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REPORT

REVISED REPORT

Evaluation of the Fruit Tree Productivity Project in Morocco: Design Report

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CONTENTS

TABLES

FIGURES

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EXECUTIVE SUMMARY

In recent years, the Government of Morocco has made a strong effort to modernize the agricultural sector by promoting high-value crops and food production, improving linkages to modern value chains, and supporting smallholder farmers (*Ministère de l'Agriculture et de la Pêche Maritime* [MAPM] 2008). To support these efforts, the Millennium Challenge Corporation (MCC) funded a $340.5 million project in the agricultural sector known as the Fruit Tree Productivity Project (FTPP). This project was part of a broader $697.5 million five-year MCC compact signed with the Government of Morocco in 2007, which also included four other projects focusing on different sectors of the economy. The FTPP's primary objective was to stimulate growth in the agricultural sector by reducing the volatility of agricultural production, accelerating the transition from annual cereal crops to perennial tree fruit crops, and strengthening the integration of tree fruit crops into domestic and foreign markets (*Agence de Partenariat pour le Progrès* [APP] 2013).

The FTPP included five activities that sought to expand the production of selected tree fruit crops—namely olives, dates, figs, and almonds—and to address constraints along these value chains. These included the following: (1) an activity in rain-fed olive, almond, and fig areas, which provided training and technical assistance for farmers and other value chain actors and expanded the area of olive production; (2) an activity in irrigated olive areas, which provided training and technical assistance to value chain actors, upgraded irrigation infrastructure, and supported water user associations; (3) an activity in irrigated date areas, which was broadly similar to that in irrigated olive areas but provided additional assistance to improve the cultivation and processing of dates; (4) a cross-cutting activity that supported a variety of services in the fruit tree sector, including research, training for agriculture ministry staff, and marketing support; and (5) an activity, known as the Catalyst Fund, that partly funded the construction of and provision of equipment to modern olive oil processing units run by second-order producer organizations (cooperatives of cooperatives, known as *Groupements d'Intérêt Economique*, or GIEs).

MCC has contracted with Mathematica Policy Research to conduct an evaluation of several components of the FTPP. Initially, Mathematica had planned to continue the two evaluations that were conducted at the end of the compact, which focused on evaluating farmer training in rain-fed olive areas (a component of activity 1) and the investments in irrigated olive and date areas (activities 2 and 3). However, based on our review of project documents and discussions with MCC and local stakeholders, we determined that the existing evaluation of farmer training in rain-fed olive areas faces several challenges that would limit its ability to identify the expected impacts. We also determined that some adjustments to the originally proposed design for the evaluation of the investments in irrigated olive and date areas would optimize the learning opportunities from the evaluation. In this report, we describe the designs for the two evaluations that we intend to pursue: (1) an evaluation of the modern olive oil processing units created by the Catalyst Fund (activity 5); and (2) an evaluation of the investments in irrigated olive and date areas (activities 2 and 3).

The proposed evaluation of the modern olive oil processing units created by the Catalyst Fund includes a mixed-methods performance evaluation and an option for a rigorous impact evaluation using a matched comparison group design. The performance evaluation will draw on

both qualitative and quantitative data, and will enable us to explore the successes and challenges of the establishment of these units, their operational status, factors affecting their success, and their long-term sustainability. During the performance evaluation, we will assess the feasibility of conducting an impact evaluation to estimate the impacts of the new units on farmer-level outcomes such as olive revenues, total agricultural revenues, and household income. The impact evaluation would leverage data from the original evaluation of farmer training in rain-fed olive areas to match farmers in areas that have access to a new processing unit to comparison farmers in areas that do not. However, we will only be able to detect measurable impacts if a sufficient share of farmers utilize the units, and if the GIEs have started to distribute profits from olive oil sales to these farmers (the key channel through which farmers are expected to benefit). Information gathered during our mission to Morocco in May 2016 suggested that these conditions had not yet been met, although they might be in the future. Therefore, we plan to assess the feasibility of adding the impact evaluation in 2017 or 2018 to complement the planned performance evaluation.

The proposed evaluation of investments in irrigated olive and date areas will involve a mixed-methods performance evaluation that includes a number of components. In irrigated olive areas, it will include a quantitative pre-post study that will leverage data collected from farmers before the rehabilitation of irrigation infrastructure and a qualitative study that will draw on farmer focus groups and interviews with other key stakeholders. In irrigated date areas, the performance evaluation will also consist of a qualitative study drawing on farmer focus groups and interviews with key stakeholders, as well as a multisite case study of the modern date processing units supported by the project.[1] The performance evaluation in the irrigated olive and date areas will enable us to explore the implementation of the activities, their perceived benefits, the contribution of different interventions, and the sustainability of the irrigation improvements and other interventions.

The proposed evaluations will draw on data from several sources. The performance evaluation of the Catalyst Fund activity will draw on qualitative data collected from a variety of stakeholders, mainly in 2017 and 2018; a quantitative survey of all 20 GIEs that operate the new processing units, to be conducted in 2016, 2017, and 2018; and testing of olive oil samples from these GIEs, to be conducted in 2017. If we determine that the impact evaluation of the Catalyst Fund processing units is feasible, it will draw on data collected from farmers during the compact, from 2011 to 2013 (before the new processing units were operational), as well as new data that we will collect from the same farmers for two successive years (beginning in 2017 or 2018, depending on when the decision to move forward is made).

The performance evaluation in the irrigated olive and date areas will draw on qualitative data collected from a variety of stakeholders in 2017. In the olive areas, the evaluation will also draw on existing quantitative data collected from farmers in 2010 (before the irrigation infrastructure improvements) and new data collected from the same farmers in 2017 and 2018 (several seasons after completion of the irrigation infrastructure improvements), which we will

[1] Information gathered during our May 2016 mission to Morocco suggested that a quantitative pre-post design is not feasible in date areas because a large fraction of the available sample of farmers (the sample for whom pre-rehabilitation data are available) was likely located in areas that did not benefit from rehabilitated irrigation infrastructure.

use to calculate pre-post estimates. In date areas, the multisite case study of the modern date processing units supported by the project will draw on qualitative and administrative data gathered from site visits to selected units, conducted in 2017. Table ES.1 summarizes the timeline for the two proposed evaluations.

Table ES.1. Evaluation and reporting timeline

Year	2016				2017				2018				2019	
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Evaluation of the Catalyst Fund processing units														
GIE survey														
GIE olive oil testing														
Qualitative data collection[a]														
Farmer survey[b]														
Reporting								P						F
Evaluation of investments in irrigated olive and date areas														
Farmer survey (olive areas only)														
Qualitative data collection														
Site visits to date processing units														
Reporting						P					F			

Note: P=Preliminary data tables based on the 2017 farmer survey; F= Final evaluation report.

[a]We plan to conduct a handful of qualitative interviews in Q3 2016, so that we can interview staff from UNOPS (which has been providing ongoing support to the GIEs in the post-compact period) before the end of their contract in November 2016.

[b]Only if an impact evaluation is feasible. If an impact evaluation only becomes feasible starting in 2018, we would collect data in Q3 2018 and Q3 2019. However, this would require an extension of our evaluation contract and a delay in the production of the final report to mid-2020.

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I. INTRODUCTION

In recent years, the Government of Morocco has implemented a variety of reforms in the agricultural sector to improve productivity, reduce the reliance on low-value cereal crops, and adapt to climate change. Although Moroccan agricultural land is suitable for growing a versatile mix of crops, many farmers concentrate on cereal crops, which provide a reliable supply of food for human and animal consumption and do not consume much water. However, cereal crops typically do not generate large profits. Government support for cereal production (for example, through subsidies for seeds and import duties) and consumer preferences have also encouraged farmers to leave fields fallow for shorter periods of time, farm on marginal low-rainfall land, and grow wheat instead of more drought-resistant barley (Lybbert et al. 2009). Overall, the focus of agricultural production on largely rain-fed cereal crops has left farmers vulnerable to external shocks, especially droughts, which have become more common as average annual precipitation in Morocco has dropped by 30 percent since 1970 (Bucknall and Lamrani 2011).

In contrast, Morocco's tree crops—including olives, dates, almonds, and figs—exploit the country's comparative advantage in agriculture, may be more suitable for the terrain, and are high value-added exports that have the potential to generate large profits for farmers. The Government of Morocco's *Plan Maroc Vert* (Green Morocco Plan), which was released in 2008, emphasizes modernizing the entire agricultural sector by promoting high-value crops and food production, improving linkages to modern value chains, and supporting smallholder farmers (*Ministère de l'Agriculture et de la Pêche Maritime* [MAPM] 2008). By working with farmers to transition from low-value cereal crops to high-value tree crops, as well as supporting improvements to the production of these existing high-value crops, the Government of Morocco seeks to facilitate improved productivity and product quality in agriculture, and increase and stabilize farmer incomes.

In line with the *Plan Maroc Vert,* the Millennium Challenge Corporation (MCC) funded a $340.5 million project in the agricultural sector known as the Fruit Tree Productivity Project (FTPP), implemented by the *Agence de Partenariat pour le Progrès* (APP), a public Moroccan entity. This project was part of a broader $697.5 million five-year MCC compact signed with the Government of Morocco in 2007, which also included four other projects focusing on different sectors of the economy.

The FTPP included five activities that sought to expand the production of selected tree fruit crops, namely olives, dates, figs, and almonds, and to address constraints along these value chains. These activities were as follows: (1) an activity in rain-fed olive, almond, and fig areas, which provided training and technical assistance for farmers and other value chain actors and expanded the area of olive production; (2) an activity in irrigated olive areas, which provided training and technical assistance to value chain actors, upgraded irrigation infrastructure, and supported water user associations; (3) an activity in irrigated date areas, which was broadly similar to that in irrigated olive areas but also provided additional assistance to improve the cultivation and processing of dates; (4) a cross-cutting activity that supported a variety of services in the fruit-tree sector, including research, training for agriculture ministry staff, and marketing support; and (5) an activity, known as the Catalyst Fund, that partly funded the construction of and the provision of equipment to modern olive oil processing units run by

second-order producer organizations (cooperatives of cooperatives, known as *Groupements d'Intérêt Economique,* or GIEs).

MCC has contracted with Mathematica Policy Research to conduct an evaluation of several components of the FTPP. Initially, Mathematica had planned to continue the two evaluations that were conducted at the end of the compact, which focused on evaluating farmer training in rain-fed olive areas (a component of activity 1) and the investments in irrigated olive and date areas (activities 2 and 3). However, based on our review of project documents and discussions with MCC and local stakeholders, we determined that the existing evaluation of farmer training in rain-fed olive areas faces several challenges that would limit its ability to identify the expected impacts (see Appendix A for details). We also determined that some adjustments to the originally proposed design for the evaluation of the investments in irrigated olive and date areas would optimize the learning opportunities from the evaluation. In this report, we describe the designs for the two evaluations that we intend to pursue: (1) an evaluation of the modern olive oil processing units created by the Catalyst Fund (activity 5); and (2) an evaluation of the investments in irrigated olive and date areas (activities 2 and 3).

Each of the two proposed evaluations will use a mixed-methods approach that draws on quantitative and qualitative data. The evaluation of the Catalyst Fund processing units (described in detail in Chapter IV) includes a performance evaluation and an option for a complementary rigorous impact evaluation, if certain conditions are met. The performance evaluation will draw on qualitative data to be collected from a variety of stakeholders in both rain-fed and irrigated olive areas, mainly in 2017 and 2018; a quantitative survey of the 20 GIEs that operate the new processing units, to be conducted in 2016, 2017, and 2018; and testing of olive oil samples from these GIEs, to be conducted in 2017. The impact evaluation, if feasible, will draw on data collected from farmers in rain-fed olive areas during the compact, from 2011 to 2013 (before the new processing units were operational), as well as new data that we will collect from the same farmers in 2017 and 2018, or in 2018 and 2019 (several years after the units became operational, with the timing depending on when the impact evaluation becomes feasible). The decision to move forward with an impact evaluation will depend on data gathered during the GIE survey and other information obtained from local stakeholders.

The evaluation of the investments in the irrigated olive and date areas will involve a performance evaluation with a number of components (described in detail in Chapter V). In irrigated olive areas, it will include a quantitative pre-post study and a qualitative study. The pre-post study will draw on data collected from farmers in 2010 (before the irrigation infrastructure improvements were completed) and in 2017 and 2018 (several seasons after the improvements were completed); the qualitative study will rely on data to be collected in 2017 through farmer focus groups and interviews with other key stakeholders. In date areas, the performance evaluation will consist of a similar qualitative study, as well as a multisite case study of the modern date processing units supported by the project, both conducted in 2017.

Table I.1 summarizes the timeline for the two proposed evaluations. As described above, the data collection activities for the evaluation of the Catalyst Fund processing units will occur between 2016 and 2018, and those for the evaluation of investments in irrigated olive and date areas will occur in 2017 and 2018 (Chapters IV and V provide motivation for our plans for data collection for the two evaluations). Based on this timeline, we expect to be able to produce the

final evaluation report for the evaluation of the Catalyst Fund processing units by mid-2019, and for the evaluation of investments in irrigated areas in fall 2018. (We plan to produce preliminary analytical tables based on the 2017 round of the farmer survey for both evaluations, if conducted, to help inform subsequent data collection efforts).

Table I.1. Evaluation and reporting timeline

Year	2016				2017				2018				2019	
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Evaluation of the Catalyst Fund processing units														
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Note: P=Preliminary data tables based on the 2017 farmer survey; F= Final evaluation report.

[a]We plan to conduct a handful of qualitative interviews in Q3 2016, so that we can interview staff from UNOPS (which has been providing ongoing support to the GIEs in the post-compact period) before the end of their contract in November 2016.

[b]Only if an impact evaluation is feasible. If an impact evaluation only becomes feasible starting in 2018, we would collect data in Q3 2018 and Q3 2019. However, this would require an extension of our evaluation contract and a delay in the production of the final report to mid-2020.

In the chapters that follow, we provide context for the proposed evaluations and describe the proposed evaluation designs in further detail. In Chapter II, we describe the activities of the FTPP and the program logic, and in Chapter III we summarize what is known from the literature about the effects of similar interventions. In Chapters IV and V, we outline the research questions that our two proposed evaluations, respectively, seek to answer, and describe the evaluation designs and data sources that will enable us to answer those questions. We conclude in Chapter VI with a discussion of administrative details related to the evaluation.

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II. OVERVIEW OF THE FRUIT TREE PRODUCTIVITY PROJECT

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

A. FTPP activities

As mentioned in Chapter I, the FTPP was part of a broader five-year compact signed in 2007 by MCC and the Government of Morocco. The goal of the compact was to increase economic growth and reduce poverty in Morocco through investments in the FTPP and four other projects covering high-potential sectors: the Artisanal Fisheries Project, the Craft Industry and Fez Medina Project, the Financial Services Project, and the Enterprise Support project. A fifth component, the Functional Literacy and Vocational Training activity, was added later. The Morocco compact entered into force in September 2008 and closed in September 2013.

The FTPP's primary objective was to stimulate growth in the agricultural sector by reducing the volatility of agricultural production, accelerating the transition from annual cereal crops to perennial tree fruit crops, and strengthening the integration of tree fruit crops into domestic and foreign markets (APP 2013). To achieve this objective, the project implemented five activities:

1. The **Rain-Fed Olive, Almond, and Fig Tree Rehabilitation and Expansion activity** aimed to increase and stabilize farm incomes in rain-fed areas by facilitating the shift to tree crops and supporting improvements in production, processing, and sales of these crops (primarily olives). It included training and technical assistance for farmers,[2] support for the creation and management of farmers' cooperatives and GIEs, and training and technical assistance to improve the regulatory compliance and business operations of existing olive oil processing units. It also funded a substantial expansion of olive production by converting more than 60,000 hectares of land from cereal to olive production through the planting of new trees (the Government of Morocco funded a further expansion of 19,000 hectares of new trees).
2. The **Olive Tree Irrigation and Intensification activity** aimed at increasing the efficiency of water-use and other crop practices to enhance the yield and profitability of olive production in targeted irrigated areas. It included training and technical assistance for farmers, cooperatives, and existing olive oil processing units that were similar to the training and technical assistance provided as part of the rain-fed activity described earlier (again, farmer training was developed in conjunction with MAPM to meet needs identified by feasibility studies); infrastructure improvements for the irrigation systems delivering water to 65 small- and medium-sized irrigated areas (known as *petites et moyennes hydrauliques*, or PMHs) where olive trees are predominant; and technical assistance to water user

[2] The training and technical assistance for farmers that was conducted in rain-fed olive areas (activity 1) and irrigated olive and date areas (activities 2 and 3) was developed in conjunction with MAPM to address needs that were identified based on feasibility studies in the supported areas.

associations in operation, management, and maintenance of irrigation water distribution systems.

