MATHEMATICA Policy Research

REPORT

FINAL REPORT

Evaluation of the Burkina Faso Agriculture Development Project: Baseline Report

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FIGURES

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ACRONYMS

ADP	Agriculture Development Project
APD	*Agence de Partenariat pour le Développement* (post-Compact successor to MCA-BF)
AMVS	*Autorité de la Mise en Valeur de la Vallée du Sourou* (Authority for the Development of the Sourou Valley)
ARF	Access to Rural Finance
BERD	Bureau d'Etude et de Researche pour le Développement
BRIGHT	Burkinabé Response to Improve Girls' Chances to Succeed
CATG	*Centre d'Appui Technique et de Gestion* (private consulting firm that provides technical assistance to water user associations)
CERFODES	*Centre d'Etudes, de Recherches et de Formation pour le Développement Economique et Social*
DA	Diversified Agriculture (Activity)
ERR	Economic Rate of Return
FAO	Food and Agriculture Organization (United Nations)
FCFA	Franc of the West African *Communauté Financière Africaine*
FGD	Focus group discussion
GDP	Gross Domestic Product
INERA	*Institut de l'Environnement et de Recherches Agricoles*
IRIS	Center for Institutional Reform and the Informal Sector, University of Maryland (defunct)
IWRM	Integrated Water Resource Management
MAAH	Ministère de l'Agriculture et des Aménagements Hydrauliques (Ministry of Agriculture and Hydraulic Installations)
MCA-BF	Millennium Challenge Account–Burkina Faso
MCC	Millennium Challenge Corporation
MIS	Market Information System
NORC	National Opinion Research Center

O&M	Operations and Maintenance
PAP	*Personne affectés par le project*: persons affected by the project. In the case of the Di perimeter, these were people who lost land to the construction of the perimeter and who later received irrigated land in compensation.
Non-PAP	Person not affected by the project
RCT	Randomized Control Trial
RD	Regression Discontinuity Design
RLGP	Rural Land Governance Project
TA	Technical Assistance
USAID	U.S. Agency for International Development
WMI	Water Management and Irrigation (Activity)
WSC	Within-Study Comparison
WUA	Water User Association

EXECUTIVE SUMMARY

In response to the challenges facing Burkina Faso's agriculture sector, the Millennium Challenge Corporation (MCC) invested in the Agriculture Development Project (ADP) as part of the Burkina Faso Compact. The project's objectives were to improve agricultural productivity, increase incomes among farmers and livestock producers, and support economic development. The ADP was implemented from 2009 to 2014 and encompassed three activities: Water Management and Irrigation (WMI), Diversified Agriculture (DA), and Access to Rural Finance (ARF). Mathematica Policy Research was engaged by MCC to evaluate the WMI and DA Activities.[1]

The WMI Activity was designed to improve water availability and delivery, flood control, and dam safety through several initiatives, particularly by constructing an irrigated perimeter in the Di Department (known as the Di perimeter) in which several groups of beneficiaries received land. As part of the activity, specialists provided water authorities with capacity building and technical assistance (TA) to strengthen the operations and maintenance (O&M) of the new perimeter and existing irrigation perimeters in Sourou Valley. The TA and support for capacity building provided in Sourou included establishing and training water-user associations (WUAs) and providing TA to the Sourou Valley Water Authority, Autorité de Mise en Valeur de la Vallée du Sourou (AMVS), for its action plan. In addition, it aimed to preserve agricultural livelihoods by supporting the development of policies to preserve and develop water resources through an integrated water resource management (IWRM) initiative in the Mouhoun and Comoé basins. Finally, the WMI activity also supported the rehabilitation of the Léry dam, an endeavor that does not fall under the scope of this evaluation.

The DA Activity attempted to increase farmer incomes by improving agricultural productivity and increasing the quantity and value of agricultural sales. Its components included (1) providing farmers with training on rain-fed and irrigated production, (2) training for producer associations and agribusinesses, (3) improving veterinary services and providing livestock training, (4) establishing a market information system (MIS) and information centers, (5) establishing and training market committees, and (6) rehabilitating rural markets.

The WMI and DA activities were designed as an integrated set of activities to increase agricultural productivity and income for beneficiaries. The WMI Activity would guarantee reliable access to irrigation, and the DA Activity would help farmers leverage this access into year-round farming, thus diversifying into higher-value crops and obtaining higher sales and profits.

[1] MCC separately contracted the evaluation of the ARF activity. A2F completed an evaluation of the ARF activity in 2015 (A2F 2015).

A. Evaluation questions and methodology

Mathematica is implementing one impact evaluation and five performance evaluations to address research questions on project implementation, outcomes, and sustainability for the WMI and DA activities.

Three of the evaluations center on the Di perimeter constructed under the WMI Activity. The first evaluation, the Di Lottery impact evaluation, has two components—an impact analysis and a methodological study. The distribution of some plots in the Di perimeter in a formal lottery process to applicants province-wide provides an opportunity to conduct a randomized control trial (RCT) to measure the impact of winning the lottery. The methodological study compares the impacts from the RCT with those from a second rigorous design—regression discontinuity (RD). Using RD, the impact analysis is possible as applications for the lottery were first scored and only those with a score above a designated threshold were admitted to the lottery. The second evaluation, the Di perimeter evaluation, studies the consequence of providing irrigated land on the perimeter as compensation for persons displaced by the project—known as persons affected by the project (PAPs)—and recalculates the Economic Rate of Return (ERR) of the perimeter. Finally, the Sourou Operations and Maintenance (O&M) evaluation assesses technical assistance for O&M on the Di perimeter and existing perimeters in the Sourou Valley.

The remaining three performance evaluations investigate the degree of integration of project activities; the effects of IWRM project activities on water management and water conflicts; and the effects of the Farmer Training Sub-activity of the DA Activity on agricultural practices and outcomes.

This baseline report covers the three evaluations for which we have baseline data: (1) the Di Lottery evaluation, (2) the Di perimeter evaluation, and (3) the farmer training evaluation. The report relies on data collected by separate organizations that were contracted to evaluate these activities prior to Mathematica's involvement.[2] For each evaluation, we first describe the data collected and—where applicable—limitations of these data. Second, we present descriptive statistics on beneficiaries, with a focus on assessing the extent to which targeted participant groups faced the constraints the WMI and DA activities were designed to overcome. The goal of this exercise is to assess whether beneficiaries could feasibly benefit from the multiple forms of assistance provided by the IWRM and DA activities', including irrigated land and land tenure assistance, training, free inputs, and rehabilitated markets.

B. Summary of findings

Our baseline analyses revealed a number of key findings for each evaluation summarized below in Table ES.1.

[2] MCC had previously contracted with two evaluators—the IRIS Center followed by IMPAQ International, to evaluate the WMI and DA activities (IRIS 2010, IMPAQ 2014b).

Table ES.1. Key findings from the baseline analysis of the Agriculture Development Project evaluation

Key finding	Discussion
Di Lottery	
Key findings on PAPs' constraints to improved outcomes	***Persons affected by the project (PAPs) had undiversified production at baseline, but they expressed plans to shift to high-value corps.*** At baseline, few PAPs cultivated substantive amounts of cash crops such as tomatoes or onions. However, PAPs reported planning to shift away from farming subsistence, non-irrigated crops (primarily sorghum) to irrigated, high–value cash crops such as tomatoes and onion. This is consistent with MCC's ERR model, which anticipates a transition from staple crops to high-value cash crops and includes profits from the sale of onions and tomatoes as part of the benefit stream.
	Overall, PAPs lost a substantial fraction of their land and agricultural sales revenue due to the construction of the perimeter. PAPs lost, on average, one hectare of land. Although the financial compensation and irrigated land distribution were intended to fully account for these losses, the evaluation will explore whether PAPs viewed the compensation as sufficient, whether they received it according to the planned timeline, and whether they faced any hardships due to these losses.
Key findings for the evaluation	***Baseline data for PAPs cannot be used to conduct a pre-post analysis or update ERRs.*** Notably, the Di PAP baseline survey did not collect information on the agricultural production on land lost by PAPs to the construction of the perimeter. Moreover, it is not clear to what extent the baseline survey is representative of PAPs because of limited information on the sampling design and high rates of survey nonresponse.
Other key findings	***The loss of land affected male and female PAPs very differently.*** On average, men lost more land and revenue than women but women lost a greater share of their land and revenue than men. Thus, it will be important to analyze gender differences across all measures of well-being using follow-up data to understand the differential impacts that the program may have had on male and female PAPs.
Di Perimeter	
Key findings on applicants' constraints to improved outcomes	***Applicants likely did not own sufficient irrigated land at baseline.*** Only half of applicants reported owning plots, and applicants irrigated only 40 percent of their plots at baseline, Interestingly, Di Lottery applicants irrigated most of their rented plots, suggesting that applicant households did not own or have communal access rights to sufficient irrigable land. Lottery winners' greater access to irrigated land and certainty of land tenure should be conducive to larger agricultural investments and greater production.
	Applicants' use of traction animals, improved seed, fertilizer, and pesticide suggest they could take advantage of new plots. Most applicants possessed traction animals to plow their fields, placing them in a good position to cultivate the full area of their Di perimeter plots. In addition, applicants use of improved seed, fertilizer, and pesticide can also help optimize production on the new perimeter plots.
Key findings for the evaluation	***Di Lottery beneficiary and control applicants and households were balanced across the overwhelming majority of variables, with a few exceptions.*** This treatment-control balance suggests that the lottery was properly implemented. Impact regression models in the interim and final evaluation will control for all variables in which beneficiaries and non-beneficiaries are not balanced, in particular the number of household members listed on the application, gender of the applicant, and access to land.
	An RD design approach is appropriate to assess the impact of providing land to Di Lottery beneficiaries. The review of the beneficiary selection process and statistical analysis of the distribution of scores and baseline outcomes indicates that the RD approach can be used to evaluate the impact of providing land to Di Lottery beneficiaries.

Table ES.1 (continued)

Key finding	Discussion
Other key findings	***Male applicants had notable advantages over female applicants.*** Male applicants had higher literacy rates, greater ownership of larger areas of cultivable land, and more experience in irrigation and rice production. These differences suggest that male and female applicants had different agricultural assistance needs, and thus may need a different mix of assistance.
Farmer Training	
Key findings on farmers' constraints to improved outcomes	***Suboptimal market access likely inhibited farmers' sales and income.*** Farmers most commonly sell onions and tomatoes directly from their farms in the dry season, implying they get lower prices than if they sold at market. The DA activity's investments to increase farmers' access to markets—namely in the form of rehabilitated markets and an MIS—could be critical to help these farmers' increase agricultural sales and revenue.
	Nonmechanized tools limited households' production. At baseline, few farmer households used advanced types of agricultural equipment such as furrowers, animal-drawn manga hoes, or irrigation pipes. Farmer training may provide instruction in the proper use of advanced agricultural equipment. However, the extent to which farmers can afford to purchase advanced equipment—either through credit or savings—is unclear.
Other key findings	***Farmer agricultural production in the dry season was oriented toward sales, whereas their production in the rainy season focused on food security.*** Driven largely by greater agricultural revenues during the dry season, farmers total household income in the dry season was nearly double that of the rainy season.

C. Next steps

We will combine these baseline data with the interim data collected in 2018 to conduct the Di Lottery impact evaluation and the performance evaluations of the Di perimeter and farmer training sub-activities.

I. INTRODUCTION

In Burkina Faso, as in much of Africa, the agriculture sector is a critical component of the economy. A large fraction of the country's population depends upon farming and other agriculture-related activities for their livelihood and their own consumption. As of 2011, agriculture contributed nearly one-third of the country's annual gross domestic product (GDP), with total production estimated at just under $3 billion annually (FAPDA 2014). The sector also employs 80 percent of Burkina Faso's workforce, primarily on small subsistence farms of five hectares or less (USAID Burkina Faso 2015; FAPDA 2014). Despite its prominent role in the country's economy, the agriculture sector is characterized by low crop and livestock productivity (USAID Burkina Faso 2015). Burkina Faso also is a net food importer (Chauvin et al. 2012). Low agricultural productivity contributes to extreme poverty in Burkina Faso, which is one of the poorest countries in the world with a GDP per capita of $634 (FAPDA 2014).

Agricultural improvements are needed for economic growth and poverty reduction in Burkina Faso. However, the sector faces several challenges—in particular, the level of rainfall is low and variable (USAID Burkina Faso 2015). Annual rainfall in Burkina Faso averages around 750 millimeters, with the northern Sahelian area typically receiving less than 600 millimeters while the southern Sudanian region receives up to 1,200 millimeters. The rainy season in Burkina Faso normally lasts from April or May to September or October. However, rainfall has been gradually decreasing since the severe droughts of the 1970s (Sally et al. 2011). Inadequate rainfall necessitates irrigation for successful agriculture, yet infrastructure is poor and farmers' access to irrigated water is low (FAPDA 2014). Less than 1 percent of cultivated land in Burkina Faso is equipped for irrigation (FAO 2016). Other challenges facing the country's agriculture sector include limited knowledge and capacity among farmers, land tenure insecurity, poor roads and other transportation infrastructure, and limited access to credit. Burkina Faso's economy is also susceptible to regional trade shocks and volatile food and fuel prices (FAPDA 2014; USAID Burkina Faso 2015).

In response to the challenges facing the country's agriculture sector, the Millennium Challenge Corporation (MCC) invested in the Agriculture Development Project (ADP) as part of the Burkina Faso Compact implemented by the Millennium Challenge Account–Burkina Faso (MCA-BF). The project's objectives were to improve agricultural productivity, increase incomes among farmers and livestock producers, and support economic development. The ADP was a five-year effort, implemented from 2009 to 2014, and was comprised of three activities: (1) Water Management and Irrigation (WMI), (2) Diversified Agriculture (DA), and (3) Access to Rural Finance (ARF). The ARF activity does not fall under the scope of this evaluation.[3]

The WMI Activity was designed to improve water availability and delivery, flood control, and dam safety through several initiatives, particularly by constructing an irrigated perimeter in the Di Department (known as the Di perimeter) on which several groups of beneficiaries received land. Also, under the activity, specialists provided water authorities with capacity building and technical assistance (TA) to strengthen the operations and maintenance (O&M) of

[3] MCC separately contracted the evaluation of the ARF activity. A2F completed an evaluation of the ARF activity in 2015 (A2F 2015).

the new perimeter and existing irrigation perimeters in Sourou Valley. The TA and support for capacity building provided in Sourou included (1) establishing and training water-user associations (WUAs) and (2) providing TA to the Sourou Valley Water Authority, Autorité de Mise en Valeur de la Vallée du Sourou (AMVS), for its action plan. In addition, it aimed to preserve agricultural livelihoods by supporting the development of policies to preserve and develop water resources through an integrated water resource management (IWRM) initiative in the Mouhoun and Comoé basins. Finally, the WMI activity also supported the rehabilitation of the Léry dam, an activity that does not fall under the scope of this evaluation.

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The WMI and DA activities were designed to work in an integrated way to increase agricultural productivity and income for beneficiaries. The WMI Activity would guarantee reliable access to irrigation, and the DA Activity would help farmers leverage this irrigation access into year-round farming, thus diversifying into higher-value crops and obtaining higher sales and profits.

Mathematica Policy Research is implementing an evaluation of the WMI and DA activities to determine their impact on the use of improved agricultural technologies, agricultural production, household income, land tenure security, maintenance of irrigation infrastructure, and IWRM. MCC contracted with Mathematica in July 2016. MCC had previously contracted with two evaluators, the Center for Institutional Reform and the Informal Sector (IRIS) followed by IMPAQ International, to evaluate the WMI and DA activities. This baseline report relies entirely on data collected by the previous evaluators and data-collection firms contracted by MCA-BF.

Mathematica's evaluation will address research questions on project implementation, outcomes, and sustainability. We are implementing a mixed-methods evaluation that will draw on a variety of data sources. Although the entire ADP evaluation will comprise six evaluations, this report focuses on the three evaluations for which quantitative baseline data are available:

(1) The Di perimeter evaluation which covers the economic analysis of the perimeter and assesses consequences for the persons affected by the project (PAPs) who formerly cultivated the land on which the Di perimeter was built.

(2) The Di Lottery evaluation which assesses the impact of the distribution of about thirty percent of land in the perimeter via a province-wide lottery.

(3) The farming training evaluation assesses the effects of the provision of technical assistance to farmers under the diversified agriculture activity.

The objectives of this baseline report are to summarize the existing data sources and present descriptive statistics from baseline that will inform the evaluation. The remainder of the report is organized as follows: Chapter II describes the compact as well as the goals and implementation

of each of the projects to be evaluated and summarizes the evaluation methodology that is presented in more detail in our evaluation design report (Ksoll et al. 2017); Chapter III describes the Di perimeter activity and presents descriptive statistics on the situation of PAPs at baseline; Chapter IV describes the Di Lottery, presents descriptive statistics on Di Lottery applicants, provides an analysis of balance for the Di Lottery randomized control trial (RCT), and investigates the feasibility of assessing the lottery via regression discontinuity (RD) analysis; Chapter V describes the farmer training evaluation and presents descriptive analyses on the beneficiaries of the farmer training activity; and Chapter VI concludes with a discussion of administrative concerns, including data preparation and documentation and the evaluation timeline.

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II. OVERVIEW OF THE COMPACT, ADP ACTIVITIES, AND EVALUATION

This chapter describes the Burkina Faso Compact and provides background on the project locations and beneficiaries targeted. We then describe the program logic for the WMI and DA activities. Finally, we provide an overview of the evaluation.

A. Overview of the Burkina Faso Compact

With the goal of reducing poverty through economic growth, MCC entered into a five-year, $480.9 million compact with the Government of Burkina Faso in July 2009 (MCC 2016b). The compact attempted to reach this goal by investing in four areas: (1) agriculture, (2) land tenure, (3) roads, and (4) girls' education. Accordingly, the compact was comprised of four separate projects: (1) the ADP, which aimed to improve agricultural outcomes; (2) the Rural Land Governance Project, which aimed to improve land tenure security and land management in rural areas of Burkina Faso and to increase efficiency of land institutions and access to them; (3) the Roads Project, which aimed to enhance access to markets through investments in the road network; and (4) the BRIGHT 2 Schools Project, which aimed to increase school enrollment and retention rates among girls. By the end of the compact, over 98 percent of anticipated funds had been disbursed.

The ADP consisted of the WMI and DA activities, which Mathematica will evaluate, as well as the ARF activity, which supported a lending facility for farmers and small- and medium-sized rural agricultural enterprises and aimed to improve the capacity of financial institutions and increase access to credit. However, due to low take-up of ARF services and limited progress toward the project's targets, MCC terminated the activity in July 2013 (MCA-BF 2014c).

B. Program logic

The program logic for the WMI and DA activities of the ADP, presented in Figure II.1, describes the problem that motivates the project; lists the project inputs, and outputs; and links them to short- and long-term outcomes and impacts. For example, the Di perimeter sub-activity financed the construction of an irrigated perimeter and the distribution of land tenure documents. These investments would help farmers increase their cropping intensity and diversification, resulting in higher agricultural incomes.

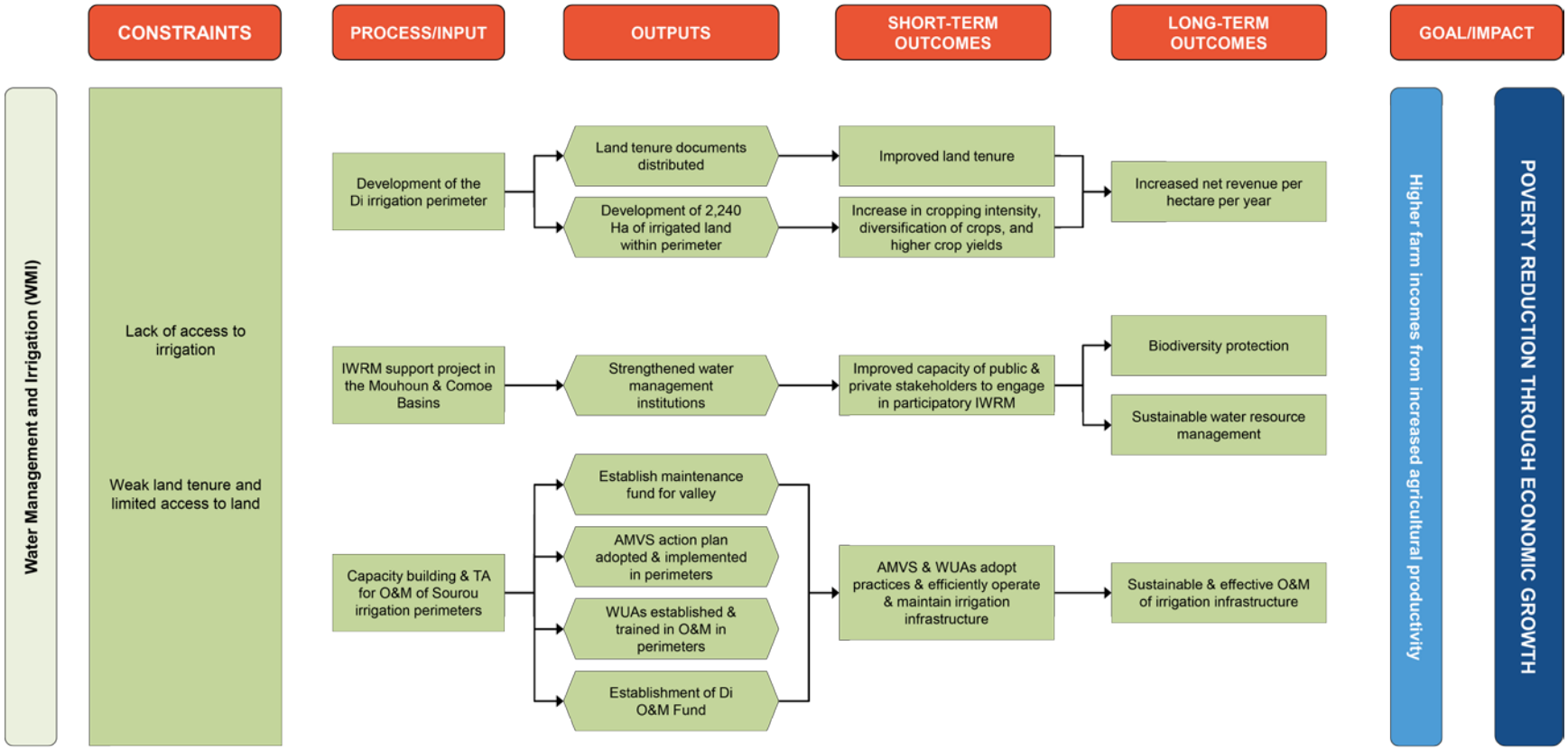
The program logic describes how the program was designed to enhance agricultural production in the Sourou Valley and the Comoé Basin, the two primary project areas. These two areas, near the country's borders with Mali and Côte d'Ivoire, respectively, are both predominantly rural areas located outside provincial capitals. Throughout the Sourou Valley, agriculture is the principal activity for over 90 percent of the population, the majority of whom also keep livestock. Cereals, legumes, and rice are the main crops, with rice being harvested primarily by female farmers (MCC 2008b). Before the construction of the Di perimeter, irrigated perimeters in the Sourou Valley covered about 3,817 hectares, primarily near Niassan. With the exception of rice, farmers in the Comoé Basin grow largely the same crops; however, some farmers are also involved in livestock, aquaculture, and forestry. Agriculture in the area has traditionally been rain-fed, but government programs and nongovernmental organizations (NGOs) began introducing irrigation infrastructure and other new technologies in the late 1990s (MCC 2008a).

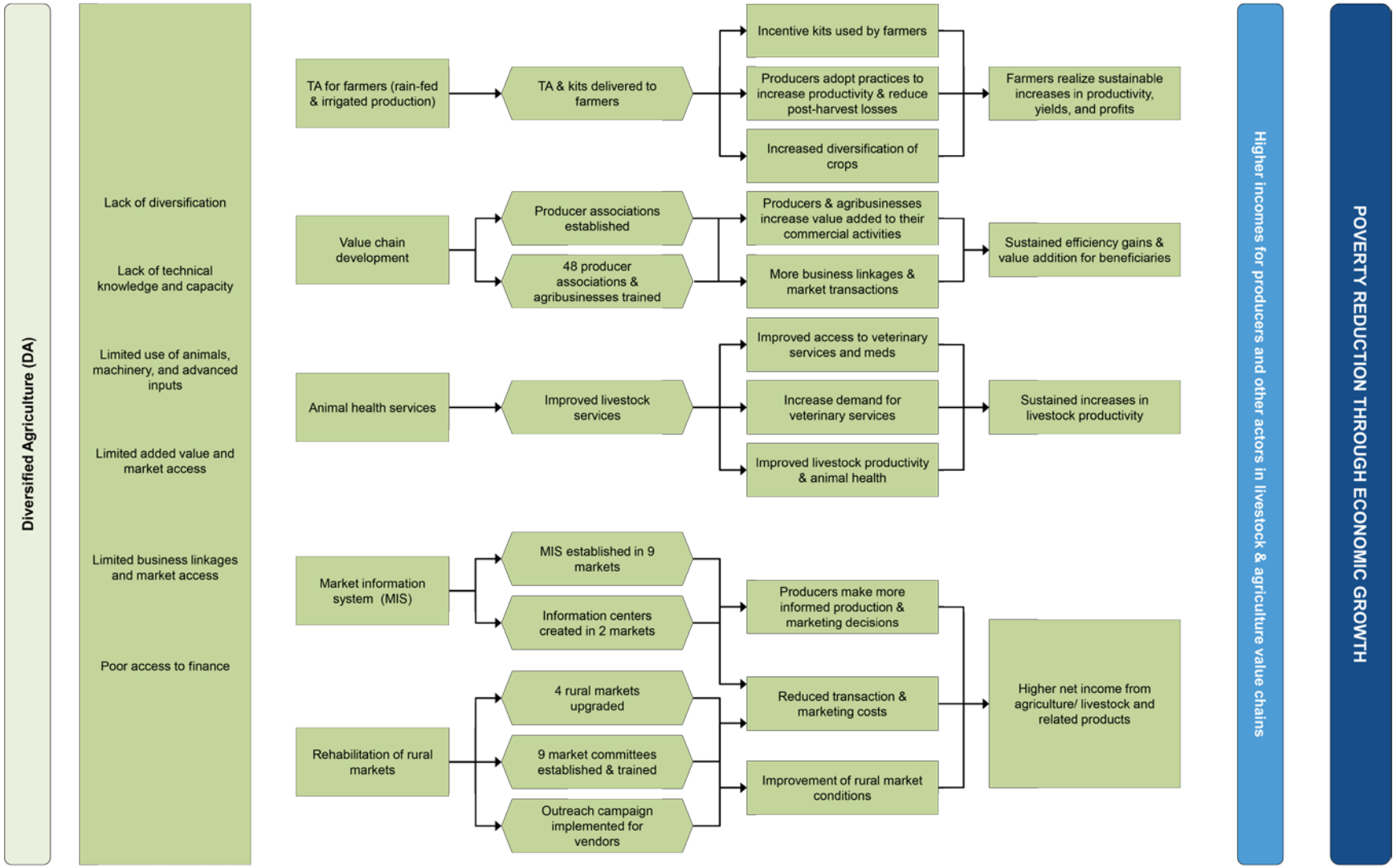
Underlying the logic for the ADP is the need for multiple approaches to supporting agriculture at each step of the value chain, including land tenure, irrigation, animal health, farming and livestock techniques, and market opportunities. The various components of the ADP were designed to work together to address the varied constraints facing farmers in Burkina Faso. We discuss the assumptions underlying the program logic in further detail in the Evaluability Assessment Report (Ksoll and Toledo 2016).

The constraints identified in the left-hand side of the logic model provide a useful framework to assess the potential for the WMI and DA activities to improve the agricultural and economic outcomes of targeted producers. In the sections that follow, this report assesses the extent to which targeted participant groups possessed each of these constraints at baseline, as well as the potential of the WMI and DA activities to overcome these constraints through training, technical assistance, land compensation, and investments in market linkages. These analyses and the findings are disaggregated by gender for the Di perimeter and the Di Lottery evaluation.[4] This analysis lays the foundation for the interim and final reports, which will assess the extent to which the activities' investments successfully addressed these constraints to generate the envisioned outcomes of higher farm incomes from increased agricultural productivity.

[4] Due to the small number of female heads of household—around 3 percent—the disaggregation of our baseline results by head of household gender would not be meaningful.

