Evaluation of the Fruit Tree Productivity Project in Morocco: Final Report on Irrigation Activities

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Mathematica strives to improve public well-being by bringing the highest standards of quality, objectivity, and excellence to bear when collecting information and performing analysis for our clients. The findings in this report solely reflect Mathematica's interpretation of available information. Mathematica staff involved in analyzing the information and authoring this report did not report any conflicts of interest. The evaluation was funded exclusively by MCC.

LIST OF ACRONYMS

AFC	Agriculture and Finance Consultants
ANDZOA	*Agence Nationale de Développement des Zones Oasiennes et l'Arganier*
APP	*Agence de Partenariat pour le Progrès*
APO	Asian Productivity Organization
AUEA	*Association d'Usagers des Eaux Agricoles*
DH	Dirhams
ERR	Economic Rate of Return
FAO	Food and Agriculture Organization
FTPP	Fruit Tree Productivity Project
GIE	*Groupement d'Intérêt Economique*
MAPM	*Ministère de l'Agriculture et de la Pêche Maritime*
MCC	Millennium Challenge Corporation
NORC	National Opinion Research Center
ONSSA	*Office National de Sécurité Sanitaire des produits Alimentaires*
PMH	*Petites et Moyennes Hydrauliques*
TAMSAT	Tropical Applications of Meteorology using SATellite Data and Ground-based Observations
USAID	United States Agency for International Development

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EXECUTIVE SUMMARY

As part of a $697.5 million compact between the Millennium Challenge Corporation (MCC) and the Government of Morocco that was signed in 2007, MCC funded a $340.5 million project to support the country's agricultural sector—the Fruit Tree Productivity Project (FTPP). The FTPP comprised several activities that sought to expand the production of selected tree fruit crops—olives, dates, figs, and almonds—and address constraints along these value chains. The *Agence de Partenariat pour le Progrès*, a public Moroccan entity, implemented the Compact between 2008 and 2013.

MCC contracted with Mathematica to evaluate several components of the FTPP. This report presents the findings from the final evaluation of two of the FTPP activities: the Olive Tree Irrigation and Intensification activity and the Date Tree Irrigation and Intensification activity. These activities upgraded irrigation infrastructure, supported water user associations, and provided training and technical assistance to value chain actors involved with these two crops. They were designed to increase the efficiency of water use and other crop practices, ultimately seeking to enhance the yield and profitability of olive and date production in targeted irrigated areas.

A. Activities, research questions, and evaluation design

These activities were implemented in 65 irrigated olive areas and 12 irrigated date areas. In these areas, the activities funded the upgrading or construction of new irrigation infrastructure. The activities also provided training and technical assistance for water user associations that were expected to manage the irrigation infrastructure and water distribution in these areas. Other interventions implemented as part of these activities included farmer training on technical management of olive and date crops as well as support for the management of farmers' olive and date cooperatives. In irrigated date areas, they also included the rehabilitation of date trees, the provision of new date tree seedlings, and the provision of equipment to seven modern date packaging and cold storage units run by second-order producer organizations (cooperatives of cooperatives, known as *Groupements d'Intérêt Economique*, or GIEs), as well as technical assistance to the management of these units. A separate project activity, the Catalyst Fund activity, which targeted 20 GIEs, partially funded the construction of and the provision of equipment to modern olive crushing units for the production of olive oil and provided technical assistance to the GIEs. Several of these units were located in or near to the olive areas that benefited from the Olive Tree Irrigation and Intensification activity. (The Catalyst Fund activity is largely covered by a separate final evaluation report.)

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

Research questions

1. Have water use patterns changed noticeably as a result of the investments in irrigated olive and date areas?
   a. How have the irrigation improvements changed the volume of water available for irrigation and effective time of irrigation in each *tour d'eau*? [a]
   b. How has the surface area irrigated changed?
   c. Has the time devoted to irrigation infrastructure maintenance changed?
   d. How do farmers use any excess water after irrigating their plots?
2. Have crop patterns changed as a result of these activities?
3. How have the activities changed production volume, yields (per tree), prices received (per kilogram), and revenues (total and per tree) from olives and dates?
4. How have the activities changed total agricultural revenues?
5. How have the activities changed net farm profits?
6. Which interventions were the main drivers of any changes observed?
7. 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? (*)
8. Are water user associations that were supported by the project functional and meeting regularly (according to their rules)?
9. Are farmers sustainably managing, maintaining, and operating the infrastructure put in place by the project?
10. Are the new date processing units likely to be sustainable in the long run? (*)

[a] 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*).

To answer these research questions, we conducted a mixed-methods performance evaluation, which includes two complementary studies: (1) a qualitative study in irrigated olive and date areas; and (2) a quantitative pre-post study in irrigated olive areas. The qualitative study drew on interviews and focus groups conducted with key stakeholders in 2018, about five years after the end of the project. The pre-post study was designed to complement the qualitative study by providing quantitative estimates of the changes in farmer-level outcomes. It drew on data collected from farmers in 2010 (before the improvements to the irrigation infrastructure were finished) and in 2017 and 2018 (between four and six seasons after the improvements were finished, depending on the area).[1]

[1] We did not conduct a quantitative pre-post study in irrigated date areas because pre-project farmer survey data were not available for those areas.

B. Key findings on the use and status of project investments

The irrigation improvements were generally of high quality and are mostly still in good condition.

There was broad agreement among key stakeholders that the improvements to irrigation infrastructure in both the olive and date areas were largely implemented as planned, and that the work during the compact period was well managed and effectively supervised by APP. There was also strong consensus that the work was high in quality, and that the infrastructure was still in good condition. Several stakeholders noted that the FTPP's high construction standards have raised the bar for similar projects and have been emulated in subsequent infrastructure projects funded by local authorities, the *Ministère de l'Agriculture et de la Pêche Maritime* (MAPM), and other donors, although these projects are typically much smaller in scale than the FTPP.

Most of the water user associations supported by the project have not been very active since the project ended.

Since the end of the FTPP, most of the water user associations supported by the project have become inactive and do not hold regular meetings. There are several reasons why these associations are not functioning well. First, since the FTPP-funded infrastructure improvements were completed, maintenance needs have substantially decreased, relieving most of the associations' workload. Second, another major function of the associations supported by the project is to interact with external entities conducting irrigation works in their areas. However, there have been no other major works in the project-affected areas since the end of the FTPP, so it has not been necessary for the associations to take up this function. Third, farmer engagement in the associations supported by the project is generally limited because traditional associations continue to manage irrigation in most areas and farmers prefer the traditional associations.

Most farmers did not attend FTPP trainings, and not all who attended adopted the new techniques because of financial constraints and other barriers.

According to farmers who participated in the focus group discussions, as well as other stakeholders, only a minority of farmers in irrigated olive and date areas attended FTPP trainings. This qualitative finding is consistent with the farmer survey data in olive areas: only about one-fifth of respondents reported that they, or a member of their household, attended any FTPP training. Further, despite high levels of satisfaction with the trainings by participants, most of these farmers did not apply the new training techniques. Financial constraints, low levels of literacy, and resistance on the part of farmers to start practicing unfamiliar techniques were common reasons cited by farmers for the low take-up of new practices. Olive and date farmers who participated in focus groups reported implementing pruning more often than the other techniques covered by FTPP training—possibly because it was the cheapest to implement. There is some evidence that, at least in the date areas, knowledge about pruning practices might have spilled over from training participants to other farmers through word-of-mouth and observing peers.

Many date GIEs are not operating at a high enough capacity to cover their costs because farmers are reluctant to sell dates to the GIEs.

Except for one GIE, the amounts stored in the 2017–2018 season were well below capacity. Date farmers have generally been slow to sell their dates to the GIEs because they can get money more easily and quickly by selling their unprocessed dates immediately after the harvest. Maintaining the unit at low capacity is not profitable because it is expensive to operate, mainly because of the electricity required to run the refrigerators. Many GIEs consequently have a budget deficit. For the units to be sustainable, GIEs emphasized the importance of the units operating closer to their capacity, which might require a commitment from cooperatives to contribute a minimum volume of dates to the GIEs. This will depend in part on the success of the GIEs' efforts to improve commercialization and marketing of dates to make it attractive for farmers to sell their dates to the GIE.

C. Key findings on effects on farmers

The improved infrastructure led to a substantial reduction in the resources required for maintenance, and many farmers thought this was the project's biggest benefit.

Almost all stakeholders reported a substantial decrease in the frequency and cost of maintenance since the FTPP was completed, as well as the time and effort required to conduct maintenance. In some areas, farmers also reported that irrigation is being disrupted by maintenance work less often. Overall, the reduced need for maintenance has saved farmers the substantial time and effort they would have spent on arduous manual labor, and also reduced spending on maintenance. In focus groups, many farmers pointed to easier maintenance as the project's most important benefit.

The irrigation improvements have made it quicker and easier for farmers to irrigate, and increased the volume of water reaching farmers' parcels.

There was broad consensus among farmers and other stakeholders that water now reaches farmers' parcels substantially faster and in higher volume through concrete infrastructure because it is no longer absorbed by the ground on its way from the source. The farmer survey data in irrigated olive areas corroborate that it is taking much less time for water to reach farmers' parcels. Farmers reported that, in the summer, the average time it took for water to reach their parcels decreased by about 27 minutes (40 percent); in the winter, it decreased by about 14 minutes (28 percent)

Even though more water was available, there was no systematic increase in the area being irrigated.

Although farmers in both olive and date areas consistently reported that water reached their parcels faster and in higher volume than before, the effects on the area being irrigated were more mixed. In date areas, several farmers in focus groups reported that they have used the increased volume of water to irrigate more of their land parcels, some of which were not irrigated or were not irrigated regularly before the project because there was not enough water. However, other date farmers did not report an increase in the area of land irrigated. In the olive areas, most farmers in the focus groups said the amount of area they irrigated stayed about the same, and the

farmer survey data revealed a small decrease in the average total area irrigated. Nevertheless, some olive farmers in the focus groups reported that having more irrigation water available enabled them to irrigate different parcels or parts of their parcels in the same irrigation cycle, whereas they had required multiple cycles to do so in the past. Thus, their water use patterns were positively affected by the project, even though the total area they irrigated did not change.

The irrigation improvements only have benefits when there is enough source water available, and source water in many areas has been adversely affected by drought.

Much of the irrigation infrastructure rehabilitated through the project depends on precipitation to feed the water sources that supply the infrastructure with water. Since the end of the project, drought has decreased the volume of water in these sources in many of the olive and date areas. As a result, many areas have not seen a net improvement in the availability of irrigation water despite the infrastructure improvements. In other areas, a net improvement has still been evident, but it was larger immediately after the project, and has been smaller in the recent drought years.

There is some evidence that more farmers are specializing in olives and dates since the end of the project.

Although the percentage of farmers in irrigated olive areas who sell olives (as well as several other types of crops) decreased between baseline and follow-up, both the survey and qualitative data suggest increased specialization in olive cultivation, likely due to a combination of the project's activities and exogenous forces. Farmers noted that olives have become the most profitable crop in these areas because they require the least effort (to irrigate, harvest, and sell), command relatively high market prices, and are less water-intensive and climate-sensitive than other crops. There has been a similar increase in the cultivation of date palms in date areas. These have become more profitable over time as a result of the combination of the project's investments in irrigation infrastructure and training, and the fact that dates can thrive even with irregular irrigation.

The project has had limited effects on olive yields, agricultural revenues, and farm profits in olive areas; in large part, this could be a consequence of worsening climate conditions.

Most farmers who participated in focus groups in olive areas said they had not experienced significant changes in olive yields, agricultural revenues (from olives and overall), or farm profits as a result of the project. This is consistent with the estimated pre-post changes based on the farmer survey data. These data suggest that the average olive yield per tree in the previous season decreased by about 20 percent between baseline and follow-up. Total revenues from olives and olive products also decreased between baseline and follow-up by about 14 percent on average, as did revenues from all sources (including other crops and animals), by about 30 percent on average. On average, farmers had small but positive profits at baseline (13,592 DH per year, which is equivalent to about $1,422) but they were only roughly breaking even at follow-up. The main reason for these decreases was worsening climatic conditions, especially lower precipitation, which depleted the water sources in some areas. Other reasons included increased sales to intermediaries who offer low prices (but take care of harvest costs and pay farmers immediately), as well as increased per-unit production costs.

In date areas, the project had positive effects for those farmers who saw increases in water availability and adopted modern techniques.

There was some evidence of positive effects on yields, revenues, and profits in date areas, although this varied substantially across and within areas. The largest positive effects on date production were experienced by farmers who lived in areas where the availability of irrigation water substantially increased *and* who also applied new techniques for producing, harvesting, and packaging dates. In areas where there was an increased availability of irrigation water, farmers who did not apply new techniques reported an increase in the quantity of dates produced but a decrease in quality, resulting in no net change in profits.

However, like the olive areas, many of the date areas have been severely affected by drought over the past few years. This has reduced the volume of water available in some of the water sources used for irrigation, limiting the effects of the improved irrigation infrastructure in those areas. (Nevertheless, farmers in these areas who have adopted new techniques promoted by the project have still observed improvements in date quantity and quality.) In addition to drought, several other barriers have prevented farmers in date areas from fully realizing the project's benefits, including a lack of profitable markets, increased production costs, old date palms, and major fires.

D. Lessons

The program logic suggested that the package of activities in the irrigated olive and date areas would work together to improve farmers' medium- and long-term outcomes. However, we found that the outcomes did not improve as much as they were expected to, which suggests that the activities did not operate with the expected synergy.

Our findings suggest several lessons for the design and implementation of similar projects in the future, both in Morocco and elsewhere. First, it could be important for future projects in the agricultural sector to explicitly integrate climate change adaptation into any interventions; in this case, there is evidence that worsening climatic conditions limited the benefits of the FTPP's improvements to the irrigation infrastructure. Second, farmer training interventions should consider the fraction of farmers trained rather than just the number trained, and need to actively address financial issues that keep farmers from adopting practices. Otherwise, only a small fraction of farmers are likely to participate in training and adopt the promoted practices, limiting an intervention's effects at the population level (even if there are spillovers to nonparticipants). Third, improved commercialization of products and access to attractive markets are key to improving farmers' profits and need an early and intense project focus. This is especially important where major changes to prevailing social norms are involved—for example, in encouraging farmers to cooperate in sales where it has not been customary for them to do so.

I. INTRODUCTION

Development of the agricultural sector has great potential to reduce poverty and increase pro-poor economic growth in developing countries (Ligon and Sadoulet 2018). Morocco is especially well placed to reduce poverty through agricultural development because the agricultural sector directly employs almost half of the country's population (World Bank 2019). The population in rural areas of Morocco, where the poverty rate is three times higher than in urban areas and the majority of the population depends on agriculture for survival, has the most to gain. Agricultural development focused on smallholder farmers, who make up most of Morocco's farmers, may help reduce poverty (Hazell et al 2007).

However, the agricultural sector in Morocco—and the Middle East and North Africa region more broadly—has grown more slowly than other sectors over the past four decades (Christiaensen et al. 2011). Key barriers to agricultural development include water resource scarcity and mismanagement, low labor productivity, and poor access to markets and value-adding technologies (Adeyemo and Okoruwa 2018; Pratt et al. 2018; Independent Evaluation Group 2017). Combined with a rapidly growing labor force, these barriers have resulted in high unemployment rates in rural areas, exacerbating rural poverty and accelerating migration to urban centers.

In 2008, the Government of Morocco introduced the *Plan Maroc Vert* (Green Morocco Plan), an ambitious initiative designed to modernize the agricultural sector and turn it into a key driver of economic growth by 2020 (*Ministère de l'Agriculture et de la Pêche Maritime* [MAPM] 2008). The plan included a wide range of projects, funding mechanisms, and policy reforms that focused on increasing agricultural production, improving the competitiveness of Moroccan agriculture in international markets, increasing the incomes of smallholder farmers, and supporting sustainable rural development (Faysee 2015). It strongly emphasized supporting and developing specific value chains, defined as the set of actors involved in the production, processing, and marketing of an agricultural commodity. These value chains include tree crops—for example, olives, dates, almonds, and figs—which are high value-added exports with potential to generate large profits for farmers. By encouraging farmers to transition from low-value cereal crops to high-value tree crops, and supporting improvements to the production of existing high-value crops, the plan sought to facilitate improved productivity and product quality, and increase and stabilize farmer incomes in poor rural areas.

In line with the *Plan Maroc Vert*, the Millennium Challenge Corporation (MCC) funded a $340.5 million project in the agricultural sector—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. APP implemented the Compact between 2008 and 2013.[2]

The FTPP included five activities that sought to expand the production of selected tree fruit crops—olives, dates, almonds, and figs—and 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 upgraded irrigation infrastructure, supported water user associations, and provided training and technical assistance to value chain actors; (3) an activity in irrigated date areas, broadly similar to that in irrigated olive areas but also providing 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 partially funded the construction 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).[3]

MCC contracted with Mathematica to conduct an evaluation of several components of the FTPP. Specifically, Mathematica is conducting two evaluations: (1) an evaluation of the investments in irrigated olive and date areas (activities 2 and 3), and (2) an evaluation of the modern olive oil processing units created by the Catalyst Fund (activity 5). This report presents the final findings for the first evaluation; a separate report will present the findings for the second.

The evaluation of the FTPP's investments in the irrigated olive and date areas targeted by the project involved a mixed-methods performance evaluation that had two main components. In both irrigated olive and date areas, it included a qualitative study, which relied on data collected through farmer focus groups and interviews with other key stakeholders in 2018, several years after the end of the project. In irrigated olive areas, it also included a quantitative pre-post study, which drew on data collected from farmers in 2010 (before the irrigation infrastructure improvements were completed), as well as in 2017 and 2018 (between four and six seasons after improvements were completed, depending on the area).[4]

In the chapters that follow, we provide context for the evaluation and present the final evaluation findings. In Chapter II, we describe the project's activities in more detail and discuss the

[2] In 2015, MCC and the Government of Morocco signed a second compact, which focuses on employability and land productivity. The Millennium Challenge Account-Morocco is implementing this compact between 2017 and 2022.

[3] Each GIE comprises several farmer cooperatives, typically focusing on the same value chain in a certain geographic area. They are intended to facilitate cooperation among the member cooperatives, especially in the commercialization and marketing of crops.

[4] We initially considered implementing a quantitative 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.

program logic model and expected economic benefits. In Chapter III, we summarize what is known from the literature about the effects of similar interventions. In Chapter IV, we outline the research questions our evaluation seeks to answer and describe the evaluation design, data sources, and analysis approach we used to answer them. In Chapter V, we assess the use and status of the project's investments several years after the end of the project; in Chapter VI, we examine the effects of these investments on farmers in the irrigated olive and date areas. We conclude in Chapter VII with a summary of the implications of our findings for the research questions and a discussion of lessons for future projects.

II. OVERVIEW OF THE PROJECT AND THE OLIVE AND DATE TREE IRRIGATION AND INTENSIFICATION ACTIVITIES

In this chapter, we provide context for the evaluation of the FTPP's activities in irrigated olive and date areas by describing these and other project activities, as well as the mechanisms through which they would be expected to affect outcomes, as set out in the program logic. We also describe the ex-ante economic rate of return (ERR) that MCC calculated to compare the costs and expected benefits of the project.

A. FTPP activities

As discussed 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 first Morocco 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 Small-Scale Fisheries Project, the Artisan and Fez Medina Project, the Financial Services Project, and the Enterprise Support Project. A sixth component, the Functional Literacy and Vocational Training activity, was added later. The 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; this evaluation report focuses on the Olive Tree Irrigation and Intensification and Date Tree Irrigation and Intensification activities (activities 2 and 3). These activities were aimed at increasing the efficiency of water use and other crop practices to enhance the yield and profitability of olive and date production in targeted irrigated areas. They were composed of several interventions targeted at various actors in the olive and date value chains in 65 small- and medium-sized irrigated olive areas (known as *petites et moyennes hydrauliques*, or PMHs) and 12 irrigated date areas (known as date oases).[5] In these areas, the activities funded the upgrading or construction of new irrigation infrastructure, which included lining existing *seguias* (canals) with concrete or constructing new concrete *seguias*, rehabilitation of *khettaras* (underground irrigation systems that use groundwater) using concrete, and construction of diversion weirs (structures that alter the natural flow of water so it can be redirected for irrigation). The activities also provided training and technical assistance for water user associations that were expected to manage the irrigation infrastructure and water distribution in these areas regarding operation, management, and maintenance of irrigation water distribution systems.

[5] On average, the irrigated olive areas targeted by the project covered about 523 hectares each, and the irrigated date areas covered about 1616 hectares each. However, there was substantial variation in size across these areas—the irrigated olive areas ranged from 40 hectares to 3,300 hectares, and the irrigated date areas ranged from 45 hectares to 9,072 hectares.

Other interventions implemented as part of these activities supported the irrigation-related interventions. They included farmer training on technical management of olive and date crops and support for the management of farmers' olive and date cooperatives.[6] In irrigated date areas, they also included rehabilitating date trees (which involved cleaning the undergrowth and offshoots and transplanting selected offshoots), providing new date tree seedlings, providing equipment to seven modern date packaging and cold storage units run by GIEs, and technical assistance on management of these units (the construction of which was funded by MAPM).

A separate project activity, the Catalyst Fund activity (activity 5), which targeted 20 GIEs, partially funded the construction of and provision of equipment to 20 new, modern, large-scale olive crushing units for the production of olive oil, and provided technical assistance to the GIEs. Several of these units were located in or near the olive areas that benefited from the Olive Tree Irrigation and Intensification activity. The Catalyst Fund activity is largely covered in a separate final evaluation report, but we discuss it in this report briefly because it might have interacted with other interventions in the irrigated olive areas.

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 Compact participants, which include producers, their families, and producer organizations. Assumptions in the program logic also provided the basis for MCC's ERR calculations for each activity.

To assess the FTPP program logic at the start of the evaluation, we reviewed 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 (Elabed et al. 2014). Overall, we determined that the FTPP program logic was based on a reasonable set of assumptions about potential links between the activities and possible outcomes. It therefore seemed reasonable that the project activities could potentially produce positive effects 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 were identified as determining the success of the project. In Chapters V and VI, we assess the extent to which the effects envisaged in the logic model occurred in practice, and the reasons why.

[6] Training and support were developed in conjunction with MAPM to address needs identified based on feasibility studies in the supported areas.

Figure II.1. The FTPP program logic

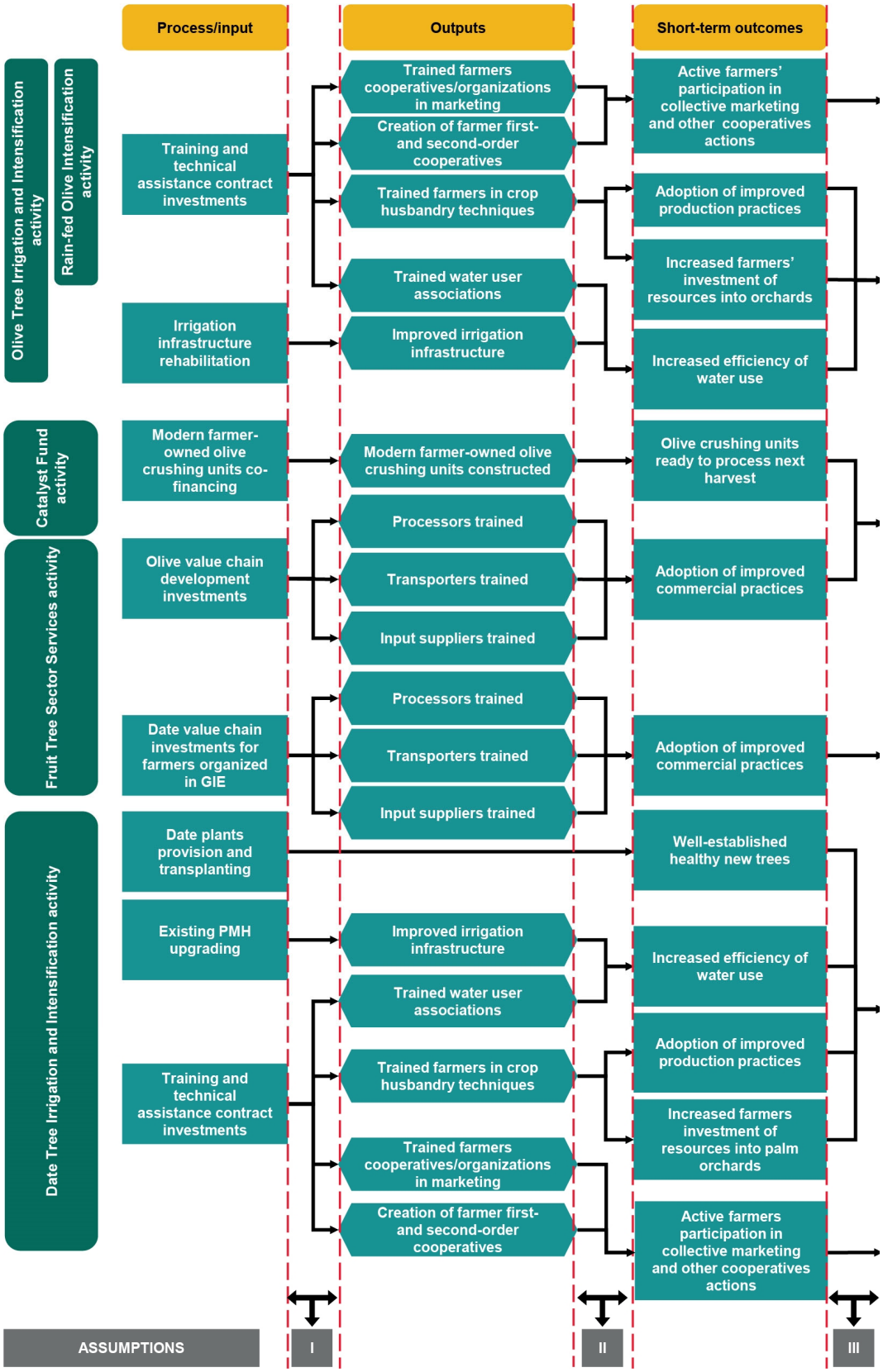


Figure II.1. The FTPP program logic (continued)

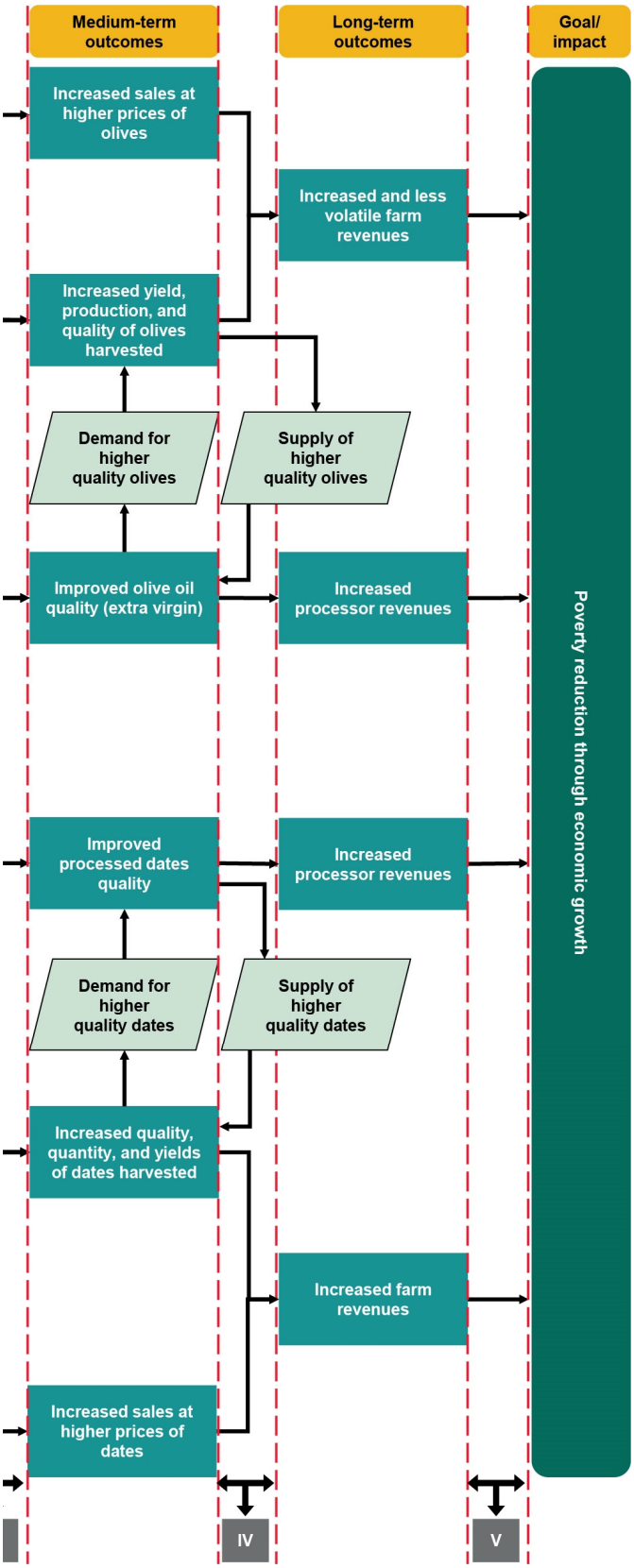


Table II.1. FTPP program logic assumptions

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 the necessary financing to adopt improved practices.
II.4. Rehabilitation of the irrigation infrastructure will lead to increased efficiency of that infrastructure.
III.1. No major changes to the market for olives or dates will de-incentivize 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.