3. The **Date Tree Irrigation and Intensification activity** was similar to the Olive Tree Irrigation and Intensification activity, but with a focus on irrigated date production areas. It provided training and technical assistance to farmers and cooperatives, upgraded existing small- and medium-sized irrigation schemes in 12 irrigated areas (known as oases) where the date palm is the principal tree crop, and supported water user associations. It also included additional interventions that were unique to irrigated date areas. These were the rehabilitation of date trees (which involved cleaning the undergrowth and offshoots, and transplanting selected offshoots); the provision of new date tree seedlings to expand the number of trees under cultivation; and the equipment for seven new, modern date packaging and cold storage units (MAPM funded the construction of the buildings housing these units).
4. The **Fruit Tree Sector Services activity** was designed to cut across the previous three activities by supporting a variety of critical value chain services that were important to the success of the FTPP. Examples of this support included an assessment of training needs (which contributed to the development of farmer-training activities); the establishment of a multidisciplinary agricultural research program; management and project management training for MAPM staff; marketing support for cooperatives, including the establishment of a market information system and a quality certification system; and pilot projects to benefit women's organizations in the tree fruit sector.
5. The **Catalyst Fund activity,** which targeted 20 GIEs, partly funded the construction of and provision of equipment to 20 new, modern, large-scale olive-crushing units for the production of olive oil. Specifically, the Fund provided grants for up to 50 percent of the long-term capital needs for this infrastructure to each GIE, with the rest of the funding contributed by the MAPM (30 percent) and the GIEs themselves (20 percent, with the *Crédit Agricole*, Morocco's agricultural bank, providing 15 percent). The Catalyst Fund activity also provided technical assistance to the GIEs.

In sum, the FTPP activities were spread across three geographic areas depending on the availability of irrigation water and the primary crop cultivated. Specifically, the first activity primarily targeted olive farmers in selected rain-fed areas (although the activity included a smaller number of almond and fig farmers in rain-fed areas). The second and third activities targeted olive and date farmers in selected irrigated PMH or oasis areas, respectively. All of the FTPP's areas potentially benefitted from the fourth activity, the Fruit Tree Sector Services activity. Finally, farmers in selected rain-fed and irrigated olive areas potentially benefitted from the fifth activity, the Catalyst Fund activity.

B. Program logic

The FTPP program logic (Figure II.1 and Table II.1) is a combination of two separate logic models developed by MCC. It presents a series of (hypothesized) causal links among program inputs and outputs and short-, medium-, and long-term outcomes that potentially support the project's overarching goal of poverty reduction through economic growth. Each of the links in the program logic reflects MCC's assumptions about how the activities would affect the compact's beneficiaries, which include producers, their families, and producer organizations.

Assumptions in the program logic also provide the basis for MCC's ERR calculations for each activity.

To assess the FTPP program logic, we began by reviewing project documents, including the compact completion report, annual activity reports, and quarterly reports from implementers and other stakeholders. We also reviewed the available evidence on the impacts of similar programs in other contexts. We then examined the program logic for each component, noting potential concerns when applicable in a logic assessment report (Elabed et al. 2014). Overall, we determined that the FTPP program logic is based on a reasonable set of assumptions about the potential links between the activities and possible outcomes. It therefore seems reasonable that the project activities could potentially produce positive impacts on the desired outcomes specified in the program logic. However, a wide range of risks or project design and implementation factors could undermine each assumption and potentially prevent the project from achieving its intended results. Factors such as market conditions and the extent to which farmers and their organizations adopt new practices will determine the success of the project.

Figure II.1. The FTPP program logic

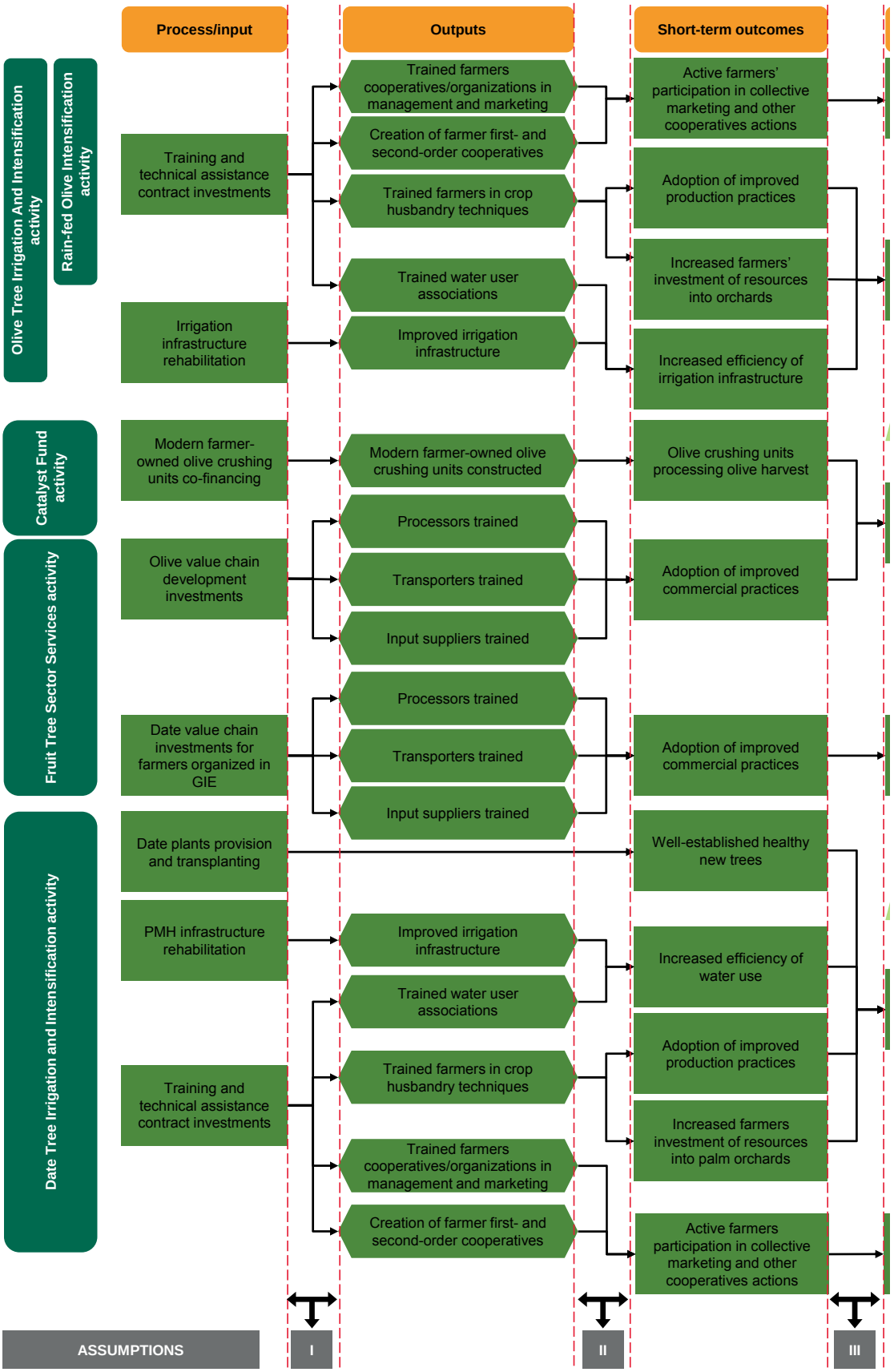

Figure II.1. The FTPP program logic (continued)

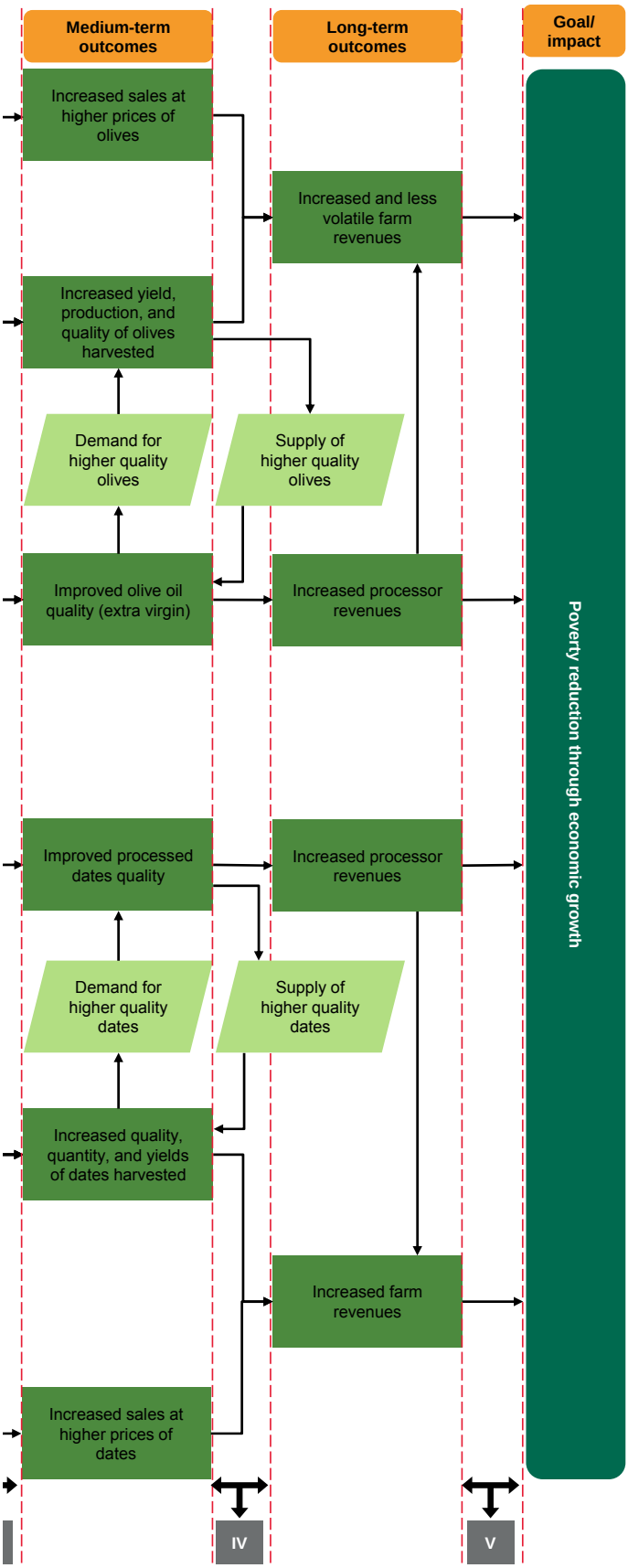

Table II.1. FTPP program logic assumptions

	Assumptions
I.1.	The budget allocated for this activity is sufficient.
I.2.	Procurement of necessary goods and services is timely and successful.
I.3.	Qualified consultants and works contractors are hired.
II.1.	Farmers and their organizations have the incentive to participate (the value of the training is clearly communicated both directly and through demonstration).
II.2.	Farmers and their organizations follow through on their commitments and responsibilities.
II.3.	Farmers are able to access necessary financing to adopt improved practices.
II.4.	Rehabilitation of the irrigation infrastructure will lead to increased efficiency of the infrastructure.
III.1.	No major changes to the market for olives or dates will deincentivize investments by farmers and/or processors.
III.2.	Demonstration effects will increase incentives for adoption of best practices.
III.3.	An increased efficiency of water use will lead to higher yield and revenue.
IV.	Both upstream (production) and downstream (commercialization) improvements will happen simultaneously.
V.	Olive and date producers and processors are able to respond to market conditions profitably.

Note: Roman numerals correspond to the boxes at the bottom of the program logic in Figure II.1

C. Economic rate of return

MCC uses ERR models to assess whether its projects are sound investments. The ERR is a summary statistic that reflects the economic merits of an investment. Conceptually, it is the discount rate at which the benefits of an intervention are exactly equal to its costs; a higher ERR implies relatively higher benefits and lower costs. MCC modeled the ERR for several of the FTPP activities and produced updated ERRs at the end of the compact, based on actual costs and expected benefits. These compact closeout ERRs were 24 percent for the Rain-Fed Olive Tree Intensification subactivity, 10 percent for the Olive Tree Irrigation and Intensification activity, and 37 percent for the Date Tree Irrigation and Intensification activity. In the logic assessment report (Elabed et al. 2014), we examined the ERR assumptions for each activity, noting potential concerns when applicable.

Ideally, we would use impact estimates from our proposed evaluations to determine ex-post ERRs based on actual benefits. However, we might have limited ability to produce updated ex-post ERRs that are comparable to MCC's end-of-compact estimates. In particular, given the evaluations we have proposed, we will not have updated quantitative estimates of benefit streams for all activities. For these activities, to the extent possible, we plan to use the data collected for the evaluation to reassess whether some of the key assumptions in the ex-ante ERR models (including those summarized in the logic assessment report) were plausible. Our specific plans to assess the ERRs for each activity are as follows:

- **Catalyst Fund activity.** The potential impact evaluation in rain-fed olive areas, if feasible, focuses exclusively on the Catalyst Fund processing units. These processing units were just one component of the FTPP in these areas, and their benefits were folded (in a nonseparable way) into the overall benefit stream in MCC's end-of-compact ERR model for the Rain-Fed Olive Tree Intensification subactivity. If an impact evaluation proves to be feasible, we might be able to obtain a separate ERR for the Catalyst Fund processing units in rain-fed olive areas by comparing the estimated benefits (in terms of the estimated impacts on net household income) with the estimated costs.[3] This ERR would not be generalizable to all areas that benefitted from the Catalyst Fund processing units because, as we discuss in Chapter IV, the impact evaluation will include only a (nonrepresentative) subset of rain-fed olive areas that benefitted, and none of the irrigated olive areas that benefitted. Nevertheless, it could provide useful suggestive evidence of the merits of investments in this type of post-harvest processing infrastructure. In producing these ERRs, it will be important to conduct sensitivity checks of the results. For example, to get a sense of the possible range of the ERR, we could reestimate the ERR using the upper and lower confidence interval bounds for the change in household income. We could also explore the effect of different assumptions regarding the trend in income over time.

  If an impact evaluation is not feasible, there will be no data to produce these ex-post ERRs. In that case we will be limited to reassessing the assumptions underlying the Catalyst Fund component of the ex-ante ERR models in olive areas. For example, key parameters in these models include the percentage of farmers using the Catalyst Fund processing units and the price premium that farmers receive from using these units, which we could estimate from our planned GIE surveys.

- **Olive Tree Irrigation and Intensification activity.** The pre-post study in the irrigated olive areas will provide estimates of changes in net farm profits associated with this activity. We could use these estimates to compute a benefit stream in these areas and compare these to the estimated costs to obtain an ex-post ERR. This ERR analysis would have several limitations: (1) estimates from a pre-post design cannot be interpreted as impacts that are fully attributable to the project interventions; (2) the pre-post estimates may not be generalizable to all olive areas that benefitted from this activity (as we discuss in Chapter V); (3) estimates of changes in net farm profits might be imprecise because profits are highly variable; and (4) we will not be able to measure changes in net household income (because income was not measured before implementation), which would be more appropriate to compute the benefit stream (for example, in case changes in farm profits substitute other income streams). Nevertheless, this ex-post ERR will be informative about whether the ex-ante ERR estimates were broadly plausible. Similar to the ERRs for the Catalyst Fund activity, we will assess the sensitivity of our ERR estimates to the assumed parameters.

  We also plan to use our survey data to assess the *reasons* for differences between the ex-ante and ex-post ERR estimates, if any. For example, the ex-ante ERR model includes assumptions about the rate of adoption of new practices and the usage rates of Catalyst Fund

[3] The estimated costs would include post-compact support provided to the GIEs by UNOPS to operationalize and manage the processing units, even though MCC did not bear these costs.

processing units; we plan to measure these in our farmer surveys in irrigated olive areas and compare to the original assumptions.