Figure II.1. Program logic




Diversified Agriculture (DA)
Lack of diversification
Lack of technical knowledge and capacity
Limited use of animals, machinery, and advanced inputs
Limited added value and market access
Limited business linkages and market access
Poor access to finance
TA for farmers (rain-fed & irrigated production)
TA & kits delivered to farmers
Incentive kits used by farmers
Producers adopt practices to increase productivity & reduce post-harvest losses
Increased diversification of crops
Farmers realize sustainable increases in productivity, yields, and profits
Value chain development
Producer associations established
48 producer associations & agribusinesses trained
Producers & agribusinesses increase value added to their commercial activities
More business linkages & market transactions
Sustained efficiency gains & value addition for beneficiaries
Animal health services
Improved livestock services
Improved access to veterinary services and meds
Increase demand for veterinary services
Improved livestock productivity & animal health
Sustained increases in livestock productivity
Market information system (MIS)
MIS established in 9 markets
Information centers created in 2 markets
Rehabilitation of rural markets
4 rural markets upgraded
9 market committees established & trained
Outreach campaign implemented for vendors
Producers make more informed production & marketing decisions
Reduced transaction & marketing costs
Improvement of rural market conditions
Higher net income from agriculture/ livestock and related products
Higher incomes for producers and other actors in livestock & agriculture value chains
POVERTY REDUCTION THROUGH ECONOMIC GROWTH

III. THE DI PERIMETER EVALUATION

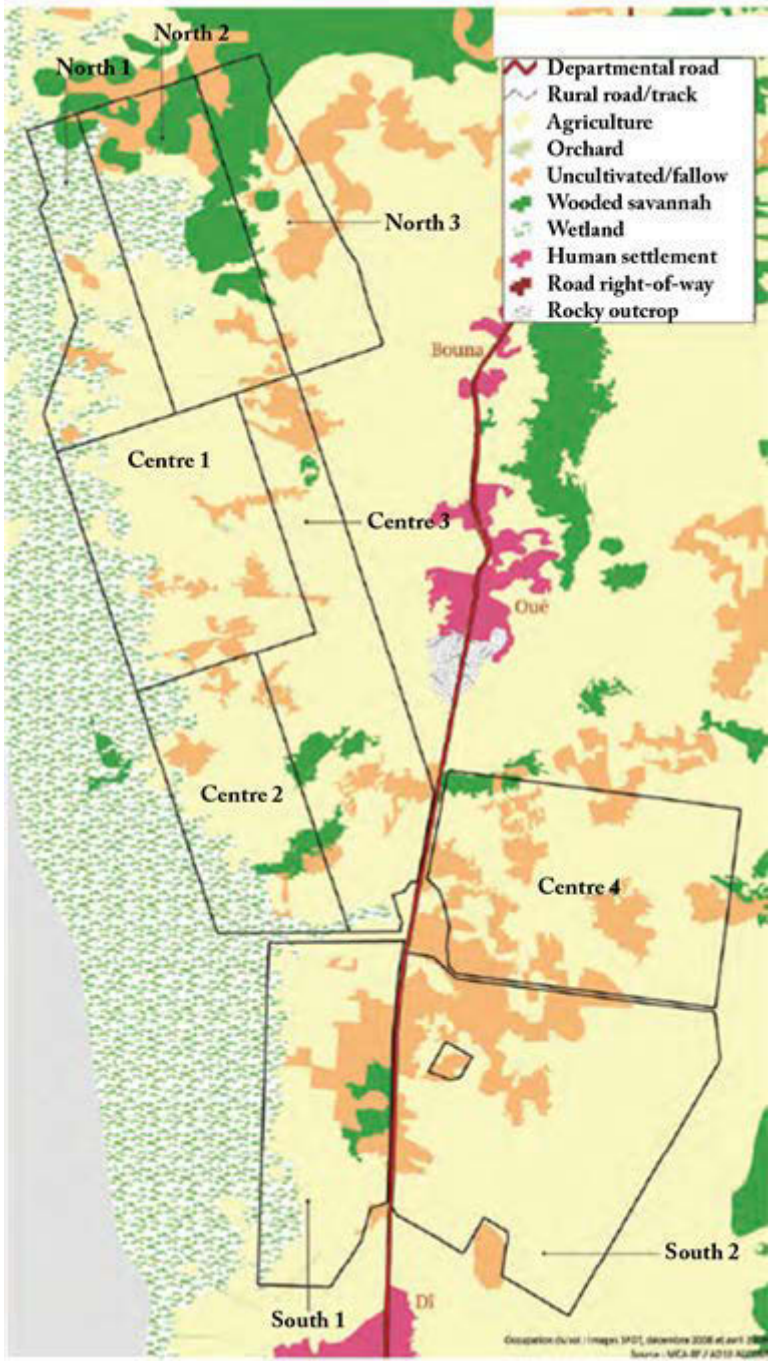
This chapter presents findings from a baseline analyses of persons affected by the Di perimeter construction. To situate these analyses, we first describe the background and history of the Di perimeter construction. We then outline the evaluation objectives and research questions and provide a brief description of the methodology for the Di performance evaluation. The methodology, which is described in greater detail in Mathematica's evaluation design report (Ksoll et al. 2017) is essential to understand how the baseline data will be used in the context of the larger evaluation, and to assess what additional information still needs to be collected.

A summary of the baseline data sources and data quality issues follows the description of the methodology. The primary focus of this portion of the chapter is to describe the characteristics of persons affected by perimeter construction, with a focus on assessing the extent to which they face the constraints to increased productivity and income that the IWRM and DA activities are designed to overcome.

A. Background

With a cost of about $89 million, the largest single investment of the compact was the construction of the Di perimeter, a 2,240 hectare irrigated perimeter, financed in order to substantially increase the amount of agricultural production by increasing land productivity through irrigation. The perimeter is located on the east bank of the Sourou River, on the border with Mali (see Figure A.1 in the Appendix). Land at the site was previously developed into large agricultural fields and open grazing areas for livestock. Figure III.1 shows the boundaries of the nine perimeter sectors overlaid on a map displaying land use before the construction of the Di perimeter. The map shows that the majority of the land was used for agriculture, but there were also sizeable portions of uncultivated and forested land. The irrigated perimeter is divided into three sectors: (1) North Sector, near the village of Bouna; (2) Central Sector, near the village of Oué; and (3) South Sector, near the village of Di. As shown in the map, these sectors are further divided into subsectors.

Figure III.1. Land use prior to Di perimeter construction



Source: MCA-Burkina Faso (2014)

The construction of the perimeter necessitated the expropriation of land cultivated by some of the local population, known as persons affected by the project (PAPs) who lived in the communities surrounding the perimeter. Approximately 50 percent of PAPs were from Di, 28 percent were from Oué, and 22 percent were from Bouna. All of the PAPs (1,469 people)[5] received financial compensation for harvests lost during the construction of the perimeter. The amount of financial compensation PAPs received was based on estimated annual revenue per hectare and average costs of inputs for the crop previously cultivated on the land and the type of irrigation used, based on prices and harvests from the 2009/2010 season.

PAPs also received irrigated land within the new perimeter to compensate them for their expropriated land. The size of the plots that PAPs received in compensation was based on the estimated value of the plot they lost. Because irrigated land on a perimeter has higher economic returns than the land that was lost, which was, for the most part, not irrigated, PAPs received a smaller plot in compensation than they had originally owned. PAPs received full ownership of this land and formal titles. The amount of land received was calculated according to a formula that included estimated revenue per hectare lost (SHER/GRET 2013).

The ADP distributed additional land as leaseholds to PAP households if a household was large enough to cultivate more land or if agricultural production on the land received within the perimeter did not allow a household to reach a minimum level of revenue. The complementary amounts of land thus allowed households to reach that level (SHER/GRET 2013). Table III.1 shows that the land received by PAP households amounted to about half of the total amount of land in the perimeter.

The ADP provided female members of PAP families, who were not themselves PAPs, a 500-square meter plot; leases were provided to them through female producer groups with a stipulation that only women could be members so that this land could not be held by male household members in the future. Additional land benefited household members' children who were over age 15 and were not themselves PAPs. This group of beneficiaries was referred to as "youths" —even though there was no upper age limit— and leases for this land were provided through youth producer groups.[6] The compensation process, known as the Resettlement Action Plan, or RAP, was initiated in two phases—corresponding with planning for the initial perimeter and for the perimeter expansion.

The number of beneficiaries and the total number of hectares owned in the Di perimeter are presented for each beneficiary group in Table III.1.

[5] The census files from 2011 and 2013 combined contained 1,469 unique PAPs. The land allocation spreadsheet contains 1,445 unique PAPs. Mathematica does not know the reason for this difference.

[6] Although the category of youths included both male and female youths, in principle, female youths would typically have received small plots as women and would be part of the female groups. As a result, there is only one mixed-gender youth group (MCC 2016a).

Table III.1. Di perimeter land allocation beneficiaries

Beneficiary category	Number of beneficiaries	Hectares in Di perimeter allocated
PAP households	846	1,099
Non-PAP from disadvantaged village	461	317
Di Lottery beneficiary	503	710
Women	1,725	90
Youth	846	16
Other: Tree nursery, National Research Institute (INERA), mixed-gender youth group	17	8
All Di beneficiaries	**4,398**	**2,240**

Note: Information on the number of beneficiaries and the hectares owned in Di comes from the land allocation spreadsheet (MCC 2016a).

B. Evaluation objectives, research questions, and methods

The specific objectives of the Di performance evaluation are to:

- Provide an economic assessment of the value of MCC's investment in the Di perimeter
- Study the effects of the displacement and compensation on PAP households' economic well-being, agricultural production, agricultural productivity, and land tenure security

The evaluation will address a number of key research questions, as summarized in Table III.2. We will answer these questions using administrative and primary qualitative and quantitative data.

Table III.2. Di performance evaluation: research questions and data collection method/source

		Data source		
		Administrative	Primary qualitative	Primary quantitative
RQ1	How were the Di perimeter construction and associated activities implemented relative to the original plans?	X		
RQ2	What is the total area planted, average yield/hectare, total production, and total profit on the Di perimeter for each of the focus crops: rice, corn, onions, tomatoes, soybeans, and cowpeas?			X
RQ2a	Have prices for these crops changed since the completion of the perimeter?			X
RQ2b	Are agricultural outcomes different for Di Lottery beneficiaries and Di PAPs? If so, why?		X	X
RQ3	What is the economic rate of return (ERR) of the Di perimeter?	X		X
RQ4	How has PAP well-being changed? Have any PAPs been harmed (socially, economically, or politically) by the intervention? How?		X	X
RQ5	Have PAPs received the compensation instruments (titles and/or leases and/or financial compensation) they were told they would receive? Why or why not?	X	X	X
RQ6	What are the PAPs' perceptions of the process by which compensation was determined and provided? What are the PAPs' perceptions of the compensation provided?		X	
RQ7	How has the PAPs' perception of land tenure security changed?		X	
RQ7a	Have any PAPs been involved in a land conflict on the perimeter?			X
RQ8	What type of land investments do PAPs make? Have PAPs rented or sold land from the Di perimeter? Have PAPs used land from the Di perimeter as collateral for credit?			X

Source: Ksoll et al. 2017

Mathematica's mixed-methods evaluation of the Di perimeter will draw on a variety of data sources, as shown in Table III.2 and described in detail in the Evaluation Design Report (Ksoll et al. 2017). Our implementation study of the Di perimeter (RQ1) covers the construction of the perimeter, the resettlement of PAPs and the attribution of land to non-PAPs, and Di beneficiary training activities, and will draw on planning and implementation documentation.[7] To describe agricultural outcomes on the Di perimeter (RQ2) and to recalculate the ERR (RQ3), we will collect and analyze quantitative data on agricultural production, incomes, and profits.

To understand whether PAP well-being has changed (RQ4), we will provide a descriptive analysis of self-reported assessments of changes in well-being collected as part of the quantitative survey. To understand how PAPs might have been harmed, we will speak with

[7] We evaluate the O&M sub-activity designed to provide capacity building for long-term sustainability in a separate evaluation, as the sub-activity also included capacity building for the old perimeters.

PAPs, implementers, WUA presidents, and WUA board members during the key informant interviews and focus group discussions.

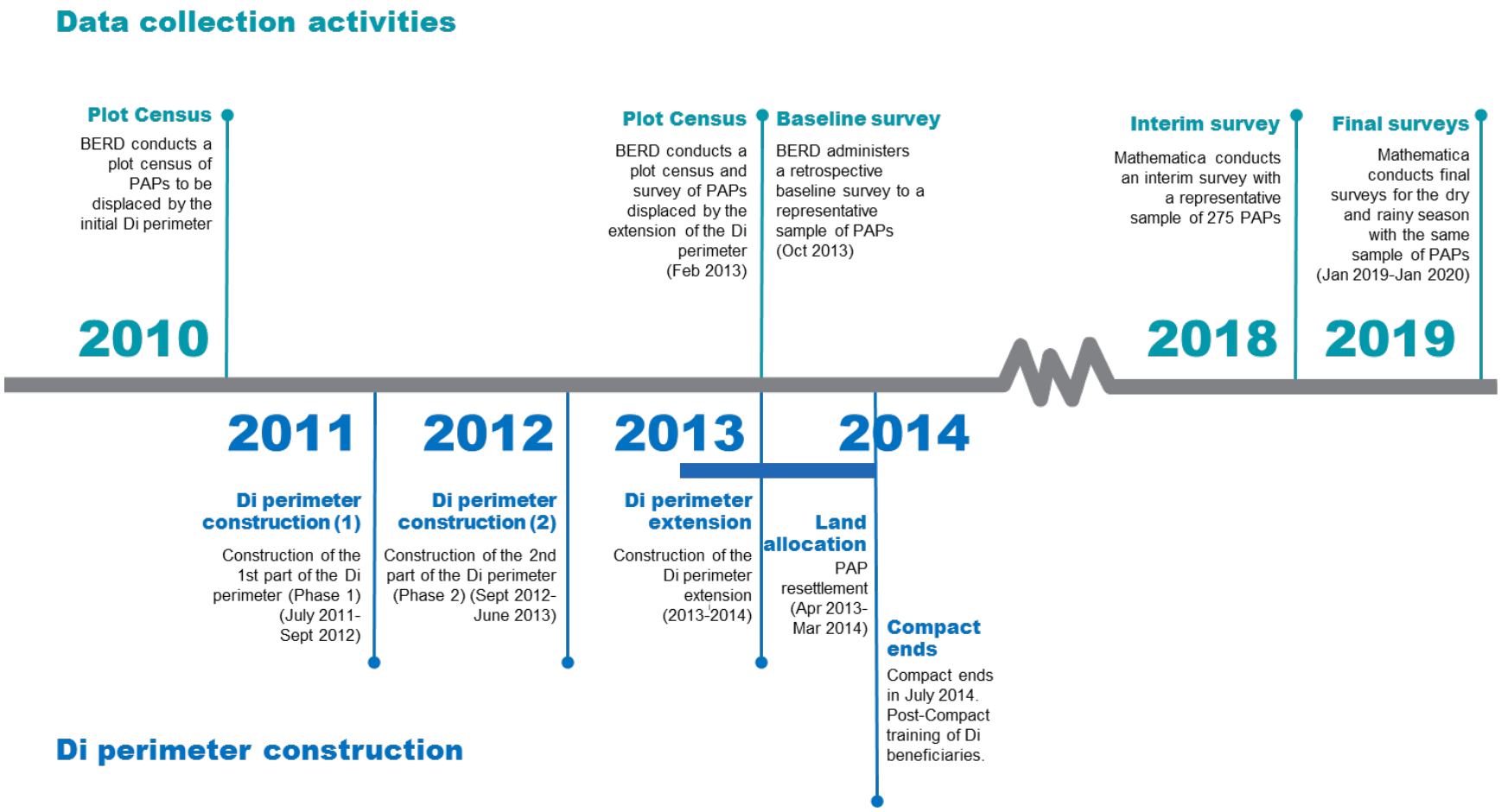
To answer the question on whether PAPs have received all compensation documents (RQ5), we review post-compact progress reports from the APD and triangulate this information using self-reports by PAPs, as part of the quantitative survey. If PAPs have not received compensation instruments, we will explore the reasons for this through in-depth interviews with people who were involved in the implementation during the compact and those tasked with the delivery of compensation instruments post-compact.

The data we collect in the in-depth interviews and focus group discussions with Di PAPs and WUA board members will allow us to address the research questions related to the perceptions of the compensation, process of compensation, and land security (RQ6, RQ7, RQ7b). Finally, we will conduct a descriptive analysis of responses by PAPs to questions in a specific Di PAP land module, which will be part of the quantitative questionnaire to investigate the research questions related to land conflict (RQ7b) and land investment, land markets, and credit markets (RQ8). The questions related to land rental and sales will also shed light on whether an active land rental and sales market has emerged. Plans for data collection are described in section F below.

C. Existing data sources

Mathematica's evaluation and data collection plans will follow several rounds of data collection conducted by previous evaluators and other data collection firms from 2011 to 2013. These data were collected for the purposes of determining compensation amounts and for baseline data on PAPs. The timing of previous and future data collection activities and project activities are summarized in Figure III.2.

Figure III.2. Timeline of data collection activities



The timeline shows that a variety of data were collected prior to and during the perimeter construction. We describe each of the data sources in the sections that follow, drawing on our own analysis as well as reports written by previous evaluators where available.

The firm responsible for the compensation process, the Bureau d'Etude et de Researche pour le Développement (BERD), undertook **plot censuses** in 2010 and 2013[8] to collect information on PAPs' land lost and to determine the amount of financial and land compensation for each PAP. BERD also conducted household surveys with a selected sample of PAPs from the census in 2013; this is the **PAP baseline survey**. The **land allocation database** is a list of all PAPs and is the only source of data regarding the amount of land that PAPs received as compensation for the land lost. Our analyses in this report are restricted to PAPs that appear in the land allocation database.[9] The plot census data are used to describe the land lost by PAPs and the crops farmed on the perimeter prior to the irrigated perimeter. The baseline survey data are the primary source of information on PAPs prior to the perimeter for the baseline analysis and are used to describe the characteristics of PAPs and their well-being and agricultural productivity.

These data sources, their content, and sample sizes are described in Table III.3.

[8] The two censuses covered different land areas and therefore include mostly different PAPs. Twelve PAPs appear in both the 2011 and 2013 plot census files. Originally, these PAPs were assigned new IDs during the 2013 plot census. However, a combined data set of all PAPs (the land allocation database) indicated that these PAPs were actually in the 2011 census data, and therefore had existing IDs. Mathematica confirmed that these 12 PAPs match on first and last name across the 2011 and 2013 census data.

[9] Mathematica considered the land allocation file as the best source of the full list of PAPs, and is the data source for sampling PAPs for the interim data collection.

Table III.3. Summary of existing data sources

Name	Purpose	Collection date	Sample	Content
2010 plot census[a]	Determine the amount of land farmed by each PAP and the primary crops grown on that land for compensation purposes	2010	1,250 PAPs; 2,209 plots	• Name and gender of PAP • Plot ID and zone • Amount of land lost, overall and by plot and by crop (hectare) • Amount of financial compensation, overall and by plot and by crop (FCFA) Crops are classified into five groups: • "Pluvial: Sorgho" (rain-fed: sorghum) • "Decrue: Mais" (flood recession: corn) • "Inondée: riz" (flooded: rice) • "Irriguée: oignon" (irrigation: onion) • "Irrigué: tomate" (irrigated: tomato)[b]
2013 plot census[c]		2013	279 PAPs; 312 plots	• Name and gender of PAP • Plot ID and zone • Amount of land lost, overall and by plot and by crop (hectare) • Amount of financial compensation, overall and by plot and by crop (FCFA) There are six crops represented in the data: corn, rice, sorghum, manioc (cassava), sesame, and peanuts[d]
Land allocation database	Provide a master list of all beneficiaries of land allocation at the Di perimeter	2010-2013	1,445 PAPs	• PAP identifying information • Amount of land allocated to PAP
2013 PAP baseline survey	Provide information on a representative sample of PAPs before construction of the perimeter	2013	388 PAPs	• Occupation of PAPs • Household roster • PAPs' production and revenue from land off-perimeter • Land use off- and on-perimeter (combined) • Sources of revenue • Asset ownership • Use of compensation money received • Access to credit • Training received

[a] The 2010 data collection also included a household survey of about 200 households. However, this data was determined to be inaccurate and was not provided to Mathematica (IMPAQ 2014b).

[b] Because the questionnaires did not link the mode of irrigation to the crop, these must have been constructs created by BERD, possibly for compensation purposes.

[c] BERD also conducted a household survey, covering only a small fraction of the total PAPs. Thus, we use only the information from the 2013 plot census that is comparable to the 2010 plot census, which provides a uniform picture of PAPs.

[d] Unlike the 2011 census, the water source of each crop is not indicated. We assume that none are irrigated crops because tomatoes and onions, which were the only irrigated crops in the 2011 data, are not represented in the 2013 data. We know that sesame, peanuts, and manioc are not irrigated crops, and it is less common for rice, corn, and sorghum to be irrigated than tomatoes or onions.

The 2010 and 2013 plot censuses contained slightly different information. We used only those data that were available in both data sets. Throughout this report, we refer simply to the plot census and ignore the distinction between the 2010 and 2013 rounds of data.

The existing data sources have significant limitations. Because the original evaluation was a pre-post design, it is important to understand these limitations.[10] Aside from data entry issues with the plot census file,[11] the primary limitations are related to the baseline survey, which cannot form the basis for understanding changes in outcomes for a representative sample of beneficiaries. There are two reasons for this: (1) the survey was designed as a stratified representative sample, but there are no sampling weights to make it representative. Further, the description in BERD's baseline report (BERD 2014) lacks detail needed to replicate sampling;[12] and (2) there was substantial survey nonresponse (22.4 percent), but because we do not have relevant information about the sampling process, we cannot address attrition appropriately.

There are other limitations to the baseline survey to establish a baseline of production in the perimeter prior to MCC's investments. The baseline survey, conducted by BERD, took place in 2013 after PAPs had been resettled. Conducting retrospective surveys can lead to recall bias. In addition, respondents may have had an incentive to report exaggerated values of agricultural production and incomes if they believed that the compensation amounts could still change. This is possible as BERD was the same contractor that also collected information for the compensation process. Also, the survey did not collect information on PAPs' production on land that was used to construct the Di perimeter at baseline, focusing on production outside of the perimeter only for the sample of PAPs who farmed land both inside and outside the perimeter. As a result, we are unable to provide a direct estimate of the value of production on the perimeter at baseline. Additional detail on the data limitations are provided in Table D.1 in Appendix D, which summarizes the data we received, the data that we did and did not use from each source, and reasons for any excluded data.

Despite these limitations, the baseline survey data represent the best available information on the PAPs' status at baseline. For that reason, Mathematica devoted considerable effort to cleaning, reshaping, and merging the data files. Combined with the plot census data files, the baseline survey data provide rudimentary information to construct a number of outcomes

[10] The initial evaluation design focused on assessing the consequences of the perimeter construction on PAPs, including a quantitative performance evaluation based on a pre-post methodology (IRIS 2010). However, the data collected as part of the compensation process did not capture information on the value of agricultural output before the relocation, and a separate baseline survey did not provide information on land use within the perimeter before resettlement. These and other data quality issues led the second evaluator to conclude in the Evaluation Design Report that the baseline survey data could not be used for a pre-post evaluation (IMPAQ 2014b). We agree with the previous evaluators that the data issues in the compensation and baseline surveys preclude a pre-post analysis for individual households (See Ksoll et al. 2017 for more details).

[11] Mathematica received the 2011 plot census data in Excel format. The data had been copied by MCC from a PDF file that contained (in the French grammatical style) commas instead of decimals, which resulted in errors in the placement of some decimals. Our team made a reasonable effort to clean the data; however, we were unable to fix some variables, which are clearly noted in the data and are not used for the analyses presented in this report.

[12] The second evaluator, as described in the Data Quality Report (DQR), also point out their inability to replicate BERD's sampling using the information provided (IMPAQ 2014c).

describing the PAPs, including estimates of their economic well-being, land value, and production.

D. Baseline findings

In this section, we describe the primary findings from descriptive analyses of the plot census, baseline survey, and land allocation file, which will help us establish a baseline regarding PAP well-being. The analyses also inform us of the extent to which PAPs faced the constraints to enhanced production and income that the IWRM and DA activities were designed to address. These include poor access to irrigation, weak land ownership and informal land tenure arrangements, a lack of technical knowledge and capacity, limited use of advanced practices and technologies, limited value added and market access, and a lack of finance. The goal is to assess whether PAPs could feasibly benefit from the IWRM and DA activities' multiple forms of assistance, including land and land tenure assistance, training, free inputs, and rehabilitated markets. In addition, these analyses can be used to recalculate the ERR (RQ4).

The analyses are presented for all PAPs combined as well as for male and female PAPs separately, who had different access to land at baseline and have been unequally affected by the perimeter construction. Unless otherwise noted, the level at which the analyses have been conducted is the level of the individual PAP as the sampling for the baseline survey was conducted at the individual level. As a result, the proportion of households in the survey with more than one PAP is lower than the entire surveyed population: the land allocation database contains data on 1,445 PAPs in 846 households while the baseline survey contains data on 388 PAPs in 306 households.[13]

1. Demographic information and economic well-being

In this section, we describe the characteristics of PAPs, including occupations, households, and economic well-being. These measures provide a picture of the PAPs at the time that the baseline survey was conducted in 2013, after the land allocation had occurred. Table III.4 summarizes the key measures related to demographics, household composition, economic status, and credit use.

Key findings: Nearly all PAPs are farmers, and most are men of working age. PAP households are relatively large and conduct a variety of productive and commercial activities—agriculture being the most common. At baseline, most PAPs had never taken out a loan for productive activities, likely in part due to a lack of collateral. In addition, less than half of PAPs had ever received some form of training in productive activities by the time of the baseline.

[13] The plot census data includes 1,469 unique PAPs. The difference in the number of PAPs across the census files and the land allocation file is due to PAPs receiving multiple IDs for different plots, perhaps across the different phases. These were clarified in the land allocation process (SHER/GRET 2013).

Table III.4. Measures of PAP characteristics, household composition, and economic status

Measures	Time frame
PAP demographic information. Age; gender	October 2013
PAP occupation. Primary occupation; secondary occupation; whether the PAP's primary or secondary occupation is agriculture	October 2013
Household size. Total number of household members; number of household members under the age of 18.	October 2013
Household occupations. Percent of adult household members who primary occupation in agriculture; percent of adult household members who secondary occupation is agriculture.	October 2013
Sources of income. Whether PAP's sources of income include: agricultural products, livestock, fishing, nonwood forest products, commerce, other nonagricultural activities, transfers received, other sources of revenue.	2008–2013
Agricultural assets. Number owned currently and number bought with compensation money for each asset: animal-pulled plow, cart, motor pump, tractor, other.	October 2013
Credit use. Has ever had a loan for agriculture or livestock; reason(s) for never having taken out a loan	October 2013

The majority of PAPs are men between the ages of 30 and 60 and nearly all participate in the agriculture sector (Table III.5). Only 22 percent of the sample of baseline survey respondents were female. Overall, the majority of PAPs (nearly 69 percent) are between the ages of 30 and 60, and 98.8 percent of female PAPs and 99.7 percent of male PAPs report that agriculture is their primary or secondary occupation. Female PAPs are slightly less likely than male PAPs to list agriculture as their primary occupation, but regardless, nearly 90 percent of female PAPs report that agriculture is their primary occupation.

Table III.5. Characteristics of PAP baseline survey respondents at baseline

	Mean		
	Total	Female	Male
Age	43.6	41.2	44.3
Age categories (%)			
Younger than 30 years	17.5%	20.0%	16.8%
Between 30 and 60 years	68.7%	71.8%	67.8%
60 years and older	13.8%	8.2%	15.4%
Female (%)	22.5%	100.0%	0.0%
Primary or secondary occupation is agriculture (%)	99.5%	98.8%	99.7%
Primary occupation (%)			
Agriculture	95.2%	89.4%	96.9%
Livestock farming	0.3%	0.0%	0.3%
Commerce	1.6%	3.5%	1.0%
Student	2.4%	7.1%	1.0%
Other	0.5%	0.0%	0.7%

Table III.5 (continued)

	Mean		
	Total	Female	Male
Secondary occupation[a] (%)			
Agriculture	10.7%	10.7%	10.7%
Livestock farming	8.8%	1.2%	11.0%
Fishing	8.0%	0.0%	10.3%
Commerce	41.3%	64.3%	34.7%
Other	31.2%	23.8%	33.3%
Sample size (PAPs)	**377**	**85**	**292**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data.

[a] This outcome is conditional on having a second occupation.

PAP households are considerably larger, on average, than the average rural household in Burkina Faso (Table III.6). The average household size in the survey sample is 12.4, of whom half are under the age of 18. Consistent with findings for the PAPs themselves, 86 percent of adults in the household list agriculture as their primary occupation, and nearly all (93.8 percent) do some form of agriculture.

Table III.6. Characteristics of Di PAP households at baseline

	Mean		
	Total	Female	Male
Household size	12.4	12.3	12.4
Household size (under 18 years)	6.4	6.5	6.4
Percent of adult household members whose primary occupation is agriculture	85.5%	89.3%	84.4%
Percent of adult household members who do any agriculture	93.8%	95.8%	93.2%
Sample size (PAPs)	**376**	**85**	**291**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full household roster sample. One PAP was missing household roster data.