Source: MCC

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

C. Economic rate of return

MCC calculates ERRs based on cost-benefit analysis 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's activities and produced updated ERRs in 2014, soon after the end of the Compact, based on actual costs and expected benefits. The compact close-out ERRs for the activities covered in this report were 10 percent for the Olive Tree Irrigation and Intensification activity and 37 percent for the Date Tree Irrigation and Intensification activity. In the evaluability assessment (Elabed et al. 2014), we examined the ERR assumptions for each activity, noting potential concerns when applicable. In Chapter VI, we use the evaluation findings to reassess whether key assumptions in the ex-ante ERR models for the Olive and Date Tree Irrigation and Intensification activities were plausible, focusing on the assumptions highlighted in the logic assessment report.

III. LITERATURE REVIEW

As we described in Chapter II, the goal of the FTPP was to stimulate growth in the Moroccan agricultural sector through a variety of interventions aimed at improving the production, processing, and sales of targeted fruit tree crops. In this chapter, we review the existing literature on the effects of the four main types of interventions most similar to the project activities in irrigated olive and date areas. These interventions are (1) irrigation infrastructure improvements, (2) farmer trainings, (3) support for water user associations, and (4) investments in postharvest infrastructure.

A. Evidence on improvements to irrigation infrastructure

Irrigation systems in developing countries are often nonexistent or in poor condition, limiting agricultural production and employment in rural areas. To address this issue, the Government of Morocco, development banks, and foreign aid agencies made significant investments to rehabilitate irrigation infrastructure in Morocco in the years leading up to the FTPP. Specifically, the FAO documented roughly $2.6 billion in investments in Moroccan irrigation in the two decades before the start of the FTPP, out of which about $400 million was allotted specifically for rehabilitation of irrigation infrastructure (FAO 2016). (Other common investments were the construction of new infrastructure, including large dams, and provision of technical assistance and training for water resource management.)

Despite these substantial financial investments in improving irrigation infrastructure in Morocco, to our knowledge there have been no rigorous evaluations of their effects. However, studies in other settings have provided evidence on the effects of introducing irrigation and have generally found that irrigation is associated with higher agricultural production and favorable impacts on economic outcomes, such as employment, wages, income, and poverty. For example, a literature review of irrigation 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 those in rain-fed settings (Hussain and Hanjra 2004). Similarly, Van Den Berg and Ruben (2006) showed that Ethiopian households with access to irrigation had higher expenditures and lower dependence on public programs than those without it. Also in Ethiopia, Tucker and Yirgu (2010) found that households experienced an average 20 percent increase in annual income after adopting irrigation. Its use allowed them to grow higher-value crops, intensify production, and reduce losses. However, the authors noted that market interventions are also necessary because farmers face high costs and risks in marketing their crops, which limit the returns from irrigation.

There are also a small number of more rigorous studies on the impacts of introducing irrigation. A study conducted in Northern Mali used a variety of quasi-experimental approaches to show that access to motorized-pump irrigation had positive impacts on poverty, agricultural production, and nutrition, increasing household consumption by 20 to 30 percent (Dillon 2008). Also, irrigating households were more likely to save and to share food with neighbors who lacked irrigation, suggesting that impacts go beyond household consumption (Dillon 2011). A more recent mixed-methods evaluation used propensity-score matching and qualitative methods

to evaluate the effects of constructing irrigation infrastructure in northern Ghana and found improvements in farm productivity, income, employment, consumption, and food security; however, there were negative effects on health (due to increased waterborne diseases), the natural environment, and the well-being of populations displaced due to dam construction (Akudugu et al. 2016).

More relevant to the FTPP interventions in Morocco, some evaluations of *improving* irrigation infrastructure using comparison group designs have found improvements in agricultural productivity and increases in incomes, whereas others have not. For example, Janaiah et al. (2004) found that rehabilitating irrigation infrastructure and improving management of irrigation in Vietnam decreased production costs and improved water availability, thus increasing farm profits and household incomes. Del Carpio et al. (2011) found that a World Bank irrigation infrastructure rehabilitation project in coastal Peru also led to improvements in farmer incomes. The study found that the project benefited the poor not by increasing production in small household plots, but rather by providing poor farmers with better wage employment opportunities on larger farms. A 2008 study in Andhra Pradesh, India showed that new construction and rehabilitation of existing infrastructure resulted in increased wage employment, along with positive impacts on yields and cropping intensity, and increased net income by 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.

There also have been several recent studies of MCC-funded interventions related to irrigation infrastructure. A matched comparison group evaluation of MCC's irrigation infrastructure rehabilitation project in Armenia found that the project increased the hours per week that land was irrigated, and farmers reported increased satisfaction with the timeliness and reliability of irrigation water; however, the study found no improvements in household incomes, farm productivity or related costs, profits, or poverty (Fortson et al. 2016). In Moldova, an interim performance evaluation of rehabilitation of Soviet-era irrigation infrastructure found that use of the infrastructure two years after the project ended had fallen short of expectations because of favorable rains and limited production of high-value crops that required regular irrigation (Borkum et al. 2018). It also found that farmers faced several technical and financial barriers to accessing and using the rehabilitated infrastructure. An interim matched comparison impact evaluation of MCC-funded rehabilitation and construction of irrigation infrastructure in rural Senegal found that the project led to an increase in the area of land under production, greater specialization in rice (the dominant irrigated commercial crop), and higher rice yields per hectare (Coen et al. 2019). Agricultural profits increased, but this increase was partly offset by a decrease in off-farm revenue. Finally, an interim evaluation of MCC's investments in constructing new irrigation infrastructure in Burkina Faso using a randomized controlled trial found that farmers randomly selected to receive land in the newly irrigated area were more likely to use improved agricultural techniques and experienced substantially higher revenues, agricultural income, and household income than farmers who did not receive irrigated land (Ksoll et al. 2019).

B. Evidence on farmer training programs

Farm productivity among the rural poor is constrained in part by the lack of access to modern technologies and knowledge of improved practices (Asenso-Okyere et al. 2008). In an attempt to close the technology gap faced by farmers in developing countries, foreign aid agencies have committed a substantial portion of their agricultural investments to farmer trainings, also known as agricultural extension or advisory services. MCC alone has funded training for more than 400,000 farmers since it was founded in 2004 (MCC 2019).

Despite the popularity of farmer training programs among foreign aid agencies, little rigorous research has been conducted to determine whether these programs are effective at increasing household well-being. Moreover, the literature that does exist shows mixed results. A study that used propensity score matching to estimate the effect of farmer training centers in eastern Ethiopia estimated significant increases in annual farm incomes of about 9 percent (Wordofa and Sassi 2017). In contrast, a difference-in-difference study of a large farmer field school intervention in Tanzania, which trained small-scale farmers in farming techniques using experiential learning techniques, showed no effects on poverty measures, despite some positive effects on food security (Larsen and Lilleør 2014). A randomized evaluation in Uganda of the effect of training farmer trainers—volunteers who disseminate information about technologies and practices to their peers—showed that the farmer trainers as well as other farmers in their communities increased their knowledge and adoption of taught practices, resulting in higher levels of production. However, only farmer trainers saw increased revenues (Behaghel et al. 2018).

Even well-implemented, large-scale training programs might not spur behavior change among farmers or reduce poverty. Mathematica conducted a randomized evaluation of the first agricultural training program funded by MCC—the Water-to-Market training program—which trained more than 50,000 farmers in rural Armenia in the cultivation of higher-value crops and efficient use of irrigation water by using demonstration farms. Three years after the training, Fortson et al. (2016) found that the trainings did not increase household income or consumption. Trainings also had no impact on mediating outcomes, such as adoption of agricultural practices or changes in cultivation of crops, suggesting that longer-term impacts are unlikely to materialize. The null effects likely were because farmers lacked the financial means to invest in new technologies, despite the fact that the trainings were highly appreciated and so desired that additional training sessions had to be provided to accommodate the unexpectedly high demand. The authors concluded that in addition to the financial resource constraint, another obstacle to adoption was the risk-averse mindset of farmers who hesitate to change their farming practices even when the trainings present convincing logic to do so (Blair et al. 2013).

In Morocco, a randomized controlled trial of the FTPP farmer training in rain-fed areas measured impacts one agricultural season after the end of the last training (NORC 2013). The study found that 60 percent of the farmers in the areas where training was implemented participated in FTPP training; however, most farmers attended only one of the four training modules offered by the project. Further, the short-run adoption rate of practices taught among farmers who attended the training was limited. The study appeared to show that farmers who attended the training were

more likely to use manure, pruning, harvesting with vibrators, and digging impluviums (basins to catch rainwater); however, after accounting for possible selection effects, these impacts were no longer statistically significant. There was also no evidence of impacts on other practices, such as the use of tarpaulins during harvesting, storage of harvested olives in crates, use of fertilizers and pesticides, use of modern processing units, and storage of olive oil in food-grade plastic containers. The low adoption rates of these practices were attributed to the lack of financial assistance and materials needed to apply them. The study also did not find any evidence of positive impacts on outcomes related to production, productivity, or income.

C. Support for water user associations

After the initial surge of investments by international donors in irrigation infrastructure between the 1970s and 1990s showed disappointing results, donors started investing in water user associations to help improve water management and infrastructure maintenance (Playan et al. 2018). Program implementers hoped to reduce the public costs of irrigation management and infrastructure maintenance, and improve the recovery of irrigation fees and equity of water allocation, by shifting these responsibilities from governments to farmers.

Although the FTPP focused 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 relate directly to the FTPP intervention, but their findings still highlight the strengths and weaknesses of water user associations in other settings. Xie (2007) provides an overview of how irrigation management transfer and participatory irrigation management initiatives have been adapted for use in many countries according to their political and economic environments. The study found that a major challenge to water user associations is their financial sustainability—that is, structuring them so they can recover the costs of operating and maintaining the irrigation system and managing the 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; the 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. Consistent with this finding, a systematic review of International Fund for Agricultural Development water user association projects in Asia concluded that participatory irrigation management approaches have failed to live up to expectations, showing mainly mixed outcomes, and the positive impacts, such as financial and improved management, show great variability across contexts (International Water Management Institute 2011).

A recent review of individual studies on irrigation management transfer and participatory irrigation management by Senanayake et al. (2015) highlighted severe limitations in data and methodology across almost all of the studies considered, few of which were rigorous impact evaluations. These individual studies generally showed mixed findings, which might reflect different contexts, implementation models, and methodologies. For example, 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 villages without such associations, no clear benefits were obvious in yield, income, or 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. In Burkina Faso, an interim performance evaluation of MCC-funded technical assistance to water user associations (established to manage the new irrigation infrastructure constructed by the project) found that the associations had the capacity to complete routine tasks, such as organizing meetings, collecting fees, and conducting basic maintenance (Ksoll et al. 2019). However, they require continued support for more complex and technical tasks, such as developing maintenance plans and water use schedules. Further, associations in some areas had seen declining fee payment rates since they were established, likely because agricultural profits were too low for farmers in those areas to pay the fees.

Evidence on the effectiveness of programs that aim to strengthen existing water user associations through technical assistance is also limited. 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, water user associations received computers, heavy equipment, and management improvement plans. As a result, program associations improved their financial standing over a three-year period and increased their membership fees and cost recovery rates. However, given their large annual deficits, they did not appear to be approaching financial solvency in the near term. The authors also found no evidence that water user associations delivered more water to their members after implementation of the program. On the contrary, the average amount of water delivered by such associations dramatically decreased over time, likely because of external factors, such as rainfall and poor global economic conditions (Fortson et al. 2016). 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 associations. In Tajikistan, a quasi-experimental evaluation of a USAID project that created, trained, and provided support to water user association members found positive impacts on members' attendance at association meetings, payment of membership fees, and participation in irrigation maintenance (Horbulyk and Balasubramanya 2018); however, the study did not assess impacts on agricultural productivity or economic outcomes.

D. Investments in postharvest infrastructure

Postharvest infrastructure can range from cold storage and processing units to improved roads for transportation of crops (Asian Productivity Organization [APO] and FAO 2005). In the context of the FTPP, the largest investment in postharvest infrastructure was establishing modern olive oil processing units through Catalyst Fund assistance, which aimed to add value by transforming olives into high quality olive oil to be commercialized through the GIEs. (As mentioned earlier, the Catalyst Fund investments will be the subject of a separate evaluation report but are relevant to this report because they might have affected farmers in the targeted irrigated olive areas.) The other FTPP investment in postharvest 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 postharvest infrastructure focuses on reducing losses through postharvest and value-added processing. Postharvest infrastructure aims to reduce losses in volume and improve the quality of produce after the harvest through pre-treatment (for example, fumigation, fungicidal dipping, or surface coating with wax) that prevents decomposition and keeps produce fresh (APO and FAO 2005); through technologies that increase shelf-life and reduce spoilage (for example, curing roots and tuber crops) (World Bank 2011; Rosengrant et al. 2015); or by improving storage conditions (APO and FAO 2005).

In addition to reducing postharvest losses, appropriate storage can enable farmers to sell their produce after the harvest season, when prices may be higher because of limited supply, and has the added benefit of improving financial stability by spreading out income over the course of the year. In the FTPP context, the new modern date processing units funded by the project were specifically designed to facilitate appropriate storage so the quality of the dates could be maintained for potentially profitable out-of-season sales. Similar to the FTPP date processing units, 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).

Another strand of the literature on postharvest 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 postharvest processing can potentially increase 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, thus increasing overall profits (TechnoServe 2013). A study in Mozambique found that farmers who started selling cashew nuts to a modern processing plant increased their annual incomes by about 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.

However, simply building postharvest infrastructure is not enough; some technologies are difficult for small-scale farmers to adopt because they require increased labor, whereas others are prohibitively expensive. An assessment of 12 international projects aimed at reducing postharvest losses found that large-scale infrastructure such as packing houses and cold storage facilities were most commonly reported to be unsuccessful because of factors such as an inconvenient location that was difficult for farmers to access, high energy costs to operate them, and the lack of trained personnel to manage them (Kitinoja 2013). In contrast, small-scale innovations that integrated postharvest management systems and involved gradual adoption were most likely to be adopted and result in long-lasting effects. Examples of successful small-scale innovations include introducing the use of protective containers for crops during harvest and transport, storing harvested crops in the shade, and sorting and grading crops for enhanced market value.

Barriers to adoption of postharvest practices might also be more likely to be overcome when coupled with social and physical infrastructure improvements. For example, Minten et al. (2014) found that cold storage practices increased in Bihar, India when the government improved road infrastructure and public service provision (such as electricity and law enforcement, the latter of which improved security for rural businesses), and implemented policy reforms (deregulating cold storage facilities, which improved access to cold storage, and privatizing agricultural marketing infrastructure, which facilitated the emergence of cold storage facilities as new hubs of marketing activity).

Overall, the existing literature suggests that postharvest infrastructure improvements have the potential to be effective in improving farmers' well-being, although the adoption of these technologies by farmers may be challenging.

E. Contribution of the evaluation

The performance evaluation of the FTPP activities in irrigated olive and date areas described in this report provides valuable information on the changes associated with the *package* of interventions in these areas, which the existing literature has typically examined separately. These interventions include irrigation infrastructure upgrading and complementary farmer training, technical assistance to water user associations, and investments in postharvest infrastructure. As shown in the program logic, these interventions were expected to work together to drive changes in farmers' irrigation use, agricultural production, and incomes. As we describe in Chapter IV, this evaluation explores the extent to which each of these interventions worked as intended (and the reasons why), the interactions between the different interventions, and the overall effects of the entire package on farmers. Given the limited literature on irrigation-related interventions—especially in Morocco and the region—the contributions of the evaluation to the literature are potentially meaningful.

IV. EVALUATION DESIGN

In this chapter, we provide an overview of the design for the mixed-methods performance evaluation of the Olive and Date Tree Irrigation and Intensification activities. We begin by listing the key evaluation questions and describing the evaluation methodology we used to answer them. We then describe the data analyzed in this final report—which include qualitative data and quantitative farmer survey data. To provide context for the findings, our description of the data also includes a discussion of the characteristics of the farmers included in the farmer survey. Finally, we discuss the limitations of our analysis of the quantitative farmer survey data.

A. Research questions

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

Research questions

1. Have water use patterns changed noticeably as a result of the investments in irrigated olive and date areas?
   a. How have the irrigation improvements changed the volume of water available for irrigation and effective time of irrigation in each *tour d'eau*? [a]
   b. How has the surface area irrigated changed?
   c. Has the time devoted to irrigation infrastructure maintenance changed?
   d. How do farmers use any excess water after irrigating their plots?
2. Have crop patterns changed as a result of these activities?
3. How have the activities changed production volume, yields (per tree), prices received (per kilogram), and revenues (total and per tree) from olives and dates?
4. How have the activities changed total agricultural revenues?
5. How have the activities changed net farm profits?
6. Which interventions were the main drivers of any changes observed?
7. 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? (*)
8. Are water user associations that were supported by the project functional and meeting regularly (according to their rules)?
9. Are farmers sustainably managing, maintaining, and operating the infrastructure put in place by the project?
10. Are the new date processing units likely to be sustainable in the long run? (*)

[a] 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 could potentially increase the volume of water that reaches farmers and reduce the time a farmer must wait for the water to reach his or her plot (hence increasing the time available for irrigation) because lining canals with concrete reduces water wasted through absorption and evaporation.

B. Methodology

To answer these research questions, we conducted a mixed-methods performance evaluation, which includes two complementary studies: (1) a qualitative study in irrigated olive and date areas; and (2) a quantitative pre-post study in irrigated olive areas. The qualitative study drew on interviews and focus groups with key stakeholders, including farmers, water user association leadership, and MAPM staff, among others. It was intended to inform all of the research questions, including by providing suggestive evidence on the changes (if any) in farmer-level outcomes in questions 1 through 5. The pre-post study was designed to complement the qualitative study by providing quantitative estimates of the changes in some of these farmer-level outcomes. Below we describe each of these two study components in more detail. (Additional detail is provided in the evaluation design report [Borkum et al. 2017].)

1. Qualitative study

The qualitative study, which was conducted in olive and date areas, focused primarily on the irrigation infrastructure investments and related support for water user associations, and on the processing units managed by GIEs in date areas. It also explored the contributions of the training-related interventions and the Catalyst Fund olive oil processing units, but they were not our main focus because either they have been covered (Amer et al. 2013) or will be covered by other evaluations (Mathematica, in progress).

The qualitative study drew on focus groups and interviews conducted in 2018, about five years after the end of the project (we describe data collection in further detail in Section C below). Specifically, we collected data through focus groups with farmers to obtain insights into their experiences with irrigation, their crop production and sales, and the effects of the various interventions. We also collected data through interviews with the following key stakeholders: officials at provincial and regional MAPM offices responsible for the irrigated olive and date areas; water user association leadership; date GIE leaders; NOVEC (which led the consortium responsible for designing and supervising irrigation construction and training water user associations); Agriculture and Finance Consultants (AFC, which was responsible for farmer training and helping to establish GIEs in the date areas); officials at the *Agence Nationale de Développement des Zones Oasiennes et l'Arganier* (ANDZOA, the National Agency for the Development of Oasis and Argan Zones); and others involved in implementation (former APP staff). We systematically triangulated the findings from these qualitative data sources to identify key themes in the responses that were relevant to the research questions, highlighting mechanisms, context, and similarities and differences in perspectives.

2. Quantitative pre-post study

The quantitative pre-post study leveraged data collected in 15 (out of 65) of the affected olive areas in 2010, before the irrigation infrastructure improvements were completed. These data serve as the baseline; we collected follow-up data from the same farmers in 2017 and 2018 to estimate long-term changes in key outcomes. To estimate these changes, we calculated the change in a given outcome for each individual farmer between baseline and follow-up, and then estimated the average change across all farmers in the sample.

By examining changes in outcomes over time for the same group of farmers, this approach fully accounts for all farmer and area characteristics that are fixed over time. However, it does not account for the effects of unrelated year-specific shocks (or time trends) on outcomes. For example, if a negative market or climate shock occurred in the same year as the follow-up survey, it would dampen measured outcomes. To help smooth the effects of year-specific shocks on outcomes—and account for the fact that some crops are alternate bearing[7]—we collected data in two follow-up years, 2017 and 2018. In Chapter VI, we therefore present estimates of the change in outcomes for each follow-up year separately, as well as the average change over both follow-up years. That is, we estimate the average change between the 2010 and 2017 surveys, the average change between the 2010 and 2018 surveys, and the average of these two changes.[8]

C. Data sources

As described above, the performance evaluation in the irrigated olive and date areas relies on qualitative and quantitative data sources. Below, we describe these data sources in more detail.

1. Qualitative data

Mathematica staff conducted a handful of interviews with high-level stakeholders in May 2018. Mathematica recorded these interviews and prepared detailed notes for use in the analysis. Mathematica contracted with C&O Marketing, a Moroccan data collection firm, to conduct the focus groups and most of the interviews in June and July 2018. Mathematica developed detailed protocols for this qualitative data collection and participated in training interviewers and piloting the protocols. C&O Marketing recorded all focus groups and interviews it conducted, and prepared transcripts in French and English. Table IV.1 summarizes the types of respondents for the qualitative study, the number of interviews or focus groups, and the criteria used to select them.

[7] Olives are among the crops susceptible to this phenomenon, which is defined as a sequence of a high yield in one year followed by a low yield in the next year. Although this phenomenon is driven by plant physiology, climatic events can trigger a new cycle of alternate bearing.

[8] There was slight variation in response rates to specific survey items within and across survey years, so not all respondents provided information on all outcomes in all years. To ensure a consistent sample for a given outcome across all follow-up analyses (2017, 2018, and the average over both of these years), the analysis sample was restricted to all respondents who provided information about that outcome in all survey years (2010, 2017, and 2018).

Table IV.1. Interviews and focus groups

Respondent	Data collection method	Number	Selection approach
Olive areas			
Farmers in areas that benefited from the interventions	Focus groups	6[a]	6 of the 15 olive areas in the pre-post study, selected for geographic diversity
Water user association leaders	Interviews	6	Leader of 1 association in each of the 6 areas in which farmer focus groups were conducted
Provincial and regional MAPM offices	Interviews	3	Offices that served the 6 areas in which farmer focus groups were conducted
NOVEC (*)	Interviews	1	Staff responsible for design and supervision of irrigation construction, and for training of water user associations
Former APP staff (*)	Interviews	2	National level
Date areas			
Farmers in areas that benefited from the interventions	Focus groups	6[a]	6 of the 12 date areas that received interventions, selected for geographic diversity and diversity in types of irrigation infrastructure improvements
Water user association leaders	Interviews	6	Leader of 1 association in each of the 6 date areas in which farmer focus groups were conducted
GIE leaders	Interviews	4	3 of the most successful date processing units and 1 less successful unit
Provincial and regional MAPM offices	Interviews	3	These 3 offices cover all 12 date areas
AFC (*)	Interviews	1	Staff responsible for training in the date areas and helping to establish date GIEs
ANDZOA (*)	Interviews	2	Staff knowledgeable about the interventions and outcomes in the date areas
NOVEC (*)	Interviews	(1)	Combined interviews with olive areas
Former APP staff (*)	Interviews	(2)	Combined interviews with olive areas

(*) = Interviews conducted by Mathematica; the remaining interviews and all focus group were conducted by C&O Marketing.

[a]Each focus group had between 8 and 10 participants.

In irrigated olive areas, the qualitative study focused on 6 of the 15 areas included in the quantitative pre-post study (Figure IV.1). Focusing on these areas enabled us to triangulate the qualitative data with the survey data collected there, giving us an opportunity to more fully understand how and why outcomes changed in a consistent sample of areas. To select the 6 areas for the qualitative study, we began by identifying the three provincial or regional MAPM offices covering the largest number of areas in our sample of 15; we then randomly selected 2 areas covered by each of these offices. This approach provided geographic variation and enabled us to triangulate the responses of MAPM office staff with those of within-area respondents linked to each office.

In irrigated date areas, the qualitative study focused on 6 of the 12 areas affected by the activity, which are spread across three geographic clusters. Specifically, we selected 2 areas in each geographic cluster to provide geographic variation (each cluster is covered by a different MAPM office) (Figure IV.1). We conducted the selection within each geographic cluster purposefully rather than randomly to ensure overall diversity in the types of irrigation infrastructure improvements implemented (they were more diverse in date than olive areas).

We also selected four date GIEs for qualitative interviews (Figure IV.1). Most of the date GIEs (six of the seven created) were concentrated in two of the three geographic clusters in which the date areas are located. We selected the three highest-performing GIEs from these clusters based on the quantity of dates stored in the last agricultural season, as well as the single GIE in the remaining cluster (which happened to be a poor performer regarding the quantity of dates stored). Table IV.2 provides descriptive information about the date GIEs in our sample, all of which started operating after the Compact ended in fall 2013. The GIEs in our sample had between 12 and 30 member cooperatives and 320 to 620 farmer members in the 2017–2018 season; the percentage of female members is low for most of the GIEs.

Table IV.2. Date GIE Sample

GIE	Province	Date unit started operating	Number of member cooperatives (2017–2018)	Number of farmer members (2017–2018)	Percentage of female members (2017–2018)
Ternata/Zagora Dattes	Zagora	2015[a]	17	360	2
Tamezmote	Zagora	January 2014	12	457	4
Oulte Dates of Tata	Tata	September 2016	30	620	12
Aufous Oasis Dates	Errachidia	October 2014	17	320	27

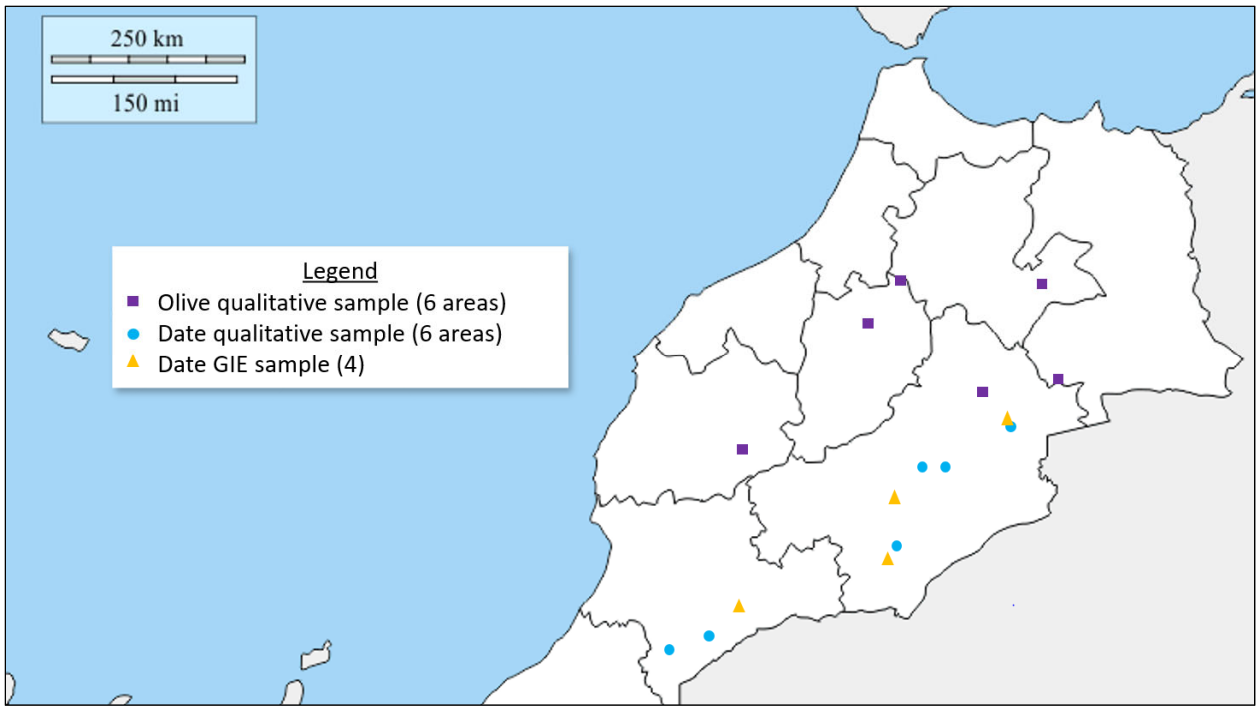
Source: Administrative data from ANDZOA.

[a]Month not provided.

We also needed to select respondents within each selected olive and date area for farmer focus groups and water user association leader interviews. To select farmer focus group participants, C&O Marketing met with local authorities, who put them in contact with village leaders. C&O Marketing then worked with these leaders, water user association leaders, and/or GIE leaders to compile a list of local farmers who could potentially participate in the focus group; potential

participants had to have been in the area at the start of the project and located in a part of the area affected by the irrigation infrastructure improvements. C&O Marketing sought to obtain the names of potential participants across a range of farmer ages and farm sizes, and selected participants (between 8 and 10 per focus group) to ensure diversity across these characteristics. For the water user association leader interviews, C&O Marketing identified a convenience sample of leaders in selected olive and date areas affected by the infrastructure improvements (one leader per area).

Figure IV.1. Location of the qualitative sample



Note: Map shows regions of Morocco where project activities were concentrated (internal boundaries demarcate the regions as they were defined during the Compact period).