- **Rain-Fed Olive Tree Intensification activity.** Because we will not have quantitative estimates of the impacts of this activity, we will not be able to estimate an ex-post ERR directly. However, we will be able to use some of the data that we plan to collect to assess the extent to which the key assumptions in the original ERR model were plausible. In particular, if the Catalyst Fund impact evaluation is feasible, the planned farmer surveys in rain-fed olive areas will provide rich quantitative information about several key farmer-level parameters in the ERR model (albeit not representative of all farmers in the rain-fed olive areas). These parameters include the adoption of training practices, olive yields, and olive sales. In the absence of these farmer survey data, we would still have some information from farmer focus groups on changes that farmers experienced over time (for example, the extent of adoption of training practices and changes in olive yields), which we could qualitatively compare to the assumptions in the original model. As discussed above, we could use information from the GIE surveys to assess the ex-ante model assumptions related to the use of Catalyst Fund processing units in these areas, including the usage rate and the price premium received by farmers.
- **Date Tree Irrigation and Intensification activity.** Our ability to reassess the ex-ante ERRs will be limited for this activity because we do not plan to conduct farmer surveys. To the extent possible, we will use qualitative and administrative data to assess whether the original assumptions in the ex-ante ERR model were plausible. For example, we could gather information about maintenance costs from provincial and regional MAPM offices, information about date prices from date processing unit administrative data, and rough estimates about the magnitude of changes in yields from farmer focus groups.

III. LITERATURE REVIEW

As we described in Chapter II, the FTPP sought to stimulate growth in the Moroccan agricultural sector through a variety of interventions aimed at improving the production, processing, and sales of fruit tree crops. In this chapter we review the existing literature on the impacts of the four main types of interventions that are most relevant to the evaluations that we propose in this report. These interventions are (1) investments in post-harvest infrastructure, (2) support for farmers' organizations in commercialization and marketing, (3) irrigation infrastructure improvements, and (4) support for water user associations. The first and second types of interventions are primarily relevant to the evaluation of the Catalyst Fund processing units in olive areas, but are also relevant to the modern date processing units that will be part of the evaluation of project activities in irrigated date areas. The third and fourth types of interventions are relevant to the evaluation of project activities in irrigated olive and date areas. Here, we review the existing evidence for each of these types of interventions and then describe how the planned evaluations will contribute to the literature.

A. Investments in post-harvest infrastructure

Post-harvest infrastructure can range from cold storage and processing units to improved roads for transportation of crops (Asian Productivity Organization and Food and Agriculture Organization 2005). In the context of the FTPP, the largest investment in post-harvest infrastructure was the establishment of modern olive oil processing units through Catalyst Fund assistance. These units are used immediately after the olives are harvested; olives are packed in plastic crates and transported to the unit as rapidly as possible, to avoid deterioration of the olives before crushing. The olives are then crushed at the unit, and the olive oil obtained is stored in tanks under appropriate conditions to maintain its quality until it is sold in bulk or bottled. The other FTPP investment in post-harvest infrastructure involved establishing modern date processing units in irrigated date areas. These units were designed to fumigate the dates, sort them, store them in refrigerated areas, and package them for sale.

Much of the existing literature on post-harvest infrastructure focuses on its role in decreasing post-harvest losses, in terms of both volume and quality. These losses can be high—the volume losses have been estimated at an average of 23 percent of the harvest in the Middle East and North Africa, and are highest for fruits and vegetables (Rosegrant et al. 2015). Post-harvest losses can be the result of many factors, including parasitic diseases, which particularly effect fruits; mechanical injury caused by poor handling and poor storage conditions; and physiological deterioration caused in part by enzymes found within the crop, which are more active in humid or hot environmental conditions (Asian Productivity Organization and Food and Agriculture Organization 2005).

Several types of post-harvest infrastructure can help to reduce these losses. First, packing stations can provide pre-treatment (for example, fumigation, fungicidal dipping, surface coating with wax, and so on) that prevents decomposition and keeps produce fresh (Asian Productivity Organization and Food and Agriculture Organization 2005). Second, some types of processing technologies, such as curing of roots and tuber crops, can help increase shelf-life and reduce spoilage and thus help farmers increase their profits (World Bank 2011; Rosegrant et al. 2015). Third, proper storage conditions can help maintain the produce's color, reduce loss due to

respiratory heat, prevent premature ripening, help conserve nutritional and caloric value and prevent flavor deterioration, and are important for food safety (Asian Productivity Organization and Food and Agriculture Organization 2005); they can also protect crops from pests and insects (Tafera et al. 2011). A study in India showed that the waste of some crops, such as potatoes, reached a new low after increases in investments in cold storage (Minten et al. 2010); another study in the Philippines showed that cabbage farmers halved their post-harvest losses with the use of cold storage (Asian Productivity Organization and Food and Agriculture Organization 2005).

In addition to reducing post-harvest losses, appropriate storage can enable farmers to sell their produce after the harvest season, when prices can be higher because of limited supply. For example, grain silos constructed in Central America enabled farmers to increase their incomes by selling their crops later; they also improved farmers' positions in negotiations with middlemen, improved household health through better nutrition, and helped farmers diversify into more profitable cash crops (World Bank 2011). In the FTPP context, the new modern date processing units funded by the project were specifically designed to facilitate appropriate storage so that the quality of the dates could be maintained for potentially profitable out-of-season sales.

Another strand of the literature on post-harvest infrastructure focuses on infrastructure used for value-added processing (University of Kentucky 2011), an example of which is the olive oil processing units established through the FTPP. By adding value to crop production, this type of post-harvest processing can potentially increases farmers' returns and is considered one of the most viable ways of reducing poverty and improving rural livelihoods, particularly for farmers with small land holdings (Lundy et al. 2002). One way in which processing crops can increase farmers' returns is by making them more competitive on the export market, which can be more profitable than selling products domestically (Cramer 1999). For example, Tanzanian farmers who switched from hand-processing coffee at home to using modern processing plants were able to access higher-paying markets by improving the quality of their coffee beans and thus increasing overall profits (TechnoServe 2013). According to a World Bank study, farmers in Mozambique who started selling cashew nuts to a modern processing plant increased their annual incomes by 20 percent, on average (Webber and Labaste 2010). In Colombia, the construction of new drying units for processing cassava into dried chips for animal feed provided a new market opportunity for cassava farmers when crop prices were low, or when quality was not good enough for human consumption (Gottret and Raymond 1999); these new drying units were associated with a decrease in poverty among beneficiary farmers.

Overall, the existing literature suggests that post-harvest infrastructure improvements have the potential to be effective in improving farmers' well-being, although the effects are likely to vary substantially based on factors such as the type of infrastructure, the affected value chains, and market conditions.

B. Supporting farmers' organizations in commercialization and marketing

Small-scale farmers in developing countries often lack access to markets where they can buy their inputs and sell their outputs. In remote areas in particular, farmers may have poor physical access to markets and face high transaction and transportation costs, which undermine their ability to participate in trade. They may also lack information on market prices, as well as access

to collective organization that can empower them in their negotiations with larger market players. To increase the access of poor farmers in marginal areas to markets and enable them to respond profitably to market requirements, the FTPP supported the creation of first- and second-order farmers' organizations and provided technical assistance to these organizations, training them on best production, processing and storage techniques as well as marketing strategies. The Catalyst Fund processing units in olive areas and accompanying technical assistance were specifically intended to help the new second-order organizations access new markets that demand high quality olive oil. Similarly, the new date processing units established in irrigated date areas were intended to help second-order organizations access new markets and extend sales out of season.

Given the importance of access to markets, international agencies have taken a number of steps to strengthen linkages between farmers and agribusiness (Wiggins et al. 2009). For example, in 2008, the International Fund for Agricultural Development and the International Food Policy Research Institute created a partnership in several countries (including Morocco) to provide the rural poor with better access to new market opportunities and the capacity to take advantage of them. Promoting farmers' organizations as a tool for enhancing market access by reducing transaction costs and improving bargaining positions has also become increasingly popular (Markelova et al. 2009; Shiferaw et al. 2011), and was highlighted in the 2008 World Development Report (World Bank 2008).

However, the existing literature on the impacts of farmers' organizations on market access is limited to several case studies and there are relatively few empirical assessments of these organizations. Although some of the available empirical studies showed that improved market access associated with these organizations resulted in increased household welfare (Jacoby and Minten 2009; Dercon and Hoddinott 2005; Mogues 2011), it is not always clear whether revenues for farmers associated with these organizations are sufficiently high to compensate for the increased administrative costs of the cooperatives and adoption of market access-enhancing strategies (Torero 2011).

C. Improvements to irrigation infrastructure

Many irrigation systems in developing countries are nonexistent or in poor condition, inhibiting farming households from engaging in agricultural production or employment that would improve their well-being. Governments, development banks, and foreign aid agencies have therefore made significant investments to rehabilitate irrigation infrastructure in many developing countries: the Food and Agriculture Organization documented 248 different irrigation infrastructure projects totaling more than $8 billion in investment costs from 1980 to 2000 (Food and Agriculture Organization 2000). In addition to physical infrastructure improvements, many countries are also considering changes to water resource management to encourage efficiency of water use and to shift toward a more decentralized system in which local water user associations assume responsibilities for irrigation operations and maintenance (Hodgson 2007).

To our knowledge, there have been no rigorous evaluations of irrigation improvements in North Africa. However, other studies have provided evidence of the effects of irrigation improvements in other settings, and have generally found that that irrigation is associated with higher production and income. A literature review of projects in Asia showed that irrigation is

associated with higher cropping intensity, land productivity, employment of farm labor, and agricultural wages; households in irrigated areas also experience higher incomes, lower income inequality, and lower poverty than rain-fed settings (Hussain and Hanjra 2004). Van Den Berg and Ruben (2006) showed that Ethiopian households with irrigation had higher expenditures and lower dependence on public programs than those without irrigation. Also in Ethiopia, a country in which only 5 percent of irrigable land is irrigated, Tucker and Yirgu (2010) found that, on average, households experienced a 20 percent increase in annual income from irrigating. However, the authors noted that market interventions are also necessary because "… farmers face high costs and risks when entering markets, which severely limit the returns from irrigation." A more rigorous study in northern Mali used a variety of quasi-experimental approaches to show how the redistribution of water to canals (through motorized pumps) increased access to irrigation and had positive impacts on poverty, agricultural production, and nutrition (Dillon 2008).

Several studies have used a quasi-experimental approach to estimate the impacts of rehabilitating existing irrigation infrastructure, which is particularly relevant to the FTPP interventions in Morocco. For example, Del Carpio et al. (2011) examined the impact of rehabilitating irrigation infrastructure on expenditures, agricultural production, and income measures in coastal Peru. Using a 10-year panel of national household survey data, the study identified treatment and comparison groups based on distance to the rehabilitation site. The study found that the project benefitted the poor not by increasing production in small household plots, but rather by providing poor farmers with better employment opportunities on larger farms. Similarly, a 2008 study used a comparison group design to show that new construction and rehabilitation of existing infrastructure in Andhra Pradesh, India, resulted in increased wage employment, along with favorable impacts on yield and cropping intensity, and that net farm income increased by almost 60 percent (Independent Evaluation Group 2008). However, the study also showed that there was less crop diversification than expected, substantial water wastage in the upper reaches of the canals, and very significant cost overruns and construction delays. Consequently, despite the positive impacts on income, the cost-benefit analysis was substantially less favorable than originally expected.

D. Support for water user associations

Although the FTPP focuses on providing technical assistance to water user associations, the existing literature gives greater attention to the effects of establishing new water user associations and transferring irrigation management responsibilities to them. These studies of irrigation management transfer do not directly relate to the FTPP intervention, but the findings from these studies still highlight the strengths and weaknesses found for water user associations in other settings. A World Bank Institute paper (Xie 2007) provides an overview of how irrigation management transfer and participatory irrigation management initiatives have been adapted for many countries according to their political and economic environments. Xie (2007) found that a major challenge to water user associations is their financial sustainability—that is, structuring them so they are able to recover the costs of operating and maintaining the irrigation system and water user association.

Mukherji et al. (2009) assessed the success of water user associations in various countries and contexts, defining success by developing a composite success score based on outcome and impact indicators. The outcome indicators included the financial viability of the water user association; the functional condition of the infrastructure; the extent to which water distribution is equitable, reliable, and adequate; community and gender participation in the water user association; degree of empowerment of the water user association; and the water user association's technical capacity. Impact indicators of success included changes in livelihoods and household wages and crop productivity. Given these criteria, Mukherji et al. (2009) showed that only 43 of 108 projects successfully met program objectives.

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

Finally, in Armenia, the Institutional Strengthening Sub-Activity of the MCC compact provided technical support to strengthen the capacity and self-sufficiency of existing regional water user associations, which more closely aligns with the focus of the FTPP. Fortson et al. (2013) showed that implementers in Armenia met all of the programmatic objectives: for example, management improvement plans were prepared and provided for each water user association, and water user associations also received office equipment (such as computers and software) and heavy equipment. Water user associations improved their financial standing over a three-year period and increased their membership fees and cost recovery rates by 13 and 11 percentage points, respectively. However, given their large annual deficits, water user associations did not appear to be approaching financial solvency in the near term. In addition, the authors warned that the apparent lack of commitment by members to strengthening activities might pose a serious challenge to the future sustainability of the water user associations.

E. Contribution of the proposed evaluations

The proposed evaluations of the FTPP that we describe in this report will contribute to these strands of the literature. The proposed performance evaluation of the Catalyst Fund processing units will provide evidence on the establishment and operations of a potentially important type of post-harvest infrastructure in the Moroccan context. An impact evaluation, if feasible, will provide some of the first rigorous evidence on the impacts of a large investment in post-harvest infrastructure used for value-added processing. An important feature of this intervention was the combination of post-harvest infrastructure investments with management and marketing support for the second-order producer organizations managing the infrastructure. These two types of

interventions are likely to be complementary; therefore, combining them could be a model for future implementation if our evaluation suggests that the combination is effective. Our evaluation may be especially valuable from a policy perspective because the government of Morocco is planning to establish additional GIEs and olive oil processing units in the future, following a similar model. Also related to post-harvest infrastructure, our performance evaluation in irrigated date areas will include a multisite case study of the modern date processing units supported by the project. This will provide evidence on the establishment and operations of another potentially type of modern post-harvest infrastructure in the Moroccan context, which could help shape the design of similar interventions.

The proposed evaluation of the FTPP activities in irrigated olive and date areas will provide valuable information on the changes associated with the package of interventions in these areas, which included irrigation infrastructure upgrading, complementary technical assistance to water user associations, and other interventions. As part of the evaluation, we also intend to qualitatively explore the relative roles of the specific interventions in driving the changes we observe (see Chapter V for details). Given the limited literature on irrigation-related interventions—especially in North Africa—the contributions of this proposed evaluation to the literature are potentially meaningful.

IV. EVALUATION OF CATALYST FUND PROCESSING UNITS

The Catalyst Fund activity provided grants to 20 GIEs in both rain-fed and irrigated olive areas for the construction of modern olive oil processing units. As described earlier, the Catalyst Fund contributed half of the costs, with the other half funded by the government and the GIEs themselves. The Catalyst Fund was introduced in mid-2011; however, the new processing units were not yet operational when the compact ended in September 2013 (a few units operated on a limited scale starting later in 2013). The Catalyst Fund activity was part of a broader set of FTPP activities in olive areas, which included training for olive farmers, support for the creation and management of farmers' cooperatives and GIEs, training and technical assistance for existing olive oil processing units, and investments in irrigation infrastructure and technical assistance for water user associations in irrigated olive areas.

In this chapter, we describe the proposed design for the evaluation of the Catalyst Fund processing units. We begin by presenting a set of research questions for the evaluation. We then describe our proposed methodology for the evaluation, which includes a mixed-methods performance evaluation and an option for a rigorous impact evaluation (which will be feasible under certain conditions). Finally, we describe the data on which the evaluation will rely and our plans for reporting the findings.