PAPs report a variety of income sources, of which agricultural products are the most common (Table III.7). Almost all PAPs (93.4 percent) report at least some income from agricultural products, and about half report income from livestock. Commerce is another common source of income, particularly for women—47 percent of women reported revenue from commerce as compared to 31.8 percent of men. At the time of the baseline survey, PAPs reported owning, on average, 1.5 animal-drawn plows and one cart. (This number includes 0.5 animal-drawn plows and 0.2 carts purchased with financial compensation provided by the compact.) Ownership patterns of male and female PAPs are similar.

Table III.7. Economic well-being of PAPs at baseline

	Mean		
	Total	Female	Male
PAPs' sources of income include: (%)			
Agricultural products	93.4%	91.8%	93.8%
Livestock	48.2%	35.7%	51.9%
Fishing	12.1%	6.0%	13.9%
Non-wood forest products	14.7%	12.0%	15.5%
Commerce	35.3%	47.0%	31.8%
Other nonagricultural activities	16.9%	9.6%	19.1%
Transfers received	11.5%	9.6%	12.0%
Other sources of revenue	1.1%	2.4%	0.7%
Agricultural assets at time of survey (number)[a]			
Animal-drawn plows	1.5	1.4	1.5
Cart	1.0	1.0	1.0
Motor pump	0.3	0.3	0.3
Tractor	0.0	0.0	0.1
Other type of equipment	0.5	0.2	0.6
Agricultural assets bought with compensation money (number)			
Animal-drawn plows	0.5	0.2	0.5
Cart	0.2	0.1	0.2
Motor pump	0.1	0.0	0.1
Tractor	0.0	0.0	0.0
Other type of equipment	0.2	0.1	0.2
Sample size (PAPs)	**377**	**85**	**292**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data.

[a] The number of assets owned at baseline (before the survey) could be roughly estimated as the number owned at the time of the survey minus the number bought with compensation money. However, this does not take into account assets that were sold or lost since they were purchased.

The ADP program sought to increase land security and provide access to credit. Thus, understanding PAPs' access to credit prior to the program is an important input to estimating change in well-being over time.

Often citing a lack of collateral, only about one-quarter of women and one third of men reported having ever taken out a loan for agricultural or livestock improvements. Over one-third of PAPs reported a lack of collateral as a reason for never having taken out a loan, suggesting that a lack of land tenure may represent a constraint to PAPs' access to finance. Women were slightly more likely than men (41 percent vs. 33 percent) to report having insufficient collateral for a loan (Table III.8). Other explanations among PAPs were high interest rate (15.7 percent), being unsure of procedures (10.9 percent), and not needing the money (23 percent).

Table III.8. Use of credit

	Mean		
	Total	Female	Male
Has previously had a loan for agriculture/livestock (%)	33.4%	27.1%	35.3%
Reason for never having taken out a loan (%)			
High interest rate	15.7%	21.3%	13.9%
Unsure of procedures	10.9%	8.2%	11.8%
No collateral	35.1%	41.0%	33.2%
Did not need to	23.0%	16.4%	25.1%
Not accessible	6.9%	1.6%	8.6%
Other	8.5%	11.5%	7.5%
Sample size (PAPs)	**377**	**85**	**292**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data.

To complement the provision of irrigated land to PAPs, the ADP provided agricultural training. In particular, the program provided training in farming corn, rice, tomatoes, and onion on irrigated land. It is therefore useful to understand how many PAPs had received any kind of agricultural-related training prior to the program's implementation.

Overall, less than half of PAPs received some form of training in productive activities by the time of the baseline. Only one quarter female PAPs had received training compared to about half of male PAPs. The most common topic of training, from among the list provided in the survey, was agriculture, followed by livestock and transformation/post-harvest (Table III.9). Only 35.9 percent of PAPs had ever received agricultural training. We add a caveat to this finding that some of these survey responses may already reflect compact activities: the survey was implemented after the farmer training activities had started, and it is possible that some PAPs may have participated in farmer training activities for land off-perimeter.

Table III.9. Training experience

	Mean		
	Total	Female	Male
Has previously received training (%):			
Any	46.7%	26.2%	52.6%
Agriculture	35.9%	16.5%	41.6%
Livestock	16.5%	7.1%	19.2%
Transformation and post-harvest	4.5%	2.4%	5.2%
Fishing	2.4%	0.0%	3.1%
Forestry	1.3%	0.0%	1.7%
Agroforestry	6.7%	8.3%	6.2%
Sample size (PAPs)	**376**	**85**	**291**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data.

2. Land use and production

Key outcomes for understanding the economic status of PAPs at baseline are those related to their production and revenue from the land they lost due to the construction of the Di perimeter. However, this data is not directly available from either the plot census or the baseline survey. The baseline survey provides estimated numbers on only *off-perimeter* land use and production. In contrast, the plot census data provides information on the amount of land lost to the construction of the perimeter, the types of crop grown on this land, and whether irrigation was used—it does not provide any information on the production or sales or crops from that land. Using the limited information from the baseline survey, however, it is possible to construct an imperfect measure of the annual value of PAPs' production on all land owned in the agriculture season prior to the perimeter construction (for on- and off-perimeter land combined)[14] as well as the estimated annual revenue from sales of crops on land lost.[15] Information on each construct is provided in Table III.10.

Table III.10. Measures of land value and production and land lost

Measures	Time frame
Off-perimeter land use. PAP farmed land off-perimeter at baseline; PAP usage of motor pump and/or traditional irrigation; proportion of off-perimeter land used to farm: onions, tomatoes, rice, corn, sorghum (directly reported in survey).	2010/2011 or 2011/2012 dry and rainy agricultural seasons
Off-perimeter land production. Estimated annual production in tons of onions, tomatoes, rice, corn, and sorghum (calculated from a variety of reported units of measurement); estimated annual production (tons) per hectare for onions, tomatoes, rice, corn, and sorghum (calculated from the PAP's estimated amount of off-perimeter land)	2010/2011 or 2011/2012 dry and rainy agricultural seasons
Amount of land lost. Average amount of land lost by PAP in perimeter (from plot census); estimated percent of PAP's total baseline land lost (calculated using the amount of on-perimeter land lost from plot census and estimated amount of off-perimeter land farmed by the PAP, from baseline survey).	2010/2011 or 2011/2012 dry and rainy agricultural seasons
On-perimeter land use. PAP lost land used to farm onions, tomatoes, rice, corn, and sorghum (directly recorded in plot census); average amount of land lost by crop: onions, tomatoes, rice, corn, and sorghum (directly recorded in plot census); proportion of on-perimeter land used to farm each crop: onions, tomatoes, rice, corn, and sorghum (calculated from plot census numbers); PAP farmed irrigated, flooded, or rain-fed crops (where tomatoes and onions are irrigated crops, rice and corn are flooded crops, and manioc, peanuts, sesame, and sorghum are rain-fed crops).	2010/2011 or 2011/2012 dry and rainy agricultural seasons

[14] PAPs reported revenue from sales on all land combined, as well as the percentage of production from all land combined that was sold. We divided sales revenue by the percentage of production sold to construct the measure of production value.

[15] Respondents were asked to estimate the proportion of off-perimeter land dedicated to farming each crop and to report the proportion of production from all land (on and off-perimeter combined) that was consumed, sold, traded, given to family and friends, or saved for seeds for each crop. The survey instrument requested both as a categorical proportion (less than 1/4, 1/4 to 1/2, and so on), as well as a specific percentage amount; however, these did not always match. Respondents were also asked to estimate the amount of agricultural and nonagricultural revenue (separately and combined) that came from land off-perimeter, in relation to the amount of revenue from land on-perimeter. Again, respondents reported a categorical proportion and a percentage value, which did not always match. The off-perimeter to on-perimeter revenue ratio was converted into the percentage of revenue lost. Multiplying this percentage by the total annual revenue for sale of crops on all land allowed for the calculation of the estimated annual revenue from sales of crops on land lost. Findings related to these measures should be interpreted with caution, given that they are imputed from a combination of self-reported estimates with clear inconsistencies.

Table III.10 (continued)

Measures	Time frame
Revenue. Estimated amount of annual revenue from sale of key crops, all key crops combined and separately for onions, tomatoes, rice, corn, and sorghum on all land (calculated from respondent-reported sales numbers); Estimated proportion of revenue lost (calculated as the amount of revenue on-perimeter over the amount of revenue from all land combined, as estimated by the survey respondents); Estimated amount of revenue from sale of crops on on-perimeter land (calculated using the estimated proportion of revenue lost and the self-reported amount of revenue from all land).	2010/2011 or 2011/2012 dry and rainy agricultural seasons
Estimated total annual value of production from all land owned by PAP at baseline. This outcome is calculated as the sum of the estimated production value of each crop. Production value by crop is calculated as the PAP's annual revenue from sales of that crop divided by the fraction of total production that was sold, as estimated by the survey respondents.	2010/2011 or 2011/2012 dry and rainy agricultural seasons

Note: The following outcomes were top-coded to three standard deviations from the mean to account for outliers: estimated annual production, estimated annual production per hectare, estimated amount of annual revenue, and estimated total annual value of household production.

The baseline survey collected information on PAPs' production on any land that they owned outside of the Di perimeter. We present information on off-perimeter land use and agricultural practices because the observed patterns can be reflective of agricultural practices on land PAPs lost to the construction of the perimeter.

Key findings: PAPs were engaged in off-perimeter farming at baseline, often using irrigation to cultivate staple crops. Most PAPs lost less than one hectare of land due to perimeter construction, typically land used to farm sorghum. Although women lost less land than men, on average, they lost a greater percentage of their total land. PAPs' loss of land caused substantive revenue losses, particularly for rice production and sales.

PAPs were engaged in off-perimeter farming at baseline. The survey found that 65 percent of PAPs farmed land outside the Di perimeter (Table III.11). Slightly more than half of PAPs used some form of irrigation for this farming—either a motor pump, traditional irrigation, or both.

In their off-perimeter farming, PAPs produced a larger quantity (in tons) of staple crops—such as corn, sorghum, and rice—than cash crops such as tomatoes and onions. This is mostly consistent with the amount of land dedicated to each crop. However, rice production was roughly equal to that of corn and sorghum, even though it accounted for only 11.5 percent of off-perimeter land, whereas corn and sorghum accounted for 25 and 30 percent of off-perimeter land, respectively; tomatoes are the most productive non-staple crop, with an average of 8.8 tons per hectare across all PAPs (see Appendix D, Table D.2).

Male PAPs were more likely to farm land off-perimeter and much more likely to use some form of irrigation on that land (Table III.11). Seventy-two percent of male PAPs, but only 41 percent of female PAPs, farmed off-perimeter land. On that land, less than 20 percent of women used some form of irrigation, while about 58 percent of men employed at least one form of irrigation. Consistent with these findings, women dedicated much less land, on average, to farming rice (an irrigated crop) than men.

Table III.11. Off-perimeter land use at baseline

	Mean		
	Total	Female	Male
Farmed land off-perimeter at baseline (%)	65.3%	41.2%	72.3%
Off-perimeter land use			
PAP uses:[a]			
Motor pump only	11.5%	5.7%	12.4%
Traditional irrigation only	34.4%	11.4%	38.3%
Both motor pump and traditional irrigation	6.1%	0.0%	7.2%
Neither	48.0%	82.9%	42.1%
Estimated proportion of off-perimeter land used to farm[b]			
Onions	3.5%	2.4%	3.7%
Tomatoes	3.1%	2.3%	3.2%
Rice	10.8%	2.6%	12.1%
Corn	24.7%	15.3%	26.3%
Sorghum	30.0%	25.8%	30.7%
Sample size (PAPs)	**377**	**85**	**292**
Sample size (PAPs farming land off-perimeter)	**246**	**35**	**211**

Source: Di PAP Baseline Survey (2013)

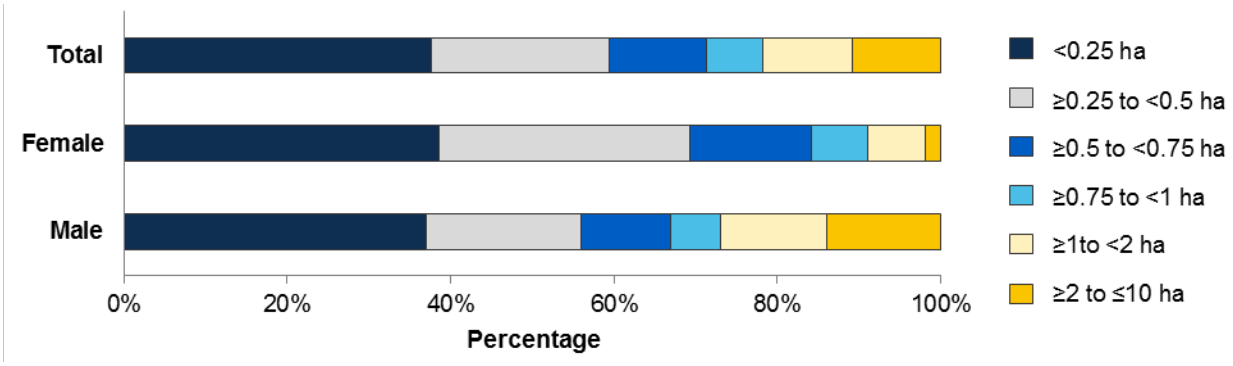
Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data. All outcomes besides armed land outside of the perimeter" are calculated for the subsample for PAPs who reported farming land off-perimeter at baseline.

[a] We interpreted this survey question to be irrigation practices that the PAPs use on off-perimeter land, because the module is restricted to those who farm land off-perimeter.

[b] Other crops were included in the survey but we list only the five main crops that appear across the various survey instruments. Millet and beans were other common crops farmed by PAPs off-perimeter.

The majority of PAPs (78 percent) lost less than one hectare of land. Figure III.3 shows the percent of PAPs (total and separately by male and female) whose total land loss falls into each category of land amount. Thirty-eight percent of PAPs lost less than 0.25 hectares, and about 60 percent lost less than 0.5 hectares. The amount of land lost varied by gender, with men losing larger quantities. Overall, men lost 1.01 hectare on average and women lost 0.43. Nine percent of women versus 27 percent of men lost more than 1 hectare.

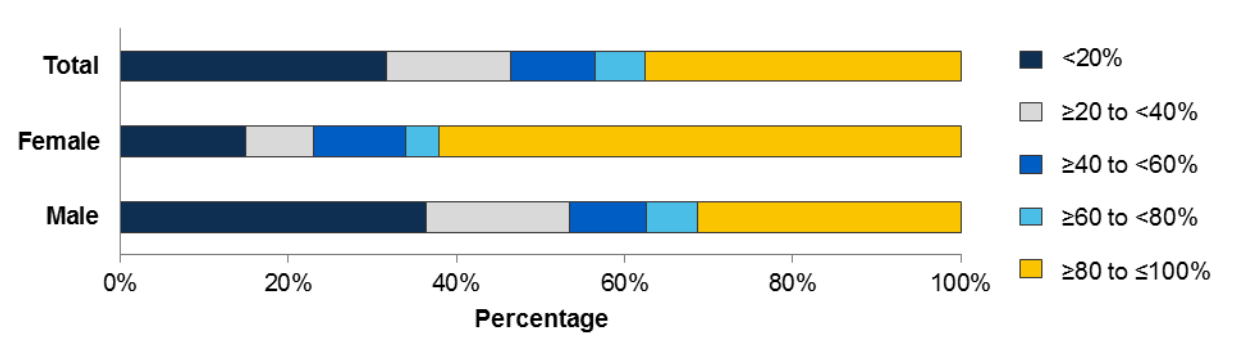
Figure III.3. Amount of land lost (percentage of PAPs)



Source: Di PAP Baseline Survey (2013); Plot Census (2011); Plot Census (2013)

Although women lost, on average, less land than men, they lost a greater percentage of their total land (on- and off-perimeter combined). The difference is stark: 62 percent of women compared to only 31 percent of men lost between 80 and 100 percent of their land due to the construction of the Di perimeter (Figure III.4). Overall, women lost 74 percent of their total land due to the perimeter construction, compared to only 47.3 percent for men (see Table III.12). This is consistent with findings in Table III.11 that women were less likely than men to farm land off-perimeter.

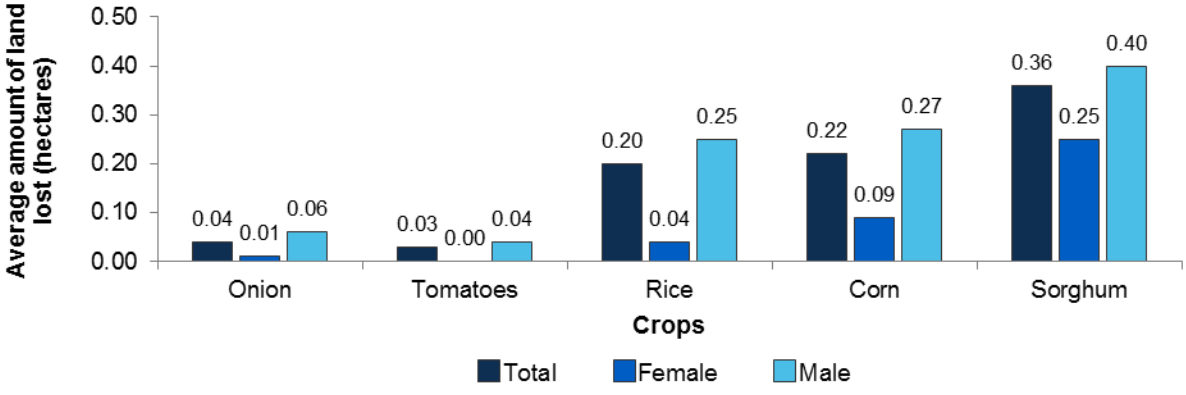
Figure III.4. Estimated percentage of total land lost (percentage of PAPs)



Source: Plot Census (2011); Plot Census (2013)

PAPs lost more land used to farm sorghum than any other crop (Figure III.5). Both men and women lost large quantities of land dedicated to sorghum (between 0.25 and 0.40 hectares), but both lost very little to farm tomatoes and onions (between 0.00 and 0.06 hectares, on average). Because sorghum is an important staple crop, this could affect PAPs' food security.

Figure III.5. Average amount of land lost by crop



Source: Plot Census (2011); Plot Census (2013)

Men were more likely than women to have farmed irrigated crops on the land lost. Consistent with patterns of irrigation use off-perimeter, 47.6 percent of men farmed irrigated crops on lost land compared to just 10.0 percent of women (Table III.12). Men were also more likely to farm flooded crops (rice and corn), whereas women were more likely to farm rain-fed crops, which include sorghum.[16] This suggests that a larger proportion of women than men would likely (need to) shift farming practices on the newly constructed perimeter, which could indicate a need for more irrigation training for women.

Table III.12. Description of land lost among Di PAPs

	Mean		
	Total	Female	Male
Average amount of land lost in perimeter (hectare)	0.86	0.43	1.01
Estimated amount of land lost as percentage of total land owned (%)[a]	53.2%	74.0%	47.3%
Lost any land used to farm[b] (%)			
Onion	19.1%	6.6%	23.3%
Tomatoes	23.4%	4.0%	29.9%
Rice	22.4%	14.6%	25.0%
Corn	33.5%	20.3%	37.9%
Sorghum	35.9%	51.4%	30.7%
Average amount of land lost in perimeter that was used to farm[c] (hectare)			
Onion	0.04	0.01	0.06
Tomatoes	0.03	0.00	0.04
Rice	0.20	0.04	0.25
Corn	0.22	0.09	0.27
Sorghum	0.36	0.25	0.40
Average proportion of land lost that was used to farm (%)			
Onion	10.3%	4.3%	12.4%
Tomatoes	15.0%	3.1%	19.0%
Rice	17.6%	13.4%	19.0%
Corn	23.0%	18.4%	24.5%
Sorghum	30.0%	48.7%	23.7%
Farmed irrigated crops[d] (%)	38.1%	10.0%	47.6%
Farmed flooded/floodplain crops[c,d] (%)	50.8%	34.9%	56.1%
Farmed rain-fed crops[c,d] (%)	40.4%	63.4%	32.7%
Sample size (PAPs)	**1,391**	**350**	**1,041**

Source: Di PAP Baseline Survey (2013); Plot Census (2011); Plot Census (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data.

[a] The outcome is calculated using data from the baseline survey and therefore is only available for the PAP baseline survey sample (n = 388).

[16] The data show that many PAPs were farming irrigated or flooded crops before the perimeter construction, and thus the evaluation may be able to determine whether PAPs observed increased productivity on the new perimeter. For PAPs that farmed flooded crops, the irrigated perimeter would have offered a level of control not previously possible.

Table III.12 (continued)

[b] These percentages may total more than 100 percent because PAPs could farm different crops across multiple plots of land. In addition, tomatoes and onions could be farmed on the same plot of land as corn, rice, and sorghum during different seasons.

[c] This outcome is not conditional on farming the given crop. If a PAP did not farm a given crop, the amount of land is included as zero.

[d] The 2013 plot census data included three additional crops: manioc, peanuts, and sesame, but with no indication as to whether those crops are typically farmed on irrigated land. We include only the five main crops that were present in both rounds of plot census data.

PAPs lost over 80 percent of their total revenue from sale of crops due to the resettlement. The estimated amount of crop sales revenue lost amounted to about 355,734 FCFA (745 USD;[17] Table III.13). Consistent with our findings for the amount of land lost, women lost a smaller amount of revenue, but a larger percentage of their total revenue than men (89.6 percent versus 81 percent). The median amount of crop sales revenue lost is much lower at 75,000 FCFA (157 USD). The median values are considerably lower than the mean values, given a large number of PAPs, in particular women, with zero sales and a few PAPs with large sales. The average estimated sales value of production on all land owned by PAPs at baseline was 1.7 million FCFA (approximately 3,564 USD).

PAPs earned more revenue from the sale of rice on lost land than from any other crop. Overall, women and men reported annual revenue of 135,110 FCFA (283 USD) and 489,246 FCFA (1,026 USD), respectively, from the sale of the five key crops on off-perimeter and on-perimeter land combined (Table III.13). Sales patterns show that sorghum and corn were primarily grown as staple crops for PAPs' own consumption, while onion and tomatoes were primarily cash crops.

Table III.13. PAP sales and revenue at baseline

	Mean		
	Total	Female	Male
Sales from land at baseline			
Proportion of production sold (%)[a]			
Onion	71.3	67.4	72.1
Tomatoes	73.7	56.3	75.2
Rice	43.4	36.3	44.4
Corn	10.6	12.7	10.1
Sorghum	5.9	8.6	5.4
Annual sales revenue from sale of crops on all land owned (FCFA)			
All key crops	422,039	136,718	509,510
Onion	112,166	26,094	137,308
Tomatoes	80,233	25,768	96,088
Rice	147,364	56,765	173,919
Corn	54,896	16,929	66,410
Sorghum	18,445	9,753	21,028
Estimated proportion of agricultural revenue lost (%)[b]	82.9%	89.6%	81.0%

[17] USD equivalents for the PAP baseline survey are based on the exchange rate as of January 2014, which was 477 FCFA to the dollar.

Table III.13 (continued)

	Mean		
	Total	Female	Male
Inferred annual revenue from sale of crops on land lost (FCFA) (Mean)	355,734	115,650	429,336
Inferred annual revenue from sale of crops on land lost (FCFA) (Median)[c]	75,000	0.4	122,500
Estimated annual value of production on all land owned at baseline (FCFA)	1,738,795	873,400	1,999,500
Sample size (PAPs)	**377**	**85**	**292**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data. As a result of missing values, the individual sales revenues do not add up to the total values.

[a] This outcome is restricted to PAPs who farmed each crop.

[b] The input variable is constructed from two variables. The survey requested both a categorical proportion (less than 1/4, 1/4 to 1/2, for example) as well as a specific percentage amount. Our approach to reconciling these two variables is described above Table III.7. Because of missing values, this is not exactly equal to annual total sales revenue multiplied by estimated proportion of agricultural revenue lost.

[c] The median value for females is so low because some PAPs did not report revenue or farming any of the key crops.

E. Discussion

The analysis provided in this report represents only partial information on the situation of PAPs at baseline because of issues with the completeness and quality of the data. We find that the data cannot be used as the basis for a pre-post evaluation or to update the baseline values for the ERR. However, because the change in agricultural production, incomes, and profits from irrigated land is expected to be large relative to the level of agricultural outcomes before the construction of the perimeter, it will possible to gain an understanding of the magnitude of these changes through this mixed-methods study.

Below are key findings focusing on PAPs' binding constraints to higher productivity and incomes at baseline and the potential of the IWRM and DA activities to overcome these constraints (see Table III.14 for a discussion of all constraints underlying the program logic).

- ***PAPs' undiversified production likely precluded greater income, but PAPs had plans to shift to high-value corps.*** At baseline, few PAPs cultivated substantive amounts of cash crops such as tomatoes or onions. However, PAPs reported planning to shift away from farming subsistence, non-irrigated crops (primarily sorghum) to irrigated, high-value cash crops such as tomatoes and onion. This is consistent with MCC's ERR model, which anticipates a transition from staple crops to high-value cash crops and includes profits from the sale of onions and tomatoes as part of the benefit stream.
- ***MCA's provision of land and tenure documents could overcome binding constraints to greater production and sales.*** PAPs lost about half of the land they owned to the construction of the perimeter, and their access to credit was generally low at baseline. If implemented effectively, the WMI Activity's land compensation and land tenure assistance could increase PAPs' irrigated land, expand production, and enable them to use land as collateral to finance productive activities.

- ***PAPs' lack of agricultural training in vegetable production and irrigation practices may have been a sizable constraint to improved outcomes at baseline.*** If MCC-funded training in these practices equipped PAPs with new, practical knowledge, it could help them diversify their production on the perimeter and boost sales and income.

These findings suggest that PAPs' receipt of irrigated land under the WMI Activity and technical assistance under the DA Activity could overcome several key binding constraints to greater productivity and incomes. However, the degree to which land compensation and technical assistance are timed and coordinated would affect the ability to address these constraints.

Additional key findings from the analyses include:

- ***Overall, PAPs lost a substantial amount of their land (53 percent) and agricultural sales revenue (83 percent) during the resettlement.*** PAPs lost, on average, 1 hectare of land. Although the financial compensation and irrigated land distribution were intended to fully account for these losses, the evaluation will explore whether PAPs viewed the compensation as sufficient, whether they received it within the planned timeline, and whether they faced any hardships due to these losses.
- ***The resettlement affected male and female PAPs very differently***. While men lost more land and more revenue than women, on average, women lost a greater share of their land and revenue than men. Thus, it will be important to analyze gender differences across all measures of well-being using follow-up data to understand the differential impacts that the program has on male and female PAPs.

These additional findings suggest that although the resettlement had a substantive effect on all PAPs' land holdings and revenue, female PAPs may have experienced particularly large losses. The evaluation will explore the extent to which female PAPs perceive that they were appropriately compensated for these losses.

Table III.14. Assessment of constraints underlying the program logic

Constraint from program logic	Assessment of the constraint at baseline	Potential of the intervention to overcome the constraint
Lack of access to irrigation	PAPs were engaged in irrigated infrastructure at baseline, often off-perimeter. However, nearly 40 percent of PAPs lost irrigated land to the perimeter's construction.	If they received land compensation promptly following their losses, PAPs could feasibly regain or even increase their access irrigated land, thus reestablishing or augmenting their production and sales.
Weak land ownership and informal land tenure arrangements	PAPs lost a substantial proportion of their land during the resettlement. Land tenure is a constraint among a sizable portion of PAPs: over one-third of PAPs who have never taken out a loan listed a lack of collateral as the reason.	If implemented fairly and efficiently, land compensation could restore or expand PAPs' access to irrigated land. Also, the WMI program's provision of land tenure documents could enable PAPs to use land as collateral to access finance.
Lack of technical knowledge and capacity	Although PAPs commonly practice irrigation, fewer than 40 percent had received agricultural training at baseline. As such, they may have lacked knowledge of advanced practices, including the correct use of irrigation, fertilizers, and pesticides.	If MCC-funded training equipped PAPs with new, practical knowledge that could help them modernize their practices and adapt to production on the perimeter, it could lead them to diversify and boost production and sales.
Lack of agricultural diversification	PAPs report little agricultural diversification, which can be a large constraint to increased sales and income.	MCC-funded training and assistance with crop diversification, complemented by PAPs' receipt of irrigated land on the perimeter, could help PAPs further diversify their production.
Limited use of traction animals, machinery, and advanced inputs	No information available.	--
Limited value added and market access	Fewer than 5 percent of PAPs had received training in transformation and post-harvest at baseline. However, not much information is available from the baseline survey about PAPs' market access at baseline.	PAPs could receive training in post-production techniques and could feasibly increase their market access through rehabilitated markets.
Access to finance	Most PAPs had never taken out a loan for productive activities at baseline.	PAPs' assistance with land tenure for their new land could overcome some farmers' constraints to credit.