The interview and focus group protocols were tailored to each group of respondents but covered similar themes to allow for triangulation of findings across respondent types. These key themes included the following:

- Nature of the irrigation infrastructure improvements, current condition of the infrastructure, and nature and sufficiency of maintenance efforts
- Extent of farmer membership and participation in water user associations supported by the project, the extent to which these associations are functioning appropriately, and reasons why
- Extent of participation in farmer training and practice adoption, barriers to adopting practices, and perceived effects of adoption

- Extent of engagement in other activity components that were unique to date areas, such as cleaning the undergrowth and offshoots and planting new date tree seedlings, and perceived effects
- Extent to which farmers are using the processing units operated by GIEs in olive and date areas, and their perceived value for farmers
- Operations of the new date processing units managed by GIEs, including the extent to which they are being used, challenges and responses to challenges, likely sustainability, and factors that may support or inhibit long-term success
- Overall effects of the activities on water use patterns, types of crops cultivated, crop production, and profitability, including how and why these effects occurred (or did not occur)
- Relative importance of different interventions implemented under the activities and the interactions between them
- Key external factors and other interventions affecting production since the end of the project, and how they mitigated the effects of the project activities

2. Quantitative farmer survey data

For the pre-post study, we drew on survey data collected in October and November 2010 from a sample of 640 farmers in 15 of the 65 irrigated olive areas (Figure IV.2). These data were commissioned by NORC to support its evaluation and were collected by Agriconsulting before implementation of the irrigation infrastructure improvements; they include information on outcomes in the 2008–2009 agricultural season.[9] According to the available documentation, these 15 areas were randomly selected from among 30 areas expected to be among the first to receive the irrigation infrastructure investments (Agriconsulting 2010).[10]

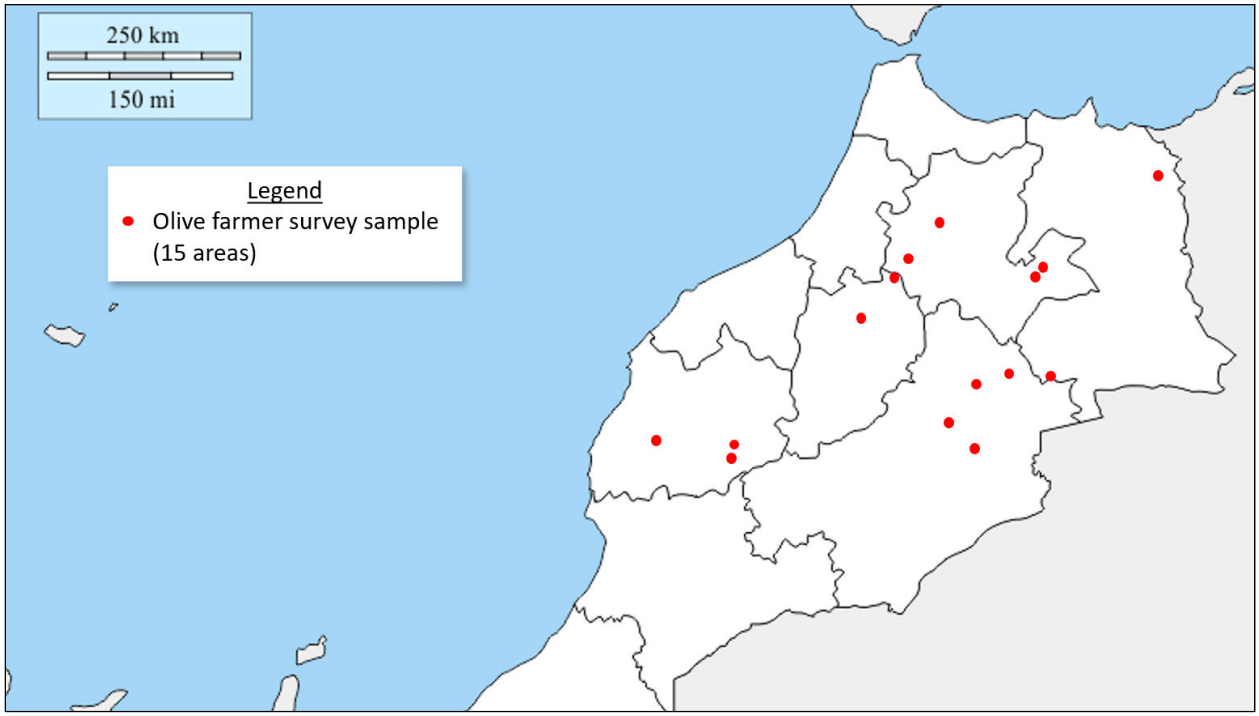
Within each of the 15 selected areas, Agriconsulting recruited farmers for the survey using a quota sampling approach, which attempted to match the expected distribution of farm size and farm operator gender within each area (for example, from the project's feasibility studies) while also ensuring that the sample was geographically dispersed throughout the area. This approach was intended to broadly replicate the fully representative sample that would have arisen from a stratified random sampling approach, which was not feasible because a sample frame of farmers was not available. (In practice there were very few female farmers, so the quota sampling approach focused mainly on farm size.) In each area, 40 farmers participated in the survey,

[9] Different crops follow different production and harvesting calendars. For the purpose of the baseline farmer survey, the 2008–2009 season refers to crops harvested sometime in 2009 for all crops, except for olives, for which the harvest may spill over into early 2010. This definition captures 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). Similar definitions apply to the follow-up surveys, which covered the 2015–2016 and 2016–2017 seasons.

[10] To select the sample for the survey, these 30 areas were divided into three strata based on the availability of water resources (perennial, seasonal, or mixed). Within each stratum, areas were selected with a probability proportional to the number of farms; 16 areas were selected, but 1 was selected twice (sampling was conducted with replacement), yielding a total of 15 areas.

except for one area with a large number of farms, in which 80 participated. The combined total was 640 respondents across the 15 areas.

Figure IV.2. Location of the farmer survey sample



Note: Map shows regions of Morocco where project activities were concentrated (internal boundaries demarcate the regions as they were defined during the Compact period).

To measure changes in outcomes in irrigated olive areas for the pre-post study, C&O Marketing conducted follow-up surveys with the same olive farmers surveyed in 2010. These follow-up surveys were conducted around the end of 2017 and 2018, several years after the completion of the irrigation infrastructure improvements (and that of the other project interventions in these areas). More specifically, the first follow-up round was conducted in December 2017 and January 2018 (covering the 2015-2016 agricultural season) and the second in December 2018 and January 2019 (covering the 2016-2017 agricultural season). The infrastructure improvements in the study areas were completed between November 2011 and October 2012. Therefore, the first (2017) follow-up round was conducted between four and five seasons after the improvements were completed, and the second (2018) follow-up round was conducted between five and six seasons after they were completed. Of the original 640 farmers surveyed in 2010, C&O surveyed 549 in 2017 (86 percent) and 530 in 2018 (83 percent).[11]

[11] Before conducting the first follow-up round, C&O attempted to locate the 2010 respondents or any family members who were informed about their farm operations and could respond to the survey. Of the original 640 respondents, 562 were located directly or had family members who could respond to the survey. In the second follow-up, C&O attempted to contact only the 549 respondents who had completed the first follow-up. Overall, about 92 percent of respondents in the second follow-up survey were original respondents; the rest were informed family members (we did not capture this information in the first follow-up survey).

The follow-up farmer survey captured farmer characteristics and a range of outcomes relevant to the research questions (Table IV.3). It covered similar topics to those of the baseline survey to enable us to measure changes in outcomes over time. However, it also collected additional descriptive and contextual information on farmers' experiences with the improved irrigation infrastructure and other activity interventions (for example, use of practices covered in training), as well as richer retrospective information on irrigation-related outcomes (for example, surface area irrigated and the time for water to reach farmers' land parcels).[12] The second round of the follow-up survey also included several open response questions, asked of a small subset of survey respondents to help us better understand the reasons for some of the changes observed in the first round. For example, we identified a large decrease between baseline and the first follow-up round in the percentage of farmers who cultivated other crops in addition to olives; we therefore randomly selected 20 respondents who had reported this change and asked them to explain it briefly when they were interviewed for the second follow-up round.

Table IV.3. Farmer follow-up survey in olive areas, topics covered

Domain	Topics covered
Farmer and household characteristics	Gender and education level of farmer; household composition; members of household actively working on the farm; main categories of income (*)
General farm information	Area of land cultivated and irrigated
Farming conditions	Weather conditions, rainfall, and olive yields compared to a typical season (*)
Water resources	Source of water; collective or individual use of water; days between irrigations; reasons for increase in days between irrigations (^^); duration of each irrigation (*); time for water to reach parcels (*); whether irrigated same or different parts of parcels with each irrigation (^^); reasons reduced time did not result in larger area irrigated (^^); donation or rental of water rights (*); level of satisfaction regarding water availability; contribution to maintenance of irrigation infrastructure (^^)
Membership in agricultural organizations	Membership in water user associations; participation in water user associations (^^); perceptions of water user associations (*); membership of cooperatives and services offered and received by cooperatives; access to GIEs (*); engagement with GIEs (^^)
Project activities	Satisfaction with project activities and condition of infrastructure (^); participation in training and use of practices covered (^); perceptions of overall project effects (^)
Olive production and revenues	Number of olive trees cultivated and irrigated; reasons for increased intensity of olive production (^^); yields; sales of production on the tree; sales of harvested olives; reasons for increased sales of production on the tree (^^); sales to GIE (*); sales of derived products and costs of derivation
Other crops produced and other revenues	Number of other fruit trees cultivated and irrigated; area of other crops cultivated and irrigated; reasons for shifting from other crops to olives (^^); sale of production on the tree/in the field; sales of harvested crops; sales of derived products and costs of derivation; revenue from animal sales and animal products; reasons for decrease in the number of animals (^^); revenues from renting out land, equipment, or irrigation water
Farming costs	Costs related to crop production; hired labor costs; cost of raising and purchasing animals; rental costs for land, equipment, or irrigation water; cost of agricultural credit repayments

(*) = Only asked in the follow-up rounds (2017 and 2018); (^) = only asked in the 2017 follow-up round; (^^) = only asked in the 2018 follow-up round.

[12] Because these measures were not available in the baseline survey, we also sought to capture baseline data about them retrospectively. Discussions with provincial and regional MAPM offices and impressions during the survey suggested that farmers were able to accurately recall these pre-intervention measures of irrigation, which are the most proximal outcomes to the intervention.

To provide context for the analysis in Chapter VI, Table IV.4 summarizes the baseline characteristics of the follow-up analysis sample of farmers (as mentioned above, this sample comprises baseline respondents who responded to both follow-up rounds). The average respondent was 55 years old at baseline; almost all respondents were male. About half of respondents were illiterate, and fewer than one in five had completed secondary education. The average household size was seven members.

We also examined various aspects of agricultural production at baseline. Respondents cultivated an average of about 4.2 hectares of land, including land inside and outside the area reached by irrigation infrastructure (known as the perimeter), but irrigated only an average of about 2.6 hectares. Focusing on land inside the perimeter, which was potentially affected most directly by the project activities, respondents cultivated 2.8 hectares and irrigated 2.2 hectares, on average. Although the project activities were implemented in olive-growing regions, respondents' farming activities and sources of agricultural revenues were fairly diverse at baseline. Specifically, more than two-thirds of respondents reported revenues from olives or olive products, but more than one-half reported revenues from other crops or related products, and more than two-thirds reported revenues from sales of animals or animal products. Revenues from other crops and animals also made an important contribution to mean agricultural revenues at baseline (mean revenues of 7,602 dirhams [DH] and 11,650 DH, respectively, compared to 11,238 DH for olives).

Table IV.4. Baseline characteristics of the pre-post analysis sample in irrigated olive areas, 2008–2009 agricultural season

Characteristic	Baseline mean
Age (years)	55
Male (percent)	97
Illiterate (percent)	47
Less than primary education (percent)	60
Primary education (percent)	21
Secondary education or higher (percent)	19
Number of household members	7
Area cultivated, inside the perimeter (hectares)[a]	2.8
Area irrigated, inside the perimeter (hectares)[a]	2.2
Total area cultivated, inside and outside the perimeter (hectares)[a]	4.2
Total area irrigated, inside and outside the perimeter (hectares)[a]	2.6
Any revenues from olives or olive products (percent)	70
Any revenues from other crops or crop products (percent)	53
Any revenues from animals or animal products (percent)	70
Total revenues from olives and olive products (DH)[b]	11,238
Total revenues from other crops and crop products (DH)[b]	7,602
Total revenues from animals and animal products (DH)[b]	11,650
Total agricultural revenues (DH)[b,c]	33,771

Source: 2010 baseline farmer survey and 2017 follow-up farmer survey in irrigated olive areas.

Notes: N = 530, except for area irrigated inside the perimeter (N = 528).

[a] Captured retrospectively in the 2017 follow-up farmer survey in irrigated olive areas.

[b] Revenues were top-coded at the 95th percentile to account for outliers. Revenues shown are for the entire 2008-2009 agricultural season, which refers to olives harvested starting in late 2009 and ending in early 2010, and other crops harvested in 2009.

[c] Includes revenues from olives, other crops, animals, land rental, water rental, and farming equipment rental.

D. Limitations of the quantitative pre-post study

The quantitative pre-post study uses the farmer survey data to estimate the average changes in outcomes between baseline and follow-up for farmers in the baseline sample who were surveyed again in both follow-up rounds. In interpreting the findings from this analysis, which we present in Chapter VI, it is important to consider several limitations of the quantitative pre-post study.

The attribution of pre-post changes to the effects of the project is limited because of annual shocks, especially changes in climatic conditions.

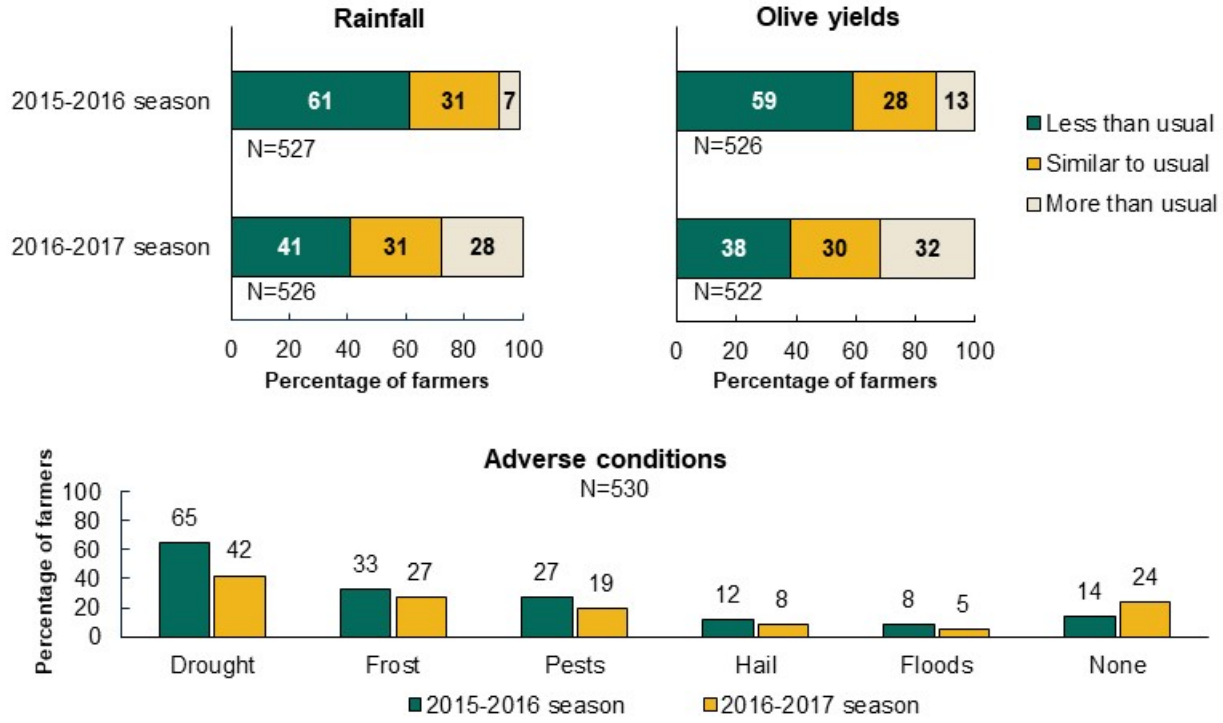
The estimated changes from a pre-post design cannot be attributed to the effects of the activity because unrelated year-specific shocks (or time trends) could partly drive observed changes. We attempted to address this possibility to some extent by collecting data separately in two follow-up years. However, 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).

There is evidence that external shocks—especially climatic conditions that could affect crop production, such as rainfall—were substantially different at baseline and follow-up. (Although the areas that received the activities use irrigation, irrigation water in these areas mostly comes from natural sources of water, such as rivers and springs, which fluctuate depending on rainfall and/or snowmelt.) A majority of respondents in the first follow-up round perceived that rainfall in the 2015–2016 season was lower than in a typical season, as were olive yields per tree (Figure IV.3). More broadly, respondents perceived that adverse farming conditions—especially extreme climatic conditions such as drought and frost—were common in the 2015–2016 season. The situation was more balanced in the following year, with a substantial percentage of respondents reporting that rainfall and olive yields were similar to or higher than usual, and a smaller percentage reporting most types of adverse conditions. We are unable to report equivalent information for baseline because these data were not collected in the baseline survey. However, respondents in qualitative interviews and focus groups emphasized that climatic conditions—especially rainfall—were much more favorable in the baseline 2008–2009 season relative to the follow-up seasons.

These impressions are consistent with data on precipitation from TAMSAT (Tropical Applications of Meteorology using SATellite data and ground-based observations) (Tarnavsky et al. 2014; Maidement et al. 2014) for the 15 areas included in the farmer survey. Total precipitation between October and the following September decreased in almost all of the sample areas (14 out of 15) between the baseline season (2008–2009) and first follow-up season

(2015–2016), with median decreases of 172mm (Figure IV.4).[13] In percentage terms, the median decrease was 35 percent (not shown). In contrast, precipitation over these months decreased in about half of the sample areas and increased in the other half between the baseline season and the second follow-up season (2016–2017); the median change is close to zero.

Figure IV.3. External conditions experienced in irrigated olive areas at follow-up



Source: 2017 and 2018 follow-up farmer surveys in irrigated olives areas

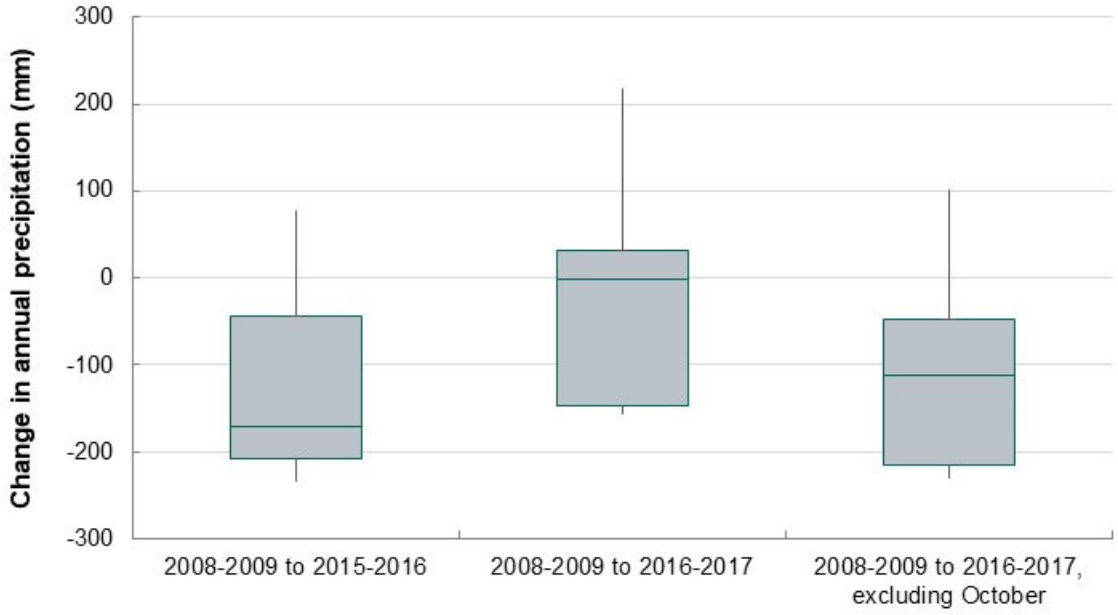
Note: Percentages for adverse conditions sum to more than 100 percent because respondents could provide multiple responses.

However, the changes for the second follow-up season mask an important difference in the timing of precipitation. Specifically, a large fraction of the precipitation in the second follow-up season occurred very early in the season (in October) rather than in the winter months of January, February, and March. Winter is an important period to replenish water sources—as well as snow stores in mountainous regions that provide snowmelt—to increase the availability of irrigation water in subsequent months, which are peak cultivation periods for many crops. These crops include olives, which can benefit from irrigation through the fall; replenishing water

[13] The survey including questions about crops harvested in a certain calendar year, except for olives, for which the harvest might spill over to early the following year. For example, the first follow-up survey focused on the 2015-2016 agricultural season, and asked farmers about crops harvested during 2016 or early 2017 (olives only). Different crops follow different crop cycles, but crop cultivation in this season would have started no earlier than late fall 2015. Most crops would have been harvested by the end of summer 2016, but olives would only have been harvested starting in late fall 2016. Therefore, the period October 2015 through September 2016 is the most relevant for the first follow-up survey in terms of rainfall.

sources sufficiently before the summer is especially important for olives because water deprivation in this period, when the olive experiences pit-hardening, reduces fruit size and thus olive yields (Zeleke et al. 2012). Excluding October, the first month of the season, precipitation decreased in 13 of the 15 sample areas between the baseline and second follow-up seasons. The median decrease was 68mm, or 24 percent (Figure IV.4). (The results for the first follow-up season were similar whether or not October was included, not shown.)

Figure IV.4. Changes in annual precipitation in the 15 irrigated olive areas included in the farmer survey between the baseline and follow-up seasons



Source: TAMSAT (Tarnavsky et al. 2014; Maidement et al. 2014).

Note: Sample size is 15 irrigated olive areas. Precipitation in each season covers the period from October until the following September unless otherwise indicated. Each box indicates the 25th percentile value (bottom), median (middle line), and 75th percentile value (top). The vertical bars indicate the maximum and minimum values. Across all seasons between 2008-2009 and 2016-2017, median annual precipitation was 388mm.

Overall, the evidence suggests that having two seasons of follow-up data was likely insufficient to fully account for annual fluctuations and long-term trends in external conditions, especially those related to climate. The estimated pre-post changes in Chapter VI are likely to reflect both the effects of the project and those of less favorable climatic conditions at follow-up relative to baseline. Nevertheless, our estimates provide useful evidence on the extent to which farmers' outcomes changed in absolute terms after the project was completed.

There is a possible lack of comparability in the baseline and follow-up surveys.

For a pre-post study, it is ideal to ensure the comparability of the baseline and follow-up data by using the same survey questions, including providing the same probes and clarifications to respondents so that the questions are understood in the same way. However, in this pre-post study, the baseline was conducted by a different organization, and the description of the questions in the baseline survey manual was limited. Further, given the necessary additions to the

baseline survey, we had to consolidate some items to avoid the follow-up survey becoming too long. For example, the baseline survey included very detailed disaggregation for items related to costs, reporting each cost separately for each crop and type of animal; in the follow-up, we aggregated these cost categories across all crops and animals. In this way, we sought to obtain comparable data across rounds without imposing an unreasonable burden on respondents. However, we cannot rule out that some of the survey responses might have been affected by differences in survey administration or topics covered. Finally, because some key outcome measures were not available in the baseline data, we asked about those outcomes retrospectively in the first follow-up survey, which might have introduced recall bias for the baseline measures.

We are unable to generalize the findings to all targeted olive areas.

We are unable to generalize the study findings in the irrigated olive areas to all olive areas that were targeted by the activities. Specifically, although the project affected 65 irrigated olive areas, the baseline sample for the farmer survey consisted of 15 areas drawn from a sample frame of 30 areas expected to be among the first to receive the irrigation infrastructure investments. As described above, we chose 6 olive areas for the qualitative study from these 15 to enable us to triangulate the quantitative and qualitative findings.

These 15 areas are not representative of all 65 irrigated olive areas that ultimately benefited from the activities. In particular, their geographic distribution is substantially different from the other 50 areas (Figure IV.5). On average, they also have substantially larger surface area, have more farmers, and had more irrigation infrastructure works completed through the project (Table IV.5), although average farm size is similar. Because the effects of the activities in irrigated olive areas could vary based on these (or related) area characteristics, our findings do not necessarily generalize to the full set of affected areas.[14] Nevertheless, the findings still provide useful suggestive evidence on the effects of the project activities in the irrigated olive areas. For date areas, a lack of generalizability is of less concern because the areas for the qualitative study were selected to reflect the variation across all affected date areas in geography and infrastructure improvements, and the sample covered a much larger fraction of the total number of affected areas (one-half of all date areas compared to less than one-quarter of all olive areas).

[14] We could at best generalize the estimated pre-post estimates to the 30 areas in the 2010 sample frame. However, it would entail a loss of statistical power (because we would have to take into account the sampling of areas); therefore, we did not attempt to generalize beyond the 15 olive areas sampled at baseline.

Figure IV.5. Region of irrigated olive areas included in the farmer survey sample

Source: Administrative data provided by APP.

Note: Regions are shown as they were defined during the Compact period.

Table IV.5. Characteristics of irrigated olive areas included in the farmer survey sample

	Mean in sample areas	Mean in non-sample areas
Surface area of arable land (hectares)	1,235	309
Total number of farmers	906	281
Surface area of arable land per farmer (hectares/farmer)	1.74	1.56
Surface area of olive cultivation (hectares)	560	179
Length of *seguias* rehabilitated (kilometers)	16.8	5.6
Total cost of irrigation works (DH)	20,855,585	5,050,369
Sample size	**15**	**50**

Source: Administrative data provided by APP.

Note: All differences between the sample areas and non-sample areas are statistically significant at the 1 percent level except for the difference in surface area of arable land per farmer, which is not statistically significant.

V. USE AND STATUS OF PROJECT INVESTMENTS

In this chapter we assess how and to what extent farmers in the irrigated olive and date areas are using the project investments and what the current status of these investments is, several years after the end of the project. We begin by describing stakeholders' perceptions about the improved irrigation infrastructure and its physical condition. Next, we assess whether the water user associations supported by the project were functioning as envisaged. We also examine the extent to which farmers participated in FTPP trainings on new practices and how widely they adopted these practices. Finally, we explore how extensively farmers are using the olive oil and date units managed by GIEs.

A. Infrastructure improvements and current condition of infrastructure

The project made a variety of improvements to the irrigation network in olive and date areas, including the following:

- Lining the *seguias* with concrete or, in some cases, building new concrete *seguias* (Figure V.1). The project focused on primary *seguias*, which transport water from the water source to the cultivated part of the area. (Secondary and tertiary *seguias* transport water from the primary *seguias* to farmers' parcels.)
- Using concrete to rehabilitate or construct *khettaras*, with wide-diameter shafts and channels to facilitate access for maintenance (Figure V.1 and Figure V.2).
- Replacing existing earth and sand structures with diversion weirs made of modern materials and design and constructing a large new diversion weir to capture water from flash floods (from summer thunderstorms) in El Khorbat, one of the date areas (Figure V.1 and Figure V.3).
- Constructing other infrastructure such as water storage basins and protective walls

The type of irrigation infrastructure improvement implemented in the areas included in the evaluation varied (Table V.1). All 15 irrigated olive areas that were included in the farmer survey had some improvements in *seguias*, ranging from just a few kilometers (for example, in Tamazozt) to more than 40 kilometers (in Outat Lhaj). A handful also had either diversion weirs or *khettaras* constructed. *Seguia* improvements in the date areas, like those in the olive areas, varied substantially in length, from less than one kilometer (Akka) to more than 40 kilometers (Todgha).

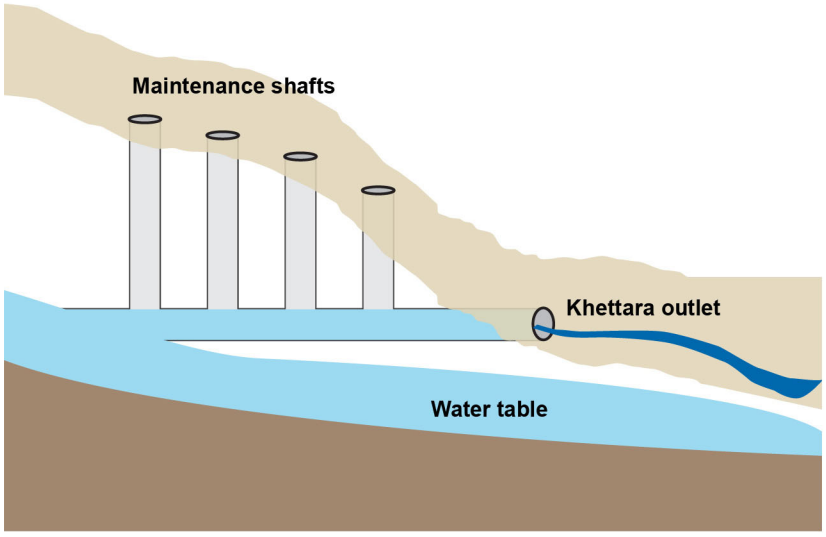
Diversion weirs were more common in date areas than in olive areas and, as noted, included a large new diversion weir in El Khorbat to capture water from flash floods. A few date areas (Akka and Tadakoust) also benefited from rehabilitated *khettaras*.

Figure V.1. Irrigation infrastructure improved by the project

Source: Mathematica.

Note: Photographs show (1) non-rehabilitated *seguia* (top left), (2) rehabilitated concrete *seguia* (top right), (3) *khettara* maintenance shaft (bottom left), and (4) diversion weir in El Khorbat (bottom right).