A. Research questions for evaluation of the Catalyst Fund processing units

The research questions for our proposed evaluation of the Catalyst Fund processing units build on MCC's original research questions regarding the impact of the FTPP overall. However, we have adjusted these questions to make them more relevant to the proposed evaluation by removing or modifying some of the original questions and adding new questions that we believe will be of interest based on feedback from MCC and key stakeholders.

Program implementation

1. How did the establishment of GIEs and the establishment of modern processing units through Catalyst Fund assistance compare with the original implementation plans, and what were the reasons for any deviations from plans?
2. What were the main challenges to implementation, and how were these addressed?

Program outcomes

3. To what extent are the GIEs established by the Catalyst Fund operating as intended? To what extent are farmers in the GIEs' catchment areas participating in cooperatives that are members of the GIEs, and why?
4. How, and to what extent, does the level of success vary across GIEs? What factors facilitate or inhibit the successful operations of GIEs?
5. What are the impacts of the Catalyst Fund processing units on revenues from olives (total and per tree)?
6. What are the impacts of the Catalyst Fund processing units on total agricultural revenues?
7. What are the impacts of the Catalyst Fund processing units on net household income?

8. What are the differences in the impacts of the Catalyst Fund processing units according to sex, age, and revenues (at baseline)?
9. Which international quality benchmarks does the olive oil produced by the Catalyst Fund processing units meet?
10. Besides making modern processing units available, what role have the GIEs played in the development of olive oil processing and marketing? Have GIEs been able to identify new markets and obtain better prices for olive oil, and how have they done so?
11. Have the new GIEs managed to repay the credit used to help fund the establishment of the new processing units? To what extent have they been successful in accessing and repaying additional short- and long-term credit to operate effectively?

Sustainability and broader effects

12. What types of government or other external support have the GIEs needed and received to sustain them? What additional support will they need (if any), and will they be able to obtain it?
13. Are the Catalyst Fund processing units likely to be sustainable in the long run?
14. To what extent has the GIEs/processing unit model been replicated outside project areas and to what degree is that attributable to the Catalyst Fund?[4]

To answer these research questions, we propose a mixed-methods performance evaluation that will draw on both quantitative and qualitative data, and an optional impact evaluation. The performance evaluation will focus on the Catalyst Fund processing units in both rain-fed and irrigated olive areas. It will enable us to explore the successes and challenges of the establishment of these units (questions 1 and 2), their operational status (questions 3, 10, and 11), factors affecting their success (question 4), and their sustainability (questions 12, 13, and 14). It will also involve independently testing the quality of the olive oil produced by the Catalyst Fund processing units to determine the extent to which it meets international quality benchmarks (question 9).

The impact evaluation of the Catalyst Fund processing units, if feasible, will focus on rain-fed olive areas, and will provide quantitative estimates of impacts on the key outcomes of olive revenues, total agricultural revenues, and household income (questions 5, 6, and 7). It will also enable us to explore the variation in impacts for different types of farmers (question 8). The impact evaluation will focus exclusively on rain-fed areas because it leverages data collected for the earlier evaluation of farmer training, which was confined to these areas. If the impact evaluation is not feasible—and in irrigated areas, where we are not planning to conduct and impact evaluation—we will try to provide suggestive evidence about the changes in these outcomes through the performance evaluation.

[4] Based on discussions during our May 2016 mission, the government already plans to create 28 new GIEs modeled on the Catalyst Fund GIEs in the near future, and 18 of these have received a commitment for funding from the Islamic Development Bank.

B. Methodology

In this section, we describe our planned approach to the performance evaluation and the possible impact evaluation of the Catalyst Fund processing units. The impact evaluation is an optional complement to the performance evaluation that MCC could choose to exercise if the necessary conditions for it to be feasible (described below) are met.

1. Performance evaluation of the Catalyst Fund processing units

The performance evaluation of the Catalyst Fund processing units will cover units serving both rain-fed and irrigated olive areas. This evaluation will seek to provide evidence on the establishment and successes of these units, identify factors associated with success, and assess the sustainability of the activity and potential for replication. It will draw on qualitative data from multiple sources, quantitative data from surveys of GIEs, and results from olive oil testing.

We will collect the qualitative information through two rounds of data collection (described in further detail in Section C), which will include interviews and focus groups with key stakeholders. We plan to conduct interviews with the following stakeholders: GIE leadership; UNOPS, which has been providing ongoing support to the GIEs in the post-compact period; the *Unité de Soutien aux GIE et d'Appui à la Valorisation* (USGAV), the unit within MAPM tasked with supporting the GIEs; other donors involved with funding GIEs and associated processing units, such as the Islamic Development Bank; the leadership of the recently-established Federation of GIEs; and other market-related informants, such as exporters and large domestic buyers of olive oil. These stakeholders will provide different perspectives on the establishment and operations of the GIEs and processing units, their main successes and challenges, and expectations for their future evolution, sustainability, and replication.

In addition to these interviews, we will conduct focus group discussions with farmers who are members of GIE member cooperatives and with farmers who are not members of these cooperatives. These discussions will provide insights on farmers' experiences with olive production, processing, and sales, as well as their involvement with cooperatives (or reasons for not being involved) and perceptions of the new units. In addition, we will explore qualitatively how involvement with the new units has affected farmers' olive revenues, total agriculture revenues, and household income, as well as how these effects differ for different types of farmers. We will also conduct focus group discussions with leaders of member cooperatives at selected GIEs. These focus groups will provide additional perspectives on farmers' experiences and involvement with cooperatives, as well as the extent to which the GIEs are operating as intended.

To analyze these data, we will develop a detailed initial coding scheme—a set of themes we might encounter in the interview and focus group transcripts, which are mapped to the research questions and logic model (for example, initial themes might include "deviation from implementation", "implementation challenges", and "agriculture revenue"). Using NVivo software, we will review and code the transcripts based on our initial codes. We will expand and refine these codes during the coding exercise and subsequent analysis of the coded transcripts, in an iterative process, as additional themes emerge. The analysis of the coded transcripts will involve triangulating the findings across stakeholders to highlight mechanisms, context, and similarities and differences in perspectives.

We will complement the qualitative data with a quantitative survey of all 20 GIEs that received assistance from the Catalyst Fund. As we describe in Section C, we plan to conduct this survey in three consecutive years to enable us to describe the evolution of the GIEs. We will produce descriptive statistics and trend analyses based on these data, which will provide insights regarding the operations of the processing units and the marketing and sales of olive oil by the GIEs. We also intend to collect and test olive oil samples from all 20 GIEs to determine the extent to which the oil meets international quality benchmarks. By combining the findings from the GIE survey and olive oil testing with those from the qualitative analysis, we expect to obtain a thorough understanding of the operations and effects of the Catalyst Fund processing units to answer the research questions.

2. Impact evaluation of the Catalyst Fund processing units

An impact evaluation of the Catalyst Fund processing units would provide rigorous quantitative estimates of the impacts of these units on farmer-level outcomes in some of the rain-fed areas with access to them. These would include impacts on the key outcomes that feature in the research questions, namely olive revenues, total agricultural revenues, and household income.

If an impact evaluation of the Catalyst Fund processing units is pursued, we will use a matched comparison group design to obtain unbiased estimates of these impacts. This design will leverage data collected for the previous evaluation of farmer training in rain-fed olive areas, which were collected before the Catalyst Fund was introduced. More specifically, we will use these pre-intervention data to match farmers in perimeters that have access to a Catalyst Fund processing unit (treatment farmers) to similar farmers in perimeters that do not have access to one (matched comparison farmers).[5] We will then estimate the impacts of the Catalyst Fund processing units by comparing how outcomes of treatment and matched comparison farmers changed after the introduction of the units (a difference-in-differences approach). These estimates will be unbiased under the assumption that outcomes would have evolved in a similar way for the treatment and matched comparison farmers in the absence of the compact activities. This assumption is plausible if the matching approach results in matched comparison farmers that were similar to treatment farmers in characteristics, outcomes, and trends in outcomes before the Catalyst Fund was introduced.

For this impact evaluation to be feasible, two conditions must hold. First, a relatively large share of treatment farmers must sell olives to the GIE (via the cooperatives); if not, the activity will not result in measurable impacts for the average treatment farmer. Second, the GIEs must have started to distribute profits to the farmers, or the measurable benefits to treatment farmers might be small.[6]

[5] A perimeter is a group of land plots that covers a geographic area of 200 to 250 hectares.

[6] Farmers who benefit from the Catalyst Fund processing units receive payments twice: once when they sell their olives to the GIE (via the cooperative) for processing during the harvest season and again when the GIE completes all olive oil sales and distributes the profits to the cooperatives. The first payment is typically similar to the market price, so the main benefit to farmers is from the second payment.

Information gathered during our May 2016 mission to Morocco suggests that these conditions have not yet been met. Specifically, cooperative membership rates for the 2015-2016 season were relatively low (on average, about 20 percent of farmers in the perimeters with access to a Catalyst Fund processing unit were members), and most GIEs did not distribute any profits in 2015-2016 because they were still repaying the initial loans taken to help fund the new processing units. However, these conditions might be met in the future, as more farmers become convinced of the benefits of membership and join cooperatives and the GIEs obtain higher profits and repay their loans. We therefore plan to use the data collected in the GIE survey and information from local stakeholders to determine whether it is feasible to add an impact evaluation in 2017 or 2018, as we describe below.

a. Matching and analysis approach

The impact evaluation, if pursued, will use propensity score matching (Rosenbaum and Rubin 1983) to identify comparison farmers.[7] The matching will rely on data collected for the farmer training evaluation in rain-fed perimeters in 2011, before the Catalyst Fund units were established. These data are available for a representative sample of farmers in 138 perimeters that were part of the training evaluation, of which 44 perimeters gained access to a Catalyst Fund processing unit and 94 perimeters did not.[8] The farmers in the perimeters with access to the new units are the treatment farmers, and the farmers in perimeters without access are the pool of potential comparison farmers.

To conduct the matching, we will first use a logistical regression model to estimate a propensity score for each treatment and potential comparison farmer—the predicted probability of being in a perimeter with access to a Catalyst Fund unit given pre-intervention farmer characteristics and outcome measures. The model will include pre-intervention characteristics and outcome measures that could affect the outcomes of interest but might differ systematically between treatment and potential comparison farmers in the absence of matching (for example, farm size, number of olive trees, olive yields in 2011, and agricultural revenues in 2011).

We will then use the estimated propensity scores to identify matched comparison farmer(s) for each treatment farmer based on the similarity in their propensity scores. We will explore various matching approaches (for example, nearest neighbor or caliper matching), conducting the matching separately by region because of the potential importance of geographic location in driving agricultural outcomes. Alternatively, we could conduct the matching in two stages,

[7] In an earlier version of this report, we proposed a matched comparison group design that would leverage the random assignment design for the training evaluation to identify the treatment and comparison groups. This design would have focused on pairs of perimeters that were randomly assigned to training in which one perimeter had access to a Catalyst Fund processing unit and the other did not, and would have compared changes in outcomes for farmers in the two types of perimeters to estimate impacts. However, further analysis of pre-Catalyst Fund data identified some important differences between farmers in these two types of perimeters that suggested that they might not be comparable and that impact estimates might be biased. Therefore, we propose the propensity score matching approach (described in the text), which will result in a more comparable treatment and comparison group.

[8] As mentioned earlier, in addition to the 20 GIEs created through the FTPP, the government plans to create 28 new GIEs in the near future. If we implement the impact evaluation, we will determine whether any of the 94 perimeters that do not have access to an FTPP processing unit will be affected by these new GIEs within the timeframe of the evaluation. If so, the farmers in these perimeters might not be valid comparisons.

matching perimeters in the first stage and farmers within the matched perimeters in the second stage. We will use diagnostics such as the standardized differences between the mean characteristics and pre-intervention outcomes of farmers in the treatment and matched comparison groups to assess the quality of the matches (Stuart and Rubin 2008).

We will also assess the quality of the matches through trend analysis. Because the existing data (from 2011) were part of a longitudinal data collection effort, most of the farmers in our 2011 sample were also interviewed in 2012 and 2013, which was still before the new processing units were operational. Therefore, we will be able to estimate the differences in *trends* in key outcomes prior to the intervention in the treatment and matched comparison groups (between 2011 and 2013). These differences should be small if the proposed matches are of high quality. Based on the trend analysis and other diagnostics mentioned above, we will select the optimal matching approach.[9]

To estimate impacts once we have collected follow-up data, we will use the following difference-in-differences regression model that compares changes over time for the matched sample of treatment and comparison farmers:

$$(1) \quad y_{ijt} = \alpha + \lambda_t + \pi C_j + \rho C_j * post_t + \omega_i + \varphi X_{ijt} + \vartheta Z_{jt} + \mu_j + \varepsilon_{ijt}$$

where y_{ijt} is the outcome of interest (for example, revenues) for farmer i in perimeter j in year t; λ_t is a year-fixed effect that accounts for common year-specific shocks; C_j is a binary variable equal to one if the farmer is located in a perimeter with access to a Catalyst Fund processing unit and zero otherwise; $post_t$ is a binary variable equal to one if the unit was operational in year t; ω_i is an individual-fixed effect that accounts for all individual- and perimeter-level characteristics that are fixed over time; X_{ijt} and Z_{jt} are vectors of year-specific farmer- and perimeter-level shocks, respectively, that can affect the outcome of interest but are unrelated to the project (for example, extreme rainfall events); μ_j is a perimeter-specific random error term; and ε_{ijt} is a farmer-specific random error term. The regression will account for the matching by weighting the matched sample. For example, if we match each treatment farmer to one comparison farmer, with replacement (nearest neighbor matching), we would weight each comparison farmer by the number of the times the farmer is used as a match. This weighting approach effectively aggregates the difference-in-differences for each treatment farmer and their matched comparison across the full sample.

The parameter of interest in equation (1) is ρ, the difference-in-differences estimate, which is an estimate of the average impact of being located in a perimeter with access to a Catalyst Fund processing unit. This is an intent-to-treat estimate because not all farmers in these perimeters will take advantage of the new processing units—it can be interpreted as the impact of having the option to use a Catalyst Fund processing unit. Because the unit of intervention is

[9] We conducted an exploratory analysis using a simple propensity score model and a nearest neighbor matching approach (matching each treatment farmer to the comparison farmer with the closest propensity score). This approach resulted in treatment and matched comparison groups that were similar in most key outcomes in 2011 and that had similar trends in outcomes between 2011 and 2013, as required for the design to produce unbiased estimates. A more careful matching approach—which we intend to conduct if an impact evaluation is feasible—could further improve the quality of these matches.

the perimeter, we will account for the correlation in outcomes among farmers in the same perimeter when estimating the standard error of the impact estimate ρ (this correlation is shown by the perimeter-level error term, μ_j). In addition, we will account for estimation error in the propensity score when estimating the standard error, as described in Abadie and Imbens (2008). We can also estimate the average impact of *using* a Catalyst Fund processing unit—a treatment-on-treated estimate. This effectively involves rescaling the intent-to-treat estimates by the usage rate, defined as the proportion of farmers in perimeters with access to a Catalyst Fund processing unit that use the unit.[10]

We intend to implement this regression model for the matched sample of farmers surveyed in 2011, using data from all three baseline years before the units became operational (2011, 2012, and 2013) and two follow-up years after they became operational (2017 and 2018, or 2018 and 2019, depending on when the impact evaluation becomes feasible). In the follow-up analysis, we plan to estimate impacts separately for each follow-up year by including additional interaction terms in the regression model (interactions between C_j and binary variables for the two follow-up years). This will enable us to compare the estimated impacts in the two follow-up years. However, we will also present results in which we use the single interaction term in equation (1); this will yield more precise estimates of the average impact over both years (McKenzie 2012).

MCC is also interested in estimating impacts on subgroups of farmers defined by sex, age, or baseline revenues. Subgroup analyses will enable us to understand which subgroups, if any, are driving observed effects, and might also prove useful for targeting future MCC programs. To calculate subgroup impacts, we will restrict the estimation sample to the appropriate subgroup, using appropriate categories for continuous variables (for example, by classifying farmers into quartiles based on baseline revenues). However, the precision of our subgroup estimates could be limited by small sample sizes, especially for small subgroups (such as female farmers).