F. Next steps

There are two additional rounds of data collection: an interim round was conducted in January to February 2018 and a final round will occur from January 2019 to January 2020. These data collection rounds will focus on receipt of land and land tenure documents as well as agricultural production among a representative sample of PAPs. This allows for any changes observed to be extrapolated to the full group of PAPs. With this data, we propose to recalculate the ERR using the information on area planted, input use, input prices, agricultural production, production sales prices, and profits. Additional information on the ERR model and calculations are presented in Appendix B.

In addition to the quantitative survey data collection, one round of qualitative data collection is occurring in February and March 2018. This data collection includes interviews and focus group discussions (FGDs) with PAPs, interviews with WUA presidents from the Di perimeter, FGDs with WUA board members and staff from Di, and interviews with Centre d'Appui Technique et de Gestion (CATG) staff. The purpose of this qualitative data collection is to understand potential harms to PAPs, changes in well-being, gender-specific changes in well-being, and perceptions of compensation, the process of compensation, and land security.

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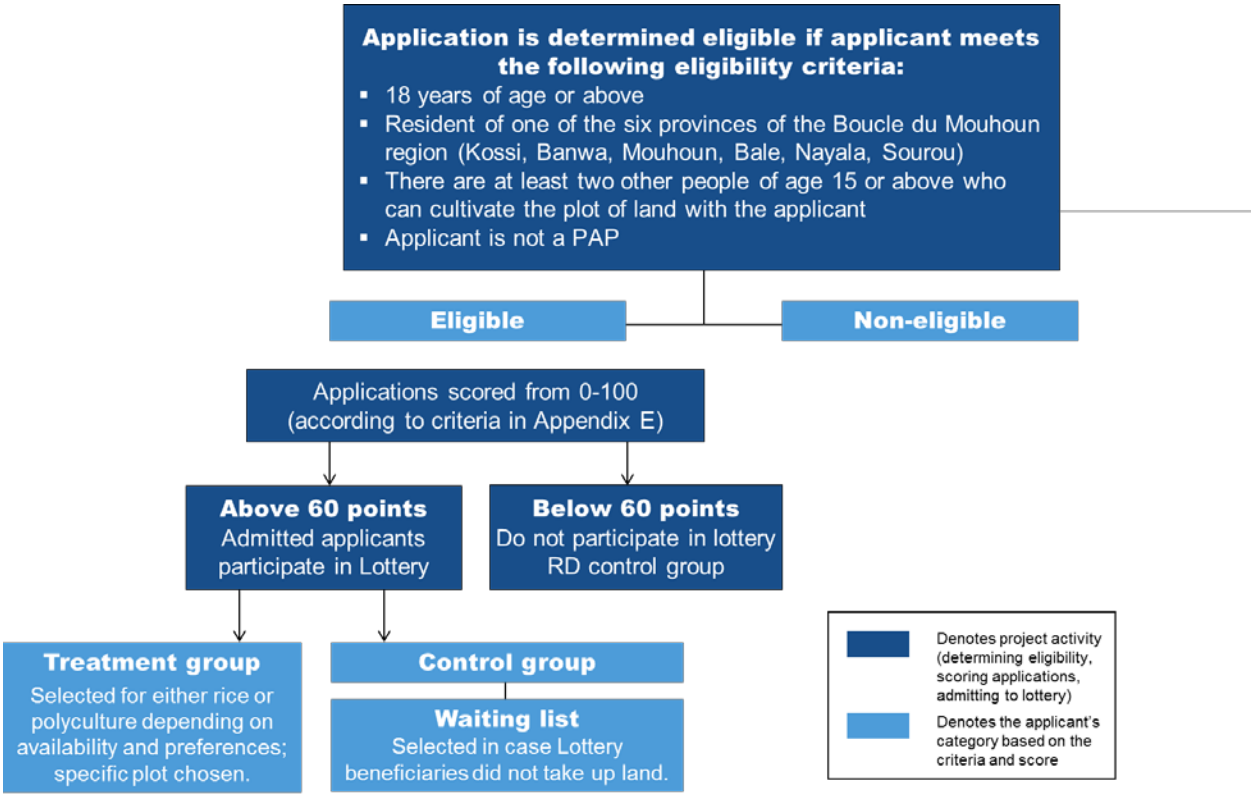
IV. DI LOTTERY

This chapter examines the data collected from the Di Lottery application process and the Di Lottery baseline survey. It provides background on the characteristics of farmers who applied to the lottery and the constraints they face, verifies whether the Di Lottery led to comparable treatment and control groups, and determines whether the implementation of the application process suggests that a regression discontinuity design is applicable.

A. The Di Lottery beneficiary selection process

As discussed in Chapter III, approximately 30 percent of land in the Di perimeter was distributed via the Di Lottery. Recruiting applicants and selecting Di Lottery beneficiaries was a multi-step process (Figure IV.1) that began with the ADP inviting individuals to apply for the lottery. The criteria included individuals who were (1) not PAP; (2) 18 years of age or older; (3) resident of one of the six provinces of the Boucle du Mouhoun region (Kossi, Banwa, Mouhoun, Balé, Nayala, Sourou); and (4) able to list at least two other people age 15 or older who could cultivate land on the Di perimeter with the applicant.

Figure IV.1. Di Lottery beneficiary selection process



Among eligible applicants, admission to the lottery was determined through a points-based system developed by MCC and MCA-BF that was designed to (1) select applicants with higher expected benefits (for example, applicants received more points when they owned certain machinery and had previous experience with irrigation); and (2) meet distributional objectives

(for example, female applicants and younger applicants received additional points). Table E.1 in Appendix E includes the scoring sheet.

Applicants were aware of the four eligibility criteria, the information they were scored on, and the associated scores, but they were not initially aware of the exact threshold that would determine participation in the lottery. To make the selection process transparent, all application information was made public in multiple locations (for example, at local town halls). AD7 verified the accuracy of the application documents, such as cross-checking debt with farmers' cooperatives and land ownership with water-user associations.

The Commission pour l'Attribution de la Terre (CAT), in collaboration with MCA-BF and MCC, set the cutoff for participation in the lottery at 60 points, resulting in roughly three-quarters of eligible applicants being permitted to participate in the lottery. Given the number of male and female applicants scoring 60 points or more, this cutoff made it highly probable that at least 20 percent of beneficiaries would be females.

A list of eligible applicants was publicly and widely posted, and MCA-BF and CAT allowed applicants to contest the information on their applications and scores. After this restitution, 1,528 applicants were admitted to the lottery.[18]

B. Evaluation objectives, questions, and methods

The goal of the Di Lottery evaluation is to provide rigorous evidence of the impact of receiving access to irrigated land—in combination with training in irrigated farming technologies, start-up materials and land tenure documents[19]—to Di Lottery beneficiaries and their households. In addition, we propose a methodological study—known as a within-study comparison (WSC)—that compares the estimated impacts of the Di Lottery RCT with the impacts estimated through a regression discontinuity design (RD). This study will provide evidence of the efficacy of the RD design in situations where an RCT is not feasible. The key research questions for this evaluation, and the methodological approach used to address them are listed in Table IV.1. Additional detail can be found in the Evaluation Design Report (Ksoll et al. 2017).[20]

[18] Only one observation on the eligible but non-lottery participant list was admitted to the lottery after posting. Some applicants with incomplete applications were also admitted to the lottery after their names and incomplete application status were posted.

[19] To exploit the awarded plot in a productive manner, Di Lottery beneficiaries were to receive additional benefits, similar to those provided by the project to Di PAPs and other recipients of land in the Di perimeter. These benefits included training in agricultural technologies for irrigated land, agricultural starter kits, and land tenure documents (see Chapter III, Section A for more detail).

[20] The Di Lottery survey for the interim and final data collection will include questions to assess individual-level outcomes by gender—for example, expenditures for education purposes, control over resources, and male and female education.

Table IV.1. Di Lottery RCT: list of research questions and methods

		Descriptive analysis	Impact evaluation	Methodological study
RQ1	To what extent did Di Lottery beneficiaries receive all benefits they were meant to receive (formal lease documents, training in agricultural technologies, starter kits)?	X		
RQ2	What impact does winning the Di Lottery have on agricultural practices, production, total agricultural income, and overall household income of the Di Lottery beneficiaries?		X	
RQ3	What are the impacts of winning the Di Lottery on land tenure security?		X	
RQ3a	Have Di Lottery beneficiaries been involved in a land conflict on or off the perimeter?		X	
RQ4	To what extent are the estimated impacts from the RD similar to those from the RCT?		X	X
RQ5	To what extent can methods that use the discontinuity to estimate impacts away from the threshold recover the average treatment effect of the Di Lottery?		X	X

The Di Lottery evaluation will rely on descriptive and impact analyses of quantitative data to address the research questions. To understand what proportion of Di Lottery beneficiaries received lease documents and training and starter kits (RQ1) we will analyze data from the interim survey that includes a module for Di Lottery beneficiaries on benefits received through the ADP.

To estimate the causal impact of winning the Di Lottery and receiving land on the Di perimeter on the primary evaluation outcomes—agricultural outcomes (RQ2) and outcomes related to land tenure security (RQ3)—we will conduct quantitative analyses within the RCT framework. This methodology relies on the random assignment of Di Lottery participants to either the treatment (lottery beneficiaries) or control (lottery participants not selected as beneficiaries) groups. We will compare the outcomes of lottery participants, who were randomly selected to receive a plot, with those of lottery participants who were not selected to receive a plot. We discuss methodological details and the regression equations that we will implement in the evaluation design report (Ksoll et al. 2017).[21] We also discuss empirical analyses of baseline data to investigate whether the random assignment led to comparable treatment and control groups in Section D.2 of this chapter, and identify unbalanced characteristics to be included in the regression model as covariates.

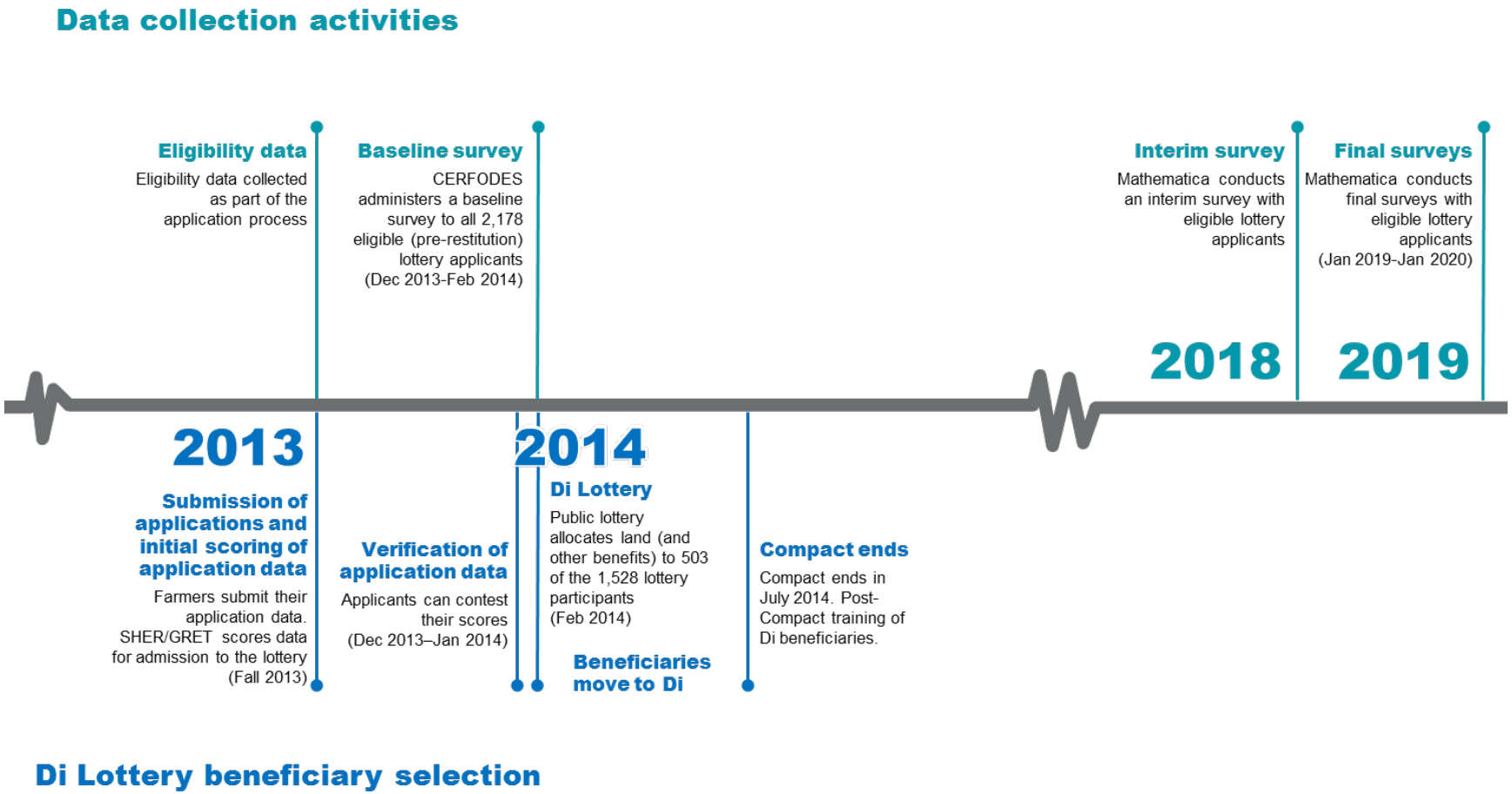
[21] There are two specificities of the lottery that lead the analysis to be different from a simple comparison between the treatment and control groups: (1) lottery applicants had to specify their preference among the two types of available plots (rice or polyculture) and multiple applications from within the household were possible. To account for applicant preferences, we include preference fixed effects into the analysis (Ksoll et al. 2017). Because applicants from multiple-applicant households constitute less than 5 percent of eligible applicants, we conduct a robustness check in which we drop applicants in multiple-applicant households from the analysis.

To conduct the within-study comparison of estimates based on an RD with estimates from an RCT, we need to estimate the impact of the program using the RD approach in a first step. In this baseline report we investigate the plausibility of the RD design by (1) assessing whether the scoring variable meets the requirement of the RD, (2) investigating whether there is a discontinuity in baseline outcome variables around the cutoff, and (3) selecting an appropriate functional form for the scoring variable (Lee and Lemieux 2010; Schochet et al. 2010). We present an empirical investigation of the plausibility of the RD assumptions in this context in Section D.3 of this chapter.

C. Baseline data sources

Upon award of the evaluation contract, MCC shared with Mathematica the main data sources collected between 2013 and 2014 by the MCA contractors implementing the Di Lottery and the previous evaluators and data collection subcontractors. These data sources include (1) the Di Lottery applicant eligibility data; (2) the database of Di Lottery beneficiaries and Di Lottery land allocation data; and (3) the Di Lottery baseline survey data. In Figure IV.2, we present a timeline of the administrative data collection (below the timeline) and past and future survey data collection (above the timeline). For reference, additional implementation activities appear below the timeline.

Figure IV.2. Timeline of Di Lottery data collection activities



The Di Lottery applicant eligibility data consists of several databases containing successive versions of the application information, corresponding to different stages in the application verification process (see Section A of this chapter). The final version of the application information was used to determine whether applicants met the eligibility criteria and to score applications. For the analysis in this report, we use the most current information on the eligibility criteria that was available to us.[22] For lottery participants, we complement the detailed eligibility information with information on final composite scores. For eligible applicants who were not admitted to the lottery, we complement the detailed eligibility information with composite scores from lists that were publicly displayed in town halls to provide applicants an opportunity to contest their scores.[23] We present an overview of the existing data-sources in Table IV.2.

Table IV.2. Summary of existing data sources

Name	Collection date	Sample	Sample size	Content
Di Lottery eligibility data				
Di Lottery applicant eligibility data	2013–2014	Eligible applicants	2,206	• Information on eligibility criteria • Multiple applicants in household
List of lottery participants	2013–2014	Lottery participants (eligible applicants with score of 60 and above)	1,528	• Final composite score • Plot preferences
List of non-admitted applicants	2013–2014	Eligible applicants not admitted to lottery (score below 60)	651	• Close to final composite score • Plot preferences
Di Lottery baseline survey				
Di Lottery baseline survey	2013–2014	Applicants deemed eligible after verification	2,128	• Socio-demographic characteristics of applicant and household • Agricultural activities, use of agricultural techniques and experience of applicant and applicant's household • Land and agricultural assets of applicant and applicant's household • Income sources of applicant's household

[22] We know that the eligibility data available to us is not the final version used to determine participation in the lottery, as there are inconsistencies between eligibility scores from our data and lottery participation. We have been unable to obtain the final database.

[23] Using these latter lists reduced inconsistencies between participation in the lottery and having a test score 60 and above to only two cases. However, the list of eligible but not admitted applicants is not complete. At least 51 applications considered ineligible were deemed eligible after the decisions were contested, with most of them being ineligible but not admitted to the lottery.

Table IV.2 (continued)

Name	Collection date	Sample	Sample size	Content
Di Lottery beneficiary information				
Database of Di Lottery beneficiaries	2014	Lottery participants selected to receive a plot	503	• Lottery participants selected to receive a plot • Type of awarded plot (polyculture or rice plot)
Land allocation database	2014	Lottery participants selected to receive a plot	503[a]	• Plot size

[a] Database includes PAPs, women's and youth groups, and beneficiaries from neighboring communities in addition to the 503 Di Lottery beneficiaries.

MCA contracted the Centre d'Etudes, de Recherches et de Formation pour le Développement Economique et Social (CERFODES) to collect baseline survey data on lottery applicants for the evaluation, the Di Lottery baseline data. CERFODES attempted to survey all 2,178 applicants who initially met the eligibility criteria in December 2013 and early 2014. Of these, 2,128 completed surveys.[24] The Di Lottery baseline survey collected data on applicants' and their households' demographic and socioeconomic characteristics, land and agricultural assets, agricultural activities (including production and training) and experience, nonagricultural activities, and income sources. The baseline data does not, however, have comprehensive information on agricultural production or agricultural incomes. Measures related to income are limited because the survey contained only six questions to determine income for all household members.

As previously noted, 1,528 eligible applicants scored 60 points or more on their application data and were thus admitted to the Di Lottery. Of these, 503 were randomly selected to receive a plot of land in the Di perimeter. The database of Di Lottery beneficiaries contains information on the 503 Di Lottery applicants who won a plot of land, which plot of land they won and whether this was a rice or polyculture plot. The Di land allocation database additionally specifies the size of the awarded plot.

In Appendix E, we review the content and quality of data sources in detail, drawing on the reports written by previous evaluators and our own analyses to discuss challenges to the Di Lottery evaluation. Table E.2 in Appendix E also provides a summary of the variables that we use in the baseline analysis.

D. Baseline findings

In this section, we present our baseline findings for the Di Lottery evaluation. We first examine the characteristics of eligible applicants and provide information on whether they face the particular constraints the WMI and DA program logic is designed to address. Constraints include lack of access to irrigated land, informal land tenure arrangements, lack of technical knowledge and capacity, and limited use of advanced practices and technologies. This analysis provides insight into whether the WMI and DA activities targeted producers with strong

[24] Because the sample frame for the baseline survey was an interim list of eligible applicants, 100 applicants deemed eligible later in the process were not surveyed and are not included in this baseline report.

potential to benefit from the provision of land on the irrigated perimeter. We then compare lottery beneficiaries to participating non-beneficiaries through a formal assessment of balance. These analyses provide a means to assess the validity of the RCT evaluation design (RQ2, RQ3). To the extent that treatment and control groups have similar characteristics at baseline, we can be more confident that estimated impacts are due to the receipt of land on the perimeter and associated benefits. Finally, we conduct an analysis of the plausibility of the RD design (RQ4, RQ5).

1. Description of Di Lottery applicants

In the descriptive analysis below, we describe the demographic, agricultural, land access, and income characteristics of the applicants eligible for the lottery. In each table, the outcomes are presented for all eligible applicants who completed the baseline survey as well as for female and male applicants separately. A particular objective of the Di Lottery was to ensure at least 20 percent of lottery beneficiaries were female. Table IV.3 summarizes these key measures included in the descriptive analysis.

Table IV.3. Measures of Di Lottery applicant demographic, agricultural, land access, and income characteristics

Measures	Time frame
Demographic information—lottery applicants and applicant households. Applicant age, gender, education level, literacy, marital status, and number of dependent children (under age 18) and children in school (ages 6 to 17); head of household characteristics; number of household members and lottery applicants in household.	December 2013
Agricultural and work experience—lottery applicants and applicant households. Applicant currently works or previously worked as a farmer; years of farming experience (if applicant ever worked as farmer); applicant received agricultural training from AD10; number of other household members that are farmers; applicant's other activities and if paid for any activity; household member migrated for work in the last 12 months.	December 2013
Agricultural assets—lottery applicant households. Farm equipment owned, animals owned, and agricultural inputs used by lottery applicant households.	December 2013
Land ownership and tenure—lottery applicants and applicant households. Household members who have property rights; number of household members with property rights; number of plots household members own; for applicants owning, renting in, renting out, and with access to communal plots: number of plots and number irrigated, contract type, total plot area, plots cultivated, labor hired, method of payment, and total value of payment per hectare; for applicant households renting in and renting out plots: number of plots and number irrigated, contract type, total plot area, plots cultivated, labor hired, method of payment, and total value of payment per hectare.[25]	December 2013
Sources and value of income—lottery applicant households. Income sources and their values for lottery applicant households.	December 2013

Note: The following variables were top-coded to three standard deviations from the mean to account for outliers: age of applicant, years of experience in farming, plot rental payments per hectare, and all measures of income.

[25] Contract type, plots cultivated, labor hired, method of payment, and total value of payment per hectare are not applicable for all types of land ownership and tenure. For example, method of payment is not applicable to plots owned or to which the applicant has communal access rights.

a. Demographic characteristics

Key findings: Di Lottery applicants tended to be men of working age who were the head of large households. In contrast, female applicants tended to be the spouse or sibling of the head of household. Although literacy rates were low across all applicants, men were more likely than women to be literate.

The majority of Di Lottery applicants are men between the ages of 25 and 55 with low levels of education. Most eligible applicants were married, from large households (roughly 11 members per household), and were in charge of about four children (Table IV.4). Eligible applicants typically had less than post-primary education and low literacy rates (only 29 percent could read and write in a national language). Generally, there was one applicant per household, but there were some households with multiple applicants (1.1 applicants per household, on average).

Female applicants tend to be the spouse or sibling of the household head. Female applicants differed from their male counterparts on several dimensions. In particular, over 90 percent of female applicants were the spouse or sibling of the head, whereas male applicants were typically the head of household (Table IV.4). Female applicants were also typically less literate than male applicants (22 percent compared to 31 percent).

Table IV.4. Characteristics of lottery applicants and applicant households

	Mean		
	Total	Female	Male
Age	35.71	35.70	35.72
Age categories (%)			
Younger than 25 years	13.6	14.5	13.3
Between 25 and 55 years	81.9	82.3	81.9
56 years and older	4.5	3.1	4.8
Female (%)	19.0	100.0	0.0
Education (%)			
None	42.9	52.8	40.5
Primary	22.3	20.8	22.6
Rural school	3.3	1.8	3.7
Medersa	10.5	2.1	12.5
Post-primary	3.4	2.8	3.6
Secondary	12.8	16.7	11.9
Higher	4.8	3.1	5.2
Can read and write (%)	28.8	21.8	30.5
Married, including polygamous	85.7	85.6	85.8
Married, polygamous only	23.9	20.0	24.8
Number of dependent children of applicant (under the age of 18)	3.91	3.53	4.00
Number of children in school (ages 6 to 17)	2.11	2.24	2.08
Applicant is head of household (%)	65.5	15.1	77.3

Table IV.4 (continued)

	Mean		
	Total	Female	Male
If applicant not head, relationship to head (%)			
Spouse	42.3	87.3	2.7
Child	36.5	3.3	65.7
Sibling	17.5	5.4	28.2
Nephew/niece	1.6	0.6	2.4
Parent-in-law	1.4	0	0
Adopted child	0.3	2.7	0.3
Other	0.1	0.3	0.3
No relation	0.3	0.3	0.0
Number of household members	11.10	10.75	11.18
Number of household members that applied to the lottery [a]	1.06	1.10	1.06
Sample size	**2,049**	**390**	**1,659**

Source: Di Lottery Baseline Survey (2013), Di Lottery applicant eligibility data (2013-14)

Note: Statistics shown are unadjusted means. Sample size is 707 (331 / 376) for applicants who are not the head of household (female subgroup / male subgroup).

[a] The number of household members that applied to the lottery was calculated using the Di Lottery applicant eligibility data. All other outcomes presented in this table were generated using the Di Lottery Baseline Survey data.

b. Agricultural and work experience

Key findings: At baseline, most applicants had at least some experience in agricultural techniques such as irrigation, cultivation of rice, and intercropping; used advanced techniques such as improved seed, inorganic fertilizer, and herbicides and pesticides. Few eligible applicants, however, had received training in vegetable production and irrigation practices at baseline.

Most applicants had some experience in agricultural techniques that are useful for cultivating plots in the Di perimeter, including irrigation and rice production. In part, this may reflect the Di Lottery selection criteria, which prioritized applicants with experience in irrigation and other advanced production techniques. Applicants also reported extensive farming experience: the majority of eligible applicants worked as farmers at the time of data collection (84 percent) or previously had worked as farmers (88 percent of those not actively farming; Table IV.5). Collectively, active and former famers had about 16 years of farming experience and lived in households with five other farmers, on average.

Although outcomes for male and female applicants were not vastly dissimilar, fewer female applicants had experience in farming than their male counterparts. For example, 39 percent of female applicants had no experience in irrigation compared to 27 percent of male applicants.

Few applicants received formal training in irrigated agriculture or vegetable production. While applicants had significant experience in irrigated agriculture, only about a fifth of eligible applicants had received training in vegetable production, irrigation techniques, or training by

AD10 (the main contractor for farmer trainings under ADP) covering these topics at the time of data collection.[26]

Table IV.5. Agricultural and work experience of lottery applicants and other members of applicant households

	Mean		
	Total	Female	Male
Currently works as farmer (%)	83.7	77.4	85.2
Previously worked as farmer, if not currently (%)	88.3	84.1	89.8
Years of experience as farmer, if ever worked as farmer	15.5	13.58	15.98
Number of other household members that are farmers	5.00	5.33	4.93
Experience in irrigation			
None	29.3	39.0	27.0
Less than 2 years	11.1	9.7	11.5
More than 2 years	59.6	51.3	61.5
Experience in rice production			
None	41.2	51.8	38.8
Less than 2 years	7.7	6.4	8.0
More than 2 years	51.0	41.8	53.2
Experience in intercropping			
None	28.6	31.0	28.0
Less than 2 years	9.1	10.5	8.7
More than 2 years	62.4	58.5	63.3
Received training in vegetable production	21.5	16.2	22.7
Received training in irrigation	22.4	16.2	23.8
Received training from AD10 (%)	17.0	11.8	18.2
Other activities currently performed (%)			
Self-employed (other than farming)	21.5	14.1	23.3
Trade	22.4	38.5	18.6
Looking for work	8.6	7.2	9.0
Training/studying	1.1	2.1	0.9
Domestic work	1.1	4.9	0.2
Retired	0.6	0.8	0.6
Other	1.3	1.8	1.1
Currently performing a paid activity (%)	22.5	21.0	22.9
Household member migrated for work (last 12 months) (%)	22.3	18.5	23.1
Sample size	**2,049**	**390**	**1,659**

Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample size is 334 (88 / 246) for applicants who are not currently working as farmer (female subgroup / male subgroup).

[26] The farmer training was administered in communities in the Sourou Valley starting in 2011. As a result, some of the Di Lottery applicants had already benefitted from training activities under the farmer training sub-activity. This was by design: applicants who had participated in AD10 trainings received additional points on their application.

c. Agricultural assets and input use

Key findings: Most applicants possessed traction animals to plow their fields and used advanced farming inputs at baseline; this suggests they have the capacity for somewhat sophisticated irrigated agriculture production on a relatively large scale.

The majority of Di Lottery applicants owned traction animals and animal drawn plows and used some modern agricultural inputs. A majority of applicant households owned non-mechanized farming equipment such as animal traction plows and carts, and most owned traction bovine and donkeys (Table IV.6). In part, applicants' widespread equipment and animal ownership may reflect the Di Lottery selection criteria, which awarded more points to applicants with machinery and animals that were conducive to operating sizable plots on the perimeter. Applicants' ownership of plows and traction animals suggest they have the capacity for irrigated agriculture production on a relatively large scale.

Applicants widely report using advanced farming inputs. About 71 percent used at least two or more of the following four inputs: improved seed, inorganic fertilizer, herbicide, and pesticide. Agricultural assets and use of inputs was generally similar for male and female applicant households. However, households of female applicants were more likely to report using improved seeds (54 percent versus 47 percent of male applicant households).