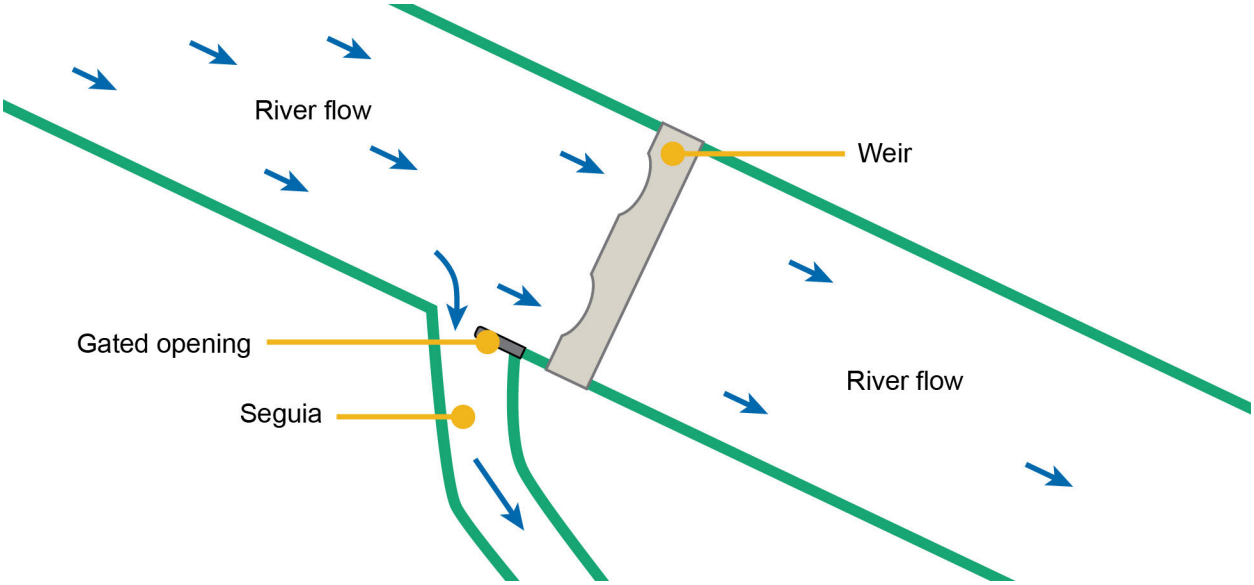
Figure V.2. Khettara structure



Source: Mathematica

Note: A *khettara* is a gently sloping underground channel or tunnel constructed to lead groundwater from an aquifer/water table to the surface. It is typically constructed with vertical shafts along the channel leading to the surface for ventilation and maintenance access.

Figure V.3. Diversion Weir structure



Source: Mathematica

Note: A diversion weir commonly takes the form of an obstruction in the river that raises the upstream water level, creating an overflow that can be diverted into a side channel or Seguia for irrigation; in El Khorbat, it consisted of infrastructure to direct floodwaters into a concrete storage basin.

Table V.1. Infrastructure works in areas included in the study sample

Area	Province	Cultivated area (hectares)	Approximate number of farmers	Seguias (km)	Diversion weirs (number)	Khettaras (km)	Cost of works (millions of dollars)
Olive areas							
Foum Anceur	Beni Mellal	700	212	7.5	2	0	0.3
Outat Lhaj	Boulemane	2,100	1,105	43.0	1	0	4.7
Tassa	Boulemane	415	136	19.3	0	0	1.9
Chichaoua Amont	Chichaoua	2,775	1,880	18.8	3	0	3.6
Tadighouste	Errachidia	390	765	8.4	0	0	1.9
Bnitadjit*	Figuig	1,232	699	8.1	0	1.0	2.8
Assaka El Broj*	Khénifra	182	120	7.0	0	0	0.5
Ouaoumana*	Khénifra	800	1,354	20.0	0	0	1.3
Ourika	Marrakech	2,000	1,300	27.5	0	0	4.1
Tahanout Ghmat*	Marrakech	3,300	1,316	17.1	0	0	2.8
Tamazozt*	Marrakech	570	2,450	2.6	0	0	1.8
Gourrama	Midelt	1,380	674	21.4	0	0	1.8
Rich*	Midelt	1,739	1,085	33.6	0	0	3.9
Zekkara	Oujda	250	107	4.3	0	0	2.7
Louata	Sefrou	690	386	14.0	0	0	8.9
Date areas							
El Khorbat	Errachidia	1,200	260	18.7	1	0	5.1
Aoufous	Errachidia	2,377	1,955	17.7	0	0	1.9
Akka	Tata	645	350	0.3	8	0.2	2.2
Tadakoust	Tata	88	96	1.5	0	1.7	0.8
Todgha	Tinghir	2,090	3,424	42.5	6	0	6.7
Draa	Zagora	9,072	7,164	20.3	6	0	8.1

Source: Administrative data provided by APP.

Note: All 15 olive areas in the table were included in the farmer survey, and the six olive areas denoted with asterisks (*) were also in the qualitative sample. All six date areas shown here were in the qualitative sample.

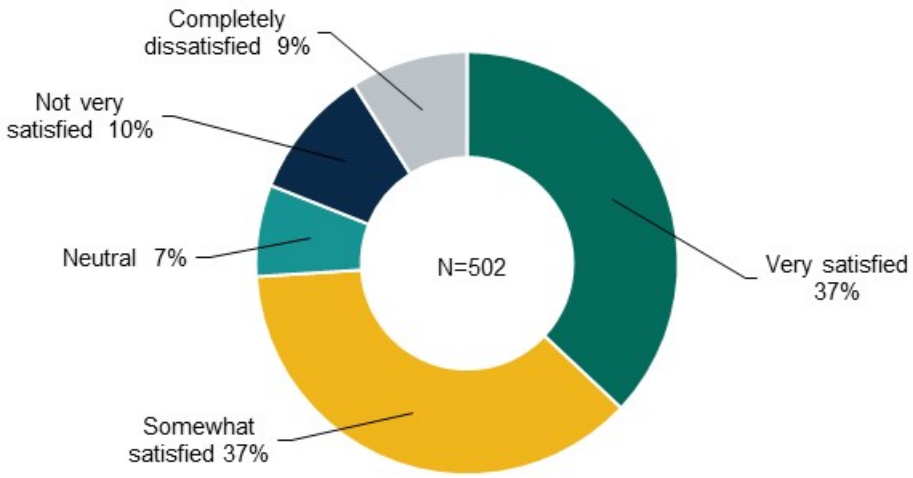
The irrigation improvements, particularly the rehabilitated *seguias*, were generally of high quality and are mostly still in good condition.

There was broad agreement among key stakeholders that the improvements to irrigation infrastructure in both the olive and date areas were largely implemented as planned, and that the work during the compact period was well managed and effectively supervised by APP. There was also strong consensus that the work was high in quality, and that the infrastructure was still in good condition about five years after the end of the project. In keeping with the qualitative findings, about three-quarters of the respondents to the second follow-up farmer survey in the olive areas reported being either very satisfied or somewhat satisfied with the project's improvements to the irrigation infrastructure (Figure V.4), and a similar proportion reported that the infrastructure was in good or very good condition in 2018 (Figure V.5). One MAPM office representative suggested that the high quality of the FTPP-funded works could be attributed to the project selecting contractors based on quality and not price, as well as APP having the right human resources to monitor the work closely. More broadly, several stakeholders noted that the FTPP's high construction standards have raised the bar for similar projects and have been emulated in subsequent infrastructure projects funded by local authorities, MAPM, and other donors, although these projects are typically much smaller in scale than the FTPP.

> *"The American project imported a new concept. It built seguias according to international standards and modern construction techniques, and used cement, concrete, and iron."*
>
> –Olive farmer

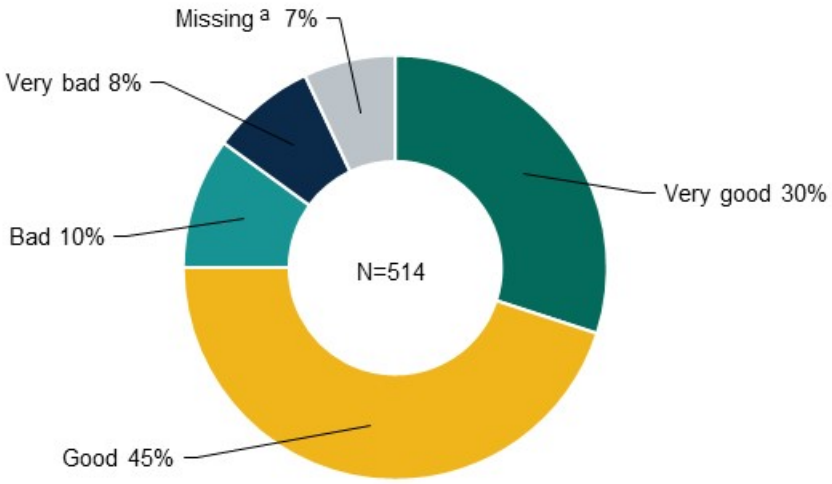
> *"For example, the regional council built new seguias that followed the construction standards of the seguias built by the American project. Before, cement and iron were not used in the seguias, but since the American project, all the programs that followed have used cement and iron. That means they were influenced by the American project."*
>
> –Date farmer

Figure V.4. Farmers' satisfaction with FTPP infrastructure in irrigated olive areas, 2018



Source: 2018 follow-up farmer survey in irrigated olive areas.

Figure V.5. Farmers' perceptions of condition of FTPP infrastructure in irrigated olive areas, 2018



Source: 2018 follow-up farmer survey in irrigated olive areas.

[a]Could include respondents who were in the parts of the affected areas that were not reached by improved irrigation infrastructure, or in areas where the infrastructure had been destroyed (for example, by flooding).

Despite high overall levels of satisfaction with the irrigation improvements, some stakeholders were dissatisfied with them.

In focus groups and interviews, a few farmers and other stakeholders expressed dissatisfaction with the irrigation infrastructure, and about one in five respondents to the olive farmer survey said they were either not very satisfied or completely dissatisfied with the infrastructure (Figure V.4). Farmers in the focus groups attributed their dissatisfaction to (1) incomplete project coverage of the infrastructure within each area, (2) technical flaws in some of the works, and/or (3) lack of follow-up after the project. Next, we provide more details on each of these reasons.

First, in most areas, improvements typically did not cover the entire irrigation network, and only part of the area or even part of a given *seguia* or *khettara* was rehabilitated because of budget limitations. Thus, some farmers in project areas did not directly benefit from the

> *"The khettaras, seguias, and deviation weirs are in good condition. However, the khettaras were only partially rehabilitated: they built 30 meters, but you need 40 more meters to connect to the seguia … it's as if nothing has been done because the khettaras should have been fully rehabilitated or not rehabilitated at all."*
>
> –Olive farmer

improvements,[15] and the improvements were diminished where only part of a given *seguia* or *khettara* was improved because irrigation water was absorbed and slowed down when flowing through the unimproved sections. Stakeholders in both olive and date areas also noted that more work remained to be done to improve irrigation in their areas (for example, lining additional parts of the primary *seguia* with concrete, and lining secondary *seguias*).

Second, dissatisfaction in some cases was a result of technical flaws in the works. Most of these flaws were minor; for example, doors between the main *seguia* and secondary *seguias* were not installed (so farmers still had to use stones and earth to control the water, a laborious task); there were sharp curves in the *seguia* (resulting in water overflowing); *seguias* were too high relative to the river (requiring farmers to construct traditional diversion structures, which are easily destroyed by the river); there were small-diameter exit pipes from *khettara*, and blockages to the exit of the *khettara* because of reinforced concrete (limiting the water provided by the *khettara*). In the most serious case, there was a major design flaw in the *khettara* constructed in part of the Bnitadjit area, and it could no longer provide water. The flaw was not addressed, so farmers who relied on the *khettara* could no longer cultivate their plots and had to migrate from the area.

Third, in many cases where there was a technical flaw or incomplete work, farmers believed their requests to the local MAPM offices had not been met with any follow-up. Several stakeholders involved in implementation, as well as one MAPM office representative, thought the project closeout was rapid, and there was not enough of a transition period, which might partly explain the perception that there was no follow-up on these technical issues.

> *"Water became abundant, and the flow became strong, but at some points the water tends to overflow. Currently, people use bricks to deal with this problem, but it is not enough. Once, an architect came and put red crosses on these parts so they would be rebuilt, but these modifications were not executed, and we still have the same problem now."*
>
> –Olive farmer

Nevertheless, most of these issues did not substantively hamper the use of the improved irrigation infrastructure. In the next section, we assess how this infrastructure was managed.

B. Water user associations

In Morocco, management of water resources for irrigation traditionally falls under the supervision of traditional associations, known as *Jmaa*. Each association has a leader (*sheikh* or *mokadem*), and the water management is regulated by customary laws based on inherited water

[15] We were concerned that some of the farmers selected at baseline for the farmer survey sample might have been located in parts of the project areas that were not reached by the FTPP infrastructure improvements. Therefore, we asked respondents to the follow-up survey whether they were directly affected by these improvements; about three-quarters of the sample reported that they were. These farmers were substantially more likely to be satisfied with the FTPP improvements than those who were not directly affected (20 percentage points more likely to be very satisfied, 9 percentage points less likely to be dissatisfied, and 12 percentage points less likely to be very dissatisfied; not shown). In Chapter VI, we note the implications of restricting the analysis sample for estimating project effects to these farmers.

rights. However, these traditional associations do not have legal status under local laws, and did not have the authority to interact with APP and the FTPP contractors. The project required the areas served by the improved infrastructure to have legally recognized water user associations. In Morocco, these are typically known as "modern" water user associations, or *Associations d'Usagers des Eaux Agricoles* (AUEAs).

The first AUEAs were introduced several years before the FTPP. These were legally recognized entities that could interface with MAPM and donors to agree to and oversee development projects in their areas. To meet FTPP requirements in project areas, AUEAs that already existed had their boards renewed, and new AUEAs were formed where they did not exist. The project also provided technical assistance to the AUEAs, including training on topics related to administrative and financial management. In this section, we explore how functional AUEAs in the project's olive and date areas were and how engaged farmers were with them.

The modern AUEAs played a supervisory role during the irrigation works, but most of them have not been very active since the project ended.

The AUEAs are supposed to be responsible for overseeing irrigation works, managing maintenance, overseeing the allocation of water to farmers, levying membership fees and fines, approving changes to infrastructure (such as digging new intakes from the primary *seguia*), and resolving water-related disputes—taking over these functions from the traditional associations. During the implementation of the FTPP, the AUEAs approached APP and MAPM when farmers objected to the planned location of some of the diversion weirs or routes of new *seguias*. The AUEAs also played a supervisory role while the irrigation works were in progress.

However, since the end of the FTPP, most AUEAs have become inactive and do not hold regular meetings. Some have even become completely dysfunctional—for example, in one date area, the only two active members of the AUEA's management passed away, and they were never replaced. There are several reasons why the AUEAs are not functioning well. First, among all the responsibilities of water user associations in the project-affected areas, managing maintenance of irrigation infrastructure has traditionally been the most substantial one. Since the FTPP-funded infrastructure improvements were completed, maintenance needs have substantially decreased, relieving most of the associations' workload. (The AUEA leaders we interviewed were located in parts of the irrigated areas where the infrastructure improvements were concentrated, and hence where maintenance needs would have decreased the most.) Second, another major function of the modern AUEAs is to interact with external entities conducting irrigation works in their areas. However, there have been no other major works in the project-affected areas since the end of the FTPP, so it has not been necessary for the AUEAs to take up this function. Third, farmer engagement in the modern AUEAs is generally limited because, as described below, traditional associations continue to manage irrigation in most areas, even where AUEAs exist. Many farmers are skeptical of the modern AUEAs, preferring the traditional approach; most are not officially members and/or do not pay annual fees, although these are nominal. In the second follow-up survey in olive areas, only 15 percent of respondents reported being a member of a modern AUEA, and only 11 percent of respondents reported paying membership fees to the AUEA (not shown).

Traditional irrigation management practices are largely continuing regardless of the existence of modern AUEAs.

Even when AUEAs exist and are active, they typically follow traditional customs in managing water rights and maintaining infrastructure. In particular, they are still guided by inherited rights through the *tour d'eau,* and to conduct maintenance, they rely on community contributions of labor and/or funds in proportion to each individual's water rights, although these rights and maintenance practices have been formalized through the AUEA's regulations. In some areas, these practices are now managed exclusively through the AUEA, with community leaders who led the traditional associations sometimes serving on the AUEA's board. More commonly, however, these community leaders simply continue to manage the distribution of water and community contributions for maintenance in parallel with the AUEA. In the olive areas, only in one of the six farmer focus groups did any farmers report that the AUEA in their area had taken over from the traditional association, raising membership fees and using them to coordinate maintenance.[16] Thus, regardless of their functionality, the new AUEAs by and large have not substantively affected irrigation management in the project-affected areas.

> *"It was the AUEAs that oversaw the work and the interventions of the State. They were created mainly for this purpose: to take care of the management and maintenance of the seguias at the end of the project. Despite our efforts to formalize the [traditional association] to abide by the law and the association standards, the inhabitants have preserved the ways of the old [traditional association] which oversees the organization of the tour d'eau and collects money to maintain the seguias based on water rights."*
>
> –MAPM office representative

> *"In some cases, farmers use traditional associations even though the formal AUEA is already set up, because only the traditional association knows the water rights well and protects customs. This knowledge is shared by elders who know the rules, customs, and ancestral practices of water sharing, whereas the AUEAs are new associations, generally formed by young people, which usually maintain relationships with preexisting traditional associations through advice and knowledge sharing "*
>
> –MAPM office representative

[16] Where the AUEAs coordinate maintenance or hire external labor for maintenance, they raise funds in various ways: (1) membership fees, which are typically in proportion to plot size or water rights (although these fees are low, many members do not pay); (2) fines for violating AUEA rules (for example, polluting the *seguia*, creating intakes from the primary *seguia* without the AUEA's permission, or not participating in maintenance efforts); (3) renting of water rights, a portion of which have been allocated to the AUEA by farmers; or (4) additional monetary contributions requested from farmers for specific maintenance efforts, again typically in proportion to plot size or water rights.

C. Farmer training: participation and practice adoption

The FTPP offered trainings on a variety of modern production techniques to both olive and date farmers in irrigated areas. For olive farmers, the training sessions covered topics such as techniques for pruning olive trees, applying pesticide, fertilization and soil tiling, and harvesting. For date farmers, they covered topics such as pruning date palms, cleaning offshoots and undergrowth, planting offshoots and new seedlings, and harvesting techniques. Training sessions typically lasted half a day, were conducted in a central location, and sometimes included a practical component or field demonstrations. In this section, we describe self-reported training attendance and farmers' adoption of practices taught during the trainings in the irrigated olive and date areas.

Most farmers did not attend FTPP trainings, although there is some evidence of knowledge spillovers from those who attended in the date areas to those who did not.

According to farmers who participated in the focus group discussions, as well as other stakeholders, only a minority of farmers in irrigated olive and date areas attended FTPP trainings. This qualitative finding is consistent with the farmer survey data in olive areas: only about one-fifth of respondents reported that they, or a member of their household, attended any FTPP training (Figure V.4).[17] Olive farmers who did attend FTPP trainings were most likely to have attended a session on pruning techniques, followed by those on olive harvesting, pesticide treatments, and fertilization and soil tilling (Figure V.6). More than two-thirds of respondents who attended trainings reported attending more than one training module, and about one-quarter of those who attended said they went to all four main modules (not shown). Further participation in trainings since the end of the FTPP has been negligible; only about 4 percent of all respondents reported attending any other agricultural trainings since the end of the project.

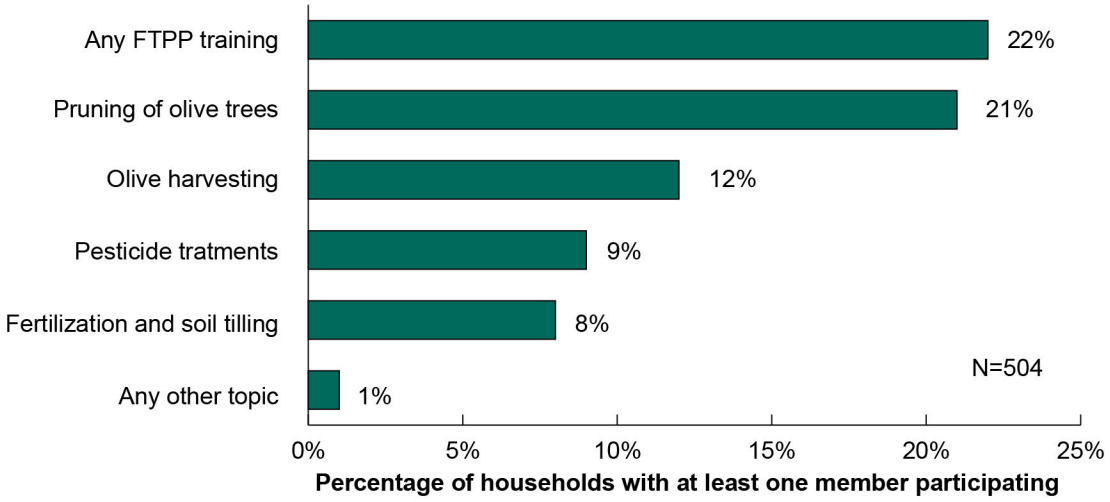
[17] Some caution is necessary in interpreting these findings, because most of the trainings would have been completed several years before the 2017 follow-up farmer survey in which we asked these questions. Therefore, it is possible that some respondents' recollections of their training participation were inaccurate.

There is some evidence that, at least in the date areas, knowledge about new practices might have spilled over from training participants to other farmers. Specifically, farmers in some of the focus groups noted that the new pruning practices taught in FTPP trainings had diffused by word-of-mouth and in opportunities to observe peers, and had become widespread in their areas. However, farmers did not mention the diffusion of other practices (which, as noted below, are generally more challenging and expensive to implement than pruning).

"The training also affected farmers who did not attend. We cannot deny that there was knowledge sharing between farmers. Thus, it is impossible to find a farmer who grows Almajhoul dates and who does not prune his palm fronds. Although the degree of pruning varies from one farmer to another, pruning is one of the training benefits that has been generalized to the whole community. It is impossible now to find a farmer who lets his date fronds grow wild because he knows that the fruit on half of the fronds would rot during harvest time ... Even if you did not attend the trainings, you use this technique."

–Date farmer

Figure V.6. Farmer participation in FTPP trainings in irrigated olive areas



Source: 2017 follow-up farmer survey in irrigated olive areas.

Note: Training participation was captured retrospectively in the 2017 follow-up farmer survey; most trainings were conducted in 2011 or 2012.

Most farmers who did attend trainings were satisfied with them, but not all of them adopted the new techniques because of financial constraints and other barriers.

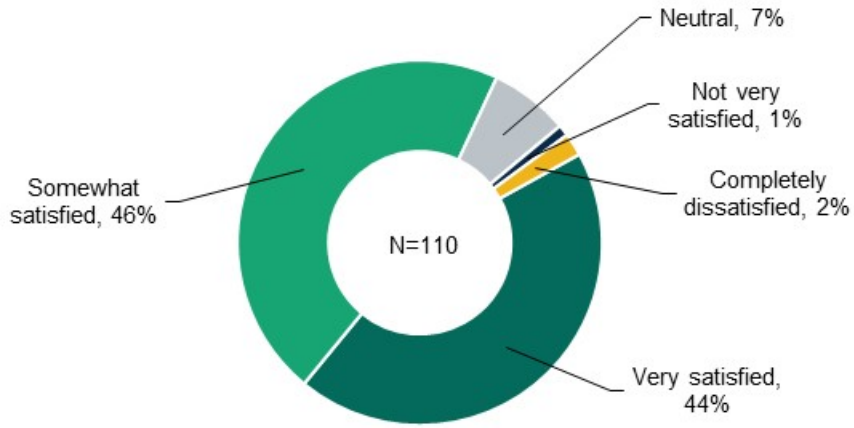
Nine in ten respondents to the olive farmer survey who attended FTPP trainings were either very satisfied or somewhat satisfied with them (Figure V.7). Despite these high levels of satisfaction, most of the olive and date farmers who attended trainings did not apply the new training techniques, according to farmers who participated in focus groups. The survey findings in olive

areas are consistent with this: less than half of the respondents who attended the trainings reported applying the new information. (Others said they applied a little of the information or did not apply it at all.) (Figure V.8). A prior impact evaluation of the FTPP training in rain-fed olive areas (which was similar to the training in irrigated olive areas, and conducted one year after the last trainings) also found no evidence of positive impacts on the adoption of any of the new techniques after accounting for selection bias (Amer et al. 2013).

Financial constraints, low levels of literacy, and resistance on the part of farmers to start practicing unfamiliar techniques were common reasons cited by olive farmers for the low take-up of new practices. These barriers have persisted since 2013, when NORC documented that olive farmers in rain-fed areas hesitated to apply the new techniques—mainly because they lacked both skilled labor and the means to purchase the necessary inputs. For farmers in date areas, financial constraints were also a reported barrier to adoption, particularly for practices that require hiring labor, such as cleaning offshoots and undergrowth, or purchasing inputs, such as pesticide application. Olive and date farmers who participated in focus groups reported implementing pruning more often than the other techniques covered by FTPP training—possibly because it was the cheapest to implement. The timing of the training might also have influenced the take-up of new techniques. For example, farmers in one date area noted that the trainings were conducted when they could practice the new techniques at the same time they were being trained on them, but in another date area, a drought struck soon after training, and farmers could not start implementing the practices they were learning right away.

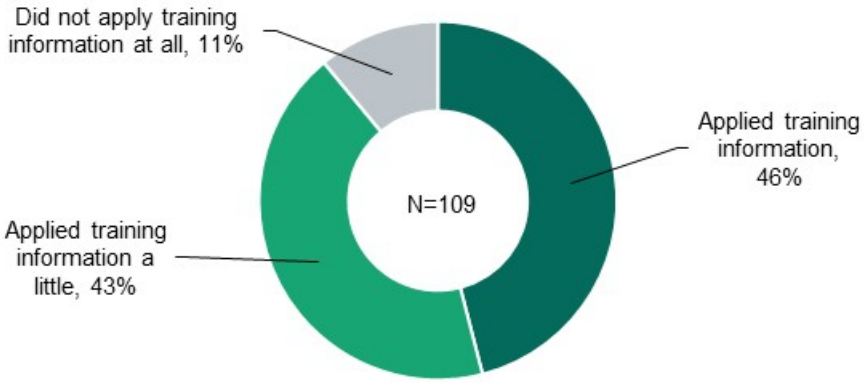
There was also limited adoption of practices that were unique to the date areas, and this could have made it harder to sustain other project components in these areas. One example of this limited adoption was in cleaning offshoots and undergrowth; as they grew back the cleaning FTPP implemented in those areas was hard to sustain. (Nevertheless, MAPM office representatives noted that the project influenced subsequent offshoot and undergrowth cleaning efforts funded by MAPM and other donors to improve in terms of design and quality.) Similarly, many of the date seedlings that FTPP provided did not survive to maturity because the farmers did not follow the proper planting and seedling care techniques as taught in the trainings. (Farmers reported that some of the seedlings were varieties of date unsuitable for the area that have not produced well.)

Figure V.7. Satisfaction with FTPP training, among farmers who attended trainings in irrigated olive areas



Source: 2017 follow-up farmer survey in irrigated olive areas.

Figure V.8. Adoption of FTPP practices, among farmers who attended trainings in irrigated olive areas



Source: 2017 follow-up farmer survey in irrigated olive areas.

D. Postharvest infrastructure managed by GIEs

The FTPP invested in postharvest infrastructure in both olive and date areas. In olive areas, the project partially funded 20 new, modern, large-scale olive-crushing units for producing and storing olive oil, which were managed by GIEs. It also gave GIE management technical assistance on operating and managing the units and commercializing olive oil. In date areas, the project provided equipment for seven new, modern packaging and cold storage units for dates, and technical assistance to GIE management.

The program logic assumed these investments would improve the quality of olive oil and dates (and generate out-of-season sales for dates), which in turn would increase revenues for farmers. In this section, we examine farmers' use of the olive oil and date units and whether they were able to improve their profits as a result. As noted, we intend to cover the functioning and effects of the project-funded olive-crushing units more extensively in a second final evaluation report related to the Catalyst Fund activity. Therefore, in this section we focus mainly on the date units, but start with a brief discussion of how farmers engaged with the olive units, which might have affected the benefits of the project in the irrigated olive areas.

1. Olive GIEs

Olive farmers have engaged only minimally with cooperatives and GIEs.

Based on the qualitative data we collected, many of the olive GIEs set up by the project are not operating according to the original model of buying olives from farmer cooperatives and sharing the profits from olive oil sales (dividends) with farmers. This is largely because the GIEs do not have enough working capital to pay farmers upfront for their olives. The GIEs have also not been returning dividends to farmers because they (the GIEs) have struggled to sell the olive oil they produce at a profit; most of the profits that are generated are used to service the debt on the large bank loan the GIEs received to help establish the units.

As a result of these financial challenges, many farmers are reluctant to sell their olives to the GIE, preferring to sell unharvested olives on trees to intermediaries who can pay them immediately or in advance. Farmers who do use the GIE crushing units mainly use them to crush their own olives, which enables them to sell the oil immediately (or keep it for personal use). Moreover, for many farmers in the focus groups, the distance to the crushing units kept them from accessing the units. Overall, most farmers in the focus groups did not believe the GIEs had substantially improved their profits, although some of them did bring up benefits like improved yield and quality of oil from the olives they crushed at the GIE, as well as complementary services provided by the GIE, such as crates and transport.

"The only limitation in all of this was that the farmers' involvement in the GIE was not efficient. The farmers are not really involved in the GIE: they just bring their olives and wait to get them crushed. As soon as the olives are crushed, the farmers pick up their olive oil and handle the commercialization themselves. There isn't this concept of the farmers bringing all of their olives and keeping only the minimum for their own needs, leaving the rest to the GIE to commercialize on their behalf at the best price to get a better profit margin."

–Olive farmer

The data from the olive farmer survey are broadly consistent with the finding that farmers were not especially engaged with the GIEs (Table V.2). In the second follow-up survey round, less than one-third of respondents reported that farmers in their area had access to a modern olive oil crushing unit managed by a GIE, and only 14 percent reported being members of an olive cooperative. Further, very few farmers—less than 1 percent—had sold any olives to a GIE or to a cooperative that sells to a GIE in the last two years, and no one had received any dividends from a GIE in those years (not shown). However, 15 percent said they had used a GIE to crush their own olives.

