World Bank 2018, 23).

Environmental and Social Safeguards

The project was classified as environmental category B. Three safeguard policies were triggered at appraisal: Environmental Assessment (OP/BP 4.01), Pest Management (OP 4.09), and Projects on International Waterways (OP/BP 7.50).

Environmental assessment and pest management safeguards. The Project Appraisal Document notes that no adverse environmental impacts were anticipated at appraisal (World Bank 2010, 14). Although the project did not envision either procuring insecticides or horizontally expanding irrigation lands, there was the possibility that intensifying crop production through vertical expansion could increase the residual pesticide or fertilizer load per feddan in some project areas. An environmental impact assessment was conducted, and an ESMP was prepared and publicly disclosed to address environmental and pest management issues at appraisal (World Bank 2010, 15). In April 2015, the ESMP was revised to include an action plan to mitigate the social impacts on project affected persons, and the ESMP included a method for safely disposing of asbestos roofs on the old pump stations. The ICR reports that the ESMP was implemented satisfactorily (World Bank 2018, 22), and 25 asbestos roofs from old pump houses were replaced with less harmful ones during implementation (World Bank 2018, 21–22).

Projects on international waterways. The Project Appraisal Document notes that an assessment made at appraisal determined that the project was not expected to adversely change the quality and quantity of water flows to the other riparian countries (the Nile—the Arab Republic of Egypt's main source of renewable water—is shared with nine other riparian countries: Burundi, the Democratic Republic of Congo, Ethiopia, Eritrea, Kenya, Rwanda, Sudan, Tanzania, and Uganda; World Bank 2010, 14). The assessment concluded that notification of riparian states was not required (World Bank 2010, 14).

Involuntary resettlement (OP/BP 4.12). This safeguard was triggered during the project restructuring in June 2016 to cover the potential loss of land value for landholder farmers (because of the installation of electrical poles on their land; World Bank 2018, 10). A Resettlement Policy Framework and a Resettlement Action Plan were prepared, and fieldwork was undertaken to register the project affected persons. At closure, 1,033 beneficiary farmers were compensated ($13 per person; World Bank 2018, 22).

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Appendix C. Methods and Evidence

This report is a Project Performance Assessment Report. The Independent Evaluation Group (IEG) explains this instrument and its methodology in "The Project Performance Assessment Report" at https://ieg.worldbankgroup.org/methodology/PPAR.

Overview

IEG based its assessment on evidence obtained through (i) a review of the project documents of the two assessed projects, including an unpublished World Bank stocktaking of lessons of the Farm-Level Irrigation Modernization Project experience and the cofinancier's completion report of the Integrated Irrigation Improvement and Management Project (IIIMP); (ii) a review of the project documents of previous irrigation projects in the Arab Republic of Egypt; (iii) interviews with World Bank staff, implementation agency staff and management, government counterparts, representatives of the local authorities, project beneficiaries, and development partners active in irrigation and water management in Egypt; (iv) a review of online literature on irrigation and water management in Egypt to triangulate findings; and (v) observations during field visits.

Field Visits: Purpose and Site Selection

Field visits were conducted to assess the quality and condition of infrastructure and convene meetings with district irrigation and agriculture officials, members of branch and mesqa Water User Associations, marwa committees, and other project beneficiaries, including women farmers. The assessment team also interviewed farmers who did not directly benefit from either project and who were encountered during the field visit, to triangulate attribution of project benefits.

Site visits were conducted in three governorates in the Nile Delta: El-Beheira, Kafr El-Sheikh, and Gharbia. The Mahmoudia irrigation canal runs through El-Beheira Governorate, and the Meet Yazid irrigation canal runs through Kafr El-Sheikh and Gharbia. El-Beheria and Kafr El-Sheikh were selected for field visits because both IIIMP and the Farm-Level Irrigation Modernization Project were implemented there. Before the projects' interventions, both governorates had problems with availability of adequate irrigation water, particularly in summer months, and tail-end farmers suffered frequent water shortages. Gharbia Governorate was selected because important infrastructure carried out under IIIMP was located there, and it houses an important irrigation headquarters for the delta region, where the IEG team met with irrigation officials to discuss institutional dimensions of IIIMP.

Field visits included a mix of head, middle, and tail positions of the irrigation command area. Field visits in El-Beheira covered areas in Mahmoudia district (considered head) and Abo-Homos district (considered middle). Kafr El-Sheikh Governorate as a whole is a tail-end region on the Meet Yazid irrigation canal. In Kafr El-Sheikh, field visits covered areas in El Reyad (considered head), Sidi Ghazi (middle), and El-Hamol (tail) districts.

The IEG team visited infrastructure rehabilitation sites on both irrigation canals, including the repaired ship lock at the beginning of Mahmoudia canal and several strengthened sections along both canals. In Kafr El-Sheikh, the mission observed embankment repairs on Meet Yazid canal and the covering of branch canals passing through residential areas. In Gharbia, the mission visited the Samatai siphon.

Interview Topics

Discussions with irrigation officials at the Ministry of Water Resources and Irrigation headquarters in Cairo focused on an overview of the irrigation network in Egypt and evolving irrigation and water management challenges.

Meetings with Project Management Unit staff focused on project-specific details, including key project achievements and their sustainability, challenges during implementation, and cooperation between the Ministry of Water Resources and Irrigation and Ministry of Agriculture and Land Reclamation.

Discussions with district irrigation officials focused on the situation before the project and improvements after the project was completed. They also explored reasons behind project achievements and shortfalls.

Discussions with project beneficiaries inquired about the situation before the irrigation improvement works compared with the current situation, beneficiaries' perceptions about irrigation modernization programs at the field level, availability of irrigation water in summer months (particularly for tail-end users), overall project benefits, cost and time savings, and ongoing challenges under the new system.