Table IV.6. Agricultural assets and input use of lottery applicant households

	Mean		
	Total	Female	Male
Farmer equipment owned by household prior to Di Lottery (%)			
Plow to be used with animal traction	71.6	67.2	72.6
Cart	70.2	71.0	70.0
Motor pump	8.2	9.5	7.9
Tractor	1.9	3.3	1.6
Herbicide or pesticide sprayer	43.4	48.2	42.3
Wheelbarrow	29.0	34.1	27.8
Animals owned by household prior to Di Lottery (%)			
Traction bovine	67.1	63.1	68.0
Other bovine	31.5	32.8	31.2
Traction donkey	57.7	57.7	57.7
Other donkey	22.6	19.3	23.4
Sheep	51.5	48.5	52.2
Goat	45.7	40.3	47.0
Pig	9.8	12.8	9.1
Chicken	88.1	87.4	88.3
Guinea fowl	19.3	15.9	20.1
Other poultry	8.4	8.2	8.5

Table IV.6 (continued)

	Mean		
	Total	Female	Male
Agricultural inputs used by household prior to Di Lottery (%)			
Traditional seed	81.1	75.9	82.3
Improved seed	48.5	54.4	47.1
Inorganic fertilizer	70.9	75.4	69.8
Herbicide	63.4	67.2	62.5
Pesticide	62.4	65.9	61.5
Compost	60.1	57.2	60.7
Organic manure	72.4	73.1	72.3
Used two or more advanced techniques[a]	70.6	74.6	69.7
Sample size	**2,049**	**390**	**1,659**

Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means.

[a] Advanced techniques included improved seed, inorganic fertilizer, herbicide, and pesticide.

d. Land access

Key findings: Lottery applicants reported irrigating around 40 percent of their plots. About half of applicants owned plots, about one-quarter rented plots, and one-quarter had communal access. Most rented plots were irrigated, suggesting that applicant households did not own a sufficient amount of irrigable land. Male applicants had greater land ownership, greater access to irrigated land, and less need for hired labor than female applicants. This suggests that male applicants had several advantages over female applicants with respect to agricultural production.

Di Lottery applicants irrigated around 40 percent of their farmland. On average, eligible applicants operated nearly two plots—whether owned, rented, or communal—and irrigated about two-thirds of a plot (Table IV.7).[27] Almost all applicants cultivated the plots they owned, rented or had communal access to.

About half of applicants owned plots; fewer rented or had communal access. More applicants owned plots (about half) than those renting or with communal access to plots (about one-fourth of eligible applicants for each).[28] The total area of the plots owned by applicants varied, although over a one-fourth of applicants owning plots possessed over 4 hectares of cultivable land. Among those renting land, the total rented area was generally one hectare or less, although most rented plots were irrigated. This suggests that applicants rented land with the specific purpose of irrigating, perhaps because they owned a suboptimal amount of irrigated land. Applicants renting plots typically did so using conventional rental transactions (only 16 percent were sharecroppers on plots) and paid their rental fees in cash (85 percent). Most

[27] A "plot" of land is defined as a parcel of cultivable land (of any size) operated by a lottery applicant or other farming member of an applicant household.

[28] These land ownership and tenure characteristics are not mutually exclusive: an applicant can both own and rent plots, for example.

applicants with communal rights had access to less than two hectares of communal land, and few of the plots were irrigated.

Female applicants were less likely to own or rent plots than male applicants, and their communal land plot sizes were smaller than those of male applicants. There are a few important differences between male and female applicants regarding access to land. First, about double the percentage of male applicants owned plots compared to female applicants (53 percent of male applicants owned plots compared to 24 percent of female applicants; Table IV.7). Similarly, a greater percentage of male applicants rented plots compared to female applicants (29 percent compared to 19 percent). The total area of plots owned and to which applicants had communal access were also both notably larger for male applicants. In particular, 29 percent of male applicants owning plots possessed four hectares or more compared to only 14 percent of female applicants (Figure IV.3). Similarly, of those with communal access, about 60 percent of female applicants had access to areas less than one hectare compared to only 40 percent of male applicants with communal access.

The majority of Di Lottery applicants, particularly women, hired labor to cultivate land. Independent of whether households owned, rented or had communal access to land, around sixty percent of households hired labor for their plots. Female applicants were more likely than male applicants to hire labor to work owned, rented, and communal plots.

Table E.3 in Appendix E presents the analysis on land tenure for the entire households of applicants, as the research questions investigate outcomes for applicants and their households.[29]

[29] About 63 percent of households had at least one member with property rights. Across all households, an average of about one member per household had property rights. Other household members also had access to communal land (38 percent of applicant households had access to communal land compared to 26 percent of lottery applicants).

Table IV.7. Access to cultivable land for lottery applicants

	Mean		
	Total	Female	Male
Land operated by lottery applicants			
Number of plots owned, rented in, or with communal access rights	1.72	0.99	1.89
Number of irrigated plots owned, rented in, or with communal access rights	0.69	0.48	0.74
Land owned by lottery applicants			
Owned plots (%)	47.3	24.1	52.8
Among those owning:			
Number of plots	1.95	1.34	2.02
Number of owned plots irrigated	0.49	0.28	0.51
Total area of owned plots (ha)			
<0.5 ha	11.2	23.4	9.9
≥0.5 to <1 ha	16.9	28.7	15.6
≥1 to <1.99 ha	16.6	14.9	16.8
≥2 to <2.99 ha	16.0	9.6	16.7
≥3 to <3.99 ha	11.2	9.6	11.4
≥4 ha	27.8	13.8	29.3
Do not know	0.2	0.0	0.2
Cultivated owned plots (last 12 months) (%)	0.98	98.9	97.9
Hired labor on cultivated owned plots (last 12 months) (%)[b]	65.5	76.3	64.3
Land rented to lottery applicants from others			
Rented plots (%)	27.4	19.2	29.3
Among those renting:			
Number of plots	1.58	2.07	1.51
Number of rented-in plots irrigated	1.39	1.91	1.31
Contract type, rented-in plots (%)			
Sharecropping	15.5	17.3	15.3
Rent	81.8	81.3	81.9
Both	2.7	1.3	2.9
Total area of rented-in plots (%)			
<0.5 ha	47.2	49.3	46.9
≥0.5 to <1 ha	36.0	34.7	36.2
≥1 to <1.99 ha	8.6	9.3	8.4
≥2 to <2.99 ha	4.8	2.7	5.1
≥3 to <3.99 ha	1.6	1.3	1.6
≥4 ha	1.8	2.7	1.6
Don't know	0.0	0.0	0.0
Cultivated rented-in plots (last 12 months) (%)	94.7	94.7	94.7
Hired labor on cultivated rented-in plots (last 12 months) (%)[b]	60.3	63.4	59.8
Method of payment for plots rented in (last 12 months) (%)[b]			
Cash	85.0	87.3	84.6
In kind	10.4	5.6	11.2
Both cash and in kind	4.6	7.0	4.2
Total value of payments per hectare for rented-in plots (FCFA/ha) [a, b]	116,401	117,753	116,192

Table IV.7 (continued)

	Mean		
	Total	Female	Male
Communal land operated by lottery applicants			
Has communal access rights to plots (%)	25.5	22.6	26.2
Among those with communal land rights:			
Number of plots	1.40	1.18	1.44
Number of communal plots irrigated	0.28	0.17	0.30
Total area of communal plots (%)			
<0.5 ha	18.2	30.7	15.6
≥0.5 to <1 ha	26.2	31.8	25.1
≥1 to <1.99 ha	17.4	17.0	17.5
≥2 to <2.99 ha	15.7	11.4	16.6
≥3 to <3.99 ha	9.2	5.7	9.9
≥4 ha	13.0	3.4	14.9
Don't know	0.4	0.0	0.5
Cultivated communal plots (last 12 months) (%)	97.1	98.9	96.8
Hired labor on cultivated communal plots (last 12 months) (%)[b]	55.7	60.9	54.6
Sample size	**2,049**	**390**	**1,659**

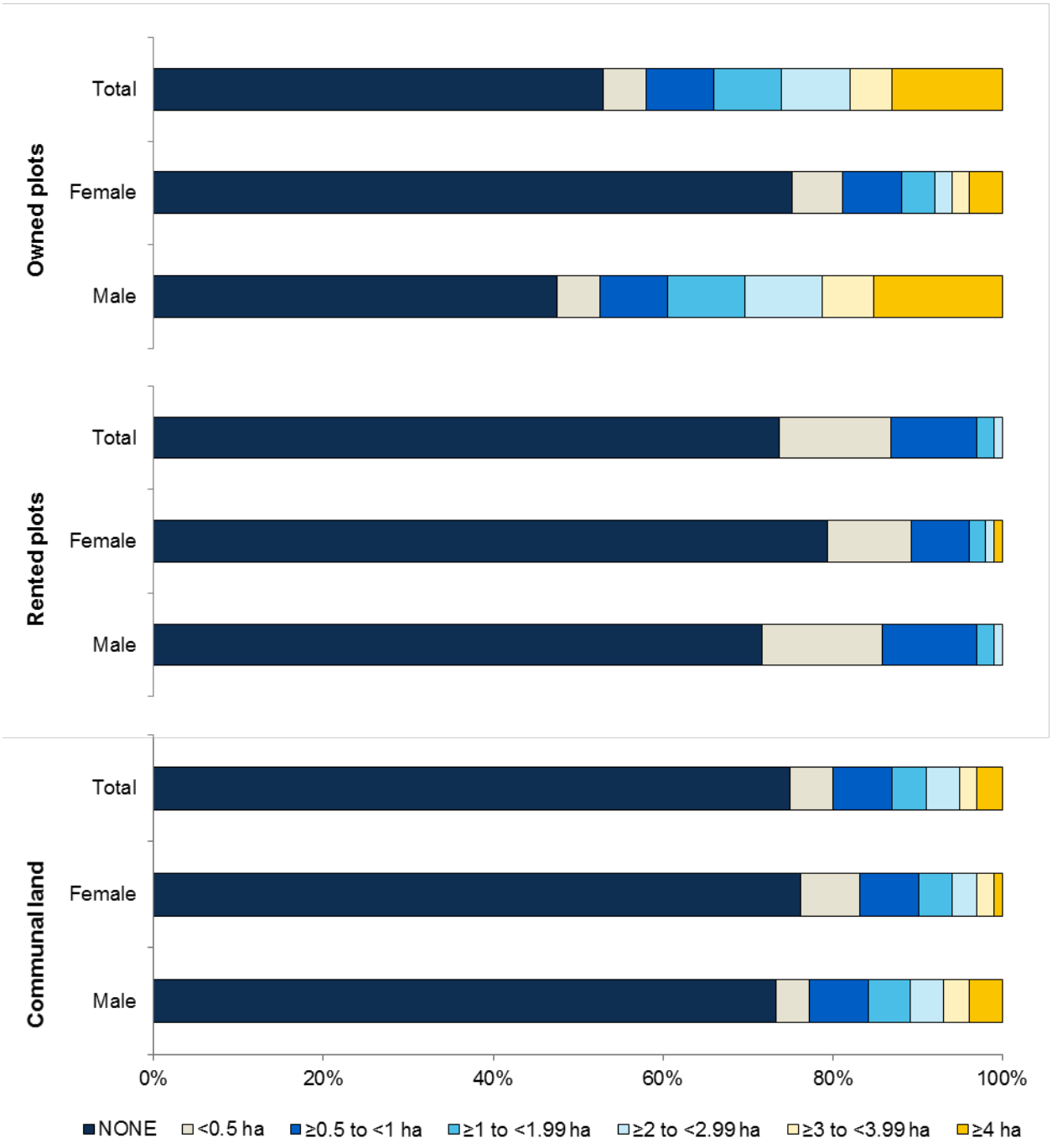
Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample size is 970 (94/876) for applicants who owned plots (female subgroup / male subgroup); 561 (75 / 486) for applicants renting in plots; 523 (88/435) for applicants with communal rights to plots.

[a] Total area of plots was collected as a categorical variable in which each category represents an area range. Because the precise value of total area was not collected, we used the midpoint of the category recorded for each observation as the denominator of total value of payments per hectare. Total value of payments per hectare was not calculated for observations with plot areas falling within the four hectares and larger range because a midpoint cannot be calculated for that category.

[b] The sample size for this indicator is restricted to applicants cultivating owned, rented, or communal plots, respectively.

Figure IV.3. Access to land by land tenure and gender



Note: Categories with less than 1 percent do not appear in graph.

e. Sources of revenue for applicant households

Key findings: Nearly the same percentage of households—around 55 percent—generated revenue from agricultural sales during the dry and rainy seasons. Dry season agricultural sales account for a large portion of applicant household revenue, reflecting applicant families' widespread use of irrigation at baseline.

Sales of dry season agricultural production were, on average, the largest source of total household revenue. Although nearly the same percentage of households generated revenue from agricultural sales during the dry and rainy seasons, the revenue received by households selling produce in the dry season was significantly higher—an average of about 625,000 FCFA (1,300 USD)[30] compared to about 268,000 FCFA (560 USD) during the rainy season (Table IV.8). Paid work was less common with only a quarter of households reporting any paid work. However, households with income from paid work received substantial amounts from this source—about 821,000 FCFA (1,720 USD), on average.

Table IV.8. Sources of revenue for lottery applicant households

	Mean		
	Total	Female	Male
Had income from revenue source (last 12 months) (%)			
Agricultural production sales–rainy season	56.17	57.95	55.76
Agricultural production sales–dry season	54.86	58.46	54.01
Trade	37.68	49.74	34.84
Animal sales	49.54	41.54	51.42
Paid work	26.94	28.46	26.58
Other income	19.52	17.18	20.07
Among those who received a specific income source or income from revenue source (last 12 months) (FCFA)[a]			
Agricultural production sales–rainy season	268,039	303,011	259,494
Agricultural production sales–dry season	625,051	817,987	575,956
Trade	396,699	405,157	393,860
Animal sales	185,114	215,337	179,374
Paid work	820,795	1,023,923	769,668
Other income	342,428	309,331	349,087
Total household revenue (FCFA)[a]	1,195,273	1,784,676	1,056,716
Sample Size	**2,049**	**390**	**1,659**

Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means.

[a] Because the average presented for each of the six income sources is for those households with nonzero income for that income source, their sum is not the same as the average of total household revenue.

[30] USD equivalents for the Di Lottery baseline survey are based on the exchange rate as of January 2014, which was 477 FCFA to the dollar.

Total household revenue during the 12 months prior to the survey was about 1,200,000 FCFA (2,500 USD) on average. The household revenue of Di applicants exceeded household revenue of farmers in the farmer training sample. All individual revenue sources (if receiving) and total household revenue were larger for female applicant households than male households with the exception of other income received. Because the survey only collected information on the sales of agricultural production but not own consumption of household agricultural production, it is not possible to compute the total value of agricultural production and income. As a result, we also cannot compute total household income.

2. Baseline equivalence of Di Lottery beneficiaries and controls

We next compare information on lottery beneficiaries (the treatment group) of the impact evaluation to participating non-beneficiaries (the control group) to determine similarities along key dimensions, a fundamental assumption of an RCT design. To ensure the rigor of the RTC design, we tested balance on two types of data (a) applicant-level administrative data and (b) survey data on applicants and applicant households. We assess balance at the level of the applicant and the applicant's household because the impact analysis will estimate impacts at both levels.

a. Balance on applicant-level data

Key findings: Across applicant-level administrative data, we found that lottery beneficiaries (treatment group) were similar to non-beneficiaries (control group) on most key dimensions, with the exception of number of household members and applicant gender. This treatment-control balance suggests that the lottery was properly implemented, and it enhances the rigor of the impact analysis. Impact regression models will control for all variables in which beneficiaries and non-beneficiaries are not balanced.

The Di Lottery beneficiary and control groups are balanced across application scoring variables, with two exceptions. Treatment and control groups are similar along most dimensions in the application data (Table IV.9). The only significant differences are that Di Lottery beneficiary households list 0.15 fewer household members on their application than control households do, and beneficiaries are 4 percentage points more likely to be female (although the latter difference is only marginally significant). A joint test of significance of the differences in scoring variables suggests that overall, treatment and control groups are balanced.

Table IV.9. Balance tests for scoring variables for Di Lottery participants [a]

Scoring criteria	Treatment group mean	Control group mean	Difference	*p*-value of difference
Number of active household members listed on the application	4.07	4.24	-0.15	0.04**
Applicant owns one piece of specific agricultural equipment from list of specific equipment	15.4	12.4	2.7	0.16
Applicant owns at least two pieces of specific agricultural equipment	74.4	75.0	-0.7	0.78
Applicant received technical training in agriculture	40.9	38.6	1.3	0.64
Applicant has no experience in irrigated agriculture	25.2	28.0	-2.5	0.33
Applicant has less than two years of experience in irrigated agriculture	5.1	7.3	-2.1	0.14
Applicant has two years or more of experience in irrigated agriculture	69.7	64.7	4.5	0.09*
Female	22.6	18.9	4.1	0.07*
Age of applicant – 18 to 30	39.5	43.2	-4.3	0.12
Age of applicant – 31 to 55	56.2	53.0	3.8	0.18
Age of applicant – 56 or older	4.3	3.8	0.7	0.54
Applicant has debt	1.3	1.3	0.1	0.87
Applicant is from village in the rural Di commune	55.9	53.7	0.7	0.82
Applicant is from Sourou province	92.8	94.1	-1.5	0.25
Applicant is from Boucle du Mouhoun region	1.5	0.8	0.9	0.11
Applicant does not have title to a parcel on AMVS perimeters	99.3	99.0	0.3	0.57
Total applicant eligibility score	71.79	71.82	-0.3	0.95
Joint test of significance[b]				0.17
Number of observations	**469**	**957**		

Source: Di Lottery applicant eligibility data (2013-14)

Note: All outcomes are percentages except number of active household members.

[a] The sample for this table is restricted to lottery participants who also completed the baseline survey, because only lottery participants with baseline data will be included in the analysis sample of the impact evaluation.

[b] The joint test of significance is from a regression of the treatment indicator on all scoring criteria as well as strata fixed effects. F-test test hypothesis that the coefficients on all scoring criteria are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

For female lottery applicants, the scoring variables are also balanced between beneficiaries and control groups. We also conducted these balance tests for only female lottery participants and find that the female beneficiary and control groups are also similar along most dimensions in the application data (Table E.4 in Appendix E).

Individual-level balance tests excluding multiple-applicant households are qualitatively similar to those including multiple-applicant households. Because households with multiple applicants have different probabilities of applicant selection to the treatment group, and may have both beneficiaries and non-beneficiaries in the household, we repeated these balance tests

excluding applicants from multiple-applicant households.[31] These additional balance tests are provided in Appendix E for all lottery participants from single-applicant households, and separately for female and male lottery participants from single-applicant households (Tables E.5, E.6, and E.7 in Appendix E, respectively). For each of these analysis, we again find that the patterns of balance or imbalance between the treatment and control groups remain similar to those presented in Tables IV.9 and E.4 in Appendix E.

b. Balance on survey data

Key findings: Analyzing survey data on applicants and applicant households, we found that lottery beneficiaries (treatment group) were similar to nonbeneficiaries (control group) on most key dimensions, with a few exceptions, the most important of which are related to land rights and land rental. Impact regression models will control for variables in which beneficiary and nonbeneficiary applicants and households are not balanced.

Treatment and control applicants and households are generally balanced across baseline survey indicators, with the exception of land rights and cultivation of rented land. Beneficiary households are more likely to have formal or informal land rights than control households while a larger proportion of control households cultivated rented land (Table IV.10). Treatment and control applicants and households are balanced across most characteristics and a joint test of significance shows that the randomization created overall comparable treatment and control groups. The notable exception to the balance are land rights. Lottery beneficiary households are 8.6 percentage points more likely to have land rights than the control households and—as a result—the average number of plots owned by lottery beneficiary households is larger. (Table E.4 shows that this trend is more pronounced among households of female applicants.) Conversely, lottery control households are 12 percentage points more likely to rent land. At the level of the lottery participant itself, lottery beneficiaries and lottery control individuals do not differ significantly in their ownership of land or access to communal land. However, lottery control applicants more likely to rent land.

The differences in land rights are not due to multiple-applicant households, and there is no differential survey non-response of treatment and control households. Because land rights and access to land are a key determinant of individual and household outcomes, we discuss possible reasons for this imbalance. First, because the selection of beneficiaries was conducted using volunteers selected from the public, it does not seem plausible that the process of selection in the lottery itself could have been the reason for these imbalances. Second, we investigate whether multiple-applicant households may be responsible for these observed imbalances. However, Table E.8 in Appendix E shows that the patterns of balance and imbalance generally remain with the exclusion of multiple-applicant households. However, the difference in dry season sales is now a significant difference—likely due to the differences in land access. We do not find any evidence for differential survey nonresponse between treatment and control households.[32]

[31] The existence of multiple-applicant households would not bias the baseline analysis presented here as data were collected for individual applicants. Due to different probabilities of winning, and possible within-household spillovers, it is important to address the existence of multiple applicants for the analysis of interim and final outcomes.

[32] Specifically, we implement a logistic regression of a binary variable for survey nonresponse on a treatment dummy as well as strata indicators. The *p*-value on the treatment dummy is 0.99.

Table IV.10. Balance tests for baseline survey variables for Di Lottery participants

Baseline survey measure	Treatment group mean	Control group mean	Difference	*p*-value of difference
Characteristics of lottery applicants and lottery applicant households				
Age	35.24	34.80	0.57	0.36
Female (%)	22.6	18.9	4.1	0.07*
Can read and write (%)	30.7	29.5	1.9	0.46
Married, including polygamous	85.9	84.3	1.8	0.37
Married, polygamous only	24.1	22.9	0.7	0.77
Number of dependent children (under age 18)	3.81	3.87	-0.09	0.65
Number of children in school (ages 6 to 17)	2.13	2.06	0.08	0.50
Applicant is head of household (%)	59.3	64.7	-4.8	0.08*
Number of household members	11.52	11.23	0.21	0.59
Number of household members that applied to the lottery (self-reported)	1.28	1.28	0.00	0.91
Agricultural and work experience of lottery applicants and applicant households				
Currently works as farmer (%)	86.1	85.8	-0.5	0.81
Years of experience as farmer, if ever worked as farmer	15.87	15.04	0.82	0.13
Number of other household members that are farmers	5.54	5.14	0.36	0.17
Received training in vegetable production	23.7	24.1	-0.4	0.87
Received training in irrigation	24.9	25.7	-1.0	0.68
Received training from AD10 (%)	17.9	18.5	-1.1	0.62
Currently performing a paid activity (%)	22.2	21.8	0.9	0.70
Household member migrated for work (last 12 months) (%)	24.7	22.0	2.3	0.33
Agricultural assets of lottery applicant households				
Agricultural inputs used – traditional seed	82.9	81.6	1.2	0.59
Agricultural inputs used – enhanced seed	52.2	49.8	2.3	0.42
Agricultural inputs used – fertilizer	73.8	72.1	1.5	0.54
Agricultural inputs used – herbicide	69.2	65.1	3.5	0.19
Agricultural inputs used – pesticide	66.3	63.9	1.3	0.62
Agricultural inputs used – compost	62.0	62.1	-0.5	0.87
Agricultural inputs used – manure	75.1	74.2	0.7	0.79
Agricultural inputs used – other input	2.4	2.0	0.3	0.74
Agricultural inputs used – two or more advanced techniques	76.1	71.8	3.9	0.12
Agricultural equipment owned – plow	77.8	76.4	1.6	0.49
Agricultural equipment owned – cart	73.8	74.1	-0.2	0.94
Agricultural equipment owned – motor pump	8.7	9.0	-0.5	0.73
Agricultural equipment owned – tractor	2.1	1.7	0.4	0.56
Agricultural equipment owned – electronic equipment	46.1	44.9	0.7	0.79
Agricultural equipment owned – wheelbarrow	30.1	31.3	-1.9	0.48
Farm animals owned – traction bovine	71.0	71.3	-0.3	0.91
Farm animals owned – other bovine	32.2	32.8	-1.5	0.57
Farm animals owned—traction donkey	62.0	61.5	0.5	0.86

Table IV.11 (continued)

Baseline survey measure	Treatment group mean	Control group mean	Difference	*p*-value of difference
Farm animals owned – other donkey	21.1	22.9	-1.4	0.54
Farm animals owned – traction horses	2.3	1.4	0.9	0.21
Farm animals owned – other horse	1.5	1.3	0.2	0.71
Farm animals owned – sheep	51.8	53.6	-2.1	0.45
Farm animals owned – goat	48.8	45.8	2.4	0.39
Farm animals owned – pig	11.1	8.9	2.5	0.14
Farm animals owned – chicken	90.8	88.5	2.6	0.14
Farm animals owned – guinea fowl	19.4	19.2	0.4	0.87
Farm animals owned – other poultry	9.0	9.7	-0.4	0.79
Farm animals owned – other animals	11.3	11.0	0.7	0.69
Access to cultivable land for lottery applicants				
Number of plots owned, rented or with communal access rights	1.66	1.73	-0.07	0.47
Number of irrigated plots owned, rented or with communal access rights	0.61	0.70	-0.11	0.07*
Land ownership by lottery applicants[a]				
Owned plots (%)	44.3	44.9	-0.6	0.84
Number of plots	0.94	0.91	0.04	0.68
Number of plots irrigated	0.21	0.22	-0.01	0.78
Cultivated plots (last 12 months) (%)	43.7	44.0	-0.3	0.92
Hired labor on plots (last 12 months) (%)	28.2	29.5	-1.2	0.63
Land rental to lottery applicants from others[a]				
Rented plots (%)	26.0	30.9	-5.3	0.04**
Number of plots	0.36	0.46	-0.11	0.03**
Number of plots irrigated	0.32	0.40	-0.09	0.05**
Cultivated plots (last 12 months) (%)	24.1	29.5	-5.7	0.03**
Hired labor on plots (last 12 months) (%)	14.3	18.5	-4.1	0.05*
Communal land accessed by lottery applicants[a]				
Has communal access rights to plots (%)	26.0	25.6	0.7	0.77
Number of plots	0.35	0.36	0.00	0.94
Number of plots irrigated	0.07	0.07	-0.01	0.67
Cultivated plots (last 12 months) (%)	24.9	24.9	0.4	0.89
Hired labor on plots (last 12 months) (%)	12.3	14.6	-2.3	0.24
Access to cultivable land for lottery applicant households				
Number of plots owned, rented in, or with communal access rights	2.85	2.61	0.24	0.08*
Land ownership by lottery applicant households[a]				
Household members have property rights (%)	68.2	59.6	8.6	0.00***
Number of household members with property rights	1.23	0.83	0.39	0.00***
Number of plots household members own	1.71	1.46	0.24	0.04**
Land rental to lottery applicant households from others [a]				
Rented in plots (%)	23.0	28.6	-5.7	0.02**
Number of plots	0.37	0.48	-0.11	0.04**

Table IV.11 (continued)

Baseline survey measure	Treatment group mean	Control group mean	Difference	*p*-value of difference
Number of plots irrigated	0.34	0.44	-0.10	0.07*
Cultivated plots (last 12 months) (%)	22.0	27.4	-5.5	0.03**
Hired labor on plots (last 12 months) (%)	11.9	16.3	-4.5	0.03**
Communal land accessed by lottery applicant households[a]				
Household members have communal land rights (%)	40.5	39.7	1.1	0.69
Number of plots	0.77	0.66	0.11	0.15
Sources of income for lottery applicant households				
Income source – production sale in rainy season (FCFA)	190,581	175,375	8,823	0.78
Income source – production sale in dry season (FCFA)	352,259	478,100	-139,641	0.12
Income source – trade (FCFA)	159,888	191,277	-38,171	0.63
Income source – animal sale (FCFA)	107,932	98,338	13,984	0.49
Income source – paid labor (FCFA)	178,009	242,643	-66,924	0.36
Income source – other (FCFA)	68,896	60,717	9,267	0.63
Total income (FCFA)	1,057,564	1,246,449	-212,661	0.26
Joint test of significance[c]				0.52
Number of observations	469	957		

Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means.

[a] All values are not conditional on owning, renting-in, or having communal access rights to plots.

[b] Total area of plots was collected as a categorical variable, with each category representing an area range. Because the precise value of total area was not collected, we used the midpoint of the category recorded for each observation as the denominator of total value of payments per hectare, which were not calculated for observations with plot areas falling within the four hectares and larger range, because a midpoint cannot be calculated for that category.

[c] The joint test of significance is from a regression of the treatment indicator on all unconditional survey variables included in the table as well as strata fixed effects. F-test that the coefficient on all unconditional survey variables included in the table are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

3. Analysis of plausibility of an RD design

We investigated the plausibility of the RD design by (1) assessing whether the scoring variable meets the requirement of the RD; (2) determining whether there is a discontinuity in baseline outcome variables around the cutoff; and (3) selecting an appropriate functional form for the scoring variable (Lee and Lemieux 2010; Schochet et al. 2010). We assessed the plausibility of the RD design using detailed guidelines developed to assess the quality of evidence from RD studies in the education sector for the What Works Clearinghouse, a curated repository of studies financed by the U.S. Department of Education (Schochet et al. 2010).[33] These guidelines are typically used to assess completed RD studies. However, we used them to assess the plausibility of the RD approach for the Di Lottery, as the criteria are also applicable to prospective studies with existing information on potential beneficiaries and control observations.