Stakeholders involved in establishing and supporting the GIEs highlighted the poor functioning of the cooperatives that make up the GIE as another major challenge to the GIEs' operating as envisaged. Many of these cooperatives were created toward the end of the Compact (as were the GIEs), and might not have had enough experience or support to effectively participate in the GIE despite the support from the project. Creating effective cooperatives is especially difficult, because farmers in these areas were not used to cooperating to commercialize their products. In this context, some stakeholders suggested that farmers' active participation in cooperatives would require a substantial change in social norms, which the project might have needed to focus on more intensely and explicitly.

Table V.2. Farmers' membership in olive cooperatives and use of olive-crushing units: farmers in irrigated olive areas

	Sample size	Percentage
Member of an olive cooperative (2016–2017)[a]	528	14%
Farmers in area have access to GIE (2016–2017)	498	29%
Sold olives to a GIE or a cooperative that sells to GIE (2016–2017)	520	<1%
Sold olives to a GIE or a cooperative that sells to GIE (2015–2016)	522	<1%
Used GIE crushing services (2016–2017)	500	15%

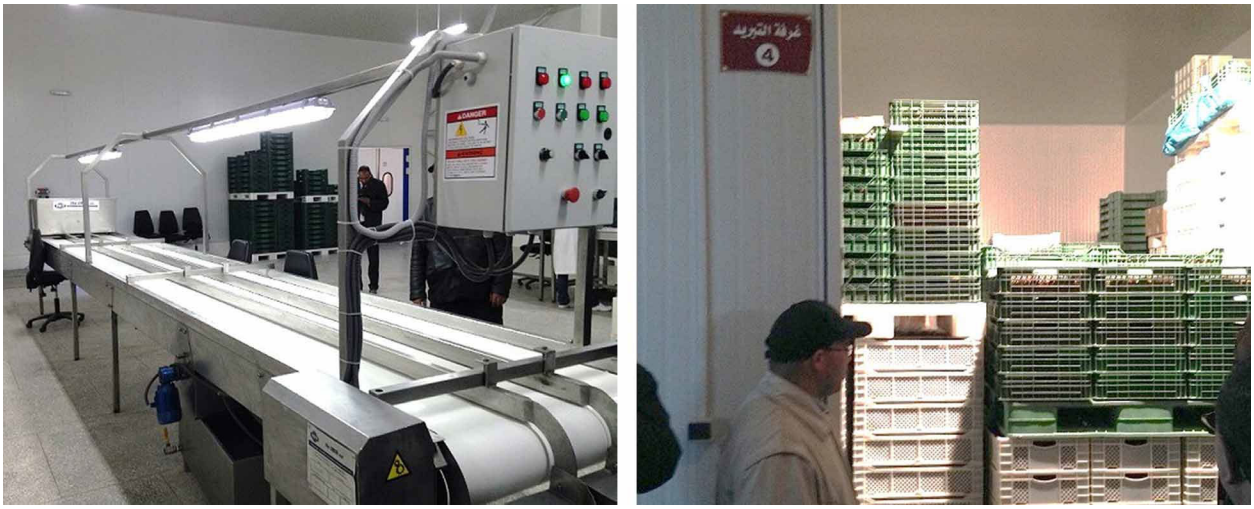
Source: 2018 follow-up farmer survey in irrigated olive areas.

[a]Includes olive oil and/or table olives. All farmers who reported being members of a table olive cooperative were also members of an olive oil cooperative, possibly because there were no separate table olive cooperatives.

2. Date GIEs

The GIE-managed date processing units were funded by MAPM, and FTPP provided the equipment and trained the GIE management in technical, administrative, and financial matters. There are some differences in infrastructure and the equipment across units. All units in our sample had an area for receiving dates, an area for sorting dates, and refrigerated rooms for storage (Figure V.9). Three of the four units also had a fumigation room. Some units also had machines for washing, hydrating, drying, and coating dates. In at least one unit in our sample, the sorting and packing rooms were combined (which is not a recommended practice because of the risk of cross-contamination from defective dates), and some GIEs relied on manual sorting even when there was a sorting line (for example, one of the GIEs operating at a minimal capacity relied on manual sorting to save on electricity). A few units have other facilities and equipment like laboratories, offices, and refrigerated vans for transporting dates.

Figure V.9. Equipment at a date GIE processing unit



Source: Mathematica.

Note: Photographs show (1) sorting equipment (left), and (2) dates stored in crates in a refrigerator (right).

Although all the date units are in good condition, some of them do not have all the equipment they need to operate effectively.

Date GIEs all reported that their units were in good condition because they have only been operating for a few years. Most have only required minor repairs to the infrastructure and equipment since they were created. However, some GIEs were slow to start because they didn't have all the necessary equipment or infrastructure. For example, many GIEs had no source of water when they were first established, but they have since dug wells and constructed water towers. One of the GIEs in our sample also did not have an electricity connection when it was officially launched, which delayed the start of operations. Since the end of the project, some GIEs— with the help of the regional offices and agencies such as ANDZOA and the Belgian development agency[18]—have been able to acquire additional equipment such as vacuum

[18] The Belgian development agency, currently called Enabel, was known as Belgian Technical Cooperation before 2018.

machines, humidifiers, scales, crates, pallets, and shelves, and to make small repairs to existing equipment. Some of the equipment provided by the project was not being used—particularly the machine to coat the dates. (GIEs reported that this was because Moroccan consumers dislike dates that have been through this type of treatment.)

GIEs noted a lack of certain types of equipment, particularly crates and pallets that meet *Office National de Sécurité Sanitaire des produits Alimentaires* (ONSSA, the Moroccan food safety agency) requirements. One of the GIEs also mentioned only having refrigerators for storage, not freezers. Farmers prefer freezers because some common varieties of dates are moist and tend to rot if they are not stored at below-freezing temperatures. To be stored in refrigerators, the dates need to be dried first, and this is not a common practice. Some farmers in our focus groups also said they were not using the GIEs because there were no freezers. In some cases, farmers had used the GIE unit when it was new, but their dates rotted because the temperature in the refrigerators was too high, and they do not plan to use the unit unless it acquires freezers. Some farmers stored their dates at cooperatives instead of the GIE because some of the existing cooperatives do have freezers, although their storage capacity is low. There were also some farmers who used privately owned freezers that were far away, although these are expensive.

> *"The problem is that we want to give the farmers crates, but they are not available. This forces us to accept any crate provided by the farmer. But on the other hand, we have a problem with ONSSA, which does not allow crates that do not fulfill its criteria and conditions."*
>
> –Date GIE president

> *"The hydration chamber and dryer is very important for preserving dates because once the dates are washed, they must be dried. But we have to dry them in the traditional way because the dryer does not work. We have some equipment, but we lack other equipment and have not been trained to handle and repair the equipment we need."*
>
> –Date GIE president

> *"There is also the factory: the date processing unit. But this unit is not complete because it does not have a negative temperature storage room. A few years ago, we had our dates there, but they ended up rotting because the temperature was not below freezing. And since this bad experience, we have stopped using this unit."*
>
> –Date farmer

Date GIEs have suffered from unstable and inexperienced management in their early years of operation.

Most stakeholders think GIE management still needs a lot of technical and managerial capacity building (for example, to know which varieties of dates can be stored in a refrigerator and do not need a freezer, how to treat dates before storage, how to operate some of the equipment, and how to ensure enough working capital). Stakeholders involved in implementation noted that some GIE leaders were unmotivated or uncharismatic—particularly older farmers who were selected out of respect for their seniority and not for their leadership abilities—and that this likely contributed to poor management and low participation rates by farmers. GIEs have also struggled with high management turnover because their managers typically work on a voluntary basis. To resolve these issues, several GIEs have hired paid managers, and one reported paying its manager partly on commission (based on date sales) as a performance incentive. The Belgian development agency is providing ongoing assistance to the GIEs, which includes support for management, equipment, and infrastructure, and working with farmers to encourage them to take advantage of the GIE.

"The reality is that the capacity of these units is beyond that of their managers. For a GIE to manage a 400T unit is not easy. It is not a GIE, it is an industrial factory. They cannot even manage a refrigerator because it's beyond their technical and financial capacity."

–Date GIE president

"We made a mistake: normally the GIE is responsible for receiving the product and organizing sales of the stored dates. For the past year, the GIE was only occupied with receiving dates without planning the commercialization, looking for markets, finding customers, and establishing purchase orders. This year, there will not be enough board members to carry out this task. We have appointed a management chair of the unit who will take care of three main steps: (1) receiving the dates; (2) controlling and sorting according to quality, quantity, and variety of dates; and (3) commercialization. The managing president will get a commission of up to 50 percent of what he has managed to sell. Thanks to this approach, the GIE can survive."

–Date GIE president

To operate the units, date GIEs rely on a variety of sources, including income from their services to farmers, contributions by cooperatives, subsidies or grants, and credit.

> *"The GIE members refused the credit proposed by Crédit Agricole. We refused because other GIEs we visited who took out this loan regret it. They told us: "It is better to suffer from these financing problems and to try to get by on your own rather than being stifled by the Crédit Agricole." This is why we prefer to find alternative solutions with the help of cooperative contributions and gradually improve our results year after year […]. It is true that on paper it seems easier to take out credit now, but we cannot foresee the nature of the season's harvest, nor the quantity of dates we will store, and the monthly credit payments are a tough reality*
>
> –Date GIE president

Most GIEs rely on providing paid services to farmers to cover some of their costs. These services typically involve sorting, storing, and packaging dates, although one GIE also mentioned providing fumigation services. After the GIE provides these services, farmers take their dates back and sell them themselves. This differs from the envisaged model of the GIE, which involves GIEs purchasing dates from cooperative members, selling them, and returning a share of profits to their members. Two of the four GIEs in our sample also receive monetary contributions from member cooperatives, and at least one other GIE intends to introduce a membership fee for cooperatives. A few GIEs reported receiving state subsidies and/or grants from ANDZOA for operating the unit. Only two of the four GIEs in our sample have been able to access and use credit to buy dates from farmers and operate the units. Others are wary of opening credit lines and have problems with cash flow as a result. Overall, the GIEs are still trying to determine a sustainable economic model because they are relatively new organizations.

Many date GIEs are not operating at a high enough capacity to cover their costs because farmers are reluctant to sell dates to the GIEs.

All the units were constructed with refrigerators that have similar storage capacity (typically 400 tons). However, the realized capacity depends on how each GIE has chosen to configure and manage the storage within the refrigerators (the extent to which the GIE uses shelving that requires the space to use a forklift, how the boxes are stacked, density of packing the dates, etc.). For example, the respondent of one GIE noted that if the GIE followed the storage guidelines recommended by the ONSSA, it would only be able to store 252 tons, but by using crates without pallets, it can store another 60 tons.

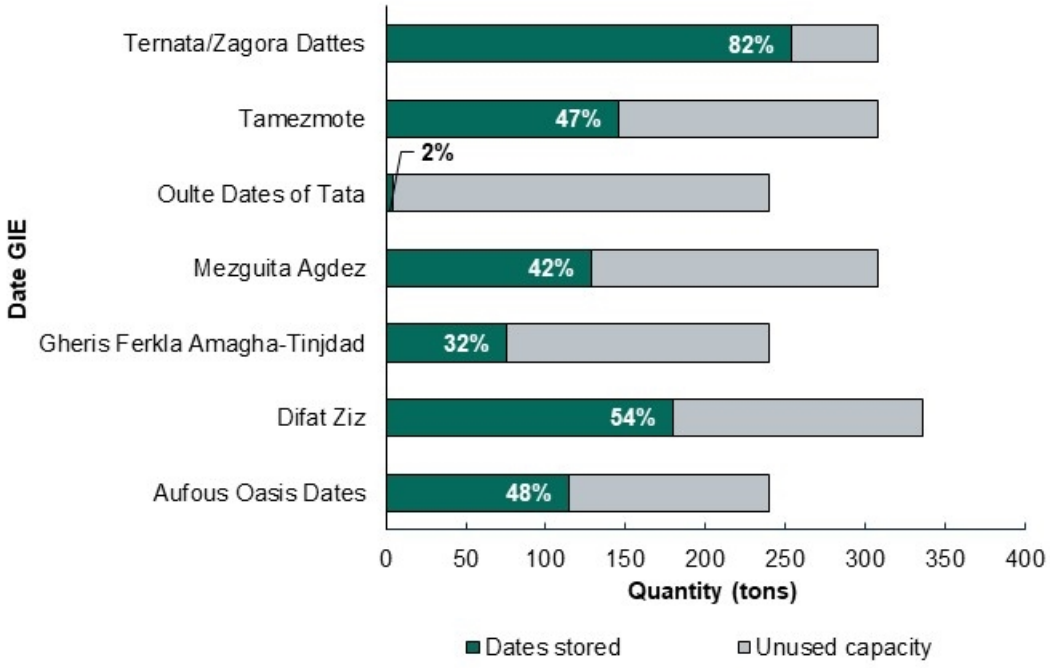
Except for one GIE, the amounts stored in the 2017–2018 season were well below capacity (Figure V.10). These amounts include dates stored as a service to farmers, as well as those purchased by the GIEs. (The intended model is for the GIEs to focus exclusively on purchasing and selling dates, instead of acting as a service provider.) Many GIEs have member cooperatives that do not actively sell dates to the GIEs, even though some GIEs have tried to impose minimum requirements on cooperatives. Date farmers have generally been slow to sell their dates to the GIEs because they can get money more easily and quickly by selling their unprocessed dates immediately after the harvest (even though in theory, they could obtain higher

revenues by processing and storing their dates for later sale). One GIE and a stakeholder involved in implementation suggested that farmers tended to sell their higher quality dates immediately after the harvest (at the *souk* or to intermediaries), and only used the GIE to store lower quality dates that they were unable to sell immediately.

Maintaining the unit at low capacity is not profitable because it is expensive to operate, mainly because of the electricity required to run the refrigerators. Many GIEs consequently have a budget deficit. A respondent from one GIE that has been operating well below capacity thought that instead of setting up one unit with a 400-ton capacity, the project should have set up more units of lower (50 tons) capacity in each area to reach a wider population. Moreover, he said there were several units with high storage volumes close to each other, all struggling to reach capacity. Overall, the new GIEs are still generally operating below capacity, even though their capacity covers only a small fraction of the date production in the area served.

> *"The financial situation is not good, because the quantities stored were very low and the costs were very high. Last year, we had losses. This year, if we have a profit, it will be very small. In previous years, we didn't work, but we still paid for the maintenance costs and the caretaker, and we could not cover the costs"*
>
> –AdS staff member

Figure V.10. Use of date GIEs, 2017–2018 season



Source: Administrative data provided by ANDZOA.
Note: Percentage of capacity used is shown within each bar.

GIEs have had some limited success with selling dates outside of traditional markets, particularly to supermarkets, but they need more help with commercialization and marketing.

The GIEs have been able to improve the quality of dates by enforcing stricter requirements at the sorting stage and by fumigating (at GIEs that conduct it) and properly storing the dates. The ONSSA has also played a big role in enforcing quality standards for dates. The GIE respondents believe that consumers and shops prefer the dates sold by the GIEs because of their better quality and the ability to trace back the source in case of problems with the dates. Although GIEs may not be able to supply dates to traditional markets at competitive prices because their dates are more expensive than those of other (lower quality) suppliers, some GIEs have been able to expand from traditional markets to local supermarkets, which are typically willing to pay more for dates that meet ONSSA standards. GIEs have not had much success in international markets, except for one GIE that reported exporting a small quantity to Jordan.

The GIEs also continue to face challenges in the domestic market related to competition from cheap imported dates. One GIE president also suggested that Moroccans produce too many varieties and cannot meet high local demand for certain varieties. Many GIE presidents said that the management did not receive support or training on marketing dates and have struggled with this critical aspect of their operations. Some of the GIEs mentioned that the Belgian and German development agencies are providing support to help GIEs with marketing (in addition to support to improve management of the units).

> *"There is a big difference between the price of processed and packaged dates at the GIE and the price of unprocessed dates sold directly by farmers. Even in terms of demand, the dates of the GIE are sought after because the mentality of the Moroccan consumer has changed […]. When shops buy from the GIE, they can return it because there is some trust. But this is not possible if they buy from informal souks. Some shops burn a few tons of dates that do not comply with hygiene standards, but when they buy from the GIE, they can return the purchase and they will be reimbursed."*
>
> –Date GIE president

> *"For this 2018–2019 campaign, a commission composed of the Belgian development agency and the GIE office was appointed to carry out an awareness campaign among the cooperatives. This year, the GIE will take care of marketing thanks to the Belgian development agency's training on commercialization and marketing. The Belgians and the GIE have established a partnership: the Belgians are committed to finding markets and taking care of marketing and each cooperative is contractually committed to provide 1 ton of dates or between 10,000 DH and 20,000 DH."*
>
> –Date GIE president

> *"The dates we buy from our GIE cost us almost 9 DH extra which corresponds to the cost of packaging, refrigeration, and labor. To this, we must add the purchase price, and our profit margin. This is why our prices are higher than those of independent farmers. So, we will never be able to compete in traditional markets and that is why we are forced to move towards modern and international markets."*
>
> –Date GIE president

The sustainability of the units depends on increasing the quantity of dates supplied to the units; improved commercialization could make the units more attractive to farmers.

Given the low reach and usage, most of the date GIE units are not operating profitably, and the units have not led to changes in income for most farmers. However, some farmers who used the units said they were able to improve the quality of their products and sell at a more opportune time (when dates were in high demand), thus obtaining better prices. For the units to be sustainable and for them to benefit more farmers, GIEs emphasized the importance of the units operating closer to their capacity, which might require a commitment from cooperatives to contribute a minimum volume of dates to the GIEs. This will depend in part on the success of the GIEs' efforts to improve commercialization and marketing of dates to make it attractive for farmers to sell their dates to the GIE.

Although they have faced challenges to date, most GIEs are hopeful that the units will be able to overcome the challenges and become sustainable. Units that have had some early success are beginning to see an increase in interest, and others are hopeful that membership and use of the units will increase once farmers see that the units are adding value. Some units have organized campaigns to raise awareness among farmers and cooperatives and thereby increase participation in and use of the units.

> *"Frankly, I believe that GIEs will survive if the cooperative members fulfill their commitment by providing the unit with good quality dates in sufficient quantities, and if they manage to find new markets. Otherwise, if we limit ourselves to traditional markets and retailers, for sure they will not be able to survive."*
>
> –Date GIE president

> *"The rate of farmer membership is linked to the success of the GIE in the region, because the farmer is afraid that his dates won't be sold. For this reason, he prefers to sell to intermediaries at low prices. But if he sees the GIE succeed in commercialization, he will surely bring his dates."*
>
> –Date GIE president

VI. EFFECTS ON FARMERS

In this chapter, we assess how the FTPP affected farmers in the irrigated olive and date areas that it focused on. We begin by examining the effects that might have been the most direct results of the improved irrigation infrastructure—those related to infrastructure maintenance, water availability, and water use patterns. We then examine the effects of the project on the crops cultivated by farmers. Next, we assess the project's effects on the outcomes that were ultimately expected to raise farmers' incomes and enhance their well-being—yields, agricultural revenues, and farm profits. We also identify a possible unexpected effect of the project on migration from rural areas. Finally, we revisit the end-of-Compact ERR estimates and use the evaluation findings to assess whether the underlying assumptions likely held in practice.

A. Infrastructure maintenance, water availability, and water use patterns

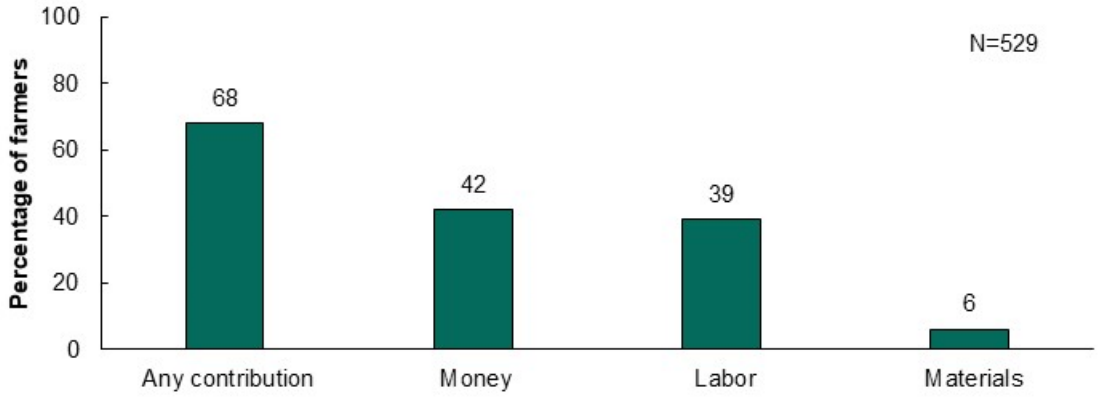
The program logic suggested that rehabilitating the irrigation infrastructure would increase its efficiency in conveying water from the source to cultivated areas, enabling water to reach farmers more quickly and in greater volume and allowing them to use more water. Below, we explore how much the improved infrastructure reduced the resources required to maintain it (one dimension of its efficiency), as well as the effects of the infrastructure on the availability of irrigation water, and its use by farmers.

Farmers play a critical role in maintaining irrigation infrastructure by contributing their labor and other resources.

In most of the irrigated olive and date areas, traditional associations or the farmers themselves coordinate the maintenance of irrigation infrastructure. Maintenance is typically conducted by the farmers, who contribute their labor to community maintenance efforts in proportion to their plot size or water rights. Farmers are typically responsible for maintaining the portion of the *seguia* near their plots. Those who are unable or unwilling to participate in these efforts can pay a fine or contribute a hired laborer instead. Farmers also sometimes make monetary or in-kind contributions for non-labor maintenance expenses (such as construction materials), again usually using water rights or plot size to determine each farmer's contribution. More than two-thirds (68 percent) of respondents to the olive farmer survey said they had contributed either their own labor or the labor of other household members; made financial contributions, including paying fines and/or hiring other labor; or contributed materials to maintain irrigation infrastructure in the 2016–2017 agricultural season (Figure VI.1).

In the relatively few areas with an active modern AUEA, the AUEAs are responsible for planning and organizing maintenance. In these areas, the AUEAs typically use monetary contributions from farmers or membership fees to cover the costs of maintenance, including hiring external labor instead of relying on community members. Some AUEAs, however, have come up with unique systems. For example, one AUEA has added a day to the *tour d'eau* and rented out the extra day, using the rental revenue to pay for maintenance.

Figure VI.1. Farmers' contributions to maintaining irrigation infrastructure in irrigated olive areas: 2016–2017 agricultural season



Source: 2018 follow-up farmer survey in irrigated olive areas.

The improved infrastructure led to a substantial reduction in the resources required for maintenance, and many farmers thought this was the project's biggest benefit.

Regardless of the system used to conduct maintenance, almost all stakeholders reported a substantial decrease in the frequency and cost of maintenance since the FTPP was completed, as well as the time and effort required to conduct maintenance. Specifically, there is less buildup of debris in *seguias* and *khettaras* because the water flows faster and in greater volume (thus carrying away any debris), wider shafts have facilitated easier access to *khettaras* for maintenance, and the concrete infrastructure is not damaged by occasional floods like the previous infrastructure was. In some areas, farmers also reported that irrigation is being disrupted by maintenance work less often, because in the past, earthen infrastructure (especially diversion weirs) was damaged by floods during the irrigation season and had to be rebuilt before irrigation could resume.

Overall, the reduced need for maintenance has saved farmers the substantial time and effort they would have spent on arduous manual labor, and also reduced spending on maintenance.[19] Consistent with this, 68 percent of respondents to the olive farmer survey reported that the costs of maintenance work on the irrigation network had diminished, and the same percentage reported that the amount of time they spent on maintenance work on the irrigation network had diminished since the FTPP (not shown). In focus groups, many farmers pointed to easier maintenance as the project's most important benefit.

[19] These costs can include purchasing materials, hiring equipment, and providing meals during community maintenance efforts.

"Nowadays, we haven't carried out dredging operations since the end of the American project, and for the last three years, each village has only been hiring three workers. We have saved in terms of time and money spent on dredging, and also the number of employees hired for this task."

–Olive farmer

"And every year during the three- or four-month dry season, when the seguias were empty, we had to organize a large community event to do the maintenance in order to remove the large quantity of clay and waste from the seguias. Now, with the existence of cement, the level of clay does not exceed 4 or 5 cm, and only 10 workers are needed to clean the seguia. This no longer requires large investments. And thanks to the high quality of the construction work, we have not yet had to do major maintenance."

–Date farmer

"Previously, we had a big problem. The inhabitants blocked the river water with diversion weirs built of earth, but they were destroyed [during periods of strong water flow] because they were constructed in the traditional way. We helped them sometimes with our equipment, we intervened [to repair them], but now we don't have to do this anymore, we don't have this problem anymore, the river passes without issues, and the irrigation is not hindered."

–MAPM office representative

The irrigation improvements have made it quicker and easier for farmers to irrigate, and increased the volume of water reaching farmers' parcels.

There was broad consensus among farmers and other stakeholders that water now reaches farmers' parcels substantially faster and in higher volume through concrete *seguias* and *khettaras* because it is no longer absorbed by the ground on its way from the source. The new diversion weirs have also increased the volume of water available. In one of the date areas, El Khorbat, the new irrigation infrastructure (*seguias* and a large diversion weir to capture floodwaters) meant that the area was irrigated from rainwater for the first time in many years. (Before the project, the only irrigation option was pumping from wells, and only wealthier farmers had this option. At one point in the past, the area had *seguias*, but they had fallen into disuse as the irrigation system feeding them stopped operating.)

The farmer survey data in irrigated olive areas corroborate that it is taking much less time for water to reach farmers' parcels. Farmers reported that, in the summer, the average time it took for water to reach their parcels decreased by about 27 minutes (40 percent) across the two

follow-up surveys; in the winter, it decreased by about 14 minutes (28 percent) (Table VI.1).[20, 21] In addition, in some areas where the irrigation improvements included doors to control the flow of water from *seguias* to farmers' plots, irrigating is less physically demanding than it was before, because farmers no longer rely on using heavy stones and earth to control the flow of water from the main *seguia* to their plots. In focus groups, farmers indicated that women were becoming increasingly involved in irrigation with the introduction of these doors.

> *"The main seguia is considered the spine: when it is full, the water reaches all farmers, no matter their location. The project has breathed new life into the seguia, and we are now able to irrigate."*
>
> –Olive farmer

Table VI.1. Water availability and use in irrigated olive areas

Outcome	Sample size	Average levels			Average pre-post changes		
		Baseline	Follow-up 1	Follow-up 2	Baseline to Follow-up 1	Baseline to Follow-up 2	Baseline to follow-up average
Overall irrigation							
Total area irrigated (hectares)	524	2.4	2.5	2.0	0.0	-0.4***	-0.2***
Percentage of total area irrigated	527	81	78	79	-2*	-2*	-2**
Average number of olive trees irrigated	502	130	147	144	15***	12**	14**
Irrigation cycles during the summer							
Time for water to get to parcel (minutes)	388	67	32	49	-36***	-19***	-27***
Area irrigated during each irrigation (hectares)	425	1.1	1.1	0.8	0.0*	-0.3***	-0.1***

[20] These findings—as well as the remaining findings in this chapter—were similar when the sample was restricted to the approximately three-quarters of respondents who reported that they were directly affected by the irrigation infrastructure improvements (not shown).

[21] To account for outliers in continuous variables in Table VI.1 and other similar tables in this chapter, we top-coded all pre-post *changes* in continuous outcomes at the 95th percentile and bottom-coded them at the 5th percentile before estimating the average changes. This was necessary because top- and bottom-coding outcomes within a particular survey round does not necessarily account for outliers in terms of changes in outcomes. For example, an individual might have a moderately high value of an outcome at baseline and a moderately low value at follow-up. In isolation, these values are not outliers, but combined, they imply a large change that might be an outlier.

Outcome	Sample size	Average levels			Average pre-post changes		
		Baseline	Follow-up 1	Follow-up 2	Baseline to Follow-up 1	Baseline to Follow-up 2	Baseline to follow-up average
Irrigation cycles during the winter							
Time for water to get to parcel (minutes)	332	50	28	42	-22***	-6**	-14***
Area irrigated during each irrigation (hectares)	367	1.1	1.2	1.0	0.1***	-0.1**	-0.1

Source: 2017 and 2018 follow-up farmer surveys in irrigated olive areas.

Note: To calculate average levels in each survey round, all continuous variables were top-coded at the 95th percentile to account for outliers. To calculate average pre-post changes, all changes were top-coded at the 95th percentile and bottom-coded at the 5th percentile to account for outliers. Because top-coding levels and top- and bottom-coding changes are not equivalent, pre-post changes are not equal to the differences in levels for these variables. All baseline values in this table were captured retrospectively in the 2017 follow-up farmer survey in irrigated olive areas.

***/**/* = statistically significant at the 1/5/10 percent level, two-tailed test.

Even though more water was available, there was no systematic increase in the area being irrigated.

Although farmers in both olive and date areas consistently reported that water reached their parcels faster and in higher volume than before, the effects on the area being irrigated were more mixed. In date areas, several farmers in focus groups reported that they have used the increased volume of water to irrigate more of their land parcels, some of which were not irrigated or were not irrigated regularly before the project because there was not enough water. However, other date farmers did not report an increase.[22]

In the olive areas, most farmers in the focus groups said the amount of area they irrigated stayed about the same. This is consistent with the farmer survey data, which revealed a small decrease in the average total area irrigated, average percentage of total area irrigated, and the average area irrigated per irrigation in summer or winter (Table VI.1). There was a slight increase in the number of olive trees that were irrigated, possibly because of more intense olive cultivation (covered in detail below). Nevertheless, some olive farmers in the focus groups reported that having more irrigation water available enabled them to irrigate different parcels or parts of their parcels in the same irrigation cycle, whereas they had required multiple cycles to do so in the

[22] One unintended negative consequence of lining *seguias* and *khettaras* with concrete is that date palms near the path of the old infrastructure have dried out and died, because they no longer benefit from seepage, and there is no other mechanism to irrigate them.

past.[23] Thus, their water use patterns were positively affected by the project, even though the total area they irrigated did not change.