The interpretation of these impact estimates is complicated by the fact that having access to a Catalyst Fund processing unit is correlated with receipt of training activities at the perimeter level. Specifically, 35 of the 44 perimeters in our sample that had access to a Catalyst Fund processing unit received training activities, compared to only 37 of the 94 perimeters that did not have access. Therefore, the intent-to-treat estimate can be interpreted as the combined impact of having the option to use a Catalyst Fund processing unit *and* a higher likelihood of the option to attend training in the perimeter, and we will not be able to disentangle the two in our regression framework. However, given the low training participation rates, the small difference in these rates in perimeters in which training was and was not conducted, and the limited intensity of training (all of which we discuss in Appendix A), we do not expect training to drive impacts. If

[10] Some farmers who are not members of cooperatives affiliated with the GIE can also use the Catalyst Fund processing units as independent users. Most commonly, these farmers use the GIE as a service provider to crush their olives for a fee, as they would any other processing unit, and receive their oil after their olives are crushed. In contrast, the GIE retains the oil produced by crushing the olives of cooperative members and markets it on their behalf. Therefore, although both independent and cooperative users potentially benefit from the modern crushing technology, only the latter benefit from the marketing of olive oil by the GIE—without which the impacts of using the units are likely to be limited. Therefore, we do not intend to include independent users when computing the treatment-on-treated estimates—we will count use of the unit only through the cooperatives and assume that the impacts of independent use are negligible.

that assumption is valid, the intent-to-treat estimate can be interpreted more cleanly as the impact of having the option to use the Catalyst Fund processing unit alone. Similarly, to interpret the treatment-on-treated estimate as the impact of using a Catalyst Fund processing unit, we must assume that the impacts of training in the perimeters that had access to the units were negligible relative to the other perimeters.

We will attempt to assess the validity of this interpretation by examining impacts on outcomes directly linked to training—such as adoption of practices covered in training—as well as stakeholders' qualitative perceptions of the relative importance of training. In addition, we will determine whether our estimates are robust to controlling for training receipt at the individual level, which is available in the 2012 and 2013 data. If the estimates are unchanged after controlling for training, it will suggest that they are not driven by training receipt.

An important caveat to interpretation is that these impact estimates will apply only to the perimeters in rain-fed areas that had access to a Catalyst Fund processing unit and are included in the evaluation. These perimeters are served by 14 of the 20 GIEs, but are not representative of all the perimeters served by these GIEs, nor of all the perimeters served by the broader set of GIEs (which also include irrigated olive perimeters). Therefore, the impact estimates will not be strictly generalizable beyond the 44 rain-fed perimeters with access to a Catalyst Fund processing unit that are included in the impact evaluation.

To determine the ability of our proposed impact evaluation design to detect impacts, we estimated minimum detectable impacts (MDIs)—the smallest impacts on key outcomes that our design will be able to distinguish statistically from zero (Table IV.1). Our MDI calculations focused on three types of outcomes. The first type is composed of proximal outcomes that are likely to be most immediately affected by the Catalyst Fund processing units and to display large impacts. These are binary indicators for a farmer selling any olives or olive oil (which we would expect to become more common as farmers sell their olives to cooperatives that are part of the GIE) and selling any olives or olive oil to intermediaries (which we would expect to become less common as farmers switch to selling to the cooperatives). The second type of outcomes are intermediate outcomes related to agricultural revenues—revenues from the sale of olives and olive oil, as well as overall agricultural revenues—which are expected to be the main channels for ultimate impacts on household wellbeing. Finally, the third outcome type is a measure of household well-being itself, namely net household income. To the extent possible, we calculated the MDIs using parameter estimates obtained from the 2011 farmer survey data. The sample sizes for the MDI calculations are tentative and reflect the matched comparison sample obtained from an exploratory propensity score matching model.

Table IV.1. Minimum detectable impacts for the evaluation of the Catalyst Fund processing units (intent-to-treat estimates)

	Sold any olives or olive oil (percentage)	Sold any olives or olive oil to intermediaries (percentage)	Annual revenues from sales of olives and olive oil (dirhams)[a]	Total annual agricultural revenues (dirhams)	Annual net household income (dirhams)
Estimated baseline treatment mean	68	38	3,086	14,576	9,149
Standard deviation	46.6	48.6	3,974	16,855	16,919
Minimum detectable impact (MDI)	10.3	10.8	876	3,716	3,730
MDI as percentage of baseline mean	15	28	28	25	41

Sources: Authors' calculations using data from the 2011 farmer survey in rain-fed olive areas and the final evaluation report (NORC 2013).

Note: MDIs are for a two-tailed test with 80 percent power and a 95 percent level of significance. We assume an 85 percent follow-up response rate for the sample of 833 treatment farmers in 44 perimeters and 486 matched comparison farmers in 94 perimeters. The matched comparison sample size is estimated based on an exploratory nearest neighbor propensity score matching model. The calculations use means and standard deviations computed from the 2011 rain-fed data for the first three outcomes or from the final evaluation report (NORC 2013) for the remaining two outcomes. Intraclass correlations were estimated from the 2011 rain-fed data, and were as follows: 0.12 for the selling of any olives or olive oil, 0.13 for the selling of any olives or olive oil to intermediaries, and 0.16 for the remaining outcomes related to revenues and income. (We computed the intraclass correlation for olive and olive oil revenues only, and assumed it to be the same for the total revenues and net income outcomes.) The calculations adjust for the fact that the difference-in-differences estimates will be based on three baseline periods using the formula in McKenzie (2012); we estimated the relevant autocorrelations for each outcome at the perimeter and individual levels from the 2011, 2012, and 2013 data. The calculations assume that covariates explain 10 percent of the variation in the outcome. We increased the estimated variance of our impact estimates by 20 percent to account for the use of weights in the impact analysis because some comparison farmers will be matched to more than one treatment farmer.

[a] Variable was top-coded at the 95th percentile in the 2011 rain-fed data to account for outliers when estimating the mean, standard deviation, and intraclass correlation.

We began by computing MDIs for the impacts of having access to a modern processing unit funded by the Catalyst Fund—that is, intent-to-treat estimates. We estimate that we will be able to detect an impact of 10 percentage points on the probability of a farmer selling any olives or olive oil (15 percent of the baseline mean) and 11 percentage points on the probability of a farmer selling any olives or olive oil to intermediaries (28 percent of the baseline mean). For outcomes related to revenues, we will be able to detect impacts of 876 dirhams on revenues from the sale of olives or olive oil (28 percent of the baseline mean) and 3,716 dirhams on overall agricultural revenues (25 percent of the baseline mean). Finally, we estimate that will be able to detect an impact of 3,730 dirhams on net household income (41 percent of the baseline mean).[11]

[11] These MDIs apply to the separate impact estimates in each of the two follow-up years. The MDIs will be about 20 percent lower for estimates of the average impact across both years using equation (1), improving our ability to detect impacts.

The MDIs for treatment-on-treated estimates—the impact of actually using a Catalyst Fund processing unit—are inversely related to the share of farmers using the new units. For example, if half of the farmers in the treatment sample used the units (and no farmers in the matched comparison sample did so), the treatment-on-treated MDIs would be double the intent-to-treat estimates in Table IV.1. If only one-third of treatment farmers used the new units, the MDIs would be triple those in Table IV.1. Though the MDIs for treatment-on-treated estimates are larger, we would likewise expect the estimated impacts to be larger.

Some of the MDIs in Table IV.1 are large, both in absolute terms and as a percentage of the estimated baseline means. We are unlikely to observe impacts of this magnitude—especially for the less proximal outcomes related to revenues and income—unless the share of treatment farmers using the new processing units is high. Therefore, obtaining a better estimate of this share is important to determine whether the proposed design is likely to enable us to detect the expected impacts, as we discuss below.

b. Assessing the feasibility of the impact evaluation

To assess the feasibility of the proposed impact evaluation, we will implement the following steps:

- **Estimate the share of farmers in treatment perimeters who are members of a cooperative.** We will use data from the fall 2016 GIE survey to estimate the share of farmers in the 44 treatment perimeters who are members of GIE member cooperatives in the 2016-2017 season. This share is closely related to the share of farmers in these perimeters that sell olives to the GIE, which must be sufficiently high for the impact evaluation to be feasible.[12]
- **Determine the extent and magnitude of profit distribution from GIEs to farmers.** The profits from olive oil sales that the GIEs distribute to farmers (via their cooperatives) are the key benefit that the impact evaluation would seek to measure. Working with local stakeholders, we will obtain information about whether profit distribution has started in the summer of 2017. (We will also gather information about profit distribution in the fall 2017 GIE survey, but would like to determine feasibility before that.) The magnitude of profit distribution per kilo of olives relative to the market price will also provide a sense of the magnitude of impacts that we might expect for olive revenues, which will help determine whether the impact evaluation has sufficient statistical power.
- **Estimate the share of farmers in the treatment *sample* who are members of a cooperative.** Finally, we will compare the names of farmers in our treatment sample to lists of cooperative members gathered from the 14 GIEs that cover this sample. This will enable us to better estimate the proportion of farmers in our sample who are members of cooperatives in the 2016-2017 season (which could differ from the overall membership rate in the perimeters in which they are located because of sampling variation). We plan to obtain these lists of cooperative members directly from the relevant cooperatives, and check the names on site at the GIEs in collaboration with the cooperative presidents. Because this

[12] Membership in a cooperative does not necessarily imply that a farmer sold his or her olives to the cooperative to be processed through the Catalyst Fund processing unit; however, we expect this to be a reasonable approximation.

step requires additional visits to the GIE, we will conduct the name comparison in the summer of 2017, only if the first two steps suggest that the evaluation is still promising.

If these steps suggest that an impact evaluation is feasible, we would be able to move forward with the first round of the farmer survey in the third quarter of 2017. If not, we will consider postponing the first round of the farmer survey until 2018. This will provide GIEs with more time to expand their membership pool and pay off their debts so they can start distributing profits. In that case, we would conduct the same steps mentioned above to determine whether the necessary conditions for an impact evaluation are met in 2018. If both of these conditions are met, we would propose to conduct farmer surveys for the impact evaluation in 2018 and 2019.

C. Data

The proposed performance evaluation requires the collection of qualitative data from a variety of stakeholders in both rain-fed and irrigated olive areas, as well as the collection of quantitative data and testing of olive oil from all 20 GIEs. The potential impact evaluation requires the use of existing quantitative data collected from farmers in rain-fed olive areas during the compact and the collection of new quantitative survey data from the same farmers. Here we describe the existing data and our plans for future data collection (Table I.1 includes the full proposed schedule for data collection).

1. Qualitative data (2017 and 2018)

We plan to conduct interviews and focus groups with a variety of key stakeholders to inform the performance evaluation. Table IV.2 summarizes these data sources, collection methods, numbers of participants, and proposed samples. Some of these stakeholders (such as representatives of the UNOPS head office and USGAV) are at the project level and will be informative about all the GIEs. However, for stakeholders that are linked to specific GIEs—such as farmers, cooperative leaders, and GIE leaders—we will attempt to ensure overlap in the GIEs that we cover. In particular, we plan to focus on 8 of the 20 GIEs, including an equal mix serving rain-fed and irrigated olive areas. This will enable us to triangulate the information we obtain in a common context, while still observing variation across different types of GIEs.

Table IV.2. Qualitative data collection for the performance evaluation of Catalyst Fund processing units

Data source	Data collection method	Number	Sample
Farmers who are members of cooperatives that are members of a GIE	Focus groups	R1: 8 R2: 8	8 perimeters, one in each of 8 GIEs (4 rain-fed and 4 irrigated GIEs)
Farmers who are not members of cooperatives that are members of a GIE	Focus groups	R1: 4 R2: 4	4 perimeters, one in each of 4 GIEs selected for farmer member focus groups (2 rain-fed and 2 irrigated GIEs)
Farmer cooperatives that are members of a GIE	Focus groups	R1: 8 R2: 8	Cooperative leaders in each of the 8 GIEs selected for farmer member focus groups
GIE leaders	Interviews	R1: 8 R2: 8	GIE presidents of each of the 8 GIEs selected for farmer member focus groups

Data source	Data collection method	Number	Sample
UNOPS national office[a]	Interview	R1: 1	National office staff
UNOPS field agents[a]	Interviews	R1: 6	Field agents representing the 8 GIEs selected for farmer member focus groups
USGAV	Interview	R1: 1 R2: 1	National office staff
Donors involved with funding GIEs and/or processing units	Interviews	R1: 2 R2: 2	Donors involved with funding GIEs and/or associated processing units such as the Islamic Development Bank
Federation of GIEs	Interview	R1: 1 R2: 1	Leader of Federation of GIEs
Other market-related informants	Interviews	R1: 1 R2: 3	Other market-related informants such as buyers who have purchased olive oil from a GIE. These informants might be identified during the first round of data collection.

R1 = Round 1 (2017); R2 = Round 2 (2018)

[a]We plan to conduct these interviews in 2016 because the UNOPS contract will end in November 2016 and these staff might not be available after that time.

We will develop a data collection protocol for each type of stakeholder to guide the focus group discussions and interviews. These protocols will cover similar themes to enable us to triangulate information across stakeholders, but will also be tailored to the perspectives and knowledge of specific stakeholders. Illustrative themes that we propose to focus on as part of the qualitative data collection include the following:

- Main challenges encountered during the development and operationalization of the Catalyst Fund processing units, and how these were addressed
- Main successes in the operations of the Catalyst Fund processing units, and the expected and unexpected implications of these successes
- Main challenges to the operations of the Catalyst Fund processing units, and how these have been or are being addressed
- Extent to which Catalyst Fund processing units are operating following the intended model and reasons for any changes
- Differences in success across GIEs and reasons for these differences
- Ability of GIEs to access and repay credit and maintain adequate cash flows
- Expectations for the evolution of the GIEs and Catalyst Fund processing units —for example, in terms of membership, scale of operations, and targeted markets
- Nature of ongoing support to GIEs and areas in which further support is required
- The extent to which the Catalyst Fund processing units are accessible to farmers (through cooperative membership or other mechanisms), and main barriers to their use
- How and why access to the Catalyst Fund processing units has affected farmers

- The role of GIEs in marketing olive oil and main opportunities and challenges related to marketing
- GIEs' capacity to manage and maintain the Catalyst Fund processing units, and the extent to which these units and the GIEs themselves are likely to be sustainable
- The extent to which the formation of GIEs and construction of Catalyst Fund processing units has served as a model in other areas of Morocco

We plan to collect these qualitative data in the fourth quarter of 2017 and 2018, after we have had time to conduct preliminary analyses of the quantitative GIE survey data. (As described below, we plan to conduct the GIE survey in the third quarter of each year.)[13] Sequencing the data collection efforts will allow us to adapt the qualitative protocols to explore findings from the GIE survey, to the extent possible. For example, if the GIE survey data suggest that cooperative membership is stagnating, the qualitative data collection effort could focus on understanding why this is the case. We propose two rounds of qualitative data collection because the GIEs are still evolving (for example, in terms of cooperative membership, production levels, and profit distribution to farmers), and having two rounds will enable us to better understand these changes over time.

2. Quantitative survey of GIEs (2016, 2017, and 2018)

As described above, the performance evaluation of the Catalyst Fund processing units will also rely on a largely quantitative survey of GIEs. The survey will cover all 20 GIEs that received Catalyst Fund assistance and will be administered to the GIE president or another member of the GIE leadership. This survey will capture information about membership; the production and sales of olive oil of different grades; revenues from olive oil and other products; loans, costs, and profits of the GIE; and distribution of profits to farmers (Table IV.3). The analysis of these data will be descriptive in nature, providing insights about the operations of the GIEs that could help inform the performance evaluation.

Table IV.3. Contents of GIE survey

Module	Key topics covered
Respondent information	Number and roles of respondents
GIE and olive processing unit information	Date of first operation, perimeters served, number of member cooperatives, number of farmer members, cooperatives expected to join
Olive oil production in previous agricultural season	Olives purchased for crushing from farmer members and non-members, price paid for olives, period and duration of campaign
Production, commercialization, and marketing of olive oil in most recent agricultural season	Olive oil produced by grade, olive oil sold, olive oil exported, average price by grade, buyers, marketing activities
Revenues in the most recent agricultural season	Revenue from olive oil and other products, revenue from crushing services

[13] The only stakeholders for which we will only conduct one round of data collection are UNOPS head office and field staff because the UNOPS contract to support the GIEs ends in November 2016. Given this timing, we plan to interview these stakeholders in October 2016 (around the same time as the 2016 GIE survey), while they are still available.