Key findings: Using the selection of Di Lottery beneficiaries via the cutoff meets three criteria for a study to meet the evidence standards for RD: (1) the score was used to select beneficiaries for lottery participation only, (2) the score was not known to applicants until very far into the process and there is no evidence that scores were systematically manipulated, and (3) the baseline values of two key outcomes do not show any discontinuity at baseline, suggesting that any observed effect on Di Lottery beneficiaries in the interim and final studies are due to winning the lottery.

Table IV.11 provides an overview of the criteria and summarizes the evidence.

[33] Hilton Boon et al. (2016) adapt these guidelines for a systematic review of evidence on health interventions.

Table IV.11. Criteria for the plausibility of the RD design

Criteria	Discussion
Study is an RD design	
Treatment assignment based on score cutoff	Admission to the lottery was determined through a cutoff. Because selection within the group of lottery participants was done through a lottery, treatment assignment between RD controls and Di Lottery beneficiaries can be thought of as having been based on the cutoff.[a]
Sufficient number of unique values (4 on each side)	Figure E.1 in Appendix E shows the raw scores with 43 unique values of the score—19 to the left and 24 to the right of the cutoff. In Figure E.2, the raw scores have been grouped into bins with each bin having a 5–point range, resulting in 16 unique bins—7 to the left and 9 to the right of the cutoff. We conduct the RD analysis using the binned scores as the scoring variable, which is equivalent to stacking the effective cutoff for different age groups. This is appropriate because around one-third of the 43 unique values of the raw score are unique to each of the age categories formed in the eligibility criteria.[b]
Score not used for any other purpose, such as to assign benefits from any other program	We have not encountered any information that the score was used for any other purposes than determining admission to the lottery.
The score that determined treatment assignment was not manipulated by applicants	
Possible manipulation of the scoring variable cannot have been done based on the (exact) cutoff	According to project documentation, the timing of the verification caused most applications to receive their final score before the cutoff was known. In particular, after the verification of the applications, the application data for applicants not admitted to the lottery was publicly displayed at the town halls of their communes (subprovince level) together with the overall score they received. Based on Compact documentation, only four applications had their score altered in a subsequent phase in which the scoring could be contested. However, participants whose files had not yet been verified by that time were able to complete the process, potentially with knowledge of the cutoff. They could have had incentives to alter their application and perhaps manipulate the data contained in the application.[c] Figure E.3 in Appendix E presents histograms of the scores for applicants who completed their applications before and after the cutoff was known. This graphical presentation raises concerns that there was indeed some manipulation of the scores for the latter group of applicants. To address this concern we will exclude these observation in the analysis of interim and final outcomes.
Statistical analysis of integrity of the scoring variable at the cutoff (no discontinuity in density at the cutoff)	We also conducted a statistical test for manipulation of a discrete scoring variable at the cutoff (Frandsen 2017) and found no evidence of manipulation for applicants whose files had been verified by the time lists of participants were published.[d] To complement the visual inspection for participants whose files had not been verified by the time the cutoff could be inferred from lottery participant lists, we also conducted a statistical test for this subgroup only. The analysis, however, does not provide statistical evidence to confirm this hypothesis. Since these observations do not have baseline survey data, we are unable to provide other evidence to support balance above and below the cutoff. Out of a sense of prudence, we will drop them for the analysis of interim and final outcomes.

Table IV.11 (continued)

Criteria	Discussion
Continuity of the Outcome-Scoring Variable Relationship	
No discontinuity in other variables (except variable used to create cutoff)	Table E.9 in Appendix E shows that the number of variables in which we detected a discontinuity is in line with the number of variables for which we would expect a discontinuity based on random chance, across a range of plausible specifications for the interim and final analysis. Nonetheless, there are a few variables that are likely to have an important relationship with the key evaluation outcomes and for which there is evidence of a discontinuity. We will include these variables as covariates in the RD impact analysis. The analysis also provides evidence that the inclusion of the score in linear form is warranted. There is no clear evidence that a quadratic specification is warranted across the board, as the number of quadratic terms that are significant is also in line with what we expect based on the number of tests we conducted.
No discontinuities at other possible cutoffs	Because of the small number of unique scores that remain after combining scores in bins and the requirement that at least four unique values remain at each side of the cutoff, there are only a few other cutoffs at which these robustness checks can be conducted. We will conduct them during the interim and final evaluation.
Functional Form and Bandwidth	
Use of an appropriate parametric, semiparametric, or nonparametric statistical model that controls for scoring variable	The appropriate statistical model for the analysis of a particular interim or final outcome depends on the functional form of the relationship between that outcome and the scoring variable, which is as yet unknown. As a result, for our discontinuity tests, we included the analysis of four plausible approaches: two parametric statistical models (linear and quadratic functional forms) and two nonparametric statistical models (local linear regression within specified bandwidths around the cutoff). For all four cases, we allowed the intercept and slope parameters to differ for lottery participants and lottery applicants. In the interim analysis, we will choose appropriate statistical models for each of the key evaluation outcomes and will also include the score in the statistical model.
Graphical analysis must be provided	The graphical analysis presented in Figure E.4 in Appendix E does not suggest a discontinuity at the cutoff in two key outcome variables—agricultural revenue and agricultural incomes. We will conduct graphical analysis for interim and final outcomes.

[a] For the RD analysis, lottery participants who were placed on the waiting list because they refused an available rice plot are considered part of the treatment group.

[b] Having 43 unique values of the raw score is an artifact of a single relevant scoring variable where points are not multiples of 5. All other relevant scoring variables give points that are multiples of 5. Age is an exception, as applicants age 56 and over received a single point, applicants between the ages of 31 and 55 (inclusive) received 3 points, and applicants age 30 and under received 5 points. In the cultural context of Burkina it may have been a sign of disrespect to provide zero points to applicants over 56 years. The official cutoff of 60 points effectively leads to age-specific cutoffs of 61, 63, and 60 points. The creation of 5-point bins stacks these three cutoffs, and we refer to this stacked cutoff as 60 points.

In principle, there was a second variable which could have led to scores that were not multiples of 5. Applicants would have received 6 points if they had had arrears of ≤ 100,000 FCFA (210 USD). All applicants, however, received 10 points in the debt category, because not a single application showed any arrears, so this scoring variable was not relevant in practice.

[c] There are a few "obvious" alterations that applicants could have used—with 6 additional household members, an applicant would receive 20 points if he or she selected polyculture as first preference, but only 15 if the first preference was a rice plot. Debt, ownership of agricultural tools and training attendance are criteria that a determined applicant could possibly have changed during the course of the verification process.

[d] The *p*-value for this test is 0.34.

E. Discussion

Below we present key findings of lottery applicants' characteristics, with a focus on binding constraints to higher productivity and incomes at baseline. Table IV.12 presents an analysis of the constraints underlying the program logic.

- **Applicants likely did not own sufficient irrigated land at baseline.** Applicants irrigated only 40 percent of their plots at baseline, and only half of applicants reported owning any plots. Of note, lottery applicants irrigated most of their rented plots, suggesting that applicant households did not own or have communal access rights to a sufficient amount of irrigable land. Through the lottery, applicants could not only gain access to irrigated land, but they received reliable land tenure. A larger amount of irrigated land and the certainty of land tenure should both be conducive to larger agricultural investments and greater production.
- **Lottery applicants lacked training in vegetable production and irrigation practices at baseline, but they had prior experience in these areas.** Although few eligible applicants had received training in vegetable production and irrigation practices at baseline, the majority of applicants had at least some experience in agricultural techniques, such as irrigated agriculture, rice cultivation, and intercropping. As such, a lack of technical knowledge may not be a binding constraint for lottery applicants as it might be for other farmer populations served by WMI and DA activities.
- **Applicants' use of traction animals, improved seed, fertilizer, and pesticide suggest they could take advantage of new plots.** Most applicants possessed traction animals to plow their fields, placing them in a good position to cultivate the full area of their Di perimeter plots. In addition, applicants' use of improved seed, fertilizer, and pesticide could also help optimize production on the new perimeter plots.

Together, these findings suggest that lottery applicants' receipt of irrigated land under the WMI activity might be sufficient to boost agricultural production and sales, given that they do not appear to face binding constraints on other dimensions.

Additional key findings from the analyses presented in this chapter include:

- **Male applicants had notable advantages over female applicants.** Male applicants had higher literacy rates, greater ownership of larger areas of cultivable land, and more experience in irrigation and rice production. These differences suggest that men and women have different agricultural assistance needs, and thus may require a different mix of assistance. The findings also highlight the importance of analyzing impacts by gender in the Di Lottery evaluation.
- **The Di Lottery beneficiary and control applicants and households are balanced across the overwhelming majority of variables, with a few exceptions.** Balance tests using the eligibility information and the survey data show that Di Lottery beneficiary and control applicants and households are balanced across the overwhelming majority of variables and suggest that the lottery was properly implemented. However, there are important characteristics that are unbalanced between lottery treatment and control groups, including the number of household members co-listed on the application, the proportion of female

lottery participants, household access to agricultural land, and— in one specification—dry season sales. Due to the importance of these characteristics, the interim and final analysis will need to account for these baseline imbalances.

- **A regression discontinuity design approach is appropriate to assess the impact of providing land to Di Lottery beneficiaries.** The review of the beneficiary selection process, statistical analysis of the distribution of scores, and of the baseline outcomes around the cutoff indicate that the RD approach can be used to evaluate the impact of providing land to Di Lottery beneficiaries. As such, the RD estimates can be compared with those from estimates obtained from the RCT that focus on the lottery beneficiaries with a score near the cutoff.

These last two findings suggest that the Di Lottery evaluation is on track to provide unbiased impact estimates, and the RD methodological study has the potential to inform the field on the comparability of RD and RCT estimates.

Table IV.12. Assessment of constraints underlying the program logic (Di Lottery applicants)

Constraint from program logic	Assessment of the constraint at baseline	Potential of the intervention to overcome the constraint
Lack of access to irrigation	Lottery applicants reported irrigating around 40 percent of their plots. Most rented plots were irrigated, suggesting that applicant households did not own a sufficient amount of irrigable land.	Upon receiving land on the perimeter, applicants could feasibly cultivate a larger area of irrigated land, likely boosting production during the dry season.
Weak land ownership and formalized tenure arrangements	About half of applicants reported owning plots, about one-quarter rented plots, and another quarter farmed on community land.	The WMI program's land tenure assistance could promote applicants' long-term investment in their plots, as well as enable them to use land as collateral to access finance.
Lack of technical knowledge and capacity	Few eligible applicants had received training in vegetable production and irrigation practices at baseline. However, most applicants had at least some experience in agricultural techniques such as irrigation, rice cultivation, and intercropping.	If MCC-funded training in these practices equipped lottery winners with new, practical knowledge that could help them adapt their practices to production on the perimeter, it could help them diversify and boost production and sales.
Lack of agricultural diversification	Data limitations preclude an understanding of applicants' diversification. However, it is probable that lottery applicants had some degree of agricultural diversification, given that they were just as likely to sell crops in the dry season as in the rainy season.	MCC-funded training and assistance with crop diversification could help applicants further diversify, but a lack of diversification does not appear to be a binding constraint to greater production and sales.
Limited use of traction animals, machinery, and advanced inputs	At baseline, most applicants possessed traction animals to plow their fields and used advanced farming inputs including improved seed, inorganic fertilizer, herbicide, and pesticide. As such, lottery applicants appear less likely to face this constraint than other populations targeted by MCC-funded activities.	Applicants' use of animals and advanced inputs illustrates their capacity for somewhat sophisticated irrigated agriculture production on a relatively large scale. This capacity could serve them in cultivating new land on the perimeter.
Limited value added and market access	No information available.	--
Access to finance	No information available.	--

F. Next steps

We will combine these baseline data with two rounds of follow-up data to conduct the Di Lottery impact evaluation—an interim round in January 2018 to February 2018 and a final round from January 2019 to January 2020.[34] Because information on Di lottery beneficiaries also informs the Di perimeter evaluation (see Chapter III), the interim and final data collection for the Di Lottery RCT is conducted jointly with the Di PAP evaluation (and to increase synergies, with the farmer training evaluation).

The Di Lottery evaluation will collect data on plot-level agricultural practices (such as crops cultivated and inputs and techniques used) and outcomes (for example, production, sales, and total agricultural income), employment outcomes, household income, perceptions of land tenure security as well as land investments. Some modules to be collected are only relevant for beneficiaries of land on the Di perimeter, including information on implementation outputs (such as titles, leases, training, and starter kits), payments to WUAs, WUA labor contributions, water availability, rental or sales of land on the perimeter, as well as the use of land on the perimeter as collateral. The follow-up surveys will also include modules specific to the Di Lottery evaluation such as information on the individual's control over resources and expenditures on education.

[34] The final round will be split into two rounds: one to collect information on agricultural production during the 2019 dry season and the second to cover agricultural production during the 2019–2020 rainy season.

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V. FARMER TRAINING

In this chapter, we describe the agricultural production, sales, income, and training at baseline of households that in time received training and materials under the sub-activity. These measures are among the key outcomes the sub-activity was expected to affect. We also examine the demographic and land tenure characteristics of the same households at baseline. Collectively, the analyses will help us understand whether the households faced the constraints the farmer training activity was meant to address, and provide a baseline to which we can compare agricultural production and income following MCC-funded assistance.

In the sections that follow, we first provide the background to the DA Activity and the training and benefits provided to farmers under its Farmer Training Sub-activity. We then outline the objectives of the farmer training evaluation, introduce the research questions, and provide a description of the methodology designed to answer the questions. We then provide a summary of the available baseline data sources followed by our baseline findings. The chapter concludes with a summary of our findings and a discussion of the next steps in the farmer training evaluation.

A. Background

1. Overview of the DA Activity

The DA Activity was designed to increase farmer incomes by improving agricultural productivity. The activity focused primarily on beneficiaries in the Sourou Valley and the Comoé Basin and included the following sub-activities:

- **Farmer training**, including technical assistance, to farmers on rain-fed and irrigated crop production
- **Animal health services**, including the improvement of veterinary services and provision of livestock training
- **Value chain development**, including the establishment of producer associations and provision of training to producer associations and agribusinesses
- Establishing a **market information system** (MIS) and information centers
- Rehabilitation of **rural markets** and provision of technical assistance to rural market management committees

Our evaluation of the DA Activity focuses on the Farmer Training Sub-activity, which we describe in greater detail below.[35]

[35] The Evaluation Design Report (Ksoll et al. 2017) provides details of the other DA sub-activities and discusses reasons for focusing on the Farmer Training Sub-activity.

2. Farmer Training Sub-activity

The DA Farmer Training Sub-activity provided training and incentive kits to farmers with the goal of improving agricultural production techniques and income. The sub-activity trained over 12,000 farmers, about half of whom were women, from 30 villages in the Sourou Valley and Comoé Basin (Figure A.1 in the Appendix shows the DA intervention areas). Training and technical assistance focused on techniques applicable to both rain-fed and irrigated crop production, including compost production and use, pesticide and chemical fertilizer use, use of improved seeds, improved planting and harvesting techniques, and crop rotation. Training sessions also focused on the production of corn, cassava, and vegetables in the Sourou Valley and on the production of corn, rice, and onions in the Comoé Basin, in particular.

The incentive kits distributed to participating farmers included items such as certified seeds or plants, fertilizers, basic farm tools, and sacks for post-harvest storage and sales. Over 5,000 incentive kits were distributed in the DA intervention areas to encourage participation in training activities and the adoption of the production techniques featured in the training sessions. Our evaluation of the Farmer Training Sub-activity will attempt to determine what effects the receipt of training and incentive kits and the application of advanced techniques may have had on agricultural production, sales, and income of beneficiary households.

B. Evaluation objectives, questions, and methods

The objectives of the evaluation are (1) to assess the effectiveness of the training and assistance provided to farmers and (2) to understand the implementation of the Farmer Training Sub-activity.

To accomplish the evaluation objectives, we will address several key research questions (RQ), as summarized in Table V.1.

We use a mixed-methods approach that relies on a variety of data sources, as shown in Table V.1 and described in detail in the Evaluation Design Report (Ksoll et al. 2017). For the analysis of quantitative data, we will use a pre-post econometric approach together with a descriptive analysis. For the qualitative analysis, we will analyze administrative information and information collected from interviews, focus groups, and site visits. Below, we describe each analysis in detail.

Table V.1. Overview of evaluation questions and data sources

		Data source		
		Administrative	Qualitative	Quantitative
RQ1	How was the Farmer Training Sub-activity implemented relative to the plans for the sub-activity?	X		
RQ2	To what extent have farmers adopted or adapted the improved production practices proposed by the project?	X	X	
RQ2a	If farmers are adopting improved farming practices, which ones have farmers adopted the most and the least, and why?			X
RQ2b	If farmers are adapting improved practices, which ones have farmers modified the most and the least, and why?		X	X
RQ2c	Have farmers continued to invest in improved seeds/fertilizers?		X	X
RQ3	Have participating farmers used the incentive kits that they received as part of the training?			X
RQ4	Do participating farmers diversify crop production more than they did before the project?			X
RQ5	What is the total area planted, average yield per hectare, total production, and total profit for each of the focus crops: rice, corn, onions, tomatoes, soybeans, and cowpeas?			X
RQ6	Have the participating farmers' average yields per hectare increased, decreased, or remained the same for each of the focus crops, compared with the average yields per hectare before the project?			X
RQ7	Have the participating farmers' overall agricultural incomes and profits increased, decreased, or remained the same compared with their incomes and profits before the project?			X

Source: Ksoll et al. 2017.

1. Quantitative analysis

To answer research questions about changes in agricultural practices and agricultural outcomes (RQ4, 5, 6, 7), we will conduct a pre-post evaluation in which we compare outcomes before the intervention are compared with outcomes after the intervention. Although we will not be able to causally attribute any observed differences to the program, we will gain insight into changes in outcomes over the study period. If no other major changes occurred, we may detect some indication that the effects are linked to the program. We will compare means of variables before and after the intervention and conduct paired t-tests, which are formal statistical tests of significance. This design will allow us to understand changes in farming practices that took place between the baseline and post-intervention surveys, such as whether farmers took up some of the techniques conveyed in the training activities and whether they changed the selection of crops they cultivated.

To answer research questions about agricultural practices (RQ2, 3)—including the use of inputs and incentive kits—we propose to use a descriptive analysis. For this piece of the quantitative analysis, we will present means and standard deviations for all variables of interest, such as adoption or adaptation of improved techniques, use of incentive kits, and investments in improved seeds and fertilizers.

Given that the pre-post approach focuses on changes in agricultural practices and agricultural outcomes before and after the farmer training intervention, we will restrict our analysis sample for both pieces of the quantitative analysis to households that participated in the Farmer Training Sub-activity after baseline data collection. The Evaluation Design Report (Ksoll et al. 2017) provides the power calculations and MDIs for the quantitative analysis.

2. Qualitative analysis

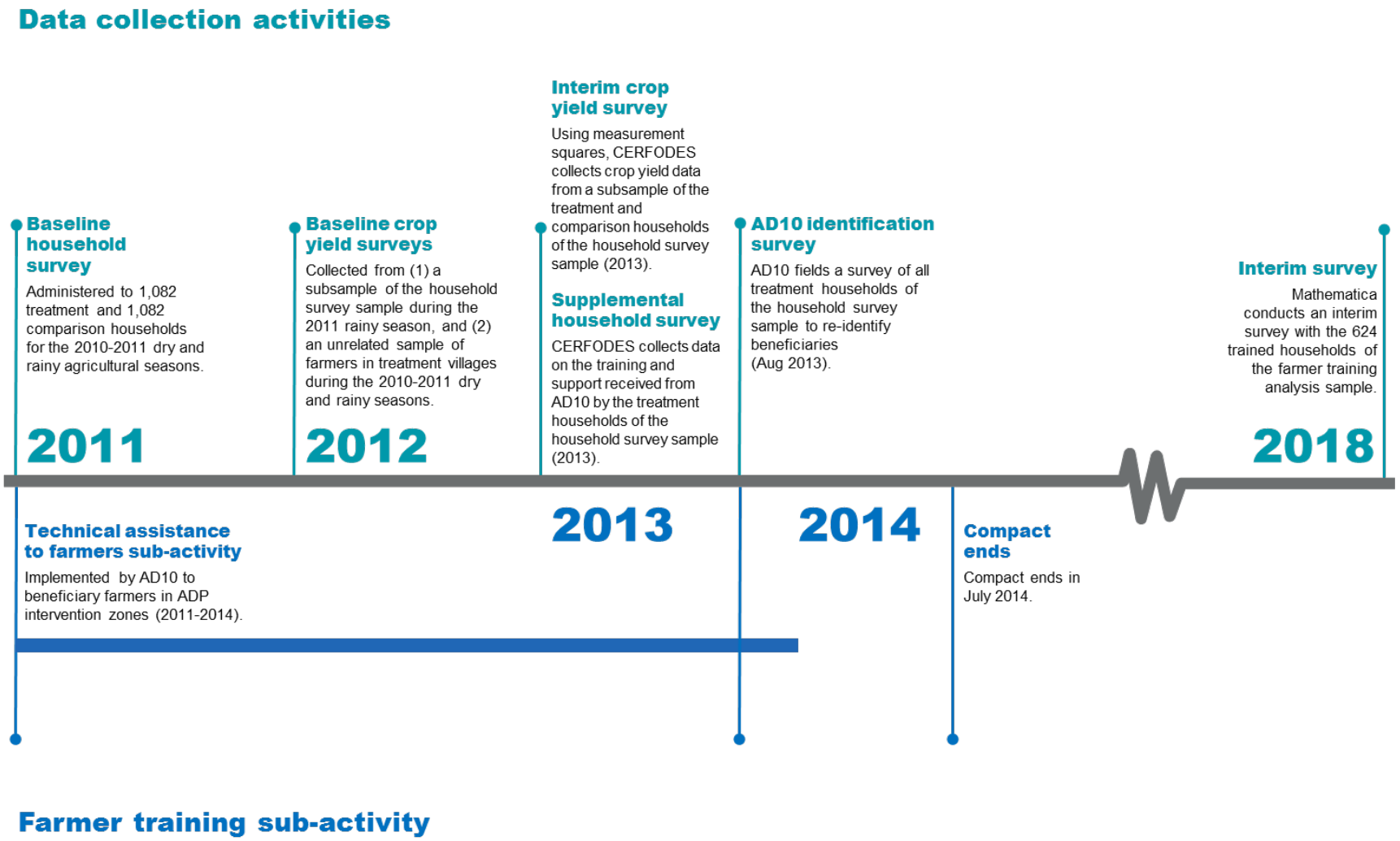
To understand how the Farmer Training Sub-activity was implemented relative to the plans for the sub-activity (RQ1), we will review project records that document implementation. Records include the strategic plan, reports compiled by the implementers, and administrative data such as the indicator tracking table that was collected as part of the compact's M&E activity.

To understand whether the techniques learned during the training activities were adapted to the local context and why farmers might or might not be using the techniques they have learned (RQ2), we will elicit the views of staff from the regional directorate of the Ministère de l'Agriculture et des Aménagements Hydrauliques. We will also conduct focus groups with trained farmers and producer associations to obtain a beneficiary perspective on the reasons for adopting and adapting improved agricultural techniques. In addition, we propose to conduct site visits to observe the use and adaptation of the techniques that were the focus of the training activities.

C. Data sources

In this section, we review the data available for analyzing the key outcomes at baseline and discuss to what extent the data are used for our baseline findings presented in the section that follows. In Figure V.1, we present a timeline of all data collection activities related to the evaluation of the Farmer Training Sub-activity. In Table V.2, we provide a summary of the data sources used in the baseline report.

Figure V.1. Timeline of farmer training data collection activities



As shown in Figure V.1, the data collectors contracted by MCA-BF—National Opinion Research Center (NORC) and its local partner, the Centre d'Etudes, de Recherches et de Formation pour le Développement Economique et Social (CERFODES)—administered several baseline and interim surveys for the evaluation of the DA Activity. The baseline **household survey**, the largest of the data sources, was administered in two rounds to 2,164 households of 1,082 matched pairs that were part of the previous evaluator's matched comparison group design.[36] It was intended to capture information about the two main agricultural cycles in Burkina Faso. The first round of data collection took place immediately after the dry season of 2010–2011; the second round took place immediately after the rainy season of 2011. Both rounds of the household survey were administered before the implementation of farmer training in 2011 and included the following modules: household, agriculture, livestock, forestry, credit and expenditures, food security, and health. The modules most relevant to the evaluation of the Farmer Training Sub-activity are the household, agricultural, and credit and expenditures modules.

After reviewing the household survey data, we determined that the data are of sufficient quality to serve as a baseline for the evaluation of the Farmer Training Sub-activity. However, as discussed in the design report, a matched comparison group design is not feasible; therefore, our evaluation relies on a pre-post analysis of beneficiary households (Ksoll et al. 2017). To identify the beneficiary households in the household survey data, we required the data collected with AD10's **identification survey,** which was administered to all households in the treatment sample in August 2013. The purpose of the survey was to identify beneficiaries of the Farmer Training Sub-activity and to compensate for the fact that the original list of trainees did not include identifiers that could be used to identify beneficiaries or their households in the household survey data. According to the identification survey data, 624 of the 1,082 sampled treatment households included at least one member who participated in the Farmer Training Sub-activity. We were able to use the identification data to identify these 624 households in the household survey data, but not the individual beneficiaries who had participated in training.[37] Thus, the 624 trained households form the analysis sample of the farmer training evaluation, and we will aggregate most outcomes to the household level.

[36] By matching households in intervention areas to households in comparison areas, the previous evaluator planned to use a difference-in-differences design to evaluate the farmer training and animal husbandry components of the project (IMPAQ 2014b). In principle, this methodology could provide a credible estimate of the impact of farmer training activities. However, a detailed review of documents from the previous evaluation as well as our site visit raised three major concerns about the difference-in-differences design's ability to detect unbiased impacts: (1) the intervention and comparison groups differ significantly from each other; (2) the location of the intervention communities is highly clustered; and (3) the expected take-up of farmer training was lower than expected. These issues—especially the differences between the intervention and comparison groups—prevent a matched comparison group difference-in-differences methodology from providing credible and unbiased estimates of the impact of the Farmer Training Sub-activity. Appendix G of the Evaluation Design Report (Ksoll et al. 2017) provides a detailed assessment of these issues.

[37] The identification data include unique household IDs and beneficiary trainee IDs. Given that the same household IDs are used in the household survey data, it is possible to use the identification data to identify households with beneficiaries in the household survey data. However, the household survey data do not include a globally unique ID for each household member or the beneficiaries' AD10 trainee IDs. As such, the identification data cannot be used to identify specific beneficiaries in the household survey data.

To supplement the crop yield data collected with the household survey, NORC and CERFODES conducted two baseline **crop yield surveys** that used measurement squares (carrés de rendement) to estimate crop yields of sampled plots.[38] The previous evaluator determined, however, that the quality of the data from the two surveys was poor. Moreover, the samples are not properly aligned with our analysis sample. Accordingly, we do not use the crop yield data in our evaluation of the Farmer Training Sub-activity. Table F.1 in the Appendix reviews the data quality issues associated with all existing data collected for the farmer training evaluation.

Table V.2. Summary of existing data sources used for the evaluation of the Farmer Training Sub-activity

Data collection period	Name	Purpose	Collection date	Sample	Content
Baseline	Household survey	Collect baseline data from the 1,082 pairs of matched households, formed under the previous evaluation, for the evaluation of the DA Activity	2010–2011 agricultural dry and rainy seasons	1,082 treatment and 1,082 comparison households	Modules • Household • Agriculture • Livestock • Forestry • Credit and expenditures • Food security • Health
Baseline	Identification survey	Identify the beneficiaries of the Farmer Training Sub-activity with which beneficiaries and their households can be identified in other baseline data sources	2013	1,082 treatment households	• Household roster • Identification of training beneficiaries • Types of training received • Trainee ID • Household ID

D. Baseline findings

In this section, we present our baseline findings for the evaluation of the Farmer Training Sub-activity. For the households in the analysis sample (the 624 households that received training from AD10 after baseline data collection), we use the household survey data to provide baseline descriptive statistics on the key outcomes that the Farmer Training Sub-activity is expected to affect. This descriptive baseline analysis will allow us to (1) understand the characteristics of households that in time received farmer training, (2) determine whether these households faced the constraints the Farmer Training Sub-activity was meant to alleviate, and

[38] A crop yield measurement square is an area (typically a square or other easily measured geometric shape) marked off inside an agricultural production plot. During harvest, the yield within the measurement square is collected and weighed. The weight per unit area from within the measurement square is then used to estimate the crop yield of the entire plot. The Direction Générale des Etudes et des Statistiques Sectorielles (DGESS) of Ministère de l'Agriculture et des Aménagements Hydrauliques (MAAH) has adopted this methodology and used it in the production of food and agricultural statistics in Burkina Faso (IMPAQ 2014b).