> *"We have approximately 3 hectares of olives. I used to irrigate from 5 p.m. until 2 a.m., and sometimes as late as 6 a.m. Today this work takes me barely four to five hours, and—if I want to—I can irrigate another area: I have time and I take more advantage of water. Before, I needed one hour or one and a half hours for water to arrive at my parcel, and today it arrives in a quarter of an hour."*
>
> –Olive farmer
>
> *"Before, water did not get to its destination in time. For example, if I have two hours to irrigate, a lot of that time used to be wasted waiting for the water to arrive, and I never fully benefited from the two hours. But now, after the project, I am able to irrigate during the entire two hours, and there is a surplus of water."*
>
> –Olive AUEA leader
>
> *"Before, the farmers rushed to use the water because of its scarcity, but in the last three years, the water flows freely, and no one wants it—there is a surplus. Before, the farmers exploited the water day and night, but now, thanks to the diversion weir, watering during the daytime is enough for the farmers."*
>
> –Date farmer

The irrigation improvements only have benefits when there is enough source water available, and source water in many areas has been adversely affected by drought.

Much of the irrigation infrastructure rehabilitated through the project depends on precipitation to feed the water sources that supply the infrastructure with water. Since the end of the project, drought has decreased the volume of water in these sources in many of the olive and date areas. For example, in one area, one of the two water sources that feed the rehabilitated *seguia* has almost dried out, and in another area, the annual number of water releases from the large dam that feeds the area has been reduced. As a result, many areas have not seen a net improvement in the availability of irrigation water despite the infrastructure improvements. In other areas, a net improvement has still been evident, but it was larger immediately after the project, and has been smaller in the recent drought years.[24]

[23] It is common for farmers to irrigate different parcels or parts of their parcels in each irrigation cycle: about 64 percent of respondents in the second follow-up survey reported doing so in summer, and 59 percent reported doing so in winter, although we have no comparable measure at baseline.

[24] In some areas farmers reported that the new diversion weirs were more resilient against drought to some extent because they captured water for irrigation more effectively. They have also helped replenish the water table in some of the date areas, which has improved the availability of water through wells for irrigation in dry periods.

Nevertheless, in rainy periods the larger volume of water reaching parcels has resulted in an excess of water in some areas. When there is an excess, farmers typically release it downstream so other users with insufficient water rights or in areas not reached by the irrigation improvements can benefit. There is typically no formal rental or sale of water, although occasionally there is a symbolic payment or exchange between farmers. The pre-post analyses only reveal a small change in the practice of renting or giving away water rights (not reported), which is consistent with the absence of a formal system for rental or sale of water rights.

"Before the implementation of the American project, there was enough water in the [water source], but this water did not arrive at our plots because of the earthen seguias we used to have, which prevented the normal flow of water. Storms also used to be a problem; they destroyed the seguias, and it would take a lot of time to repair them. Now, thanks to the American project, concrete seguias have been installed, but now the problem is that there is no more water in the [source]."

–Olive farmer

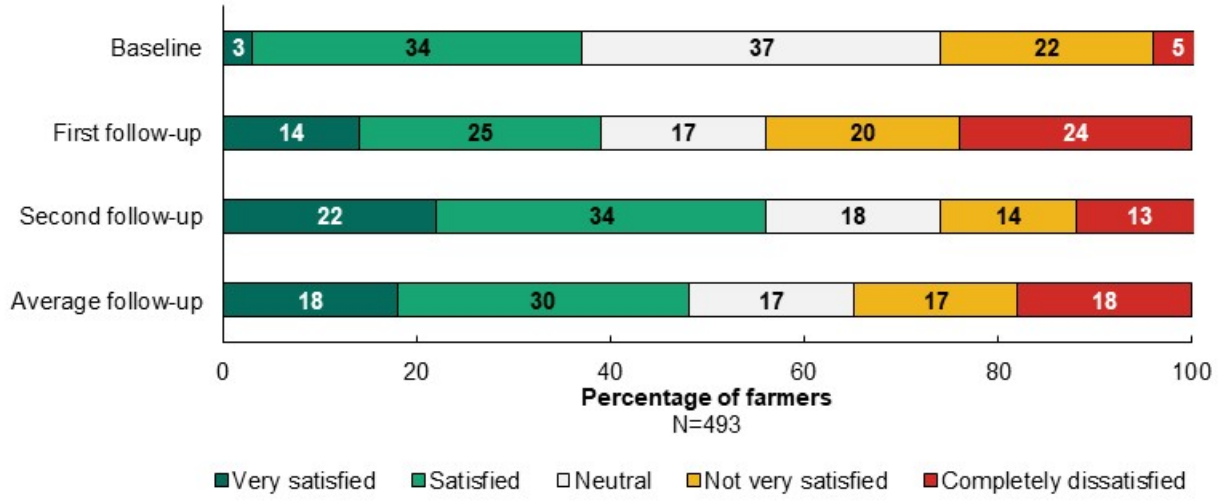
"There are farmers downstream from here whose plots look like iron, their earth looks like coal and requires a lot of water. In this sense, the excess water allows us to fulfill their water needs."

–Olive farmer

Overall, opinions about the sufficiency of water resources in olive areas have become much more polarized since the end of the project.

At baseline, only a small percentage of respondents to the farmer survey in olive areas (less than 10 percent) reported that they were very satisfied or completely dissatisfied with the sufficiency of water resources (Figure VI.2). More commonly, respondents were satisfied (33 percent), expressed a neutral opinion (37 percent), or were not very satisfied (22 percent). On average, across the two follow-up surveys, there was a 15 percentage point increase in the share of farmers who were very satisfied with the sufficiency of water resources, a 13 percentage point increase in the share that were completely dissatisfied, and a 19 percentage point decrease in the share of farmers who expressed a neutral opinion. (These changes were all statistically significant at the 1 percent level.) This might be because the effects of the drought on water sources and the extent of the infrastructure improvements varied across areas.

Figure VI.2. Farmers' satisfaction with water resources in irrigated olive areas



Source: 2010 baseline farmer survey, 2017 follow-up farmer survey, and 2018 follow-up farmer survey in irrigated olive areas.

B. Crop patterns

The program logic does not explicitly describe the expected effects of the project activities on the types of crops cultivated by farmers in the affected olive and date areas, and the possible effects are ambiguous. On the one hand, the greater availability of irrigation water might have enabled farmers to diversify and cultivate (potentially more water-intensive) crops they did not cultivate before. On the other hand, the project activities, which included complementary activities such as farmer training and GIEs that were specifically focused on olives and dates, might have increased the profitability of olives and dates relative to other crops, encouraging farmers to specialize in them. Below, we discuss the effects of the project on crop patterns in the olive and date areas.

In the irrigated olive areas, commercial cultivation of most crops has decreased since the end of the project, and there is some evidence that more farmers are specializing in olives.

The farmer survey data in irrigated olive areas reveal that the percentage of farmers commercially cultivating various types of crops—measured by whether farmers sold any of each type (or related products such as olive oil)—either remained similar (for other fruit trees and vegetables) or decreased (for olives, cereals, fodder crops, and garden crops) between baseline and follow-up (Table VI.2).[25] Specifically, the percentage of farmers selling olives and/or olive products commercially decreased by about 12 percentage points (17 percent) between baseline

[25] It is possible that farmers cultivated some crops commercially but did not sell them (for example, if the harvest failed). However, our definition of commercial cultivation in this section focuses on crops sold, which is the most accurate measure we have that is consistent across survey rounds.

and the average follow-up, and there were even larger decreases in the percentage selling cereals and garden crops.[26]

The qualitative data were consistent with an overall shift away from cultivating non-fruit tree crops since the end of the project. However, these data also suggested an increased focus on cultivation of olives (and to a lesser extent other fruit trees), even though the survey data showed, as noted, that commercial cultivation of olives decreased. This could reflect the fact that farmers had recently planted new olive trees that had yet to mature and were therefore unable to counteract a decrease in olive sales for other reasons (for example, unfavorable climate factors). To corroborate the increased specialization in olive cultivation reported in qualitative data, we showed in Table VI.1 that the average number of irrigated olive trees increased by about 14 per farmer (11 percent) between baseline and the average follow-up.[27]

In focus groups, olive farmers mentioned several reasons for specializing in olive production. First, cultivating olives require less effort than cultivating grains or field crops, especially because the enhanced irrigation infrastructure enables farmers to irrigate this perennial crop with little effort. Irrigating annual crops, in contrast, requires farmers to dig new irrigation channels on their fields every year. Farmers also have the option of selling olives to buyers on the tree instead of harvesting them themselves, which further reduces the required effort and has become more and more common. Many farmers are elderly and unable to perform the manual labor required to cultivate and harvest other crops; at the same time, hired labor is scarce and expensive. Second, olives are less water-intensive and climate-sensitive than many other crops, and climate is becoming more unpredictable and unfavorable. Third, olive yields and quality (and therefore price) have improved with application of modern techniques such as pruning. Finally, market prices for olives have become more attractive over time. (GIEs might have contributed to this in areas where they are active, but prices are driven to a large extent by external conditions that affect supply.) Overall, the olive tree has simply become the most profitable crop in these areas given climatic fluctuations and the lower effort required to cultivate them.

[26] Because of differences in survey questions in the baseline and follow-up surveys that might have affected respondents' answers, we were unable to confidently assess overall changes in cultivation that included crops grown for farmers' own consumption. However, it is clear from the data that almost all farmers in our sample cultivated olives at baseline and follow-up; the large percentage of respondents who did not sell olives commercially suggests that cultivating purely for one's own consumption is common.

[27] These numbers apply to the full sample of farmers, almost all of whom cultivated olives, but not always commercially. The change in the total number of olive trees, including non-irrigated trees, was similar.

"It's the same for us too; we increased the number of olives, apples, plums, almonds, and a few apricot trees that we cultivate. These are generally crops that we didn't used to cultivate. We turned towards these types of crops for two main reasons: better yields, and less work."

–Olive farmer

"Farmers cultivate fewer cereals, for example, but not because of the American project. The climate is the reason for the decline in cereal cultivation over the past few years: market-gardening agriculture is not profitable anymore because farmers who grow cereals spend more than what they gain."

–Olive AUEA leader

Table VI.2. Crops sold by farmers in irrigated olive areas

		Percentage of farmers selling crop			Average pre-post change in percentage of farmers selling crop		
Outcome	Sample size	Baseline	Follow-up 1	Follow-up 2	Baseline to Follow-up 1	Baseline to Follow-up 2	Baseline to follow-up average
Olives	530	70	58	58	-12***	-12***	-12***
Almonds	530	5	4	4	-1	-1	-1
Dates	530	0	1	1	0	0	0
Other fruit trees	530	14	16	16	3	3	3
Cereals	530	25	7	11	-18***	-14***	-16***
Fodder crops	530	7	2	1	-5***	-6***	-6***
Garden crops	530	20	6	6	-15***	-14***	-14***
Vegetables	530	6	4	5	-2	-1	-2

Source: 2010 baseline farmer survey and 2017 and 2018 follow-up farmer surveys.

Note: The binary variables for crops sold as reported in this table were imputed as zero if missing to reflect the approach used to calculate total revenues.

***/**/* = statistically significant at the 1/5/10 percent level, two-tailed test.

In irrigated date areas, there has been an increase in the cultivation of date palms since the end of the project.

Qualitative data suggest that despite the improvements to irrigation infrastructure, cultivating water-intensive crops in irrigated date areas is still risky because climatic fluctuations make the available volume of irrigation water and its timing uncertain. Instead, mirroring the situation in olive areas, there has been an increased specialization in date palms; these have become more

profitable over time as a result of the project's investments in infrastructure and training. Importantly, date palms can thrive even with irregular irrigation, which is becoming more common in the date areas because of a long-term drought. Nevertheless, in some date areas the project has also been associated with an intensified cultivation of other existing crops through the expansion of irrigation to previously non-irrigated plots or, in some cases, the use of space previously taken up by undergrowth. (In many of the date areas, farmers cultivate other crops such as wheat only for their own consumption, although there is some limited commercial cultivation of fruit trees.)

> *"Farmers are shifting more toward less water-intensive crops because of the scarcity of this resource in this area. Many farmers who used to cultivate vegetable crops now prefer to replace them with two palm trees that are drought-resistant. The palm has become the priority of all farmers in the region*
>
> –Date AUEA leader

C. Yields, agricultural revenues, and farm profits

The project logic suggested that the improved availability of irrigation water—combined with better farming techniques and more effective commercialization through cooperatives—would increase the revenues farmers received from olives and dates through improved yields and quality. In the long term, this was expected to contribute to an overall increase in agricultural revenues and farm profits. In this section, we explore how widely these effects occurred in practice, first for olive areas (drawing on qualitative and survey data) and then for date areas (drawing on qualitative data only).

The project has had limited effects on olive yields, agricultural revenues, and farm profits in olive areas.

Most farmers who participated in focus groups in olive areas said they had not experienced significant changes in olive yields, agricultural revenues (from olives and overall), or farm profits as a result of the project. This is consistent with the estimated pre-post changes based on the farmer survey data. These data suggest that the average olive yield per tree in the previous season decreased by about 20 percent between baseline and the average follow-up (Table VI.3).[28] We also asked respondents about the average yield over the past three seasons, which might better smooth out seasonal fluctuations; the pre-post change in this measure was smaller, but still slightly negative.

[28] This measure is only available for the approximately 82 percent of farmers who reported olive yields in all survey rounds. The missing values for this measure are driven in large part by the baseline, where we understand that the question on yields was only asked of farmers who harvested their own olives, and not of farmers who sold olives on the tree.

Table VI.3. Olive yields and revenues in irrigated olive areas

Outcome	Sample size	Average levels			Average pre-post changes		
		Baseline	Follow-up 1	Follow-up 2	Baseline to Follow-up 1	Baseline to Follow-up 2	Baseline to follow-up average
Olive yields, among farmers who harvested olives							
Yield per tree (kilograms per tree)	432	40	31	32	-10***	-8***	-8***
Average yield per tree over previous three seasons (kilograms per tree)	396	38	38	34	0	-5***	-2**
Mean olive revenues[a]							
Revenues from olives sold on the tree (DH)	530	1,119	1,808	2,551	859***	1,359***	1,440***
Revenues from harvested olives (DH)	530	5,859	3,240	3,613	-2,658***	-1,962***	-1,961***
Revenues from table olives (DH)[b]	530	0	0	0	0	0	0
Revenues from olive oil (DH)	530	2,875	2,070	1,884	-806***	-919***	-617**
Total olive revenues (DH)	530	11,238	8,761	9,465	-2,551***	-1,293*	-1,533**
Total olive revenues per tree (DH per tree)	494	77	55	72	-24***	-7	-12***

Source: 2010 baseline farmer survey, and 2017 and 2018 follow-up farmer surveys.

Note: To calculate average levels in each survey round, all continuous variables were top-coded at the 95th percentile to account for outliers. To calculate average pre-post changes, all changes were top-coded at the 95th percentile and bottom-coded at the 5th percentile to account for outliers. Because top-coding levels and top- and bottom-coding changes are not equivalent, pre-post changes are not equal to the differences in levels for these variables. Follow-up estimates of revenues were adjusted to be comparable to baseline estimates by adjusting for the national inflation rate between baseline and follow-up (9 percent for data collected in the first follow-up and 10 percent for data collected in the second follow-up). Revenues are therefore in baseline (2009) Dirhams.

[a]Imputed as zero if missing.

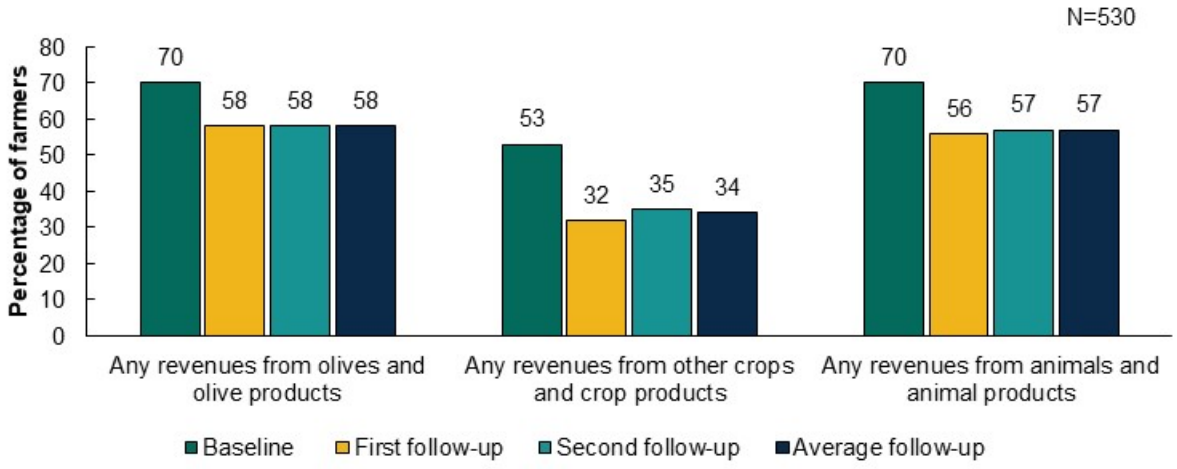
[b]Because few respondents reported revenues from table olives, the top-coding procedure meant that the few positive values were treated as outliers; the average levels and changes were therefore estimated as zero.

***/**/* = statistically significant at the 1/5/10 percent level, two-tailed test.

Total mean revenues from olives and olive products (table olives and olive oil) also decreased between baseline and the average follow-up, by about 1,533 DH (14 percent).[29] This decrease is the net effect of an increase in mean revenues from olives sold on the tree and decreases in mean revenues from olives harvested and sold, as well as from olive oil. As described below, these patterns reflect a shift away from selling harvested olives to selling them on the tree. Similarly, mean olive revenues per tree decreased by about 12 DH (16 percent) between baseline and the average follow-up. Mean yields and revenues decreased in both follow-up rounds, but the decreases were larger in the first round.

We also estimated other sources of revenues which, combined with estimates of costs, provide a measure of agricultural profits in a given season. The percentage of farmers reporting any revenues decreased for all sources—olives, other crops, and animals—between baseline and follow-up, with the largest decrease for other crops (Figure VI.3).

Figure VI.3. Sources of agricultural revenue in irrigated olive areas



Source: 2010 baseline farmer survey, and 2017 and 2018 follow-up farmer surveys.

Note: All differences between baseline and follow-up were statistically significant at the 1 percent level.

[29] The revenue variables presented here have multiple components, so it was important to determine how to best account for missing values. The baseline survey did not clearly distinguish between zeros and missing values; we generally assumed missing values were equal to zero. In the follow-up surveys, there were far fewer missing values for individual components of revenues, but these still resulted in many missing values for the combined variables. We considered imputing missing values using zeros or medians; the results were very similar (because medians were typically zero), but we decided to impute with zeros for consistency with baseline.

Consistent with this, there was a decrease in mean revenues from all sources between baseline and the average follow-up. In addition to the 1,533 DH (14 percent) decrease in mean revenues from olives reported above, mean revenues from other crops decreased by 4,135 DH (54 percent) between baseline and the average follow-up, and mean revenues from animals decreased by 3,500 DH (30 percent) (Table VI.4).[30] Combined, total agricultural revenues decreased by 10,158 DH (30 percent) between baseline and the average follow-up. At the same time, total costs were similar at baseline and the average follow-up, resulting in a net decrease in mean seasonal agricultural profits of 10,909 DH (80 percent), with a similar percentage decrease on a per-hectare basis.[31] Thus, on average, farmers had small but positive profits at baseline (13,592 DH per year, which is equivalent to about 1,422 dollars) but they were only roughly breaking even at follow-up. Similar to the pattern for olive yields and olive revenues, total revenues and profits decreased in both follow-up rounds, but the decreases were larger in the first round.

Table VI.4. Total revenues, costs, and profits in irrigated olive areas

		Average levels			Average pre-post changes		
Outcome	Sample size	Baseline	Follow-up 1	Follow-up 2	Baseline to Follow-up 1	Baseline to Follow-up 2	Baseline to follow-up average
Mean total revenues[a]							
Revenues from olives and olive products (DH)	530	11,238	8,761	9,465	-2,551***	-1,293*	-1,533**
Revenues from other crops and crop products (DH)	530	7,602	2,926	2,644	-4,394***	-4,844***	-4,135***
Revenues from animals and animal products (DH)	530	11,650	8,404	7,613	-3,478***	-4,249***	-3,500***
Total agricultural revenues (DH)[b]	530	33,771	23,276	22,730	-11,226***	-11,519***	-10,158***
Total agricultural revenues per	522	12,672	8,785	9,498	-3,559***	-2,916***	-2,936***

[30] Because farm animals are an important source of revenue in olive areas, we also explored how respondents' ownership of farm animals changed over time. There were substantial decreases between baseline and follow-up in the percentage of farmers who owned cattle, sheep, and equine animals (donkeys, mules, and horses; not shown). Respondents attributed this to an increase in drought conditions, which raised the price of fodder, left them in need of income (which they raised by selling their animals), and, in some cases, even led to their animals dying. Other factors included low prices for animal products such as milk, and the increasing cost of hired labor to maintain the animals.

[31] Because the project would most directly have affected crop production and not animal production, we also checked the implications of excluding revenue and profits from animals and then estimating changes in total revenues and profits; the changes between baseline and follow-up were almost the same (in percent terms) as those reported here.

Outcome	Sample size	Average levels			Average pre-post changes		
		Baseline	Follow-up 1	Follow-up 2	Baseline to Follow-up 1	Baseline to Follow-up 2	Baseline to follow-up average
hectare (DH per hectare)[b]							
Mean total costs[a]							
Costs of crop production (DH)	530	11,638	11,288	10,873	-374	-1,002*	-660
Costs of animals (DH)	530	7,841	9,185	7,123	1,352**	-869*	480
Total costs (DH)	530	20,860	21,203	18,744	1,121	-1,891**	73
Mean net profits[a]							
Total profits (DH)	530	13,592	2,230	3,860	-12,680***	-10,021***	-10,909***
Total profits per hectare (DH per hectare)	522	4,383	962	1,292	-3,445***	-3,406***	-3,483***

Source: 2010 baseline farmer survey, 2017 follow-up farmer survey, and 2018 follow-up farmer survey in irrigated olive areas.

Note: To calculate average levels in each survey round, all continuous variables were top-coded at the 95th percentile to account for outliers; profits (which can be negative) were also bottom-coded at the 5th percentile. To calculate average pre-post changes, all changes were top-coded at the 95th percentile and bottom-coded at the 5th percentile to account for outliers. Because top- and bottom-coding levels and top- and bottom-coding changes are not equivalent, pre-post changes are not equal to the differences in levels for these variables. Follow-up estimates of revenues, costs, and profits were adjusted to be comparable to baseline estimates by adjusting for the national inflation rate between baseline and follow-up (9 percent for data collected in the first follow-up, and 10 percent for data collected in the second follow-up). Revenues, costs, and profits are therefore in baseline (2009) Dirhams.

[a]Missing revenues and costs were imputed as zeros.

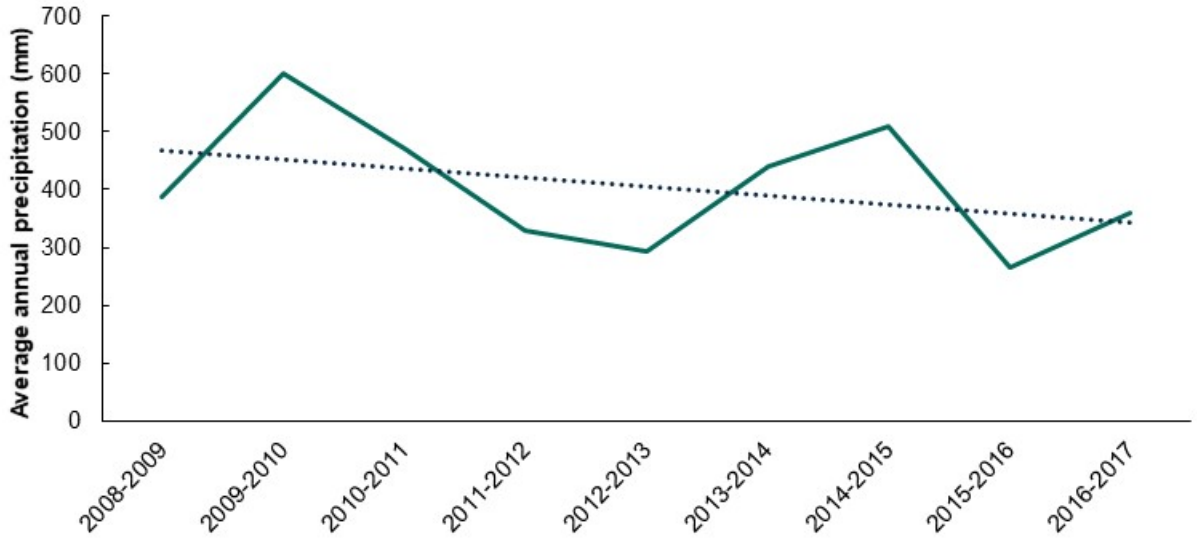
[b]Includes revenues from olives, other crops, animals, land rental, water rental, and rental of farming equipment.

***/**/* = statistically significant at the 1/5/10 percent level, two-tailed test.

In large part, these limited effects could be a consequence of worsening climate conditions; other reasons could include an increase in sales to intermediaries, higher production costs, and limited effects of the project activities on water use patterns.

According to farmers and other respondents in the irrigated olive areas, the main reason the project did not result in improvements in yields, revenues, and profits is the influence of external factors—especially climate (including the volume and timing of rain, temperature, snowstorms in winter, and so on). These factors are the main determinants of agricultural production, and have generally become less favorable in their effects over time. As we discussed in Section VI.1, precipitation is especially important because it affects the availability of water in the water sources that feed the improved irrigation infrastructure. Where these sources have been depleted, the improved infrastructure has not resulted in a net improvement in water availability for farmers. Across the 15 areas included in the farmer survey, there has been a strong negative trend in average annual precipitation between the baseline and follow-up seasons (Figure VI.4).

Figure VI.4. Average precipitation across the 15 irrigated olive areas included in the farmer survey



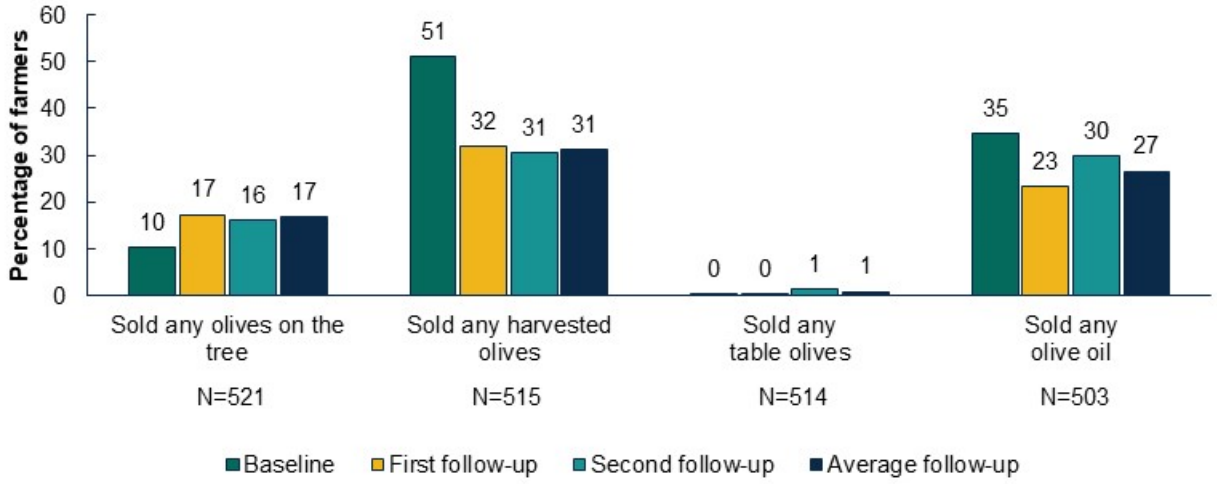
Source: TAMSAT (Tarnavsky et al. 2014; Maidement et al. 2014).

Note: Precipitation in each season covers the period from October until the following September. Dotted line represents a best-fit linear trend line.

Farmers also identified several other reasons for the limited effects they described:

- The climatic factors tend to affect all the olive production in a broad geographic area, so that individual farmers have to accept a common market price (in the absence of improved commercialization or access to new markets, which were limited). This price tends to be lower in years when climatic conditions are favorable for production (and the market supply of olives is correspondingly higher), and vice versa, often resulting in no net change in revenues. Consistent with this, the survey data suggest that olive prices increased by about 211 DH per quintal (60 percent) between baseline and the average follow-up (not shown). As shown above, this did not translate into higher olive revenues, which was probably at least partly because the less favorable climatic conditions at follow-up reduced production relative to baseline.
- In many areas, intermediaries continue to dominate the market, and farmers often sell unharvested olives on the tree to intermediaries at relatively low prices, because they can receive cash up front earlier in the season. The survey data reveal that farmers were substantially more likely to sell olives on the tree—instead of harvesting and selling them themselves—in both follow-up rounds than they were at baseline. Specifically, farmers were 7 percentage points more likely to sell olives on the tree and 20 percentage points less likely to sell harvested olives at the average follow-up compared to baseline (Figure VI.5). (They also were 8 percentage points less likely to sell olive oil.) Respondents identified several reasons for the shift to selling olives on the tree, including the advanced age of many farmers (who are physically unable to harvest olives), an increase in the cost of hired labor, and an urgent need for money after several unfavorable seasons.