Module	Key topics covered
Loans, costs, and profits in the most recent agricultural season	*Avance sur Marchandise* (ASM) loans, operating costs, profits, distribution of profits to cooperative farmer members, investments and debt repayment
Challenges and changes	Challenges experienced, changes experienced or expected (open response questions)

We propose to conduct three rounds of the GIE survey, in 2016, 2017, and 2018. Collecting data from the GIEs in multiple years will enable us to assess how they evolve over time. As mentioned earlier, the GIE surveys will also help us assess the feasibility of the impact evaluation design by providing information on cooperative membership.

We propose conducting the GIE surveys around the same time each year—in the third quarter—to ensure that the data are comparable across years.[14] Conducting the surveys in the third quarter will ensure the GIEs have completed the sale of olive oil from the previous agricultural season and made decisions on profit distribution, enabling us to capture information on this important benefit. This timing will also enable us to use preliminary analyses of these data to inform the qualitative data collection in the fourth quarters of 2017 and 2018.

3. Testing of olive oil samples from GIEs (2017)

In 2017, we will also collect olive oil samples from all 20 GIEs and conduct tests of the quality of the oil produced. Evaluating olive oil quality is important because there are trade categories that correspond to the quality of oil produced, and different qualities yield different market values. Because GIEs typically produce several different quality grades, we will focus on testing the highest quality oil produced, which will provide an upper bound on quality. Quality testing typically includes analyses for free acidity, peroxide value, ultraviolet absorbance, alkyl esters of fatty acids, and sensory evaluation. We propose to conduct these tests in the first quarter of 2017, shortly after the processing season, to ensure that high quality oil is still available at the GIEs prior to being sold.

4. Existing quantitative data from farmer surveys (2011–2013)

The impact evaluation of training in rain-fed areas, from which our proposed evaluation of the Catalyst Fund processing units leverages data, collected three waves of data from a representative sample of olive farmers in the rain-fed perimeters included in that evaluation. These surveys were conducted in 2011 (baseline), 2012 (first follow-up) and 2013 (second follow-up); all were conducted in February through March.[15] Most farmers—but not all —were surveyed in all years, forming a panel sample of almost 3,000 farmers for the original training evaluation. Table IV.4 shows the items covered by the existing farmer-level data.

[14] We may have to conduct the 2016 round at the start of the fourth quarter to accommodate the Moroccan general election schedule.

[15] Data were also collected in 2010. However, because the 2011 round reflected several improvements relative to 2010 in terms of the questionnaire and data collection protocols and was still conducted before the farmer training, the training evaluation used the 2011 data as the baseline.

Table IV.4. Contents of farmer survey in rain-fed areas (2011–2013)

Module	Key topics covered
Olive parcel characteristics	Area of olive parcels; ownership status; number, types, and ages of olive trees; cultivation of olive trees on parcels belonging to others
Olive cultivation	Cultivation practices; tillage; pruning; harvesting techniques; challenges to cultivation; participation of women and young men; intercropping
Production and commercialization of olives and olive oil	Sales of olives on the tree; sales of table olives; use of crushing units and sales of olive oil; olives kept and given away; sales from existing stock of olives and olive oil
Other olive-related products	Production and revenues from other products derived from olives
Participation in agricultural training related to olive production	Techniques covered by training; household participants in training; application of techniques covered by training; participation in APP/MCA/UNOPS/*Projet Americain* training*; application of techniques covered by APP/MCA/UNOPS/*Projet Americain* training*; demonstrations and other training activities conducted by APP/MCA/UNOPS/*Projet Americain**
Overall crop cultivation	Cultivation, harvest, and sales of crops other than olives; total area cultivated; total area irrigated; area of noncultivated land
Livestock production	Types and number of livestock owned, bought, and sold; production and sales of animal-related products; livestock-related expenses
Farming expenses	Expenses related to cultivation and harvesting; physical modifications to olive parcels and related costs; hydro-agricultural work and related costs; farming equipment owned, bought, and sold; building construction
Agricultural employment	Number of employees and time worked; employee payments; work by household members on others' farms
Loans and other revenue	Agricultural loans in previous 10 years; nonagricultural sources of revenue
Social interactions and participation in agricultural organizations	Diffusion of information about new techniques; membership and participation in agricultural organizations
Farming household information	Respondents' characteristics; household composition; household characteristics

Source: Farmer surveys conducted in rain-fed olive areas in 2011, 2012, and 2013.

*Asked in 2012 and 2013, but not in 2011

5. New quantitative data from farmer surveys (2017 and 2018, or 2018 and 2019)

The primary quantitative data source for the impact evaluation, if conducted, will be a survey of the farmers from the 2011 training evaluation sample (we focus on these farmers because we plan to use the 2011 data to conduct the matching). This sample includes 833 treatment farmers and 1,674 potential comparison farmers. However, the matched sample will likely consist of fewer comparison farmers than the full 2011 sample because some comparison farmers might be matched to more than one treatment farmer and some comparisons might not be used. We will also consider reducing collection costs by excluding perimeters that have very few farmers in the matched sample, or by implementing a two-stage matching procedure that matches perimeters in the first stage so that only some of the comparison perimeters are used.

We expect this farmer survey to be very similar to the 2013 survey of olive farmers in rain-fed areas, but with an increased focus on processing and sales to reflect the focus on the Catalyst Fund processing units. We propose to conduct the first round of this farmer survey in the third quarter of 2017 or 2018, after the GIEs would have distributed profits to farmers, so that we can capture this key benefit.

We intend to conduct a second round of the farmer survey in 2018 or 2019, depending on the timing of the first round, for two reasons. First, the additional round would enable us to estimate longer-term impacts that more closely reflect the stable operations of the Catalyst Fund processing units. Second, we are concerned about the implications of the phenomenon of alternate bearing, in which olive production tends to vary substantially in a given geographic area on a two-year cycle, with a high-yield "on" year followed by a low-yield "off" year (Lavee 2007). Interactions between the cycle and the Catalyst Fund processing units could lead to substantially different impacts in the on and off years (for example, in the off year the units might struggle to meet the minimum volumes required to operate at certain times during the harvest season). Therefore, having follow-up measures in two consecutive years would be important to better estimate the average impact of the Catalyst Fund processing units.

D. Reporting

Based on the data collection plans described above (and summarized in Table I.1), data collection for the evaluation of the Catalyst Fund processing units will be completed in the fourth quarter of 2018. This will enable us to produce a draft final report for the evaluation by mid-2019. The final report will include the findings from the performance evaluation and, if conducted, the impact evaluation. (If the impact evaluation is conducted, we plan to produce preliminary analytical tables in late 2017 based on the first follow-up round of the farmer survey to help inform subsequent data collection efforts.) However, if the impact evaluation only becomes feasible in 2018, we would only complete data collection in the third quarter of 2019. In that case, we would have to delay the final report until mid-2020 to enable us to conduct the impact analysis.

V. EVALUATION OF THE OLIVE AND DATE TREE IRRIGATION AND INTENSIFICATION ACTIVITIES

The Olive and Date Tree Irrigation and Intensification activities of the FTPP were composed of several interventions targeted at various actors in the olive and date value chains in 65 irrigated olive areas (olive PMHs) and 12 irrigated date areas (date oases). In these areas, the activities funded the upgrading of irrigation infrastructure,[16] which included lining existing canals (*seguias*) with concrete, improvements to existing *khettaras* (underground irrigation systems that use groundwater), and construction of diversion weirs (dams that redirect flood water to irrigate farmers' crops). The activities also provided training and technical assistance for water user associations that manage the irrigation infrastructure and water distribution in these areas.

Other interventions implemented as part of these activities supported the irrigation-related interventions. These other interventions included farmer training on technical management of olive and date crops, support for the management of farmers' cooperatives, and support for the creation and management of GIEs. In irrigated olive areas, the other interventions included technical assistance for existing olive processing units and technical and financial assistance to GIEs for new modern olive oil processing units serving some of these areas through the Catalyst Fund activity. In irrigated date areas, they included the rehabilitation of date trees (which involved cleaning the undergrowth and offshoots, and transplanting selected offshoots), the provision of new date tree seedlings, and the provision of equipment to seven modern date packaging and cold storage units run by GIEs (the construction of these units was funded by MAPM).

This chapter describes our proposed design for a performance evaluation of the Olive and Date Tree Irrigation and Intensification activities. We begin by presenting the research questions for the evaluation. We then describe our proposed design for the performance evaluation in olive and date areas, respectively, and the data on which it will rely in each of these areas. Finally, we describe our reporting plans for the evaluation.

A. Research questions for evaluation of the Olive and Date Tree Irrigation and Intensification activities

The evaluation of the Olive and Date Tree Irrigation and Intensification activities will seek to answer the following research questions (questions denoted with an asterisk apply to date areas only):

Program implementation

1. How did the implementation of the irrigation-related interventions (infrastructure investments and support for water user associations) compare with the original implementation plans, and what were the reasons for any deviations from plans?

[16] The project funded construction of new irrigation infrastructure in one date area. In all other areas, the project funded rehabilitation or upgrading of existing infrastructure.

2. What were the main challenges to the implementation of the irrigation-related interventions, and how were these addressed?
3. How did the establishment of GIEs and modern processing units in date areas compare with the original implementation plans, and what were the reasons for any deviations from plans?[17] (*)
4. What were the main challenges to the implementation of GIE-related activities in date areas, and how were these addressed? (*)

Program outcomes

5. Have water use patterns changed noticeably as a result of these activities?[18]
    a. How have the irrigation improvements changed the volume of water available for irrigation and effective time of irrigation in each *tour d'eau*?
    b. How has the surface area irrigated changed?
    c. Has the time devoted to canal maintenance changed?
    d. How do farmers use any excess water after irrigating their plots?
6. Have crop patterns changed as a result of these activities?
7. How have the activities changed production volume, yields (per tree), prices received (per kilogram), and revenues (total and per tree) from olives and dates?
8. How have the activities changed total agricultural revenues?
9. How have the activities changed net farm profits?
10. Which interventions were the main drivers of any changes observed?
11. What is the perceived value of the modern processing units in date areas and what factors determine the success of these units? Besides making modern processing units available, what role have the GIEs in date areas played in the development of date processing and marketing? (*)

Sustainability

12. Are water user associations that were supported by the project functional and meeting regularly (according to their rules)?

[17] Because the GIE-related activities in irrigated olive areas will be covered separately as part of the Catalyst Fund performance evaluation described in Chapter IV, the GIE-related research questions in this chapter focus on date areas.

[18] In rural Morocco, farmers typically possess inherited water rights that entitle them to use water for a given period of time during each multiday irrigation cycle (*tour d'eau*). Based on discussions with local stakeholders, our understanding is that the irrigation infrastructure improvements increase the volume of water that reaches farmers and reduce the time a farmer has to wait for the water to reach his or her plot because the concrete lining reduces water wasted through absorption and evaporation. Thus, in the same amount of time in a given *tour d'eau*, a farmer can irrigate a larger surface area. Farmers may also benefit from having to devote less time to maintenance of the upgraded irrigation canals, and may even be able to sell some of their water rights to others if the availability of water now exceeds their needs.

13. Are farmers sustainably managing, maintaining, and operating the infrastructure put in place by the project?
14. Are the new date processing units likely to be sustainable in the long run? (*)

To answer these research questions, we propose a mixed-methods performance evaluation that will draw on both quantitative and qualitative data. In irrigated olive areas, this will include a quantitative pre-post study and a qualitative study. The pre-post study will enable us to provide quantitative estimates of changes in some of the outcomes related to water use and crop patterns (questions 5 and 6), yield and prices (question 7), and total agricultural revenues and farm profits (questions 8 and 9).[19] We will answer the remaining research questions for irrigated olive areas through the qualitative study, which will draw on interviews and focus groups with key stakeholders.

In irrigated date areas, the performance evaluation will include a qualitative study—drawing on interviews and focus groups with key stakeholders—as well as a multisite case study of the modern date processing units supported by the project. We will use the qualitative study to address the research questions (including by providing suggestive evidence on the changes in outcomes in questions 5 through 9), and will complement this with the multisite case study for research questions related to the date processing units (questions 3, 4, 11, and 14).

B. Methodology in irrigated olive areas

As mentioned above, the performance evaluation in irrigated olive areas will consist of two complementary components: a quantitative pre-post study and a qualitative study.[20] The pre-post study leverages data that were collected in 15 (out of 65) of the affected olive areas in 2010, before the irrigation infrastructure improvements were completed. These data will serve as the baseline; we will collect follow-up data from the same farmers in 2017 and 2018 to estimate long-term changes in key outcomes. The qualitative study will rely on data to be collected in 2017 from interviews and focus groups with a variety of key stakeholders, including farmers. Many of these stakeholders will be located in a subset of the 15 olive areas involved in the pre-post study, although we will also interview some national or project-level stakeholders.

[19] We focus on farm profits rather than household income because pre-intervention data on the latter are not available, so we cannot implement the pre-post study. However, we will attempt to obtain post-intervention data on non-agricultural sources of income to get a sense of the contribution of farm profits to total household income.

[20] In an earlier version of this report, we suggested the possibility of a more rigorous between-area comparison group design in irrigated olive areas. This design would compare farmer outcomes in the areas that received the interventions (treatment areas) to similar areas that did not (comparison areas). We visited several provincial and regional MAPM offices (covering a subset of treatment areas) in May 2016 to get their input on suggested comparison areas. We subsequently received suggestions for comparison areas for some, but not all treatment areas covered by these offices. However, we determined that this design was not feasible because: (1) we could not be certain of the quality of the proposed comparisons given the lack of baseline data to verify baseline equivalence with the treatment areas; (2) the proposed comparisons seemed to be of mixed quality given the limited area-level data that the offices provided; and (3) we only obtained recommended comparisons for some offices and areas, which would further reduce the already limited statistical power for this design.

1. Quantitative pre-post study

The pre-post study seeks to estimate the average changes in outcomes over time for farmers in our sample (those for whom a baseline survey was conducted in 2010). To estimate these changes, we will use the following ordinary least squares regression:

$$(2) \quad y_{ijt} = \alpha + \psi post_t + \delta_i + \varepsilon_{ijt}$$

where y_{ijt} is the outcome of interest for farmer i in area j in year t (baseline or follow-up); $post_t$ is a binary indicator that is equal to one in the follow-up year and zero in the baseline year; δ_i is an individual-fixed effect; and ε_{ijt} is a random error term. This model fully accounts for all farmer and area characteristics that are fixed over time through the inclusion of the farmer-fixed effect. The coefficient of interest is ψ, which gives the average pre-post change in the outcome.

There are two main limitations to this approach. First, the estimated changes from a pre-post design cannot be attributable to the effects of the activity because unrelated year-specific shocks (or time trends) could partly drive observed changes. For example, if a negative market shock occurs in the same year as the follow-up survey, dampening measured outcomes, it might not be correct to conclude that the intervention has no impact. To help smooth the effects of year-specific shocks—as well as to account for the phenomenon of alternate bearing described in Chapter IV—we will collect data in two follow-up years, 2017 and 2018. In our analysis, we will produce estimates of the average change over both years, as well as separate estimates for each year. However, this approach still does not fully rule out the potential for unrelated shocks, especially because we have only one year of baseline data (and therefore cannot use multiple years of data to smooth shocks that may have affected baseline outcomes)[21] and do not have information on a rich set of time-varying external factors that we could use to control for shocks in the regression model. We will therefore not be able to confidently attribute the estimated pre-post changes to the impacts of the activity. Nevertheless, the pre-post estimates will complement the qualitative study by providing valuable quantitative evidence of the changes associated with the activity.

Second, we will not be able to generalize the estimated pre-post changes to all of the irrigated olive areas that benefitted from the activities. Specifically, although the project affected 65 irrigated olive areas, the baseline sample consists of 15 areas drawn from a sample frame of 30 areas expected to be among the first to receive the irrigation infrastructure investments. Therefore, the sampled areas are not necessarily representative of all 65 irrigated olive areas that ultimately benefitted from the activities, and the estimated changes might not reflect the average changes associated with the activities in all of these affected areas.[22] We could, at best,

[21] An exception is the yield per tree outcome, for which the 2010 survey captured information on the average in the three most recent seasons. We will be able to use this average as a baseline measure to examine the robustness of the results that use the 2010 measure as the baseline.