(3) establish a baseline for the pre-post evaluation in which we will compare households' agricultural production, particularly of focus crops, and income before and after receiving training (RQ4, 5, 6, 7).[39] Given the differences between agricultural activities and production during the dry and rainy seasons, we discuss the results separately by season when relevant.

1. Household demographic and land tenure characteristics

To contextualize our baseline findings, we begin by describing the demographic and land tenure characteristics of the households in the analysis sample. In Table V.3, we summarize the key measures related to the characteristics presented in this subsection.

Table V.3. Measures of households' demographic and plot-level land tenure characteristics

Measures	Time frame
Demographic characteristics. Number of household members; age, gender, education, and farming status of head of household	2010–2011 agricultural dry season/2011 agricultural rainy season
Land tenure of household plots. Method of acquiring plot and type of plot ownership	2011 agricultural rainy season

Note: Age of head of household was top-coded to three standard deviations from the mean to account for outliers.

Key findings: Households in our analysis sample tended to be large and headed by working-age men. Households typically did not have official land rights to the plots they operated.

The typical household was larger than the national average and headed by a middle-aged male farmer. The typical household in the analysis sample had about 11 members (Table V.4). Typically, men headed the households in our sample (98 percent of households) and were about 48 years of age.[40] Nearly all household heads currently farm, and most (64 percent) have no education. These household characteristics are generally the same across the two intervention regions: Sourou and Comoé.

[39] Focus crops include corn, cowpeas, onions, rice, soybeans, and tomatoes. One of the key compact goals was to increase the cultivation, yields, and sales of these focus crops.

[40] The small number of female heads of household indicates that the disaggregation of our baseline results by head-of-household gender would not be meaningful.

Table V.4. Demographic characteristics of households

	Mean		
	Total	Sourou	Comoé
Number of household members	10.58	11.26	9.58
Age of head of household	47.62	47.42	47.92
Age of head of household (%)			
Younger than 30 years	6.4	5.4	7.9
Between 30 and 60 years	73.6	75.0	71.4
60 years and older	20.0	19.6	20.6
Female head of household (%)	2.4	1.3	4.0
Education of head of household (%)[a]			
None	64.1	58.6	72.1
Koranic school	9.8	13.8	4.0
Madrassa	3.7	5.7	0.8
Primary	14.3	11.1	19.1
Secondary	2.7	3.2	2.0
University	0.0	0.0	0.0
Kindergarten	0.0	0.0	0.0
Literacy	4.7	6.8	1.6
Other	0.6	0.8	0.4
Head of household currently farms	97.4	96.2	99.2
Sample size	**624**	**372**	**252**

Source: Household module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means.

[a]Education outcomes are calculated with the dry season data because education level was omitted from the rainy season version of the household survey. All other outcomes are calculated with the rainy season data because 3 of the 624 households that were eventually trained by AD10 did not complete the household survey after the dry season.

Households received most of the plots they operate in the dry season via inheritance or as a gift, the majority without official land titles. Because the rainy season data do not include land tenure outcomes for plots acquired before June 2011 (about 98 percent of plots operated in the rainy season), we use the dry season data to describe land tenure outcomes and note that the data may not reflect ownership over the larger number of rainy season plots. Over 70 percent of plots operated by households during the dry season were acquired via inheritance or as a gift (Table V.5). About a fifth of the plots were rented, mainly in the Sourou region. Households had no ownership of any type of more than half the plots they operated during the dry season and only unofficial rights to almost all other plots (41 percent were owned under "customary right" or "land owner—first occupant").

Table V.5. Land tenure of plots operated by households[a]

	Mean		
	Total	Sourou	Comoé
Method of plot acquisition (%)[b]			
Purchase	2.9	4.6	0.6
Inheritance	39.3	29.0	53.5
Sharecropping	0.5	0.8	0.1
Rent	20.6	31.3	5.6
Gift	31.3	30.9	31.7
Collateral	4.3	1.4	8.4
Other	0.4	0.8	0.0
Type of plot ownership or access right (%)			
Local land agreement report[c]	1.0	0.6	1.6
Land title	1.9	1.6	2.3
Customary right[d]	27.1	27.8	26.1
Land owner-first occupant[e]	13.9	4.7	26.6
None	53.8	62.1	42.1
Other	2.3	3.2	1.2
Sample size	**2,483**	**1,446**	**1,037**

Source: Household module of baseline household survey—dry season (2010–2011).

Note: Statistics shown are unadjusted means.

[a]We use the dry season data for the land tenure outcomes presented in this table because the rainy season survey did not collect characteristics on plots acquired before June 2011.

[b]A plot is defined as a parcel of land operated by a decision maker within the household.

[c]"Local land agreement report" is the English translation for "Procès Verbal sous l'arbre à palabre" ("PV de palabre" on the survey instrument). According to our local research coordinator, the "PV de palabre" is the starting document of the land formalization process. The report is typically completed at the village level by local land stakeholders and the village chief while assembled under a large tree or other village landmark.

[d]Customary rights are acquired from local land authorities called "chefs de terre.".

[e]"Land owner-first occupant" ("Propriétaire terrien" on the survey instrument) refers to a landowner who possesses the land based on ancient customary considerations, not on a formal land document. "Propriétaire terrien" is different from "PV de palabre" in that the latter may lead to a formal land document.

2. Agricultural characteristics, assets, production, and sales

We next describe households' agricultural activities on the plots they operated during the 2010–2011 agricultural dry and rainy seasons. In Table V.6, we summarize the key measures on cultivation, asset use, production, and sales that we examine from both rounds of the household survey.

Table V.6. Measures of households' cultivation characteristics; and agricultural assets, production, and sales

Measures	Time frame
Cultivation characteristics. Total area cultivated; number of plots operated by household; number of household agricultural workers (operators); whether household hired temporary and permanent labor; whether household irrigated any crops; source of irrigation water; cultivation of crops and area cultivated	2010–2011 agricultural dry season/2011 agricultural rainy season
Agricultural assets. Number and types of agricultural equipment used; types, quantities, and costs of agriculture inputs used	2010–2011 agricultural dry season/2011 agricultural rainy season
Agricultural production. Amount of focus crops harvested (yield); value of focus crops harvested[a, b]	2010–2011 agricultural dry season/2011 agricultural rainy season
Agricultural sales and revenue. Crops sold; focus crops sold; amount of focus crops sold; agricultural sales revenue; sales revenue of focus crops; characteristics of focus crop sales (point of sale)	2010–2011 agricultural dry season/2011 agricultural rainy season

Note: The following outcomes were top-coded to three standard deviations from the mean to account for outliers: number of agricultural inputs used and input costs, area cultivated, crop yields, harvest value, and agricultural sales revenue and quantity sold.

[a]Focus crops include corn, cowpeas, onions, rice, soybeans, and tomatoes.

[b]Harvest value is calculated by multiplying yield times the price per unit sold. If a household harvested but did not sell a specific focus crop, we imputed sales price by using the village median or, if no household in the village sold the crop, the regional median.

Key findings: Agricultural production in the dry season was directed more toward sales of high-value crops, whereas production in the rainy season focused more on consumption and food security. Production in both seasons relied on nonmechanized agricultural equipment and the application of both inorganic and organic fertilizers.

Households exhibited greater agricultural activity during the rainy season. Farming households in Burkina Faso usually rely on rain-fed agriculture for sustenance and thus are likely to be more active agriculturally during the rainy season than during the dry season. In corroboration, we find that nearly every household in the analysis sample cultivated crops during the rainy season versus about three-fourths of households in the dry season (Table V.7). Households on average also cultivated more land across more plots and used more intra-household and contracted labor during the rainy season. The two most commonly cultivated focus crops in the rainy season were corn and rice (grown by 90 and 56 percent of households, respectively); the two most commonly cultivated focus crops in the dry season were onions and tomatoes (grown by 48 and 28 percent of households, respectively). The evaluation's key research questions will determine if households exhibit greater agricultural activity after training, particularly in the dry season, and whether households diversify focus crop production in both seasons (RQ4, 5).

Most households irrigated their crops in the dry season. During the dry season, 70 percent of farmers irrigated their crops versus 41 percent in the rainy season. Most farmers reported use of a pump irrigation system in both seasons.

Table V.7. Cultivation characteristics

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Number of plots operated by household[a]	1.95	2.04	1.81	5.81	4.51	7.73
Total cultivated area (ha)	0.67	0.83	0.44	3.91	3.69	4.24
Cultivated crops (%)	70.3	78.3	58.6	99.7	99.7	99.6
Cultivated focus crops (%)	64.7	78.3	44.6	94.9	91.9	99.2
Cultivation of focus crops (%)						
Corn	11.9	7.3	18.7	89.6	84.7	96.8
Cowpeas	0.5	0.5	0.4	4.6	5.6	3.2
Onions	47.6	65.0	21.9	18.8	28.5	4.4
Rice	18.5	24.9	9.2	55.6	49.7	64.3
Soybeans	0.0	0.0	0.0	1.6	2.7	0.0
Tomatoes	28.1	33.1	20.7	9.8	0.5	23.4
Cultivated area of focus crops (ha)						
Corn	0.03	0.02	0.04	0.88	0.93	0.80
Cowpeas	0.00	0.00	0.00	0.02	0.02	0.01
Onions	0.20	0.32	0.03	0.09	0.14	0.01
Rice	0.17	0.24	0.07	0.79	0.90	0.62
Soybeans	0.00	0.00	0.00	0.01	0.01	0.00
Tomatoes	0.12	0.14	0.08	0.02	0.00	0.05
Number of household agricultural workers	1.00	1.11	0.82	2.36	2.27	2.50
Hired temporary laborers (%)	34.8	48.9	13.9	62.3	55.1	73.0
Cost of temporary labor (FCFA)	23,213	36,258	3,983	27,230	22,877	33,655
Hired permanent laborers (%)	9.0	12.2	4.4	6.9	8.1	5.2
Cost of permanent labor (FCFA)	8,060	12,960	836	3,111	3,687	2,261
Household irrigated (%)	70.4	78.4	58.6	41.0	55.1	20.2
Irrigation sources, if irrigated (%)						
Simple gravity irrigation	8.7	9.0	8.2	12.9	6.8	37.3
Gravity irrigation—pumped	82.2	87.6	71.4	79.3	89.8	37.3
Manual (hand-carried) irrigation	8.7	0.3	25.2	6.3	0.5	29.4
Mobile boom irrigation	2.3	3.4	0.0	0.4	0.0	2.0
Pivot irrigation	0.2	0.3	0.0	3.1	3.9	0.0
Other	0.9	1.4	0.0	0.4	0.5	0.0
Sample size	**621[a]**	**370**	**251**	**624**	**372**	**252**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means. Sample sizes are 437 (290/147) and 256 (205/51) for households irrigating in the dry and rainy seasons, respectively (Sourou subgroup/Comoé subgroup). Cultivation area was collected at the plot level. For intercropped plots, we divided the cultivated area by the number of crops grown on the plot to impute the area devoted to the cultivation of each intercropped crop.

[a]Only 621 of the 624 households in our analysis sample completed the dry season round of the household survey.

ha = hectares

Most households did not use advanced types of agricultural equipment. During the more agriculturally active rainy season, the majority of households used animal-drawn plows (77 percent of households) and carts (65 percent). However, few households used advanced types of agricultural equipment such as furrowers, animal-drawn manga hoes, or irrigation pipes. The daba hoe—the traditional hand-held hoe—was the most common type of equipment used by households in either season. The percentage of households using the daba hoe by season was nearly identical to the percentage of households cultivating in each season (Table V.8), indicating that the daba hoe, though rudimentary, is still integral to agricultural production in Burkina Faso. A key question of the evaluation will determine if, after training, more households use more advanced types of agricultural equipment, which may also suggest whether households have adopted improved production techniques (RQ2).

Table V.8. Agricultural equipment used by households

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Number of different equipment items used	3.94	4.72	2.78	5.41	5.83	4.80
Types of equipment used (%)						
Tractor	18.4	29.2	2.4	25.0	39.2	4.0
Mechanical plow/harrow	5.3	7.6	2.0	9.5	10.5	8.0
Animal-pulled plow	47.2	61.6	25.9	77.2	81.7	70.5
Cart	44.3	63.2	16.3	65.0	76.9	47.4
Tractor/trailer	1.1	1.6	0.4	1.6	1.6	1.6
Seed drill	6.8	5.7	8.4	0.6	0.0	1.6
Combine harvester	0.2	0.3	0.0	0.0	0.0	0.0
Sprayer	43.0	51.6	30.3	58.7	62.1	53.8
Wheelbarrow	8.2	9.2	6.8	8.7	8.3	9.2
Pedal pump	1.1	0.5	2.0	0.6	0.0	1.6
Motor pump	21.1	14.1	31.5	10.1	5.9	16.3
Irrigation pipe	15.3	9.7	23.5	9.3	5.6	14.7
Generator	1.8	2.4	0.8	1.1	1.3	0.8
Manga hoe[a]	13.4	20.0	3.6	25.5	28.2	21.5
Daba hoe[b]	70.4	78.4	58.6	98.7	99.2	98.0
Machete	60.5	65.4	53.4	86.5	85.8	87.6
Planting wheel	0.5	0.5	0.4	0.5	0.5	0.4
Furrower	22.2	32.7	6.8	29.1	40.6	12.0
Axe	--	--	--	15.7	13.4	19.1
Pick	--	--	--	4.3	7.0	0.4
Other	10.6	14.6	4.8	12.0	12.9	10.8
Sample size	**621**	**370**	**251**	**621**	**370**	**251**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means.

[a]A manga hoe is a modern hoe drawn by a beast of burden.

[b]A daba hoe is a traditional hand-held hoe.

The majority of households cultivating crops used inorganic fertilizers, although households also used large amounts of traditional organic fertilizers. During the dry season, nearly every household cultivating crops used one of the two inorganic fertilizers mentioned in the household survey: urea or NPK (Table V.9). However, fewer households used organic fertilizers during the dry season (67 and 25 percent of households used manure and compost, respectively). The data suggest that a portion of farmers do not use both organic and inorganic fertilizers on their crops.

Households were more likely to use insecticides and improved seeds during the dry season. During the dry season, 90 percent of cultivating households used insecticides and improved seeds, but only about half of cultivating households used insecticides and improved seeds during the rainy season. The objective of the Farmer Training Sub-activity was not only to encourage households to use these items but also to increase the amount used per hectare. As such, the outcomes in Table V.9 provide an important baseline for assessing the possible effects of the sub-activity on the use of advanced inputs after implementation (RQ2).

Table V.9. Agricultural inputs used by households cultivating crops

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Use of inputs (%)						
Urea	97.7	98.3	96.6	83.4	73.9	97.6
NPK	96.8	98.6	93.2	87.8	82.7	95.2
Manure	66.7	56.7	86.4	15.8	13.2	19.7
Compost	25.2	27.0	21.8	66.5	71.7	58.6
Herbicides	69.5	75.1	58.5	74.9	67.3	86.1
Insecticides	90.1	90.3	89.8	47.5	46.8	48.6
Improved seeds	89.7	88.9	91.2	49.2	46.4	53.4
Sample size	**436**	**289**	**147**	**622**	**371**	**251**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means. Sample sizes are restricted to those households cultivating crops in each season. Quantities of and expenditures on inputs used by households appear in Appendix Table F.2.

The most commonly cultivated focus crops in each season also generally produced the largest average yields and harvest values. Using the agricultural equipment and inputs just described, households produced the largest average yields for the focus crops they most commonly cultivated (Table V.10). On average, households harvested more tons of onions (3.2 tons) and tomatoes (2.6 tons) in the dry season and more tons of corn (2.2 tons) and rice (0.6 tons) in the rainy season than any other focus crop grown in those seasons, respectively. The pattern largely holds true for the measures of harvest value, with the exception of harvest value

per hectare for rice in the rainy season (about 262,000 FCFA (525 USD) per hectare, only the fourth-largest value that season) (Appendix Table F.3).[41]

Yields per hectare of each crop were largely the same across regions. With the outcomes disaggregated by region, the size of focus crop yields still largely correlates with the percentage of households cultivating each crop within each region. However, yields per hectare were generally the same for each focus crop across regions. Given differences in regional markets and prices, a comparison of harvest values per hectare across regions is somewhat less meaningful. Nonetheless, focus crop yields and harvest values per hectare are measures that the Farmer Training Sub-activity intended to improve. As such, the values presented in Table V.10 and Appendix Table F.3 establish an important baseline for evaluating the possible effects of the sub-activity on these key proximal outcomes (RQ6).

Table V.10. Crop yields of households

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Yields (tons), focus crops						
Corn	0.09	0.07	0.11	2.25	2.47	1.91
Cowpeas	0.00	0.00	0.00	0.01	0.02	0.00
Onions	3.19	4.80	0.82	0.05	0.05	0.05
Rice	0.41	0.59	0.15	0.65	0.63	0.67
Soybeans	0.00	0.00	0.00	0.00	0.00	0.00
Tomatoes	2.55	3.17	1.64	0.08	0.00	0.20
Yield per hectare (tons/ha)						
Corn	4.33	5.26	3.79	4.16	3.80	4.62
Cowpeas	1.73	1.55	2.08	1.29	1.69	0.25
Onions	19.82	18.58	25.20	1.31	0.93	5.06
Rice	2.29	2.29	2.28	1.67	1.60	1.75
Soybeans	NA	NA	NA	0.19	0.19	NA
Tomatoes	28.19	27.51	29.76	7.68	9.00	7.64
Sample size	**621**	**370**	**251**	**624**	**372**	**252**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means. The sample sizes of focus crop outcomes per hectare are restricted to households cultivating each of the focus crops during that season.

tons = metric ton (1000 kilograms); ha = hectares

[41] USD equivalents for rainy season values are based on the exchange rate as of January 2012, which was 499 FCFA to the dollar.

Agricultural production in the dry season was directed more toward sales than production in the rainy season. As shown in Table V.7, just over 70 percent of households cultivated crops during the dry season. In Table V.11, we observe that 69 percent of households sold crops in that season. Thus, nearly all production in the dry season was directed toward sales. The outcome is similar when we restrict crops to focus crops: 65 percent of households cultivated and 60 percent sold focus crops during the dry season. Onions and rice were the most commonly cultivated focus crops in the dry season as well as the most commonly sold crops (47 and 27 percent of households sold onions and tomatoes, respectively). Conversely, only about half of households sold crops in the rainy season even though nearly all households cultivated crops during that season. Moreover, only one-third of households sold focus crops during the rainy season even though 95 percent of households cultivated them during that season. The results could indicate that crops such as corn and rice, the season's most commonly grown focus crops, are often produced for food security rather than for sales during the rainy season.[42]

Table V.11. Crop sales of households

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Sold crops (%)	69.2	77.8	56.6	51.5	41.6	65.7
Sold focus crops (%)	60.2	77.8	34.4	33.4	32.3	35.1
Sold focus crop (%)						
Corn	3.4	1.9	5.6	19.1	20.2	17.5
Cowpeas	0.3	0.3	0.4	0.6	1.1	0.0
Onions	46.5	64.1	20.7	2.2	1.9	2.8
Rice	10.8	14.7	5.2	8.1	11.8	2.8
Soybeans	0.0	0.0	0.0	1.1	1.9	0.0
Tomatoes	26.7	32.3	18.3	8.2	0.3	19.9
Amount sold, focus crop (tons)						
Corn	0.02	0.01	0.03	0.12	0.14	0.09
Cowpeas	0.00	0.00	0.00	0.00	0.00	0.00
Onions	2.73	4.13	0.66	0.03	0.03	0.03
Rice	0.14	0.20	0.04	0.10	0.16	0.01
Soybeans	0.00	0.00	0.00	0.00	0.00	0.00
Tomatoes	2.20	2.78	1.35	0.07	0.00	0.18
Sample size	**621**	**370**	**251**	**624**	**372**	**252**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means.

tons = metric ton (1000 kilograms)

[42] Differences by region do exist. For example, notably more households in Sourou versus Comoé sold rice during the rainy season. However, the key finding from our baseline analysis of crop sales remains the same: production in the dry season focuses more on sales than does production in the rainy season.

Agricultural sales revenue was higher in the dry season during which a greater percentage of households sold crops. Despite relatively balanced total harvest values across growing seasons (Appendix Table F.3), agricultural sales revenue was higher on average in the dry season, during which more households sold crops (Table V.12). Sales revenue was about 494,000 FCFA (1,100 USD) for the typical household during the dry season compared to roughly 104,000 FCFA (208 USD) during the rainy season.[43] Not surprisingly, households earned more from the focus crops they more commonly sold in each season. For example, during the dry season, the crops most commonly sold by households were onions and tomatoes, for which households earned, on average, about 323,000 FCFA (719 USD) and 45,000 FCFA (100 USD), respectively. As expected, differences in sales revenues across regions correlated with the percentage of households selling each crop by region.

Patterns of sales and sales revenue suggest that, during the dry season, households decided to cultivate the focus crops from which they earn the highest sales revenue per hectare. Consistent with our finding that dry season production is focused on sales, the focus crops most commonly grown in the dry season were those from which households earned large sales revenues per hectare. For example, onions and tomatoes, the most commonly grown crops in the dry season, generated the highest sales revenues per hectare (about 1,957,000 and 632,000 FCFA, respectively (4,359 and 1,408 USD, respectively)). However, the same is not true during the rainy season, when more households cultivated corn and rice despite higher sales revenues per hectare for onions and tomatoes in that season. Again, the pattern may be attributable to consumption and food security considerations and the disincentive to grow onions and tomatoes in the rainy season, given the considerably higher expected sales revenue per hectare when grown during the dry season.

Farmers most commonly sold onions and tomatoes directly from their farms in the dry season, implying that they did not receive full market price. In contrast, the local market was the most common point of sale for all crops, including tomatoes, during the rainy season (Appendix Table F.4). Given that one of the objectives of the DA Activity was to increase access to markets, we plan to examine if households sell at local and other markets even more frequently in the 2018 interim data.

[43] USD equivalents for dry season values are based on the exchange rate as of June 2011, which was 449 FCFA to the dollar.

Table V.12. Agricultural sales revenue of households

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Sales revenue (FCFA)	494,398	669,396	234,402	104,039	77,588	142,398
Sales revenue (FCFA), focus crops						
Corn	2,371	1,630	3,463	18,898	23,193	12,531
Cowpeas	177	149	219	128	214	0
Onions	323,017	496,605	67,131	3,528	3,383	3,742
Rice	33,969	49,321	11,372	14,104	22,944	1,249
Soybeans	0	0	0	106	177	0
Tomatoes	45,352	58,272	26,410	3,381	210	8,079
Sales revenue (FCFA/ha)	955,447	1,067,053	731,442	31,758	29,163	35,526
Sales revenue (FCFA/ha), focus crops						
Corn	125,973	137,921	119,109	37,789	46,750	26,173
Cowpeas	358,889	205,000	666,667	17,444	24,090	0
Onions	1,956,872	1,929,078	2,078,155	95,276	78,478	257,145
Rice	236,376	222,220	294,287	35,289	63,743	3,830
Soybeans	NA	NA	NA	22,058	22,058	NA
Tomatoes	631,730	643,638	604,250	290,659	315,000	289,834
Sample size	**621**	**370**	**251**	**624**	**372**	**252**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means. The sample sizes of focus crop outcomes per hectare are restricted to households cultivating each of the focus crops that season. The sample sizes of aggregate outcomes per hectare are restricted to households cultivating crops that season.

ha = hectares

3. Agricultural profits, household revenue, and credit

By increasing yields and sales of focus crops, the Farmer Training Sub-activity is expected to increase the financial well-being of trained households. Thus, after examining crop yields and their sales revenues, we consider baseline measures for agricultural profit, household revenue, and credit. In Table VI.13, we summarize the key measures we examine in this subsection for these more distal outcomes at baseline.

Table V.13. Measures of households' agricultural profits, revenue, and credit

Measures	Time frame
Agricultural profits. Agricultural sales revenue plus the value of yield not lost or sold minus agricultural input and labor costs	2010–2011 agricultural dry season/2011 agricultural rainy season
Nonagricultural income. Income from other paid activities; income from other sources	2010–2011 agricultural dry season/2011 agricultural rainy season
Total household income. Agricultural profits plus income from other paid activities and other sources; household income excluding other sources	2010–2011 agricultural dry season/2011 agricultural rainy season
Credit. Loan application; loan approval	2010–2011 agricultural dry season/2011 agricultural rainy season

Note: All measures of income were top-coded to three standard deviations from the mean to account for outliers.

Key findings: The typical household depends on agricultural production for most of its income. Households supplement their incomes with other sources more during the dry season than during the rainy season.

Profit from agricultural production accounted for most of the typical household's income in both agricultural seasons. Roughly two-thirds of the typical household's income in either agricultural season consisted of agricultural profit (Table V.14). Because agricultural profit includes the harvest value of crops not sold or lost, average agricultural profit during the rainy season (when more households cultivated) was roughly equivalent to the profit earned in the dry season despite greater sales revenue in the dry season. However, households also earned more income from other paid activities and sources during the dry season. Thus, total household income was larger during the dry season compared to the rainy season.

Table V.14. Households' agricultural profits and total income (FCFA)

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Agricultural profit	476,689	621,355	264,119	463,679	369,665	605,886
Income from other paid activities[a]	209,203	221,452	191,148	179,354	197,206	153,070
Income from other sources	41,189	43,324	38,029	22,910	26,537	17,556
Total household income[b]	758,482	922,344	516,718	689,582	617,216	798,739
Household income excluding other sources	713,636	871,688	481,397	662,444	587,308	775,780
Sample size	**621**	**370**	**251**	**624**	**372**	**252**

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means.

[a]Income from other paid activities includes agricultural wage labor.

[b]The sum of income sources may not equal total household income because all income variables were top-coded to three standard deviations from the mean to account for outliers. In addition, total household income was set to missing if any component income measure was missing in the sum.

One-third or fewer households applied for a loan in either season; nearly all applicants were approved. In terms of credit, just over one-third of households applied for a loan during the dry season, while about one-fourth applied for a loan during the rainy season (Table V.15).

Table V.15. Households' access to credit

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Applied for loan(s) (%)	34.5	38.6	28.4	25.5	26.6	23.8
Received loan(s), if applied for (%)	90.2	90.9	88.7	100.0	100.0	100.0
Size of loan(s) (FCFA)	225,040	255,544	162,579	213,290	270,769	118,450
Purpose of loan(s)						
Construction	2.9	3.4	1.8	1.3	2.1	0.0
Purchase of agricultural land	8.5	8.3	8.9	5.2	5.2	5.3
Agricultural inputs	61.7	63.4	58.3	69.4	71.4	66.1
Animal husbandry	1.2	0.9	1.8	2.6	2.1	3.4
Fishing products	5.2	6.8	1.8	2.6	4.2	0.0
Agricultural processing	14.2	17.5	7.1	9.7	11.3	6.9
Fruit tree products	0.0	0.0	0.0	1.3	0.0	3.5
Education	1.7	1.7	1.8	4.6	2.1	8.8
Other	22.5	19.3	28.8	12.4	9.4	17.5
Sample size	**621**	**370**	**251**	**624**	**372**	**252**

Source: Expense and credit module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means. Sample sizes for receiving a loan are restricted to households that applied for a loan. Sample sizes for size and purpose of loan(s) are restricted to households that received a loan. Because more than one operating household member could have applied for and received a loan, size of loan(s) is the sum of all loans received by operating household members, and the percentages for the purpose of a loan may sum to greater than 100 percent.

4. Agricultural training

To conclude our baseline investigations, we examine the training and assistance received by the households in the analysis sample during the 2010–2011 dry and rainy seasons. We examine these outcomes to understand the level and types of training received by households in the agricultural seasons immediately before implementation of the Farmer Training Sub-activity (RQ2, 3), as described in Table V.16.

Table V.16. Measures of agricultural training received by households

Measures	Time frame
Agricultural training. Participation of household in training; type of training received; application of practices learned during training	2010–2011 agricultural dry season/2011 agricultural rainy season/2013 agricultural season

Key findings: The majority of households had received no agricultural trainings before implementation of the Farmer Training Sub-activity.

Fewer than one-third of households received agricultural training during either of the two agricultural seasons immediately before implementation. During the 2010–2011 dry season, 27 percent of households in the analysis sample received agricultural training; only 18 percent received training during the ensuing 2011 rainy season (Table V.17). In both seasons, the most common types of training focused on cultivation and soil conservation (over 80 percent of participant households received training in these topics). Managing of operating accounts was the least common type of training received.