Figure VI.5. Olive sales by farmers in irrigated olive areas



Source: 2010 baseline farmer survey, 2017 follow-up farmer survey, and 2018 follow-up farmer survey in irrigated olive areas.

Note: Differences between baseline and follow-up were all statistically significant at the 1 percent level, except for differences for table olives (not significant) and the difference between baseline and the second follow-up for olive oil (significant at the 10 percent level).

- Production costs such as labor and transport costs have generally increased over time (again because of external factors, such as labor availability and gasoline prices), further limiting increases in profits even where production did improve.[32]
- Some farmers said they have always been able to irrigate their olive trees appropriately, and the projects' main benefit is that it reduced the effort and time involved in irrigation. This is consistent with the data from the farmer survey (covered in Chapter V) revealing that the average area irrigated and the percentage of area irrigated in olive areas were largely unchanged.

[32] The survey data suggest that changes in *total* costs between baseline and follow-up were limited; however, per-unit costs might have increased, and we did not measure these in the survey.

"Production did not change after the project. The yield was about the same as it was before, and the same for the ratio of oil obtained per quintal, because the farmers do not work harder than they did before the project. They do not use the techniques that were taught in the trainings. The only difference is that they have to work less to maintain the seguias."

–Olive AUEA leader

"As for the harvest, nothing has changed. Olive trees that used to give a quintal before the rehabilitation of the seguia produce the same thing today. But indeed, we put in much less effort."

–Olive farmer

"The production varies from one year to the other, from one farmer to the other. Certainly, the water volume has increased, but it is not enough to increase the annual yields."

–Olive farmer

In date areas, the project had positive effects for those farmers who saw increases in water availability and adopted modern techniques.

There was some evidence of positive effects on yields, revenues, and profits in date areas, although this varied substantially across and within areas. (Unlike the findings for olive areas, these findings are drawn exclusively from qualitative data; we were unable to triangulate them with quantitative data because we did not conduct farmer surveys in date areas.) Based on qualitative data, the increased availability of irrigation water and application of modern techniques appear to have been complementary, as envisaged in the program logic. The largest positive effects on date production were experienced by farmers who lived in areas where the availability of irrigation water substantially increased *and* who also applied new techniques for producing, harvesting, and packaging dates. (For example, switching from selling in bulk by volume to selling by weight in smaller packages has helped farmers get better prices.) Many farmers also said they knew more about the different qualities of dates and could now get better prices for good quality dates, although it is unclear how much the project contributed to this. Combined, these factors led to an increase in the quantity and quality of date production, and hence substantial increases in revenues and profits for these farmers.

In areas where there was an increased availability of irrigation water, farmers who did not apply new techniques said they were producing more dates, but the dates they produced were of lower quality than before. This is because quantity and quality have a naturally inverse relationship at the tree level, and these farmers did not apply modern pruning techniques to counter this. Producing lower quality dates and dealing with the higher harvest costs associated with higher yields meant that these farmers did not see an increase in profits.

Finally, in areas where farmers have not seen a higher volume of irrigation water—typically because their water sources were severely depleted by drought, or because the improvements were smaller in scale—the effects of the project on date production have been more modest. However, farmers who have applied the modern techniques taught by the project have still observed improvements in date quantity and quality. For example, cleaning undergrowth that used to stress the date palm has improved quantity, and better harvesting techniques have improved quality.

A long-term drought was a constraint on more widespread positive effects in date areas; other constraints included a lack of profitable markets, increased production costs, old date palms, and major fires.

Like the olive areas, many of the date areas have been severely affected by drought over the past few years. This has reduced the volume of water available in some of the water sources used for irrigation, limiting the effects of the improved irrigation infrastructure in those areas. In addition to drought, several other barriers—similar to those in olive areas—have prevented farmers in date areas from fully realizing the project's benefits. First, many farmers still sell their dates to a few local buyers who have market power and offer low prices, and improvements in commercialization (for example, through GIEs) have largely not yet taken place. Second, farmers mentioned increases in production, harvesting, and transportation costs. In some areas, many youth have migrated away, leaving only elderly farmers and making it difficult to find agricultural labor (although the project might have reduced migration in some areas, as we discuss in the next section). Third, the date palms in some areas are mostly old and unproductive, even though the FTPP provided seedlings and transplanted offshoots. Finally, fires, which are associated with drought conditions and uncleaned undergrowth (despite the efforts of the project in this regard), have destroyed large parts of at least one date area.

D. Effects on migration

Although the program logic did not encompass migration patterns, there is some anecdotal evidence that the project affected them, especially in some of the date areas.

The project might have mitigated a trend toward urban migration in some areas, although migration is still a challenge in many areas.

Stakeholders suggested that the project rejuvenated some of the areas where opportunities for profitable agricultural production had been hampered by a lack of irrigation water. This has encouraged local residents—especially youth—to stay in the area and farm instead of migrating to cities in search of better job opportunities. This effect was mentioned by AUEAs in two of the six date areas in our sample—El Khorbat and Toudgha—where there was a substantive change in the availability of irrigation water as a result of the project. (In El Khorbat, there were no means for irrigation besides pumping from wells before the new diversion weir was constructed; Toudgha benefited from improvements to diversion weirs and from the most extensive *seguia* improvements—in terms of length—of all the date areas in our qualitative sample.) This effect was also mentioned by the AUEA in one of the six olive areas in our sample, as well as more broadly by some of the high-level stakeholders involved in implementing the project. However,

farmers in the areas did not bring up changes in migration (although we did not ask about migration specifically).

In other areas, more stakeholders emphasized that the trend of youth migration had continued, and that most of the farmers who remained were elderly, which constrains agricultural development. This was especially the case in areas where the improved infrastructure only reached a small part of the area, water resources had been severely affected by drought, or large-scale migration had already taken place. In one olive area, Bnitadjit, respondents claimed that the irrigation works had rendered the area's *khettara* inoperative, and there was increased migration out of the area as a result. Overall, the positive effects on migration appear to be concentrated in some areas, and we view the evidence for it as suggestive.

> *"At a certain point, the farmers were really thinking of migrating and leaving this area because the wells were dry, and the water had become very scarce. The arrival of the American project has created a certain stability and fostered a commitment to palm trees, which are drought-resistant. Today, we only need the river bed to flood twice during the season to have enough irrigation. The water gained from the floods has encouraged farmers to work more and plant more palm trees. All this thanks to the seguia and the diversion weir, which allowed the farmers to remain in the area and not to migrate, while developing their agriculture."*
>
> –Date AUEA leader

E. Reassessment of end-of-compact ERR estimates

MCC conducted cost-benefit analyses for the activities in the irrigated olive and date areas in 2014, soon after the end of the Compact. These models resulted in estimated ERRs of 10 and 37 percent for the olive and date areas, respectively, over a 20-year time horizon. In this section, we use the evaluation findings to assess whether some of the key assumptions underlying these ERR estimates held in practice, focusing on the assumptions summarized in the project's logic assessment report (Elabed et al. 2014). Tables VI.5 and VI.6 show these assumptions and our assessment for the olive and date areas, respectively.

We find little evidence that the key cost-benefit assumptions held in the olive areas, at least for the 15 areas included in the pre-post study. In particular, the assumptions about the rate of practice adoption were probably too optimistic, and we did not find evidence of the predicted increases in olive yields. Further, the cost-benefit analysis had a strong focus on farmers' olive oil sales, but several years after the Compact, only a minority of farmers produced olive oil commercially (and most did not use the modern crushing units that produce high quality oil), as shown above. Although we did not produce a quantitative ex-post ERR estimate for olive areas because our pre-post analysis did not identify any increases in agricultural profits—the main

anticipated benefit stream—our findings suggest that the ex-ante ERR was likely too high.[33] (We cannot rule out that the decrease in average profits in olive areas would have been even greater absent the project, which would mean the project had an economic benefit; but our pre-post data do not enable us to determine this.)

There is more positive evidence on the plausibility of the original assumptions in the date areas, although it is qualitative evidence only; there are no farmer survey data in these areas. In particular, the qualitative findings suggest that the greater availability of water through the new and rehabilitated irrigation infrastructure likely increased yields for at least some farmers. For farmers who adopted modern techniques, this was probably accompanied by an increase in quality that would have resulted in a net increase in revenues. However, the lack of quantitative data means that we are unable to quantify how great the increase in yields and revenues was. Overall, the evidence suggests that the ERR in date areas was higher than it was in the olive areas, as predicted ex-ante, although we are unable to assess the accuracy of the ex-ante estimate of 37 percent given the absence of quantitative data from date areas.

Table VI.5. ERR assumptions and ex-post assessment: irrigated olive areas

Assumption	Ex-post assessment
After the end of the Compact, 100 percent of farmers will use modern processing plants for olive oil.	This assumption likely did not hold. In the 2016–2017 agricultural season, only about one-third of respondents to the farmer survey reported using modern processing units for olive oil (of which less than half were units established through the Catalyst Fund). Another one-third used semi-modern units, and the remaining one-third used traditional units or did not crush olives for oil. Further, less than one-third of respondents to the farmer survey sold any olive oil in 2016–2017; most crushed olives for personal use only. The limited use of modern processing units combined with limited commercial sales imply that the economic benefits from olive oil sales were substantially more limited than originally envisaged.
Adoption of modern practices will increase by a constant annual rate to reach 100 percent 35 years after the beginning of the training.	This assumption likely does not hold. Most farmers did not attend project-funded training (less than one-fifth of respondents to the farmer survey), and even many of those who did attend did not fully apply the promoted practices. (There was some evidence of positive spillovers of training, but mainly in date areas and only for certain practices.) The qualitative study suggests that financial constraints, low literacy levels, and farmers' hesitancy to adopt unfamiliar practices were common reasons for low take-up of modern techniques.
The annual gains in yield of olive trees are proportional to the average annual rate of adopting best practices.	The adoption of best practices was low. We did not find any evidence that olive yields increased.

[33] The ex-ante cost-benefit model did not explicitly include the benefits to farmers in terms of reduced effort spent on maintenance, which many farmers highlighted as the project's main benefit. We are unable to quantitatively estimate these economic benefits using the available data, but they are likely to be relatively small given farmers' typical incomes in these areas (meaning the opportunity cost of their time is also likely to be small).

Assumption	Ex-post assessment
Higher yields from existing olive trees will result in higher farm income.	The evaluation did not find an increase in yields. However, the evaluation also identified factors that might have constrained increases in revenues even if yields had increased, including (1) general equilibrium effects (increasing yields across a broad area lower prices, resulting in no net change in revenues); (2) increasing reliance on intermediaries (through selling olives directly on the tree at low prices to obtain cash upfront); and (3) increased production costs.
Olive picking mode affects the quality of the oil and not the yield per tree. It affects the degree of acidity of the olives.	This assumption was likely plausible, as determined in the evaluability assessment. However, the expected shift to more modern picking modes likely did not occur. Specifically, farmer survey data suggest that there was a large shift from farmers harvesting their own olives to selling them on the tree. This might have degraded the quality of the olives (leading to lower prices) given that intermediaries typically use traditional picking modes such as beating the trees with racks. Further, given that less than one-third of respondents to the farmer survey sold any olive oil in 2016-2017 (and typically sold those to traditional markets that do not necessarily value high quality), meaning that changes in the quality of olive oil would have had a limited effect on farmer income.

Table VI.6. ERR assumptions and ex-post assessment: irrigated date areas

Assumption	Ex-post assessment
The annual costs of maintenance of irrigation systems are 1 percent of the investment cost, and will be incurred starting in the fourth year of the Compact.	This assumption was likely plausible. Although we did not quantitatively assess the amount and costs of maintenance, our qualitative findings suggest that the new infrastructure has required relatively little maintenance to maintain its current good condition. The maintenance that has been required has typically involved farmers contributing a small amount of their own labor (at low opportunity cost) or paying a nominal monetary fine. Therefore, higher-than-expected maintenance costs were likely not a concern in practice.
Rehabilitation investments will raise overall system efficiency by an average of about 50 percent.	This assumption was probably plausible. Our evaluability assessment suggested this assumption was plausible based on findings from the literature. Although we did not quantitatively assess system efficiency, our qualitative study did find strong evidence that water now reaches farmers' parcels substantially faster and in higher volume than before.
Net profits without the project will decrease by 1 percent.	We are unable to assess this assumption because we do not have a counterfactual. Given the effects of drought in date oases, it is plausible that net profits would have declined in the absence of the project, but we cannot determine by how much (or compare the decline to the change associated with the project, given the absence of quantitative farmer survey data in date areas).
The irrigation schemes will rapidly improve crop yields.	This assumption likely held to some extent. There was some qualitative evidence of positive effects on yields in date areas, although this varied substantially across and within areas, and we are unable to quantify it because we have no quantitative farmer survey data. Farmers in areas where the availability of irrigation water substantially improved as a result of the improved irrigation infrastructure typically reported increases in yields.

Assumption	Ex-post assessment
Higher yields resulted in higher net revenue per hectare.	This assumption likely held to some extent. In practice, higher yields depended on the adoption of modern techniques. Farmers who did adopt these techniques likely saw an increase in quality along with an increase in yields, which would increase revenues. However, these increases (where they occurred) might have been limited by (1) farmers continuing to sell their dates directly to a few local buyers who offer low prices, and (2) general equilibrium effects. For farmers who did not adopt modern techniques, quality might have decreased as the availability of more irrigation water increased yields, leading to more limited effects on revenues.

VII. CONCLUSION

This report presented the findings from the final evaluation of the FTPP's investments in irrigated olive and date areas, which are based on data collected several years after the project ended. In this concluding chapter, we summarize these findings in the context of the evaluation's research questions and highlight lessons for future projects.

A. Summary of key findings

The key findings on each research question are summarized in Table VII.1. They reveal that the upgrading or construction of new irrigation infrastructure—the centerpiece of the activities in irrigated olive and date areas—greatly improved its efficiency in conveying irrigation water to farmers' parcels. As a result of the irrigation works, water reaches farmers' parcels faster and in greater volume then before. The infrastructure was constructed to a high standard of quality and remains in good condition several years after the end of the project. It has also relieved farmers of much of the burdensome maintenance they had to do before the infrastructure was upgraded.

In terms of other project activities, training was beneficial to those farmers who applied the new techniques to complement the availability of more water. However, relatively few farmers adopted the techniques. The new water user associations supported by the project are mostly non-functional because their major responsibilities (maintaining and supervising infrastructure works) have not required much effort since the end of the project, and because many farmers continue to prefer the traditional associations. Finally, the modern date packaging and storage units managed by GIEs are operating at low capacity and are struggling to cover their costs. To be sustainable, they need to make it more financially attractive for farmers to use the units, which might require more effort to improve the units' commercialization and marketing of dates.

Overall, the effects of the project on farmers' yields, agricultural revenues, and farm profits have been limited. In the subset of olive areas where we have quantitative farmer survey data, these outcomes declined relative to where they were before the project, on average. (Because we do not have an estimate of the counterfactual, however, we cannot rule out that they might have declined even more without the project.) In irrigated date areas, we do not have quantitative farmer survey data, but findings from qualitative data suggest that the project's effects on these outcomes were mixed at best. In both olive and date areas, farmers remain dependent on climatic conditions—especially precipitation, which feeds the water sources that supply irrigation infrastructure—and these conditions have worsened over time, limiting the project's effects. Other commonly mentioned factors that could have constrained the benefits of the project include a lack of profitable markets and higher production costs. Nevertheless, some farmers said they did see their production, revenues, and profits improve as a result of the project, especially in date areas.

Table VII.1. Summary of key findings

Research question	Key findings
1. Have water use patterns changed noticeably as a result of the investments in irrigated olive and date areas?	• **Water for irrigation is reaching farmers' parcels faster and in greater volume** than it did before the project. • There was **no systematic increase in the area of land irrigated.** However, there was an increase in the area of land irrigated for some farmers in date areas, and some farmers in olive areas were able to irrigate different areas in the same irrigation cycle, whereas they used to require multiple cycles. • There was **a substantial reduction in the time and resources required to maintain the irrigation infrastructure,** thanks to the project-funded improvements. Many farmers thought this was the project's biggest benefit. • In rainy periods, some farmers have excess water as a result of the infrastructure improvements. **Excess water is typically released to other users downstream** and not rented or sold.
2. Have crop patterns changed as a result of these activities?	• Most farmers have **not diversified the crops they cultivate commercially,** but in some areas, farmers have **intensified their cultivation of olives and dates.** These crops have become the most profitable crops in their respective areas, both as a result of the project activities (such as irrigation improvements and training) and external factors (such as worsening climatic conditions and changes in market prices).
3. How have the activities changed production volume, yields, prices received, and revenues from olives and dates? **4.** How have the activities changed total agricultural revenues? **5.** How have the activities changed net farm profits?	• In olive areas, the project **did not improve average olive yields, revenues from olives, total agricultural revenues, or farm profits.** Worsening climatic conditions could bear much of the responsibility for this; other reasons might include increased sales to intermediaries, higher production costs, and limited effects of the project activities on water use patterns. • In date areas, the **effects on date yields, revenues, and farm profits were mixed, and varied substantially across and within areas.** These effects depended on changes in water availability and on how extensively farmers applied modern techniques. A long-term drought constrained the project from realizing its envisaged benefits in some date areas; other constraints include a lack of profitable markets, higher production costs, old date palms, and severe fires.
6. Which interventions were the main drivers of any changes observed?	• In the areas where irrigation infrastructure was improved, stakeholders consistently cited **irrigation infrastructure improvements as the main driver of positive changes,** although the training was also cited as beneficial for those farmers who adopted the promoted practices.
7. What is the perceived value of the modern processing units in date areas, and what factors determine the success of these units? What other role have the GIEs in date areas played in the development of date processing and marketing?	• Many **date GIEs are operating well below capacity and have had limited effects on farmers' profits thus far.** This is largely because farmers prefer to obtain money sooner by selling their unprocessed dates immediately after the harvest. The GIEs have also suffered from unstable and inexperienced management and a lack of key equipment (including crates and pallets that meet food safety standards, and freezers). • GIEs have had some limited success with selling dates outside of traditional markets, particularly to supermarkets, but they **need more support with commercialization and marketing.**

Research question	Key findings
8. Are water user associations that were supported by the project functional and meeting regularly (according to their rules)?	• Most of the **water user associations supported by the project have not been particularly active since the project ended.** Maintenance needs have substantially decreased, and there have been no other major irrigation works since the end of the project, relieving most of the associations' workload. Many farmers prefer the traditional associations, which continue to manage irrigation in most areas, and farmers have consequently been slow to engage with the new associations.
9. Are farmers sustainably managing, maintaining, and operating the infrastructure put in place by the project?	• The irrigation improvements are **mostly still in good condition and have required little maintenance since the end of the project.** • **Traditional irrigation management practices are largely continuing** as they were before the project.
10. Are the new date processing units likely to be sustainable in the long run?	• The sustainability of the units **depends on increasing the quantity of dates supplied,** because operating below capacity is not profitable**.** Improved commercialization and marketing could make the units more attractive to farmers.

B. Lessons

The program logic suggested that the package of activities in the irrigated olive and date areas would work together to improve farmers' medium- and long-term outcomes. However, we found that the outcomes did not improve as much as they were expected to, which suggests that the activities did not operate with the expected synergy. Our findings suggest several lessons for the design and implementation of similar projects in the future, both in Morocco and elsewhere.

Agricultural interventions need to account for long-term changes in climatic conditions.

Since the 1970s, Morocco has experienced steady increases in temperature and decreases in precipitation (Schilling et al. 2012). The World Development Report on Climate Change (2010) predicted that these climatic trends would continue in Morocco at some of the highest rates in the world. Diminishing precipitation over time was evident between the baseline and follow-up surveys in the olive areas (Figure VI.4 in Chapter VI). Extreme weather events are also predicted to increase—meteorologists estimate significantly prolonged droughts and heat waves in the country. These changes are predicted to persist into the more distant future, with temperature increases of up to 5 degrees Celsius and rainfall decreases of up to 52 percent by the end of this century (McSweeney et al. 2012).

Our findings suggest that worsening climatic conditions, which substantially reduced the availability of water from some sources, kept the FTPP infrastructure improvements from achieving the envisaged effects. Although the FTPP's and the *Plan Maroc Vert's* focus on shifting farmers from cereal crops to more drought-resistant tree crops and irrigation improvements that aimed to decrease water losses were forms of adaptation to climate change, it could be important for future interventions in the sector to be tailored to more extreme climate change scenarios. For example, a World Bank project that ended in 2015 was designed to integrate climate change into the *Plan Maroc Vert* by piloting an awareness and training program

for government officials, farmers, and other stakeholders, and by piloting climate change adaptations on smallholder farms (such as the use of direct seeding machines, which preserve the soil structure so it can retain more rainfall) (World Bank 2019a).

Training interventions should consider the percentage of farmers trained instead of just the number trained, and they need to actively address financial issues that keep farmers from adopting practices.

Our findings suggest that farmers who adopted practices taught in FTPP-funded training found the trainings beneficial and that the practices complemented the irrigation improvements, as envisaged in the logic model. However, because a relatively small percentage of farmers attended training—and an even smaller percentage adopted the new practices—the benefits of training were limited at the population level. That is, even though training targets were met in terms of the number of trainees (APP 2013), it probably was not enough to lead to widespread adoption of practices in the targeted areas because the percentages of farmers attending training was low. (There was some evidence that farmers who did not participate adopted the practices—a demonstration effect—but this was less widespread than envisaged, possibly because the percentage of direct attendees was low.)

Although training attendance will always be optional, future projects might consider ways to increase the percentage of farmers trained, which might require focusing resources on fewer areas. For example, offering training sessions at multiple times during the appropriate part of the season, holding them on-site instead of in a central location, strongly promoting training among farmers, and following up with farmers to help them understand and implement the practices might increase the rate of training attendance and practice adoption. Further, complementary interventions (such as providing subsidized inputs) might be required to alleviate financial constraints that keep farmers from adopting practices. The program logic explicitly assumed that these constraints would be overcome, but many respondents cited them as the reason for not adopting the practices.

Improved commercialization of products and access to attractive markets are key to improving farmers' profits, and need an early and intense project focus.

The program logic assumed that farmers would actively engage with the GIEs through their cooperatives. Specifically, it was expected that farmers would supply olives and dates to the GIE (via their cooperatives) in quantities appropriate for the GIEs' capacity, and would be incentivized to do so by receiving higher profits once the GIE sold the resulting olive oil and dates. The program logic also explicitly assumed that both upstream (production) and downstream (commercialization) improvements would happen simultaneously, so that improvements in production would translate into higher revenues and profits.

However, it was not easy to create effective cooperatives through the project because farmers in these areas were not used to cooperating to commercialize their products. Further, GIE managers had limited experience in managing processing units or commercializing products, and were unable to make it attractive for farmers to use the units, in part because of a lack of working capital. The GIEs were also only established late in the project, which did not give them much time to develop before the project ended. (The GIEs have received additional support from other

entities since the end of the project, but many are still struggling, confirming how difficult it is for these new organizations to operate effectively.) Therefore, even those farmers who did see an improvement in production as a result of other aspects of the project still largely sold their products immediately to intermediaries for low prices, limiting the benefits that the project could realize.

To be more successful, the commercialization and marketing aspect of the project might have required a much earlier and more intense focus to encourage farmers to cooperate and work with the GIEs and help the GIEs overcome their initial operational challenges. It is important for future projects to be realistic about the difficulty of successfully improving commercialization and marketing of agricultural products—especially where this requires major changes in prevailing social norms—and to devote enough project resources and time to these aspects. A forthcoming separate final evaluation report for the FTPP that covers the Catalyst Fund activity should give more insight into the functioning of GIEs in olive areas.

Addressing these lessons in future projects in the agricultural sector might help overcome the challenges inherent in these projects, given the sensitivity of agricultural outcomes to external conditions and the difficulty of initiating major behavior change among farmers.

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Appendix:

Responses to stakeholder comments

Page Number	Comment	Evaluator Responses
Overall	Three overall questions/comments: 1) given the finding that farmers spend a lot less resources (time/money) on repairing weirs and channels that feed water into their fields, and that this was noted as one of the biggest and most shared benefits of the project, I am surprised that there were no attempts to quantify these savings. do we know what farmers likely did with this extra time? what resources other than time did farmer's expend to perform this maintenance? during implementation we heard many anecdotes about traditional diversion weirs collapsing during storms, then taking months if not years to rebuild (also noted in this report)...meaning that there would be no water available for anyone downstream of the diversion weir that entire time. was this able to be captured somehow by the evaluation?	In qualitative interviews, farmers did not mention what they did with the time saved from reduced maintenance efforts. In terms of other types of savings, farmers avoided arduous manual labor and experienced some monetary savings on purchasing materials, hiring equipment, and providing meals during community maintenance efforts (as we mention in the report, farmers typically make a contribution to these monetary costs.) We did not capture the value of these savings quantitatively because the relevant variables (e.g. time spent on maintenance, time lost to damaged infrastructure, and monetary expenditure on maintenance) were not captured in the baseline farmer survey data.
Overall	2) the main lessons of this project seem to be thin given how successful the infrastructure components seemed to be paired with the finding that revenues and farm incomes were flat. not only are irrigation works mostly still functional, but new projects are incorporating these standard, which demonstrates a real knock on effect across Morocco. furthermore, we should likely come to some conclusion about whether the project may have in fact kept the situation from degrading quite precipitously had the project not intervened, given the frequent references to increased and sustained drought. either the project helped avert a disaster during a particularly intense period of drought or in fact more water wasn't really needed, but one of these conclusions might lead to different lessons. if in fact it is the former, then the lesson is that ag perimeters in climatically stressed areas such as these will need significant investments in efficiency to avoid collapsing completely. or if the latter, then efficiency gains, water volume/speed improvements and time savings are a necessary but not sufficient factor in increased yields and farm incomes, which are more linked to enhancing the value of crops and adopting improved farming techniques.	Given the lack of a counterfactual, we cannot determine with certainty what would have happened in the absence of the FTPP investments. However, it is certainly possible that the situation would have worsened even further. Overall, our findings are more consistent with limited net changes in water availability due to climatic conditions rather than a substantial improvement in water availability that did not translate into improved yields and incomes. We highlight the need for additional climate-related interventions in the lessons subsection in the conclusion.
Overall	3) what role do the evaluators envision the water users associations having since the major 'raison d'etre' (organizing and funding maintenance of common irrigation infrastructure) has essentially been resolved by the project? is there a finding/lesson here that perhaps post-project farmers could better use their common time/organizational structures to focus on sharing/financing improved practices and/or strategies to commercialize their crops?	Indeed, the new water user associations appear to lack a "raison d'etre" now that the FTPP has ended. More generally, there is certainly scope for substantially more cooperation among farmers, especially in commercializing their crops. However, encouraging cooperation among farmers may be challenging in certain social contexts and may require intensive and ongoing support, as we highlight in the report in the context of cooperatives.

Page Number	Comment	Evaluator Responses
xii	Question regarding main finding, 'irrigation improvements only have benefits when there is enough source water available', isn't it true that so long as any source water is available there are benefits? If more water is coming through more quickly after constructing concrete seguia, then there should be a benefit either way, although i do appreciate the point that in order for this to be maximized there would need to be sufficient water for all users. but the counterfactual would be even worse without the concrete lining, no? and how was that counterfactual captured? if drought has become more frequent, and there has been less rainfall and more climate stress since the project was implemented, yet almost as much area is still under irrigation and yields have held steady/slightly decreased, then wouldn't the counterfactual be a significant decrease without our project? in other words, would it be reasonable to conclude that without our project yields and revenues could have decreased more dramatically?	Unfortunately the evaluation did not include a counterfactual, so we cannot determine with certainly what would have happened in the absence of the FTPP investments. It is certainly possible that the situation would have worsened even further, but we are not able to quantify this. We are only able to assert that farmers, on average, did not experience net improvements in yields, revenues, and incomes relative to before the project.
xiii	regarding lesson: 'could be important for future projects in the Ag sector to explicitly integrate climate change adaptation' - see findings above, where it was acknowledged that irrigation improvements moved more water more quickly to farmer's parcels, losing less to groundwater recharge and evaporation, as well as the finding that crops of project focus were less water intensive and more drought resistant than others. a major objective of the project was to conserve a fragile resource and focus on crops that were more likely to survive and even thrive under increasingly tough climatic conditions. the rainfed component of the project was even more targeted to resource management/climate resiliency. curious as to understand how specifically the project could have been more explicit in this regard? i would think the lesson was rather applauding the project's focus on these elements given how much worse the situation has gotten since the project was implemented. designers and farmers would have been tempted to switch to less drought resistant, more profitable crops, or even cereals which are more traditionally popular, with the increased volume and frequency of water.	We agree that the irrigation improvements and the encouragement to focus on drought-resistant tree crops were forms of adaptation to climate change, and have noted this in the report. However, there are additional interventions that could be considered in the future, particularly those related to irrigation techniques. For example, drip irrigation is one potential intervention than can further help adapt to climate change due to its greater water application efficiency compared to other types of irrigation. A few farmers who participated in our focus group discussions discussed the need for drip irrigation. Other technologies shown to attenuate the effects of climate change in terms of enhancing resilience and increasing productivity include crop insurance, weather-based crop agro-advisories, site-specific integrated nutrient management, contingent crop planning, and laser land levelling.
67	the report mentions that production costs such as labor and transport…have generally increased over time - what about the cost savings attributed to decreased maintenance due to improved irrigation infrastructure? What % of the cost profile were these costs? assuming they were not material, or it would have shown up somehow in net revenues (profits) but please confirm.	These savings would mainly have manifested as savings in farmers' time and manual labor effort spent on maintenance. They would not be included in our estimates of monetary costs. During focus group discussions, a few farmers did mention some small monetary savings related to maintenance costs, but these were not captured in the quantitative data at baseline or follow-up.