[22] The 15 olive areas in the sample cover half of the provinces in which the irrigated olive activity was implemented and more than 50 percent of the total area of olive trees that was affected; however, they cover less than 20 percent of the total cultivated area (which includes land devoted to crops other than olives) and the number of potentially affected beneficiaries. This suggests that the estimated changes in the 15 areas sampled at baseline could potentially differ substantially from the average changes associated with activities in all 65 affected areas.

generalize the estimates to the 30 areas in the 2010 sample frame. However, this would entail a loss of statistical power (because we would have to take into account the sampling of areas); therefore, we will not attempt to generalize beyond the 15 olive areas that were sampled at baseline. This implies that we will not apply sampling weights or adjust the standard errors to reflect the sampling of areas (the first stage of sampling used to obtain the 2010 sample) when we estimate equation (2). However, we will apply weights to account for different sampling probabilities of farmers in each sampled area so that the estimates are representative of the average farmer in the 15 sampled areas.

To determine the ability of the pre-post study in olive areas to detect changes over time, we computed Minimum Detectable Differences (MDDs), the smallest changes that we will be able to statistically distinguish from zero. (We use the term MDDs rather than MDIs to make it clear that they cannot be interpreted as impacts that are attributable to the interventions.) The MDD calculations focus on six illustrative outcomes that are related to the research questions: (1) the percentage of farmers who are satisfied with the sufficiency of water resources (a proximal outcome); (2) the average yield of olives per tree; (3) total revenues from olives; (4) total agricultural revenues; (5) total agricultural revenues per hectare; and (6) net farm profits.

Assuming that we will be able to obtain a follow-up response rate of 70 percent for the farmers in the 2010 baseline sample, we will be able to detect a change of 7 percentage points (20 percent of the baseline mean) in the percentage of farmers who are satisfied with the sufficiency of water resources, 3.1 kg per tree (8 percent of the baseline mean) in the yield of olives, and 1,660 dirhams (21 percent of the baseline mean) in olive revenues (Table V.1).[23] Focusing on total agricultural revenues and profits (including crops besides olives), we will be able to detect a change of 3,522 dirhams (18 percent of the baseline mean) in total agricultural revenues, 728 dirhams per hectare (14 percent of the baseline mean) in total agricultural revenues per hectare, and 2,498 dirhams (35 percent of the baseline mean) in net farm profits. The MDD for farm profits is relatively high because farm profits is a highly variable outcome.

[23] In late 2016, before conducting the first follow-up round of the farmer survey, we intend to visit a subset of the 15 areas to determine the approximate proportion of the baseline sample of farmers that we will be able to locate. If this proportion is much lower than 70 percent—for example, because of migration over the previous few years—our ability to detect changes might be more limited, and the design might not be feasible.

Table V.1. Minimum detectable differences for the evaluation of the Olive Tree Irrigation and Intensification activity, pre-post study

	Satisfied with sufficiency of water resources (percentage)[a]	Yield of olives per tree cultivated (kg per tree)	Total olive revenues (dirhams)	Total agricultural revenues (dirhams)	Total agricultural revenues per hectare (dirhams per hectare)	Net farm profits (dirhams)
Estimated mean	35	40.6	8,010	19,493	5,242	7,051
Standard deviation	47.7	21.6	11,458	24,303	5,021	17,238
MDD	6.9	3.1	1,660	3,522	728	2,498
MDD as percentage of mean	20	8	21	18	14	35

Sources: Authors' calculations using data from the 2010 farmer survey in irrigated olive areas.

Note: MDDs are for a two-tailed test with 80 percent power and a 95 percent level of significance. We assume that we will obtain a 70 percent response rate for the sample interviewed in 2010 (640 farmers in 15 olive areas) in the follow-up survey. The calculations use means and standard deviations computed from the 2010 data in irrigated olive areas. All continuous variables were top-coded at the 95th percentile to account for outliers before computing the means and standard deviations; net farm profits (which can be negative) were also bottom-coded at the 5th percentile. The calculations assume that individual-fixed effects will explain 40 percent of the variation in outcomes.

[a] In the 2010 farmer survey in irrigated areas, respondents rated their satisfaction with the sufficiency of water resources on a 5-point scale. This measure is the percentage of farmers saying that they were satisfied or very satisfied (with the other options being neither satisfied nor dissatisfied, dissatisfied, or very dissatisfied).

MDD = minimum detectable difference.

2. Qualitative study

We will complement the pre-post study in olive areas with a qualitative study drawing on interviews and focus groups with key stakeholders. This study will focus primarily on the irrigation infrastructure investments and related support for water user associations. We will also explore the contributions of the training-related interventions and the Catalyst Fund olive oil processing units, but these interventions will not be our main focus because they have been or will be covered by other performance evaluations (NORC 2013 and the performance evaluation described in Chapter IV, respectively).

The key stakeholders whom we plan to interview include the following: officials at provincial and regional MAPM offices responsible for the irrigated olive areas; water user association leadership; NOVEC (who led the consortium responsible for design and supervision of irrigation construction and training of water user associations); and others involved in implementation (for example, former APP or national MAPM staff). As part of our interviews with the MAPM offices, we also plan to collect administrative data (for example, size, number of farmers, length of irrigation network rehabilitated, and so on) to enable us to fully describe the 15 irrigated olive areas in our pre-post sample. In addition, we will conduct focus groups with farmers, which will provide insights into their experiences with irrigation, as well as their production, processing, and sales of olives and other crops. Similar to the performance evaluation of the Catalyst Fund processing units described in Chapter IV, we will triangulate the

findings from these qualitative data sources by systematically coding data across sources and identifying key themes in the responses.

C. Data in irrigated olive areas

The performance evaluation in the irrigated olive areas will rely on multiple data sources. To implement the pre-post study, we will use baseline survey data collected from farmers in 2010. We will also collect two new rounds of survey data from the same farmers, one round in 2017 and the second in 2018. To implement the qualitative study, we will rely on interviews and focus groups with a variety of stakeholders in 2017. Below, we describe the existing data and give more detail on our plans for further data collection (the evaluation timeline in Table I.1 includes the full proposed schedule for data collection).

1. Existing quantitative data from farmer surveys in irrigated olive areas (2010)

For the pre-post study, we will draw on data collected in 2010 from a representative sample of 640 farmers in 15 of the 65 irrigated olive areas. These data were collected before implementation of the irrigation infrastructure improvements (the survey captured data on outcomes in the 2008–2009 agricultural season).[24] Table V.2 shows the items covered by the survey.

Table V.2. Contents of farmer survey in irrigated olive areas (2010)

Module	Key topics covered
Farmer, household, and land characteristics	Gender and education level of farmer; household composition; members of household actively working on the farm; area of land available for cultivation; type of land occupancy
Water resources	Source of water; collective or individual use of water; days between irrigation cycles; level of satisfaction regarding water availability
Farm operations	Membership in agricultural organizations; availability of technical support; use of agricultural equipment; availability of buildings and infrastructure; number of paid employees and their wages; agricultural credit; farm-level costs and revenues
Plot characteristics	For plots of land cultivated in 2008–2009: plot size, crops cultivated on plot, whether plot is irrigated, number and age of trees (when relevant)
Production and sales of olives, dates, and almonds	Varieties and number of trees cultivated; changes in number of trees in the previous three seasons; average yield in the previous three seasons; techniques and costs of production; value of production sold on the tree; yield of harvested crops; sales of harvested crops (quantity, value, location, and buyer); sales of derived products (type, quantity, value, location, and buyer) and costs of derivation; sale of stored crops and cost of storage (for dates)
Production and sales of other crops	Land area of crop cultivated; techniques and costs of production; value of production sold on the spot; yield of harvested crops; quantity and value of harvest consumed, sold, or other
Livestock production and sales	Livestock owned, bought, sold, and consumed (type, number, and value); livestock-related expenses; production and sales of animal-related products

[24] Data were also collected from farmers in some of the irrigated olive areas in 2013, soon after completion of rehabilitation of the irrigation infrastructure in these areas. However, these were not the same farmers—or the same areas—that were surveyed in 2010. This would make it challenging to use the 2013 data as part of our pre-post design (for example, to compare short- and long-term changes); we therefore focus exclusively on the 2010 data.

2. New quantitative data from farmer surveys in irrigated olive areas (2017 and 2018)

To measure changes in outcomes in irrigated olive areas in the pre-post study, we will conduct follow-up surveys of the same olive farmers who surveyed in 2010. These follow-up surveys will be conducted in 2017 and 2018, several years after the completion of the irrigation infrastructure improvements (and after the completion of the other project interventions in these areas). As mentioned earlier, conducting this survey in both 2017 and 2018 will enable us to smooth some of the year-specific shocks that might affect follow-up outcomes. Consistent with the approach in the baseline survey, we will capture outcomes for the previous agricultural season (for example, the 2017 survey will capture outcomes in the 2015-2016 season). This will enable us to capture outcomes for a full season for all crops, which follow different agricultural calendars but might all be affected by the interventions (especially irrigation infrastructure improvements). We propose to conduct the farmer survey at the end of the first quarter of each year, to minimize recall error for the previous season while conducting the survey after the olive harvest to ensure that farmers are available for the survey.

We will use a similar survey instrument to the 2010 survey (see content in Table V.2) to enable us to measure changes in outcomes over time. However, we will consider modifying the survey to collect additional descriptive and contextual information on farmers' experiences with the improved irrigation infrastructure and other interventions implemented as part of the activities (for example, use of practices covered in training), as well as to capture richer retrospective information on baseline irrigation-related outcomes (for example, we would like to collect information on the surface area irrigated and the effective time of irrigation per *tour d'eau* before the irrigation improvements were made).[25]

3. Data for the qualitative study in irrigated olive areas (2017)

The qualitative study in irrigated olive areas will require us to collect qualitative data through interviews and focus groups with a variety of key stakeholders (Table V.3). We plan to focus the data collection on eight of the 15 areas included in the quantitative pre-post study. The 15 areas were drawn from the 30 areas that received the interventions first, so would have had the most time for long-term effects to manifest. Focusing on these 15 areas will also enable us to triangulate the qualitative data with the survey data that have been and will be collected there, giving us an opportunity to more fully understand how and why outcomes changed in these areas. For the farmer focus groups, we will select participants using pre-specified criteria to ensure representation across their catchment areas, including diversity in demographic and socioeconomic characteristics (including gender, age, and farm size), and exposure to various project interventions besides irrigation infrastructure improvements.

[25] Discussions with provincial and regional MAPM offices suggested that farmers will be able to accurately recall these pre-intervention measures of irrigation, which are the most proximal outcomes to the intervention. These measures will complement the very basic irrigation-related information available in the 2010 survey, namely satisfaction with irrigation and days between *tours d'eau*.

Table V.3. Data collection for the qualitative study in irrigated olive areas

Data source	Data collection method	Number	Sample
Farmers in areas that benefitted from the interventions	Focus groups	8	8 of the 15 olive areas in the pre-post study
Provincial and regional MAPM offices	Interviews; administrative data for the 15 olive areas included in the pre-post study	4	Offices that serve the 8 areas in which farmer focus groups will be conducted
NOVEC	Interviews	2	Staff responsible for design and supervision of irrigation construction Staff responsible for training of water user associations
Water user association leaders	Interviews	8	Leaders of one WUA in each of the 8 areas in which farmer focus groups will be conducted
Others involved in implementation	Interviews	2	National level

We will develop data collection protocols tailored to each group of respondents; however, protocols will cover similar themes to allow for triangulation of findings across respondent types. Illustrative themes that we propose to focus on as part of the data collection for the qualitative study include the following:

- Experiences with implementation of irrigation infrastructure improvements, challenges faced, and deviations from initial plans
- The benefits of the irrigation infrastructure improvements, including how and why these benefits have manifested
- The nature of support provided to water user associations and the extent to which these associations are functioning appropriately
- The extent to which water user associations and farmers are sustainably managing, maintaining, and operating the improved irrigation infrastructure
- Ongoing challenges faced by water user associations and farmers with respect to irrigation
- Contributions of the training-related interventions to outcomes
- The relative importance of different interventions implemented under the activity and the interactions between them

We plan to collect these data in the third quarter of 2017. Collecting the qualitative data after we have had time to conduct a preliminary analysis of the quantitative farmer survey data will enable us to use the qualitative data collection to better interpret any preliminary findings about changes in farmers' outcomes over time.

D. Methodology in irrigated date areas

Our proposed performance evaluation in irrigated date areas is qualitative in nature, and will include two complementary components.[26] The first is a qualitative study that will rely on information collected in 2017 from interviews and focus groups with a variety of key stakeholders, including farmers. The second is a multisite case study of the modern date processing units supported by the project, which we also plan to conduct in 2017.

1. Qualitative study

Similar to the qualitative study in irrigated olive areas, the qualitative study in irrigated date areas will draw on information collected through interviews and focus groups with key stakeholders. This study will focus primarily on the irrigation infrastructure investments and related support for water user associations, but will also cover other interventions that were specific to irrigated date areas.

We plan to conduct interviews with the following stakeholders: officials at provincial and regional MAPM offices responsible for the irrigated date areas; water user association leadership; NOVEC; AFC (which was responsible for farmer training and helping to establish the GIEs in the date areas); officials at ANDZOA (the National Agency for the Development of Oasis and Argan Zones); and others involved in implementation (for example, former APP or national MAPM staff). We will also conduct focus groups with farmers, which will provide valuable information about the effects of the interventions in date areas on farmers' irrigation and crop production and sales, as well as the contribution of the various interventions. Although this information will be largely qualitative in nature, we will attempt to obtain a rough sense of the magnitude of changes in farmers' outcomes such as surface area irrigated, yields, and revenues, in the absence of quantitative survey data. Again, we will triangulate findings from these stakeholders by systematically coding the data and identifying key themes that are relevant to the research questions.

2. Multisite case study of GIE date processing units

The date-processing units supported by the FTPP play an important role in the program logic because modern packaging and cold storage facilities can potentially improve the quality of and price obtained for dates. However, these units may differ in their ability to operate successfully and provide benefits to farmers. A multisite case study approach can help us understand the successes and challenges related to operating these units. We plan to select for our study four of the seven units that were established under the FTPP, including three that are

[26] We initially considered implementing a pre-post study in the date areas using existing 2010 data. However, our discussions with staff at provincial and regional MAPM offices suggested that it would be challenging for this design to detect changes over time because, in most cases, the irrigation activities did not reach all parts of the targeted date areas. Therefore, many farmers in the 2010 sample were not affected by the intervention, making resulting changes difficult to detect. We also considered a within-area comparison group design (proposed in an earlier version of this report) which would compare farmer outcomes in the parts of an affected area that were reached by the irrigation improvements to parts that were not. However, we determined that this design was not feasible because the MAPM staff could not provide specific criteria on which sub-areas within a targeted date area were selected for the irrigation improvements, nor could they provide pre-project data for these sub-areas to show which were similar before the project.

considered among the most successful by local stakeholders, and examine them in detail using qualitative and administrative data. Focusing on the most successful units will enable us to explore key factors underlying their success, understand how they have overcome challenges, and describe best practices.

To conduct this study, we will visit each selected unit, collecting qualitative and administrative data. We will conduct interviews with GIE leadership, focus groups with leaders of cooperatives that are members of the GIE, and focus groups with farmer members of these cooperatives. In addition, we will collect administrative data from the selected units to better understand their operations—for example, the number of cooperative and farmer members, the volume of cold storage available and used during the previous season, the quantity of dates sold and the markets where they were sold, revenues obtained from sales, and profits distributed to members. Our analysis for this component of the evaluation will focus on understanding the extent to which these modern processing units were successful in improving the quality and quantity of dates sold, increasing access to markets for farmers, obtaining better prices for the dates, and distributing profits to farmers.