Page Number	Comment	Evaluator Responses
74, Table VII.1	do the evaluators think that enough time has passed to truly ascertain whether water use patters will change as a result of the project? In traditional rural settings users would likely need multiple seasons of proof that more water is coming more often and faster before making changes to their practices...what do the evaluators or the research tell us about how long it takes for these kinds of changes to take hold?	The follow-up farmer survey was conducted five or six seasons after the irrigation infrastructure improvements were completed; farmers would therefore have had many seasons to adjust their behavior.
74, Table VII.1	with respect to 'farm profits' I am trying to understand how the maintenance costs and lost water due to traditional dam breaks is captured on the 'cost' side of the leger. Either these costs are negligible compared to other costs or they were not accounted for if farm profits were unchanged. or the reduced maintenance costs were non-cash, and more a result of time savings. but then it is not clear what all/some/most farmers did with the saved time. are they using this time for non-farm activities? was there an attempt to look beyond 'farm profits' to see if HHs derived more revenue with time saved but not in farming?	Our cost measures were limited by what was available in the baseline data. We were unable to measure changes in non-farm revenues, or changes in non-monetary costs like time spent on maintenance and time of irrigation lost due to infrastructure damage. These variables were not captured at baseline and retrospective measures would have been inaccurate with such a long recall period.
75-76	we agree with the finding/lesson that Ag interventions need to account for long term changes in climatic conditions but find it bizarre that there was no linkage to how our project and activities intended to do just that by making more water more quickly available to avoid losses due to evaporation and seepage. this is particularly true when taken as a whole, and not isolated into activities such as irrigated infra. furthermore, it should be noted that MCC and APP integrated the project and its strategies, particularly the focus on conversion to drought resistant and less water intensive crops into the Ministry's Plan Maroc Vert very deliberately.	It is clear that FTPP's and Plan Maroc Vert's activities were forms of adaptation to climate change, as we acknowledge in the report. However, our findings suggest that these activities were not sufficient to counteract the intense climate change that Morocco is experiencing, so the improvement in farmers' outcomes was limited. As we note above, it is possible that farmers' outcomes would have worsened even more in the absence of the FTPP; because we did not have a counterfactual, we were unable to assess this hypothesis. .
29	in the section titled: "We are unable to generalize the findings to all targeted olive areas.", was it known at the EDR stage that the findings wouldn't be generalizable? Was there any attempt to determine what is happening in the other 50 areas that aren't measured? If the evaluation doesn't cover those areas, are we missing results from 75% of the olive activity?	The EDR specified that the findings would not be generalizable to all olive areas, and that this was one of the limitations of our study. Ideally the sample for data collection would have been more representative of the full set of olive areas; however, baseline quantitative data were only available for 15 areas. Given the importance of these data, we built the evaluation around these 15 areas, so that we could triangulate the findings quantitative and qualitative data for a consistent set of areas.
Overall	It is really difficult to follow if all of the research questions have been properly answered. They are listed in the Executive summary, and I can see how a systematic answering of them might disrupt the flow of the report. I'm wondering if the simplest solution would be to have a table mapping where in the report they are answered.	The conclusion summarizes the findings for each research question (Table V.1).

Page Number	Comment	Evaluator Responses
38	Why didn't farmers attend the training? Was that by choice? Not enough resources?	In focus groups, some farmers mentioned that they were not aware of the trainings; some of those who were aware of them said that they did not attend because they were too busy. According to the NORC end-of-Compact evaluation report, farmers lacked incentives (financial and certificates) to attend trainings. Additionally, there was a lack of trainers and limited efforts put into awareness-raising campaigns about the trainings. Furthermore, the recruitment approach was not ideal; farmer participants were recruited through cooperative presidents, who did not always inform all farmers in the perimeter since not all farmers are members.
71-72	Nice tables explaining the ERR assumptions.	Thank you.
74	Table VII.1 - can you include that in the executive summary as well?	We experimented with bringing this table into the executive summary, but it does disrupt the flow and makes the executive summary quite long; we would prefer to leave this table in the conclusion if possible.

Page Number	Comment	Evaluator Responses
	I have completed my review of Mathematica's evaluation of the irrigated olive and date tree activities of the Fruit Tree Productivity Project in Morocco. I did not find any "fatal flaws" in the analysis. But I admit that I am surprised that the results were not better. If climate change is having as much impact as the evaluation implies, the future of Moroccan agriculture is in grave danger. I found only one glaring, albeit minor, error in the document. In TableIV.5 on Page 30 I believe the units for "Length of seguias rehabilitated" is meters and not kilometers, or the comma in the numbers should be replaced with a decimal point. I am disappointed at the finding the agricultural water users associations are not very active. I had high hopes after visiting a few in December 2013, several months after CED, and finding one in Erfoud that of its own initiative had purchased a computer and was in the process of digitizing the records. This finding is also contrary to our visit to the irrigated perimeter near Beni Mellal, with the gentlemen who was also in charge of the olive oil processing plant there. As you may recalled he told us that he has a general meeting every Friday to address association business, which mainly means adjudicating disputes. You may also remember some of the improvements this association had made to the system the project financed, notably increasing the height of the seguias in certain locations where fast flowing water had previously overflown the structures. The evaluation's findings regarding the date processing plants are consistent with what I would have expected and our visit of last year. They need much more help with marketing if they are going to become going concerns. Yes, they are probably too large at 400 mt capacity, and the Ministry of Agriculture would have been wiser to build small units that had smaller catchment areas making them more accessible to producers. But size was a Ministry decision, the project was responsible for the equipment.	We have addressed the unit issue in Table IV.5. We cannot rule out that some WUAs are functioning well; this just does not appear to be the case overall in our sample.

Page Number	Comment	Evaluator Responses
	I think there is one quote that you may wish to extract from this evaluation and put on your white board as a permanent reminder. On Page 12 it states that "The low adoption rates of these practices [presented in the olive train program] were attributed to the lack of financial assistance and materials needed to apply them." I know that's obvious, but sometimes in our excitement to do great things, we forget the obvious. Across the board the Fruit Tree Productivity Project failed to address short-term financing needs. Making sure trainees had the means to adapt what they learned about pruning, fertilizing, harvesting, and handling (i.e. stacking in plastic crates not polypropylene sacks) would have been helpful, but there was no formal agreement with the logical source for this type of financing, the agricultural development bank Credit Agricole. This is one more evaluation, not that you need one more, that strongly suggests that in its efforts to help poor rural populations, MCC's interventions should focus on addressing marketing constraints first, the problems that are keeping producers from getting a better price for their crops or livestock. As you know this often means addressing "soft" issues of management, cooperation, communication, and market information, before making larger investments in infrastructure. But you know that.	
p. x	Reference to "FTTP" instead of FTPP. Also spotted same error on p. 33	Noted and fixed.
p. xii	"Thus, their water use patterns were positively affected by the project, even though the total area they irrigated did not change." It's not fully clear to my why this is an improvement to their water use pattern. Presumably it's an improvement in the time they have to spend to irrigate, but I'm not sure that's what you mean by "improvement to their water use pattern". Please clarify (either make the text more direct, or clarify if I'm the only one confused by this).	Water use pattern improvements are essentially improvements in the frequency with which the farmers are able to irrigate certain portions of their plots. For example, when a farmer used to only be able to water part of their plots with one tour d'eau, having to wait for the next tour d'eau to water the remaining plots, and after the project they are able to irrigate all of their plots with a single tour d'eau. So while the total area of land being irrigated has not increased, the frequency with which all of the land is irrigated has improved.
p. x	High quality of the infra raised the bar…this could be a sign of Cadillac infra design (and/or doing high-ticket items when spreading across a higher number of sites with smaller-ticket infra might have been more efficient). Did you look into these questions?	Respondents uniformly praised the quality of the improvements relative to others that had been conducted in the past. We cannot say whether less costly improvements would have been more efficient, only that they were substantively better than typical improvements.

Page Number	Comment	Evaluator Responses
p. xii	Paragraph on Specialization seems somewhat mixed/misleading. How confident are you in the evidence that this change is due to market forces, project interventions, or some combination of the two (or even the latter leading to the former, i.e.. the project intervention may be affecting market price or other typically-exogenous market forces)? I read the second sentence as saying that this is mostly due to market forces, but the final sentence also suggests (I think) that it was due, at least in part, to irrigation investments. Carefully unpack these, if possible, or perhaps aim for more careful language here.	For both olives and dates, specialization is likely the outcome of a combination of project-related and market-related forces, but the qualitative data did not enable us to separate out the effects of these. We have adjusted the language in the report.
p. xii	"Other reasons included increased sales to intermediaries who offer low prices (but take care of harvest costs and pay farmers immediately), as well as increased per-unit production costs." To me, this finding is extremely suggestive of some secondary change that we're not picking up. To me, the most obvious potential explanation for this change is that farmers are beginning to see this line of business' profit drop and they are beginning to diversify their interests away from agriculture (or at least the particular crops being explored here), or perhaps less drastically, that there is less and less labor available (again, perhaps due to education-driven urbanization), meaning that the harvesting labor that these intermediaries provide has become a more important stand-in for a resource that has become increasingly scarce/expensive (i.e.. on-farm labor). Obviously, I'm just spitballing a theory here, but this is meant as a question as to what is happening that is driving farmers to all-of-the-sudden begin selling to intermediaries who are eating into their profits. Obviously it seems like the climate favorability question is a greater one, but this last sentence on p. xii seems like it begs some big questions that may (or may not) be answerable with the data you already have on hand.	There is no indication that this change in selling to intermediaries is sudden; it could just as easily reflect a gradual shift since the end of the Compact. Reasons for shifting towards selling olives on the tree to intermediaries are mentioned on pages 59 and 67, and are mainly that respondents are aging (so harvesting their own crops is becoming physically more difficult), costs of labor have increased, and several years of poor harvest have increased the need to obtain money quickly. We do not have strong evidence in changes in other economic activities because this was not measured at baseline, but at follow-up about 80 percent of olive farmers in our sample reported that agriculture was their main source of income.
1	The claim at the bottom of the first paragraph doesn't seem entirely credible to me, albeit a sexy notion in the field of rural development. Moreover, the Arndt citation seems tangential. Not sure if maybe Arndt cites other credible reasons to believe this claim, but it's not a claim I'm terribly convinced is supported in the evidence. Of course, you use the term "may", but it still seems like a heroic assumption that small-holder farmers are the next great hope for poverty reduction, as this sentence seems to suggest.	Noted and addressed.

Page Number	Comment	Evaluator Responses
1	There's a claim that Morocco has a comparative advantage in agriculture. This isn't specified, but both the above paragraphs citing 40 years of slow growth and all the info in the executive summary seem to suggest maybe the comparative advantage in agriculture is a myth (granted, one that I've heard many times). However, feel free to clarify the reason you're suggesting they have a comparative advantage in agriculture (e.g. high proportion of Ag to GDP w.r.t. neighboring countries/competitors, lower costs of production, etc.)	Noted and addressed.
10	Reference on pg 10 to a study finding large wastage of water in upper reaches of canals. This seems like a big potential question here, do we have any information on this which would give reason to believe this is or is not the case here?	In this cited study the water wastage was due to a water pricing structure that did not discourage excessive use of water for paddy crops (which require large columns of water), which subsequently deprived farmers further down the canal of water. This situation is specific to Andhra Pradesh and does not apply to the Moroccan context.
11 and 12	This paragraph across 11 and 12 appears to both say this had an impact and that it didn't in the same sentence. In my opinion, it seems misleading to say that an impact that doesn't take selection into account is an impact. Therefore, to me it would seem more precise to say something to the effect of "appeared to show that the training increased x, y, and z….but, upon accounting for selection effects (more motivated, entrepreneurial farmers choosing to attend the training), the average effects were not statistically significant." Of course, my quote may not fully match the evidence, but just giving you an idea of why this sentence seems deceptive/confusing and how I would tend to want to fix it.	Noted and addressed.
12	Am I the only one who doesn't know what a tarpaulin is?	A tarpaulin is also known as a "tarp" and is a large heavy-duty sheet, often made out of plastic.
12	Not certain whether or not it belongs, but the para. beginning section C begs the question of what the perceived linkage between weak results in irrigation and more investments in WUAs (coordination failures, tragedies of the commons, etc.?). No pressure to change this section, but for me personally it seems like it would be nice for the reader to understand what it was about the earlier generation of programs/evaluations that suggested (or seemed to suggest) that WUAs were the solution to weak results.	According to Playan et al (2018), the performance of new irrigation projects in 1980s was poor. Specifically, state-owned irrigation project had financial problems due to low irrigation fees and poor fee recovery, which then led to unreliable water delivery and further precluded fee collection. Thus, there was a push for new irrigation management models, so new policies involved water user organizations to improve governance of irrigated areas. Specific motivations for the shift from state control to non-government organization control of water resources were reduction in public costs, improvement of profitability, fee recovery, efficiency and equitability of water allocation, as well as infrastructure maintenance.
20	Is the "diversity in data irrigation clusters" described elsewhere? I remember seeing mentions of this above, but not sure it's clear each of the different types of irrigation in the date clusters or the reasons for the differences.	See Table V.1 for diversity of irrigation structures in date areas, which reflect differences in water sources and availability.
24	Helpful explanation of the evolution of some of the questions included to try and unpack some of the observed changes.	Thank you.

Page Number	Comment	Evaluator Responses
25	If possible to fit that table onto one page, it makes it easier for readers to spot the asterisk, the ^ and the ^^ (my first read, I thought you had accidentally forgot the key to these symbols)	Noted and addressed.
Table IV.4	Might be useful to clarify periodicity of the revenues figures (per year or per harvest, I presume?)	Noted and addressed.
30	Would it be possible to transpose Figure IV.5 onto a map? (i.e.. maybe just similar bars on top of each region)	We considered this change but found that the transposed graphic was too difficult to interpret.
29	I had to read the 65 to 30 to 15 question a few times to follow what was happening. Feels like would be visually easier to present this information. Related, might there be a better way to make clear that the 15 perimeters AND the 50 perimeters are all treatment perimeters. A natural interpretation without careful reading might be that non-sample areas are non-treated/comparison areas. Maybe "project areas not sampled"?	Noted and addressed.
32	As a non-expert in irrigation (as 98% of the consumers of this type of report), I was able to understand the various types of irrigation visually during site visits much better than I think is possible from these pictures. Are there drawings (presumably from other authors/reports) that could be used to visually show what a diversion weir is meant to do, what a seguia is meant to do, etc.? Or at a minimum, some kind of stock picture marked up to highlight/describe their key features?	Noted and addressed.
32	Do we have costs of these different sites or perhaps globally across these 15 olive perimeters and 6 date perimeters? It seems like this would be hugely useful information to easily be able to unpack approximate per-farmer costs	Noted and addressed.
39	Just a stylistic preference, but I feel like Figure V.4 would benefit from a "%" somewhere on this graph, either after each number or on the X-axis. Your call, of course.	Noted and addressed.
40	Parenthetical starting (Nevertheless…) seems wordy/awkward to me, maybe due to all the acronyms. Perhaps re-reading, you'll see my confusion, but in effect, I think the issue also lies in the phrase "positively influenced"…I'm not sure what you mean by that. I think you're saying MAPM chose to invest in this, in part due to seeing it happen during the project, but I'm not certain of that interpretation from the current wording.	Noted and addressed.
41	I imagine it's clarified somewhere in the data collection description, but I'm wondering why you use the 2017 survey here.	Because these questions were not asked at baseline we had to ask them retrospectively at follow-up.

Page Number	Comment	Evaluator Responses
42	Do we know if the GIEs would be allowed to sell their units if they chose? It seems like given the current status, it would be massively in their best interest simply to sell/liquidate and share the profits….surprised none have done that (this may be detailed in the other report, I recognize, but this section begged that question). My (albeit uninformed) impression is that an individual entrepreneur could turn a profit with one of these units if they could just buy enough olives (similar for dates) and run them at scale	We did not hear about GIEs selling the crushing units, although this might be legally complicated since technically they are owned by a combination of cooperative members and CAM (because the CAM loans that the GIEs took to contribute to the units' establishment have not yet been repaid). Two of the units rented themselves out to private operators/olive oil companies in the 2017-2018 season, which is along the lines of this suggestion. However, this is a temporary measure to help them overcome their debt obligations, after which they hope to resume regular operations. The GIEs and cooperative and farmer members are generally still interested in trying to make the units work well following the envisaged operational model, and are not (yet) looking to cut their losses.
44	Any information on how one of these GIEs could even confirm that the machinery they received was in working order without electricity to turn it on. I assume this is generally a contract requirement to pay the provider of the equipment, so I'm wondering if there is any question here about the degree to which the contractors were being paid for delivery of equipment without testing said equipment.	We did not ask about this contractual issue specifically. However, we note that all GIEs received the same equipment and it worked well in other GIEs.
page 54, Table VI.1	I assume the numbers of trees is an average per farmer, correct? I.e.. at follow-up 2, that 502 farmers samples reported having an average of 144 trees being irrigated? Just wanted to confirm I'm interpreting correctly.	Noted and addressed.
p 57-8, Figure VI.2	Can you rule out that this may be due to survey differences or simply enumerator training differences? Seems like a pretty bizarre jump without an apparent conclusion about what is driving that change over time. I think this is mostly in line with your comment on page 57, but my best guess would be that the winners are huge winners and those that didn't "win" (by getting irrigation which reaches their plots) are experiencing a dejection effect. Have you tried to explore this?	The survey questions were identical at baseline and follow-up, however we cannot account for enumerator training differences given that we didn't conduct the baseline.
p 58	A Track changes line is visible near the very bottom of the page	Noted and addressed.

Page Number	Comment	Evaluator Responses
Overall findings	This general downward shift, particularly in the olive areas, continues to beg the question for me of whether farming families are diversifying away from agriculture, writ large. In other words, in some sense potentially because the irrigation allows them to shift some of their family's labor away from agriculture (p 69 refers to a reduction in migration, potentially, but it might also be true that it's a perceived reduction in the rate prior to the project, but that the phenomenon is still trending towards migration in a way that is driving the weakening profitability results shown in the surveys), but also potentially because they see the writing on the wall and know that their style of farming is becoming less profitable over time and they need to shift their labor into other activities. I think it's really important to explore, to the extent feasible, this dynamic, given that various of your other findings are pointing to it. Of course, it may or may not be borne out in the evidence, but it seems worth exploring	Given the limitations of the baseline farmer survey data, we weren't able to explore changes in non-farm revenues quantitatively. Our qualitative data suggests that farmers are getting old, young people are migrating (despite some potential reversal due to the project), and inheritances are dividing land up into small and unprofitable parcels. Many of these trends have nothing to do with the project, but in general it seems that traditional agriculture in some of these areas is in decline.
35	There was a passing reference to a massive design flaw in Bnitadjit, which I expected to be unpacked, as it sounds pretty severe, but it wasn't revisited further down, so I'm left wondering what the story was, whether the project was to blame, and how the local ministry handled the situation, as I suspect they would have been involved if it were as severe as it sounds.	Unfortunately it wasn't very clear from the transcripts what exactly the technical issue was. We know for certain only that there was a fundamental flaw in the design and it wasn't corrected.
78	The typo "Rabbat" appears in the References section	Noted and addressed.

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	L'évaluation aurait dû procéder à une analyse des données recueillies sur la base d'une typologie selon deux critères susceptibles de s'avérer déterminants des performances du projet. Le premier se rapporte à la localisation géographique des interventions et des bénéficiaires qui est de nature à renseigner sur le niveau de dotation en facteurs de production, en l'occurrence la terre et l'eau. Le deuxième est lié aux catégories des exploitations agricoles bénéficiaires. Cette typologie permettrait de caractériser les stratégies développées par les différentes catégories d'agriculteurs bénéficiaires au niveau des différentes zones d'intervention (en termes de gestion des risques liés aux fluctuations des prix et des marchés, de capacités en ressources humaines, matérielles et financières, etc.) et partant, de cerner quelles sont les stratégies les plus efficientes en termes d'amélioration de la productivité et des revenus, des agriculteurs et en termes de rentabilisation et de pérennisation des investissements consentis dans le cadre du projet. L'intérêt de cette typologie est de renseigner les pouvoirs publics sur les facteurs clefs qui déterminent les performances des exploitations agricoles (découlant des stratégies identifiées), pour en tenir compte lors de la prise de décision et par conséquent d'améliorer la conception des interventions et notamment de leur pertinence par rapport aux besoins prioritaires des bénéficiaires cibles et de leurs capacités propres.	Our study design was constrained to using the baseline sample, which was too small to obtain precise estimates of changes over time for subgroups such as farm size and geography. Nevertheless, we ran some exploratory analyses that provide suggestive evidence that decreases in profits and revenues were somewhat larger for farmers in Zone A (zone with less water) and for larger farms (>2ha) than for the rest of the sample, and yields worsened for small farmers (<0.5ha) more than for the rest of the sample.
	Le rapport n'a pas exposé/rappelé la méthodologie adoptée et le déroulement réel de la réalisation des enquêtes quantitatives sur le terrain : type et critères d'échantillonnage retenus, taille de l'échantillon réellement enquêté, taux de réponse par périmètre de PMH/oasis. Certes, ces aspects ont été présentés dans le rapport méthodologique mais ils restent théoriques, ce travail est nécessaire pour faire un rapprochement entre ce qui est prévu et ce qui est réalisé lors de la mise en œuvre de l'approche méthodologique. De même, il permettra de faire une comparaison avec les données de l'enquête de la situation de référence. A ce titre, le bureau d'études devrait élaborer et présenter un tableau récapitulatif et comparatif entre les données des deux enquêtes. La lecture et l'interprétation des résultats de l'évaluation ex-post en dépendent fortement.	The sampling approach for the baseline survey is summarized on page 22. The overall response rates are described on page 23 (86% response rate for follow-up 1 in 2017, and 83% for follow-up 2, in 2018). We are not able to provide any results, including response rates, at the perimeter level in order to ensure the confidentiality of the respondents. The main reasons for attrition were refusal to participate, and sickness or death.

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	Le rapport fait état des résultats agrégés des enquêtes quantitatives à l'échelle de l'échantillon dans sa globalité pour les deux zones étudiées (PMH et oasis). Le bureau d'études n'a pas procédé à une stratification de l'échantillon à l'instar de ce qui a été fait lors de la réalisation de l'enquête d'établissement de la situation de référence. Les résultats agrégés ne reflètent pas les différences qui existent entre les strates pour l'ensemble des variables et indicateurs étudiés, ce qui réduit considérablement l'analyse et l'interprétation des résultats. En effet, l'étude de la situation de référence a concerné, en zones oasiennes, un échantillon de 900 exploitations dans les périmètres-échantillons. L'enquête a touché aussi les 12 unités de valorisations (UV) et les 12 organisations professionnelles agricoles (OPA) opérant dans le domaine du palmier dattier. Les résultats ont été présentés pour toutes les classes d'exploitations agricoles selon la taille de la superficie agricole utile (<= 0,5 ha, 0,5 à 2 ha, > 2 ha), pour les deux sous-populations d'oasis : oasis irriguées à partir des ressources en eau régulières (barrages) et ressources en eau irrégulières (eaux de crue). Idem pour les zones de PMH : La collecte des données a concerné un échantillon de 640 exploitations, 83 unités de valorisations (UV) et 40 organisations professionnelles agricoles (OPA) opérant dans le domaine de l'olivier. Les résultats de la zone PMH ont été présentés pour toutes les classes d'exploitations agricoles selon la taille de la superficie agricole utile (<= 2 ha, 2 à 5 ha, > 5 ha) et pour les deux sous-populations de périmètres : les périmètres dont le déficit hydrique maximum en année moyenne est inférieur ou égal à 55% (zone A), et les périmètres dont le déficit est supérieur à 55% (zone B). (voir les deux rapports de l'enquête de référence concernant les deux zones étudiées en pièce jointe).	Please see earlier response (two rows above) regarding subgroup analysis by geography and farm size.
	Le rapport mentionne que les résultats de l'enquête de référence pour les zones oasiennes sont indisponibles alors que ce n'est pas du tout vrai (voir document en pièce jointe). Ce qui fait que seuls les résultats de l'enquête ex-post pour l'ensemble des indicateurs sont présentés sans procéder à une comparaison avec les valeurs de référence de ces indicateurs.	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 have clarified this in the report.

Page Number	Comment	Evaluator Responses
	Le présent rapport a complètement ignoré le rapport de l'évaluation finale du PAF réalisée en 2013 et n'a même pas pris la peine de le citer dans les références bibliographiques (voir rapport en pièce jointe). Ce dernier a porté sur la totalité des activités du PAF et regorge de constats et d'enseignements riches, fort intéressants et qui sont confortés par les résultats de l'évaluation ex-post. De même, le rapport de l'évaluation finale du PAF, bien que plusieurs effets et impacts attendus ou non attendus du PAF ne s'étaient pas complètement manifestés lors de la clôture du projet en 2013, a anticipé les risques encourus par le projet dans l'atteinte les résultats qui lui ont été assignés. Malheureusement, ces risques sont devenus une réalité et finalement l'évaluation ex-post ne fait que ressortir presque les mêmes constats et les mêmes enseignements que l'évaluation finale. L'évaluation ex-post se devait d'aller plus loin dans l'analyse et l'interprétation des résultats obtenus et répondre aux questions fondamentales suivantes : dans quelle mesure les recommandations de l'évaluation finale du projet ont été mises en œuvre ? quelles sont les contraintes ayant entravé leur concrétisation ? si elles ont été mises en œuvre, pourquoi elles n'ont pas donné les résultats escomptés ?	Our findings are more or less consistent with those of the previous report, but our study adds to the original study by revealing how these findings persist over a longer period of time. The additional questions posed here are outside of the scope of our study, which focuses on the research questions described in the evaluation design report.
	Nous sommes surpris des résultats sur les effets et les impacts de l'irrigation. Alors que l'étude ne conteste pas que l'un des résultats du projet est une augmentation du volume d'eau à la parcelle, l'étude n'a pas pu mesurer les effets de ces volumes d'eau sur les rendements. On peut détecter qu'un volume d'eau plus élevé au niveau de la parcelle augmenterait le calibre des olives et partant le prix des olives qui seraient orientées vers la conserve plutôt que vers la trituration, (1DH/kg de différence), ce qui affecterait significativement la marge à l'Ha.	Our qualitative findings suggest that the volume of water arriving at the parcels increased, holding source water availability constant. However, because source water had been depleted in many areas, the net change in water volume might have been limited. Our survey data suggest that only a handful of farmers sold table olives at follow-up, although we did not measure changes in the quantity of olives sold to other parties destined for processing into table olives. If there were gains to be made by selling more olives to be processed into table olives, those gains would have been captured in increased total revenues from olives; as our results show, this did not occur.
	L'étude précise que depuis le démarrage du projet, le volume des précipitations connait une tendance à la baisse. En même temps, l'étude conclut que les effets et les impacts du projets sont limités. La question qui se pose est: est-ce que le projet n'aurait-il pas permis une atténuation des effets de la sécheresse. L'étude aurait pu creuser	It is possible that the project mitigated the effects of the drought, but our study is unable to assess this given that we did not have a counterfactual. We are only able to assert that there was no improvement in farmers' net outcomes, on average.
	Le rapport se contente d'observer que les agriculteurs, membres des GIE, ne vendent/stockent pas leur dattes au niveau des unités de stockage mais ne donnent aucune explication de la cause profonde de ce comportement. Le fait que les producteurs se comportent de la sorte, ne serait-il pas le résultats d'un manque d'outils de financement appropriés. Le projet ne devrait-il pas (à travers la convention signée avec le CAM) prévoir des outils spécifiques pour encourager l'utilisation des unités construites.	Reasons for low participation are described in the report and include farmers' preference to be paid immediately, GIEs' limited experience and capacity in marketing, and a lack of freezers at the GIE, among others.

Page Number	Comment	Evaluator Responses
	L'étude devrait sortir avec des recommndations actionnables et faisables pour corriger les insuffisantes et rentabiliser les lourds investissements réalisés. Or, les recommandations formulées restent d'ordre général.	We provided specific suggestions for the lessons we identified to the extent possible, given the constraints of the methodology and scope of the study. For example, we provide a list of suggestions for how to increase farmer training attendance is provided. We rely on local stakeholders with more in-depth knowledge of and experience with the local context to implement these lessons through future interventions.
	Les unités des dattes connaissent un taux d'utilisation de la capacité très variables. ceci serait probablement dû à des problèmes de gestion de ces unités. l'étude n'a analysé les causes profondes de ce constat. Du coup, il est difficile de fourmuler des recommandations appropriées qui permettraient au MAPM de corriger cette situation dans le futur.	The variation in performance across date GIEs (similar to the olive GIEs) is likely due in part to variation in management capacity and the spirit of cooperation among farmers. However, only one of the units is operating close to capacity, so we consider their performance to generally be low rather than highly variable. As we note in the report, the GIEs have a specific need for additional support in commercialization and marketing.
	Dans certains espace spécifique, l'impact du projet serait très visible, comme dans le cas de Khorbat, où le projet a permis d'irriguer une grande superficie qui était abandonnée suite aux changments climatiques. L'étude gagnerait à adapter sa méthodologie (échantillon) pour faire un zoom sur ces espaces.	El Khorbat was highlighted in the report as an example of project success. However, the approved study design focused on results for a broad range of project-affected areas (to the extent possible, given the limitations of the baseline data), and did not follow a case study methodology focused on specific areas.
	L'étude aurait pu analyser/comparer entre les années de baseline/endline pour voir dans quelle mesure, cette différence n'aurait pas tendance à surestimer ou sous-estimer les effets du projet. Si l'année endline et moins pluvieuse que la baseline, est-ce que celà n'affecterait pas les résultats obtenus. En d'autres termes, est-ce que le résultats aurait été le même si les deux années étaient comparables.	An inability to control for climatic variation is one of the limitations of our pre-post design, as we described in the evaluation design report. We attempted to address climatic variation to some extent by having two follow-up years, but average precipitation was substantially lower at follow-up than at baseline. As we note in the report, this could be a key reason for the limited changes in farmers' outcomes that we observe.

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