We will triangulate information from the interviews, focus groups, and administrative data to describe the processing units included in the study and draw broad lessons across the units, organized by topic area (for example, successes and challenges to operating units, ability of the units to access markets and obtain better prices, benefits to farmers, and so on). The findings for this multisite case study will not be generalizable beyond the four units in the study. However, should we find success, the findings will provide evidence on how a successful processing unit *can* work, show examples of how other date processing units in Morocco might seek improvement, and help shape the design of similar interventions.

E. Data in irrigated date areas

The qualitative study in the irrigated date areas will rely on interviews and focus groups with a variety of stakeholders in 2017. The multisite case study of modern date-processing units will draw on qualitative and administrative data we will collect through site visits, also in 2017. Below, we describe our plans for data collection in date areas in more detail.

1. Data for the qualitative study in irrigated date areas (2017)

Similar to the qualitative study in irrigated olive areas, the qualitative study in irrigated date areas will rely on qualitative data collected through focus groups and interviews with a variety of key stakeholders (Table V.4). We will focus the qualitative data collection on six of the 12 areas affected by the activity (two in each of three geographic clusters in which they are found), providing geographic variation while still enabling us to triangulate the information in a common context.

Table V.4. Data collection for the qualitative study in irrigated date areas

Data source	Data collection method	Number	Sample
Farmers in areas that benefitted from the interventions	Focus groups	6	6 of the 12 date areas that received interventions[a]
Provincial and regional MAPM offices	Interviews; administrative data for the 15 olive areas included in the pre-post study	3	These 3 offices cover all 12 date areas
NOVEC	Interviews	(2)	Combined interviews with olive areas
AFC	Interviews	2	Staff responsible for training in the 12 date areas and for helping to establish the GIEs in date areas
ANDZOA	Interviews	2	Staff knowledgeable about the interventions and outcomes in the 12 date areas
Water user association leaders	Interviews	6	Leaders of one WUA in each of the 6 areas in which farmer focus groups will be conducted
Others involved in implementation	Interviews	(2)	Combined interviews with olive areas

Note: Interview numbers in parentheses for date areas indicate that the same interviews will cover both olive and data areas.

[a]Because the irrigation improvements did not reach all parts of each targeted date area, we will conduct focus groups in the parts of these areas that were reached.

The data collection protocols will cover similar themes to those in olive areas (which we described earlier), but will be tailored to date areas. For example, we will explore how the provision of seedlings and rehabilitation of date trees was conducted, and the relative importance of these and other interventions in driving changes in these areas.

We plan to collect these data in the third quarter of 2017, at the same time as the qualitative data collection in irrigated olive areas. It will be efficient to collect these data at the same time in olive and date areas, given the overlap in some of the relevant stakeholders and the similarity of the topics about which the interviewers will inquire.

2. Site visits for the multisite case study of modern date processing units in irrigated date areas (2017)

The multisite case study of the modern GIE processing units in date areas will use qualitative and administrative data (Table V.5) to strengthen our understanding of the establishment, operations, and best practices of these units. As mentioned earlier, we will select four of the seven units for site visits, purposively targeting at least three units perceived to be the most successful. In our visit to each unit, we will gather administrative data and conduct in-depth interviews with GIE leaders, focus groups with the leaders of farmer cooperatives that are members of the GIE, and focus groups with farmer members of these cooperatives. (We will also use some data collected during the qualitative study interviews with staff from provincial and

regional MAPM offices, AFC, and ANDZOA to augment this information.) Similar to the qualitative study, we will seek to include a diverse group of farmers in these focus groups, including those who benefitted from other project interventions in the date areas (to enable us to explore the interactions between these interventions and the date processing units).

Table V.5. Data collection for the multisite case study of modern date processing units

Data Source	Data collection method	Number	Sample
GIE leaders	Interviews; administrative data	4	3 of the most successful units and 1 other unit
Farmer cooperative leaders	Focus Groups	4	Leaders of cooperatives who are members of the 4 selected GIEs
Farmer members of cooperatives	Focus groups	4	Selected from farmer members of the 4 selected GIEs[a]

We will focus our data collection on three main areas. First, we will focus on implementation, examining the process of establishing the GIEs and the new processing units, emphasizing successes, challenges, and responses to challenges during this process. Second, we will examine the operations of the units, including the extent to which they are being used, their perceived value for farmers, challenges and responses to challenges, and factors that determine success. Third, we will consider the sustainability of the units, exploring perceptions of likely sustainability and identifying factors that may support or inhibit long-term success.

We will also collect administrative data for the previous two agricultural seasons from each of the units that we visit. As mentioned earlier, these data could include the number of cooperative and farmer members, the volume of cold storage available during the previous seasons, the quantity of dates sold, the markets in which they were sold, the timing of sales, revenues obtained from sales, and profits distributed to members. Being able to review these data and ask further questions of GIE leaders during the site visit will add additional insights and depth of understanding.

We plan to collect these data in the third quarter of 2017 along with the data for the qualitative study in date areas. Given the overlap in topics and locations for the multisite case study and qualitative studies, conducting these studies at the same time will enable us to realize efficiencies in data collection.

F. Reporting

Based on the data collection plan described above (and summarized in Table I.1), we expect data collection for the evaluation of the Olive and Date Tree Irrigation and Intensification activities to be completed in the first quarter of 2018. This will enable us to produce a draft final report in the third quarter of 2018, which will cover both olive and date areas. (In olive areas, we plan to produce preliminary analytical tables by mid-2017 based on the first follow-up round of the farmer survey to help inform subsequent data collection efforts.)

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VI. EVALUATION ADMINISTRATION AND MANAGEMENT

We will carefully administer and manage the evaluations proposed in Chapters IV and V to help ensure their success. In this chapter, we summarize several administrative and management issues relevant to the conduct of these evaluations.

A. Institutional review board

Mathematica will prepare and submit institutional review board (IRB) applications for each discrete data collection activity that we plan to conduct. For the evaluation of the Catalyst Fund processing units, we will seek IRB approval for the following data collection activities: (1) the 2016 GIE survey (together with the handful of interviews that we plan to conduct with UNOPS staff in 2016), (2) the 2017 GIE survey, (3) the 2018 GIE survey, (4) the 2017 and 2018 qualitative data collection, (5) the first round of the farmer survey in 2017 or 2018 (if conducted), and (6) the second round of the farmer survey in 2018 or 2019 (if conducted). For the evaluation of the Olive and Date Tree Irrigation and Intensification activities, we will seek IRB approval for the following data collection activities: (1) the 2017 farmer survey in olive areas, (2) the 2017 qualitative data collection in olive and date areas (including the qualitative study and multisite case study), and (3) the 2018 farmer survey in olive areas.

We intend to use Health Media Lab as our IRB, based on our positive experience with Health Media Lab on previous MCC projects. For each IRB application, we will submit a set of required documents, including a research protocol providing details of the study and data collection activity, copies of all data collection instruments, and a completed IRB questionnaire that summarizes the key elements of the research protocol and plans for protecting participants' confidentiality. The data collection instruments (both quantitative surveys and qualitative protocols) that we will prepare and share with the IRB will include consent statements approved by MCC, which guarantee the confidentiality of respondents to the extent possible.

B. Data access, privacy, and documentation plan

After producing and finalizing each of the final evaluation reports, we will prepare corresponding de-identified data files, users' manuals, and codebooks based on the quantitative farmer survey data; these files could be made available to the public.[27] These data files, user manuals, and codebooks will be de-identified according to the most recent guidelines set forth by MCC. Public use data files will be free of personal or geographic identifiers that would permit unassisted identification of individual respondents or their households, and we will remove or adjust variables that introduce reasonable risks of deductive disclosure of the identity of individual participants. We will also recode unique and rare data using top and bottom coding or by replacing these observations with missing values. If necessary, we will also collapse any variables that make an individual highly visible depending on geographic or other factors into less easily identifiable categories.

[27]It will likely not be feasible to produce public use files based on the GIE surveys. These surveys will cover 20 GIEs at most (the universe of GIEs established under the project), and it would therefore be very challenging to ensure that GIEs could not be identified from their responses while still maintaining the utility of the data. We plan to work with MCC to determine how best to share these data.

C. Dissemination plan

Mathematica will present the final evaluation findings in person to MCC and stakeholders in Morocco after completing the first draft of the final report for each evaluation (mid-2019 for the evaluation of the Catalyst Fund processing units, and fall 2018 for the evaluation of investments in irrigated olive and date areas). These presentations will be valuable both for disseminating the findings to relevant stakeholders and for gathering feedback from these stakeholders to revise the draft reports. In addition, we will collaborate with MCC and stakeholders to identify a variety of forums—including conferences, workshops, and publications—to share results and encourage donors, implementers, and policymakers to integrate the findings into future programming.

D. Evaluation team

Mathematica's tightly knit team brings together strong design, data collection, and evaluation expertise, as well as experience in conducting evaluations of agriculture investments in developing countries. Our core team includes Mr. Matt Sloan, Dr. Evan Borkum, Dr. Kristen Velyvis, Dr. Anitha Sivasankaran, Ms. Elena Moroz, and Dr. Jane Fortson. Mr. Sloan serves as program manager; Dr. Borkum is leading the evaluation design and will lead the quantitative analysis activities, with support from Dr. Sivasankaran; and Dr. Velyvis will lead the data collection activities and qualitative analysis, with support from Ms. Moroz. Dr. Fortson will serve as a senior advisor, providing technical guidance as needed and reviewing key project deliverables. Our team also draws on expertise from our expert consultants, Drs. Maria Lisa Clodoveo and Travis Lybbert, as well as other Mathematica staff.

E. Budget

We believe that the remaining project funds are sufficient to support the proposed evaluation. Once MCC has approved the final version of this report, we plan to prepare a cost to complete estimate that will provide a more accurate assessment of the funds required to execute the evaluation.

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APPENDIX A

REVIEW OF EVALUATION OF FARMER TRAINING IN RAIN-FED OLIVE AREAS CONDUCTED AT THE END OF THE COMPACT

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In this appendix we review the impact evaluation of farmer training in rain-fed olive areas conducted at the end of the compact, which Mathematica had initially intended to continue. As we describe below, our initial review of the project documents identified several important challenges faced by this design. Based on this assessment, we determined that it would not be worthwhile to continue this evaluation, and that we would instead focus on the two evaluations described in Chapters IV and V.

The impact evaluation of farmer training in rain-fed olive areas involved a random assignment design that included 142 olive perimeters. The perimeters included in the evaluation had to meet several requirements, which were mainly related to their locations (such as the existence of a road or distance to markets), physical characteristics (such as soil type and topography), access to technical resources, and the characteristics of their olive farms (such as typical farm size) (NORC 2013). The 142 perimeters were organized into 71 pairs, with the perimeters in each pair matched to be as similar as possible based on criteria that were closely related to the selection criteria described earlier. Within each pair, one perimeter was then randomly selected for the treatment group and the other was included in the control group, resulting in 71 treatment and 71 control perimeters.

The evaluation estimated the impacts of farmer training using three different methods (NORC 2013). The first compared the average outcomes of the farmers in the treatment perimeters to those of the farmers in the control perimeters (an intent-to-treat estimate).[28] The second compared the average outcomes of the farmers in the treatment perimeters who attended training with those of the farmers in the control perimeters (a treatment-on-treated estimate that does not account for selection bias). The third approach conducted the same comparison as the second approach, but attempted to statistically control for the differences that might arise between the farmers who chose to attend the training activities and those who did not (a treatment-on-treated estimate that does account for selection bias). These approaches were implemented using data collected from a representative sample of olive farmers in the treatment and control areas who were interviewed in early 2011 (baseline) and again in early 2012 and early 2013 (first and second follow-ups, conducted one to two years after the receipt of training). The evaluation found some evidence of improved adoption of some of the practices covered in trainings by farmers who attended trainings, although these impacts were no longer statistically significant in the approach that accounted for selection bias; it found no significant positive impacts on outcomes related to production, productivity, or income using any of the estimation approaches.

Mathematica's initial plan was to return to the same perimeters and farmers included in this evaluation to study the longer-term effects of farmer training using the original random assignment design. Examining longer-term impacts could be important because it might take multiple cropping seasons of experimentation with new techniques before farmers decide

[28] The intent-to-treat estimate gives the impact of *offering* farmers in treatment perimeters the opportunity to participate in training. Because not all farmers take up the offer of training (and some farmers in control perimeters could have attended training), this differs from the treatment-on-treated estimate, which gives the impact of *participating* in training.

whether to adopt them consistently. In addition, farmers might have to implement some improved techniques for several seasons before the benefits become apparent.

However, after reviewing the project documents, we determined that pursuing the planned design would be unlikely to generate detectable impacts, for several reasons. First, random assignment was not always respected in implementation—several treatment perimeters did not host trainings, and several control perimeters hosted trainings. Second, even when random assignment was respected, a relatively small proportion of treatment perimeter farmers were trained and a nontrivial proportion of control perimeter farmers were trained. Third, the duration of the training program was likely too short to generate changes in farmers' cultivation practices that are sizeable enough for the evaluation to detect. Next, we discuss each of these reasons in further detail.

Random assignment was not always respected in implementation. Within each pair of perimeters included in the training evaluation, one was assigned to the treatment group and the other to the control group. However, based on implementer reports, implementation did not always follow assignment. In particular, some treatment perimeters did not receive training and some control perimeters received training. Of the 142 randomly assigned perimeters, 21 (composed of 12 treatment and 9 control perimeters) did not adhere to their original treatment status (Table A.1). This would reduce our ability to detect training impacts—the expected intent-to-treat impacts would be dampened and statistical power for the treatment-on-treated impacts would be lower.

Table A.1. Adherence to random assignment among the 142 assigned perimeters (number of perimeters)

	Trained	Not trained
Treatment	**62**	9
Control	12	**59**

Source: UNOPS implementation data and NORC random assignment information (NORC 2013).

Note: Bold highlighting indicates perimeters that adhered to random assignment.

Even when random assignment was respected, most farmers in treatment perimeters were not trained and a nontrivial proportion of farmers in control perimeters were trained. In the perimeters in which random assignment was respected (that is, the treatment perimeters that hosted trainings and the control perimeters that did not), only 18 percent of farmers who were part of the treatment perimeters reported in the 2013 survey that they or someone in their households participated in at least one olive training module offered by APP/ Millennium Challenge Account-Maroc (MCA-Maroc)/UNOPS/*Projet Americain* in the previous three seasons (2010–2011, 2011–2012, 2012–2013).[29] In addition, 7 percent of the farmers in the control perimeters reported having participated in at least one such training.

[29] The farmer survey referred to multiple entities offering the project trainings to reflect possible differences among respondents in their perceptions of the responsible entity (for example, although APP funded the trainings, staff

Because a perimeter's random assignment status does not perfectly align with receipt of training among farmers—even within perimeters that adhered to their assigned status—our ability to detect impacts will be limited even further. Specifically, the intent-to-treat estimator is unlikely to detect substantial differences in average outcomes between farmers in the treatment and control groups. In addition, statistical power for the treatment-on-treated estimator—which depends on the difference in training rates in the treatment and control groups—is low.

Training sessions were relatively short in duration. Training in rain-fed areas included four modules (harvesting, pruning, fertilizing, and phytosanitary treatment), each of which was about a half-day in duration. Among trained farmers, most (63 percent) participated in just one module; only 16 percent participated in three or four modules (UNOPS 2013). Because participating farmers received less than one day of training, on average, we would expect impacts of the training to be relatively small.

Overall, these challenges suggest that it is unlikely that the planned evaluation would be able to detect impacts of the expected magnitude. Because of the limited intensity of training, we expect the impacts of the training to be small. However, a misalignment between perimeter random assignment and receipt of training among farmers (because of nonadherence to random assignment both at the perimeter and farmer levels) suggests that the intent-to-treat estimates would likely be able to detect only relatively large impacts. The misalignment between random assignment status and training receipt would also severely limit our ability to estimate precise treatment-on-treated impacts.

Because of these substantial challenges, we decided not to continue the evaluation of farmer training in rain-fed olive areas. However, the new evaluation of the modern GIE processing units funded by the Catalyst Fund that we describe in Chapter IV includes an option for an impact evaluation in rain-fed olive areas (if feasible) that will leverage the data collected during the compact for the training evaluation in these areas.

from UNOPS conducted the trainings, and respondents could have viewed either of these as the entity responsible for the trainings).

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