Table V.17. Agricultural training received by households before implementation of the Farmer Training Sub-activity

	Dry season (mean)			Rainy season (mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Household with member participating in training (%)	27.0	39.0	9.2	18.2	18.6	17.4
Type of training received (if trained) (%)						
Cultivation	83.8	82.6	91.3	81.3	84.1	76.7
Harvesting	62.3	60.4	73.9	57.1	46.4	74.4
Storage	50.9	50.0	56.5	58.0	47.8	74.4
Soil conservation/fertility management	83.2	82.6	87.0	86.6	82.6	93.0
Seed production	55.1	52.1	73.9	42.9	31.9	60.5
Management of operating accounts	43.7	44.4	39.1	27.7	15.9	46.5

Source: Agricultural module of baseline household survey—dry and rainy seasons (2010–2011).

Note: Statistics shown are unadjusted means.

E. Discussion

In this chapter, we examined the agricultural activities, production, income, and training at baseline for the households in the analysis sample: the 624 households that, according to AD10, were beneficiaries of the Farmer Training Sub-activity after baseline data collection. Our baseline findings help us understand the types of households that, in time, received training and assistance under the Farmer Training Sub-activity, and, importantly, provide the baseline measures for the outcomes the sub-activity was designed to affect.

Below, we present major findings with respect to characteristics of farmer training beneficiaries, with a focus on applicants' binding constraints to higher productivity and incomes at baseline and the potential of the DA activities to overcome these constraints (Table V.18).

- ***Farmers exhibited a need for agricultural training.*** Less than one-third of households participated in agricultural training during either of the two agricultural seasons immediately before implementation. MCC-funded training could help farmers modernize their practices, further diversify their production, and boost sales. In particular, training could help farmers improve their use of organic and inorganic fertilizers and pesticides and take advantage of newly developed seeds. Baseline survey results indicate that farmers may not consistently or correctly use these inputs.
- ***Suboptimal market access likely inhibited farmers' sales and income.*** Farmers most commonly sell onions and tomatoes directly from their farms during the dry season, implying that they receive lower prices than if they sold at market. The DA Activity's investments to increase farmers' access to markets—namely, through rehabilitated markets and an MIS—could be critical in helping farmers' increase agricultural sales and revenue.
- ***Nonmechanized tools limited household production.*** At baseline, few farmer households used advanced types of agricultural equipment such as furrowers, animal-drawn manga hoes, or irrigation pipes. Farmer training can deliver instruction in the proper use of advanced agricultural equipment, but the extent to which farmers can afford to purchase advanced equipment—either through credit or savings—is unclear.

Together, the above findings suggest that the DA Activity's farmer training, rehabilitated markets, and MIS investments could overcome several key binding constraints to greater productivity and higher incomes. However, it is also possible that, despite training in more advanced practices, farmer households may not be able to implement such practices if they do not acquire the necessary mechanized equipment.

Other important findings from the analyses in this chapter include the following:

- ***Income from agricultural production accounted for most of the typical household's income in both agricultural seasons.*** About two-thirds of the typical household's income in either agricultural season consisted of agricultural profit supplemented by income from other paid activities and sources.

- ***Agricultural production in the dry season was directed more toward sales, whereas production in the rainy season focused more on food security.*** During the dry season, the typical household in the sample cultivated high-revenue crops, such as onions and tomatoes, because the market values for those crops are greatest in that season. During the rainy season, the typical household cultivated but largely did not sell crops such as corn and rice, probably for consumption and food security reasons. Our evaluation will determine if households are more likely to diversify crop production and adopt new production techniques in the dry season compared to the rainy season.

Table V.18. Assessment of constraints underlying the program logic for farmers targeted by the DA Activity

Constraint from program logic	Assessment of the constraint at baseline	Potential of the intervention to overcome the constraint
Lack of access to irrigation	Most households irrigate their crops in the dry season. 70 percent of farmers irrigate their crops in the dry season, versus 41 percent in the rainy season.	Under the DA Activity, no assistance is planned to increase households' access to irrigated land or to improve their irrigation technologies.
Weak land ownership and formalized tenure arrangements	Households received most of the plots they operate in the dry season via inheritance or as a gift, the majority without official land titles. However, it is unclear if households' lack of land titles posed a constraint to investment or access to finance.	The compact's Rural Land Governance Project (RLGP) planned to increase households' access to land tenure documents in the two farmer training project areas. This assistance falls outside the scope of Mathematica's evaluation.
Lack of technical knowledge and capacity	Fewer than one-third of households received agricultural training during either of the two agricultural seasons immediately before implementation. However, the extent to which households received agricultural training in the preceding years in unclear.	MCC-funded training could equip farmers with new, practical knowledge that could help them modernize their practices, further diversify their production, and boost sales. In particular, training could help farmers improve their use of organic and inorganic fertilizers, pesticides, and improved seeds.
Lack of agricultural diversification	Farmers appeared to undertake relatively diversified production, as evidenced by their emphasis on cash crop production and sales in the dry season. As such, lack of diversification may not be a binding constraint to increased production and sales.	MCC-funded training in and assistance with crop diversification could help farmers not currently growing high-value crops in the dry season move into onion and tomato production.
Limited use of traction animals, machinery, and advanced inputs	The majority of households used animal-drawn plows and carts. However, few households used advanced types of agricultural equipment such as furrowers, animal-drawn manga hoes, or irrigation pipes.	Farmer training may provide instruction in the proper use of advanced agricultural equipment. However, the extent to which farmers can afford such equipment—particularly mechanized equipment—is unclear.
Limited value added and market access	In the dry season, on-farm sales were more common than market sales for cash crops, suggesting that farmers may not have good market access and may not receive the market price for their production.	MCC-funded investments in rural markets and value-added activities in the Sourou Valley might help improve market access for farmer training beneficiaries in the Sourou Valley. This could improve farmers' prospects for securing market prices for their agricultural production rather than the lower farm-gate prices.
Access to finance	No more than one-third of households applied for a loan in either season; nearly all applicants were approved. However, it is unclear whether the remaining two-thirds of households did not need finance or did not apply because of a low perceived chance of approval.	MCC-funded assistance with land tenure documents under the RLGP could overcome the constraints some farmers face in acquiring constraints tocredit—to the extent that farmers face such constraints and benefit from access to land tenure documents.

F. Next steps

We will combine the baseline data with the interim data collected in January–March 2018 to conduct the performance evaluation of the Farmer Training Sub-activity. Using a shared module, the interim survey will collect data common to all ADP evaluations, including agricultural practices (e.g., crops cultivated and inputs and techniques used) and outcomes (e.g., production, sales, and total agricultural income).

The interim survey will also include two modules unique to the farmer training evaluation. One module, to be administered to all households in the analysis sample, will collect data on implementation outputs (such as training and starter kits), employment outcomes, household income, and benefits from other ADP activities. A second module, to be administered to households in the Sourou Valley with plots on old perimeters at Niassan, will collect data on these households' water availability and their payments and labor contributions to WUAs. The final round of data collection, scheduled for 2019, will not collect any data related to the farmer training evaluation. Accordingly, we will present our findings from the performance evaluation of the Farmer Training Sub-activity in the interim report.

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VI. ADMINISTRATION

In this section, we discuss administrative issues related to the evaluation and present a timeline of evaluation activities.

A. Preparing data files for access, privacy, and documentation plan

The qualitative and quantitative data collected for the evaluation will be stored on Mathematica's secure server and will be accessible only to project team members. After producing and finalizing the interim and final evaluation reports, we will prepare de-identified data files, user manuals, and codebooks for the relevant baseline, interim, and final data sets. We understand that these files could be made available to the public; therefore, we will de-identify the data files, user manuals, and codebooks according to the most recent guidelines set forth by MCC. Public use data files will be free of personal or geographic identifiers that would permit unassisted identification of individual respondents or their households, and we will remove or adjust variables that introduce reasonable risks of deductive disclosure of the identity of individual participants. We will also recode unique and rare data by using top and bottom coding or by replacing the affected observations with missing values. If necessary, we will also collapse into less easily identifiable categories any variables that make any individual highly visible because of geographic or other factors. We will not submit qualitative data as restricted or public use files, though we will submit qualitative instruments and codebooks.

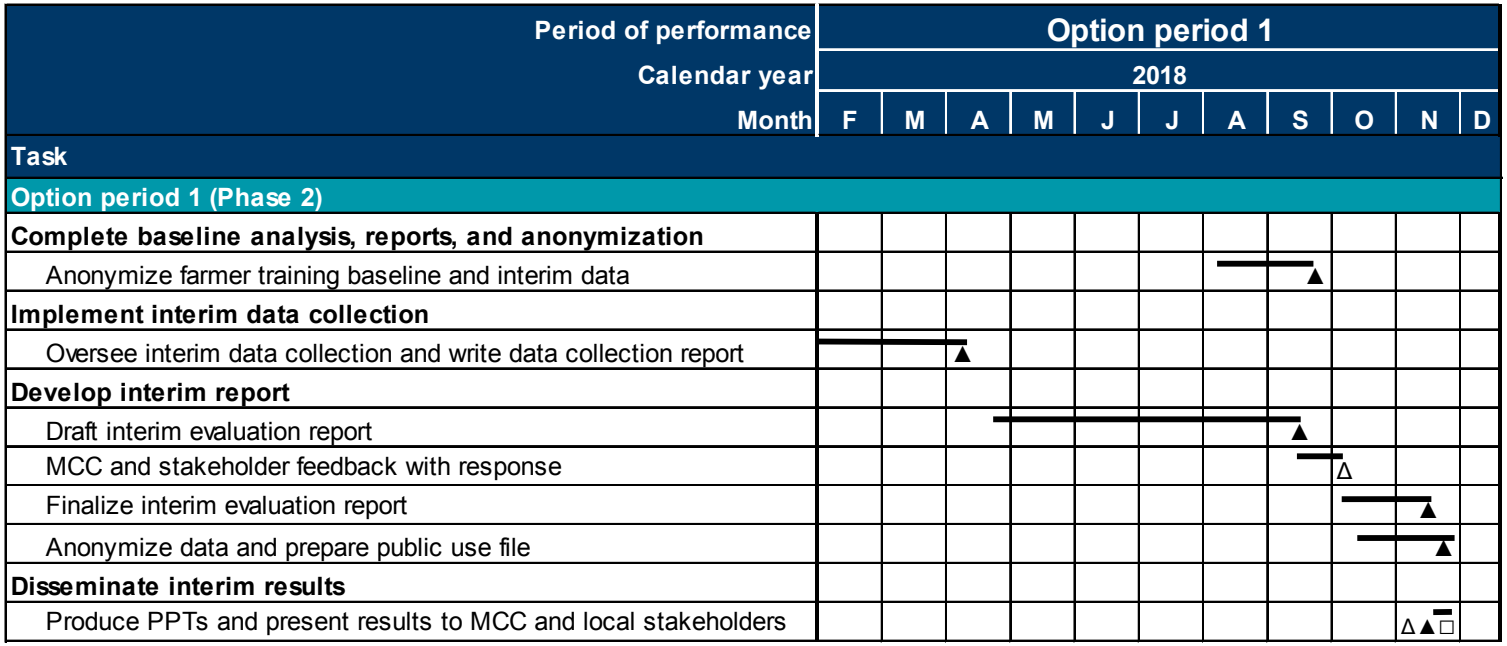
B. Evaluation timeline and reporting schedule

We will cluster the evaluation activities into two time periods corresponding to the interim and final data collection activities. Interim data collection will involve household surveys for the Di perimeter and Di PAP, the Di Lottery, and the farmer training surveys as well as qualitative data collection in the first quarter of 2018. We will produce a report summarizing the findings from these data. We expect to finalize the report in the third quarter of 2018 after we have presented the draft report to stakeholders and obtained their comments.

The final data collection activity will include two rounds of household surveys—one for the dry season and one for the rainy season—for the Di PAP and Di Lottery households as well as for crop cuttings covering both seasons for a representative sample of plots on the Di perimeter. The data will inform the final evaluation report, which we will complete by the end of our evaluation contract in the first quarter of 2020, again incorporating stakeholders' comments on the draft report. Figure V.1 provides an overview of the future evaluation activities and the reporting schedule.

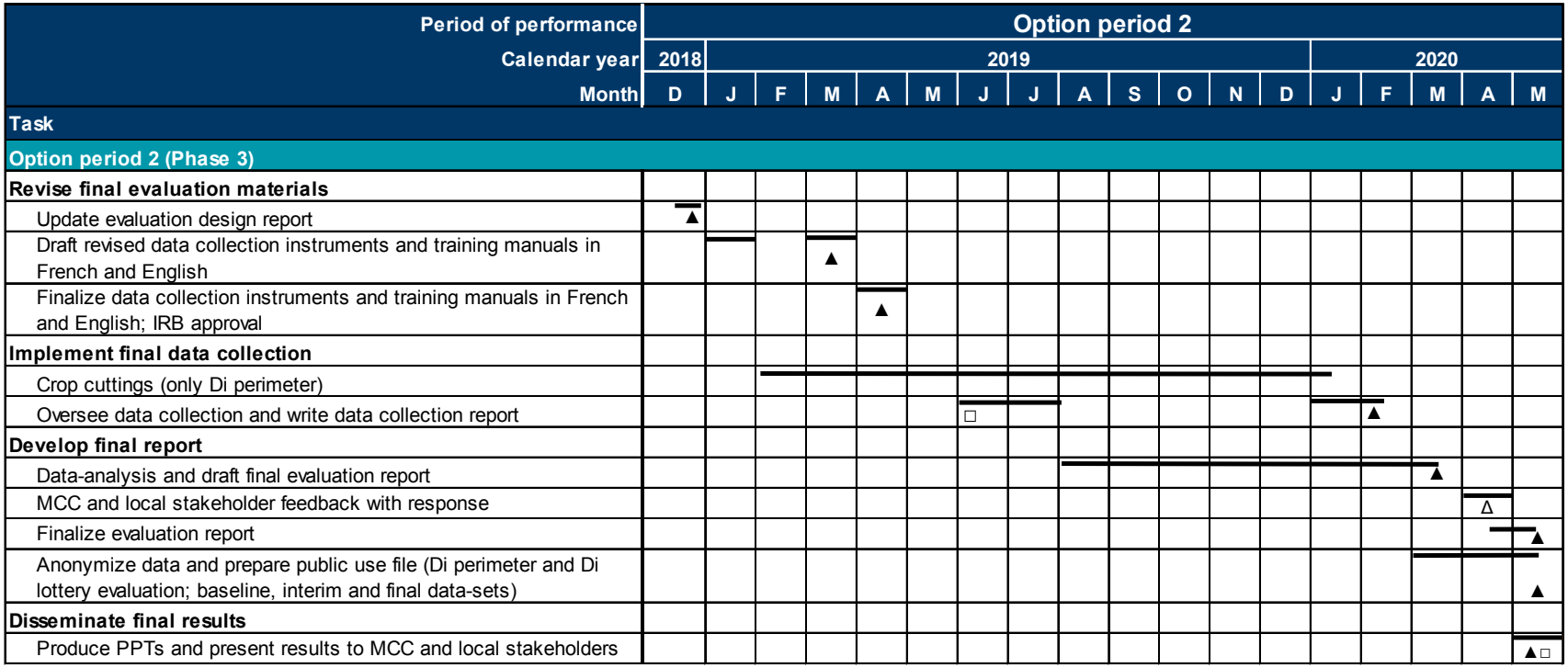
Figure VI.1. Evaluation timeline and reporting schedule

Option period 1



Δ Meeting with MCC ▲ Report/deliverable □ Trip to Burkina Faso

Option period 2



Δ Meeting with MCC ▲ Report/deliverable □ Trip to Burkina Faso

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REFERENCES

A2F. "MCC Final Report. Evaluation of the Access to Rural Finance Activity in Burkina Faso." Bethesda, MD: A2F, October 2015.

Bureau d'Etudes et de Recherche pour le Développement (BERD). "Rapport sur l'identification d'indicateurs d'impact et collecte de données de référence pour l'évaluation de l'impact de la réinstallation involontaire sur les PAP du périmètre irrigué de Di en fin de compact (AD2.2B). " Ouagadougou, Burkina Faso: BERD, 2014.

Chauvin, N.D., F. Mulangu, and G. Porto. "Food Production and Consumption Trends in Sub-Saharan Africa: Prospects for the Transformation of the Agricultural Sector." Addis Ababa, Ethiopia: United Nations Development Programme, Regional Bureau for Africa, 2012. Available at http://www.undp.org/content/dam/rba/docs/Working%20Papers/Food%20Production%20and%20Consumption.pdf. Accessed September 22, 2016.

Christiaensen, Luc, Lionel Demery, and Jesper Kuhl. "The (Evolving) Role of Agriculture in Poverty Reduction—An Empirical Perspective." *Journal of Development Economics*, vol. 96, no. 2, 2011, pp. 239–254.

Food and Agriculture Organization of the United Nations (FAO). "AQUASTAT Main Database," 2016. Available at http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en. Accessed February 19, 2017.

IMPAQ International. "Burkina Faso Agricultural Development: Project Impact Evaluation. Agricultural Survey: Interim Crop Yield Data Quality Review." Columbia, MD: IMPAQ International, 2014a.

IMPAQ International. "Evaluation Design Report: Impact of the Agricultural Development Project Burkina Faso." Columbia, MD: IMPAQ International, 2014b.

IMPAQ International. "MCA-Burkina Faso Agricultural Survey in the Sourou Valley and Comoé Basin: Data Quality Review Report." Columbia, MD: IMPAQ International, 2014c.

IRIS Center (University Research Corporation, International). "Deliverable #12—Preliminary Evaluation Design Report: Final Version. Impact Evaluation Design—Burkina Faso." College Park, MD: The IRIS Center, University of Maryland, 2010.

Ksoll, Christopher, and Chantal Toledo. "Evaluability Assessment Report for the Burkina Faso Agriculture Development Project." Washington, DC: Mathematica Policy Research, 2016.

Ksoll, Christopher, Chantal Toledo, Seth Morgan, Anca Dumitrescu, and Kristen Velyvis. "Evaluation of the Burkina Faso Agriculture Development Project: Design Report." Washington, DC: Mathematica Policy Research, June 6, 2017.

Lee, David S., and Thomas Lemieux. "Regression Discontinuity Designs in Economics." *Journal of Economic Literature*, vol. 48, no. 2, June 2010, pp. 281–355.

Millennium Challenge Account–Burkina Faso (MCA-BF). "Rapport d'Achèvement du Compact du Burkina Faso." Ouagadougou, Burkina Faso: Millennium Challenge Account–Burkina Faso, 2014a.

Millennium Challenge Account–Burkina Faso (MCA-BF). "Burkina Faso Post-Compact Monitoring and Evaluation Plan." Ouagadougou, Burkina Faso: Millennium Challenge Account–Burkina Faso, 2014b.

Millennium Challenge Account–Burkina Faso (MCA-BF). "Atlas des Activités et des Réalisations Entreprises par le MCA-BF Durant le Compact (2009–2014)." Ouagadougou, Burkina Faso: Millennium Challenge Account–Burkina Faso, 2014c.

Millennium Challenge Corporation (MCC). "Burkina Faso Agricultural Development Project, Di Irrigated Agriculture Closeout ERR." Washington, DC: MCC, 2017. Available at https://assets.mcc.gov/content/uploads/2017/04/mcc-err-burkina-di-irrigation-close.xls. Accessed April 26, 2017.

Millennium Challenge Corporation (MCC). "Di Land Allocation (as of July 8 2014)." Excel spreadsheet. Washington, DC: Millennium Challenge Corporation, 2016a.

Millennium Challenge Corporation (MCC). "Burkina Faso Compact." Washington, DC: Millennium Challenge Corporation, 2016b. Available at https://www.mcc.gov/where-we-work/program/burkina-faso-compact. Accessed September 22, 2016.

Millennium Challenge Corporation (MCC). "Final Report: Comoé." Washington, DC: Millennium Challenge Corporation, 2008a.

Millennium Challenge Corporation (MCC). "Final Report: Di." Washington, DC: Millennium Challenge Corporation, 2008b.

Sally, H., H. Lévite, and J. Cour. "Local Water Management of Small Reservoirs: Lessons from Two Case Studies in Burkina Faso." *Water Alternatives*, vol. 4, no. 3, 2011, pp. 365–382.

Schochet, Peter Z. "Technical Methods Report: Guidelines for Multiple Testing in Impact Evaluations." NCEE 2008-4018. Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education, 2008.

SHER/GRET. "Rapport de fin de phase 1 (Plan d'attribution aux PAPs). Livrable 11.2." Submitted to Millennium Challenge Account Burkina Faso, March 2013.

USAID Burkina Faso. "Fact Sheet: Agriculture and Food Security." Washington, DC: USAID, 2015. Available at https://www.usaid.gov/sites/default/files/documents/1860/BF%20Fact%20Sheet%20-%20Food%20Security.pdf . Accessed September 22, 2016.

APPENDIX A

MAPS

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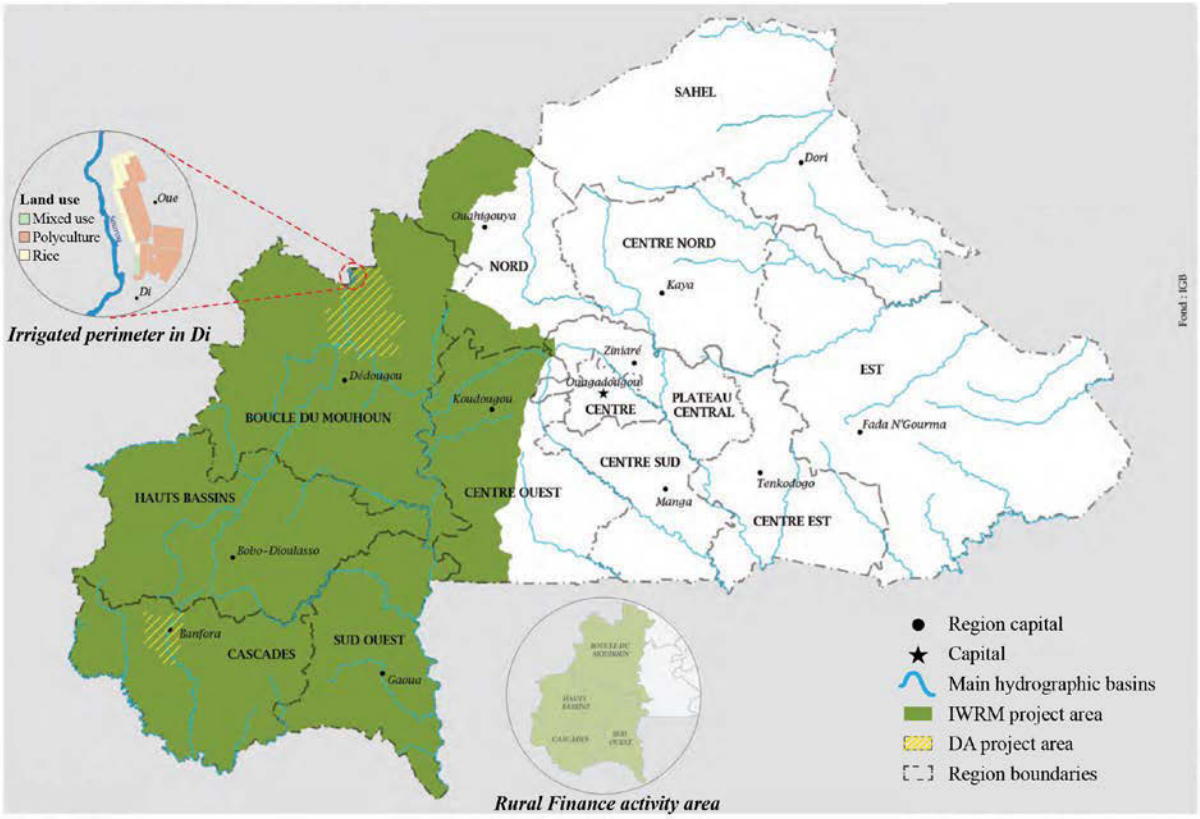
Figure A.1. Map of ADP intervention areas



Source: MCA (2014d).

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APPENDIX B

DI PERIMETER ERR

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MCC uses ERR models to assess whether its projects are sound investments. The ERR is a summary statistic that reflects the economic merits of an investment. Conceptually, it is the discount rate at which the benefits of an intervention are exactly equal to its costs; a higher ERR implies relatively higher benefits and lower costs.

MCC finalized the closeout ERR for the Di perimeter on March 7, 2017 (MCC 2017). MCC's ERR analysis computes the increase in agricultural profit for the land on which the Di perimeter was built.

MCC's calculations are based, in part, on realized agricultural outcomes that the *Agence de Partenariat pour le Développement* (APD) collects as part of the post-compact monitoring activities (see MCA-BF 2014b for the post-compact M&E plan). This includes information on the area planted and agricultural yields for the primary crops grown on irrigated land at Di—that is, corn, rice, cowpeas, onions, and tomatoes. Soya is used as a proxy for any other crops. Total production for a crop is calculated as the area planted with a crop multiplied by its average yield.

To estimate the value of this agricultural production, the ERR calculation makes assumptions on post-harvest losses and prices. Crop prices are assumed to be fixed across time and across season, while losses vary by season but are fixed across time. Agricultural profits subtract the cost of inputs from the value of total production. The main costs are (1) labor costs for land preparation, weeding, and harvesting; (2) the costs of fertilizer, seeds, and pesticides; (3) post-harvest and marketing costs; and (4) contributions to the WUAs. The calculation assumes that the amounts of inputs used differ across crops and dry and rainy seasons, but that input prices are constant across years and seasons.

The value of production without the perimeter is based on a similar calculation using information from the pre-compact period on the area planted by crop, the quantities produced, the inputs used, and the prices for inputs and crops. This information cannot be updated with the baseline data given the poor quality of the data.

Regarding program costs, MCC takes into account direct costs—such as costs associated with construction of the perimeter itself—and indirect costs, such as costs of design and supervision, costs related to environmental and social mitigation plans and a share of compact administration and M&E costs. These costs do not include costs spent by the post-compact entity APD after the close of the compact.[44]

Total costs per hectare amount to $39,731 U.S. dollars when compact administration costs are excluded and $45,088 U.S. dollars when they are included.[45]

[44] As not all Di beneficiaries were trained by the end of the compact, GOBF committed to funding the training that occurred during the post-compact period. In addition, GOBF also provided subsidies to CATG during a transition period. The inclusion of these costs would likely not change the overall cost of the perimeter nor the ERR substantially.

[45] We calculated the per hectare value based on the assumption that the total land area at Di perimeter comprises 2,240 hectares of land (MCA-BF 2014a). The Atlas of Realizations (MCA-BF 2014c) and the ERR calculations use a value of 2,246 hectares. We note that the Atlas of Achievements computes a cost per hectare of $37,554 U.S. dollars, using the same total cost of the perimeter. This is a clerical error.

To estimate future agricultural profits, MCC uses the values for agricultural production from 2016, assumes prices for inputs and agricultural production will remain stable, and that long-term land productivity will be about 90 percent of the 2016 value. MCC calculates that agricultural profit would increase from about 242,425 CFA to a long-term value of 1,974,184 CFA per hectare per year, resulting in an increase of 1,864,227 (about $3,000 U.S. dollars) per hectare per year.[46] The period of analysis for the ERR is 25 years; the ERR (including compact administration costs) was estimated to be 5.5 percent.

We propose to recalculate the ERR using the information on area planted, input use, input prices, agricultural production, production sales prices, and profits that we collect as part of the Di perimeter evaluation. We propose two rounds of data collection—interim and final quantitative data collection. We will make use of information from both rounds, as well as the crop cutting measurements, to update the ERR calculations.

In the design report, we note that we also analyze whether the additional production on the Di perimeter has led to lower crop prices. If this is the case, we cannot multiply pre-compact production from land used by the perimeter with post-compact prices. We will instead multiply pre-compact production with prices that are predicted based on our relationship of the prices at Di and other markets in Burkina Faso.[47]

Our information on agricultural profits in the counterfactual scenario (that is, the scenario without the construction of the Di perimeter) was based on limited information on agricultural outcomes on the land used for the Di perimeter. We will therefore conduct a sensitivity analysis around these counterfactual profits. This may include, for example, calculating the ERR with counterfactual profits that are 50 percent higher and lower than in MCC's published ERR.

We will also provide a qualitative assessment of the state of the irrigation infrastructure by conducting a site visit to the Di perimeter. We will reference available information on soil fertility from the Bureau National des Sols at this site that might indicate whether the land productivity is declining as anticipated and whether recommended amounts of organic fertilizer are used to maintain productivity. Together with information on maintenance of primary and secondary canals, this will provide us with a plausible ranges for the life-span of the irrigation infrastructure and the evolution of land productivity on the perimeter. We will also address these questions to AMVS. We will include this information into the ERR, and conduct sensitivity analyses around this assumed lifespan and evolution of productivity.

[46] We calculated these values by dividing total profits by 2,240 hectares.

[47] To the extent that nearby markets are partially affected by the additional production at Di, we will only be able to partially address the effect of Di on lower prices.

APPENDIX C

QUANTITATIVE DATA COLLECTION PLANS

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We will collect quantitative and qualitative data from a range of sources to evaluate the WMI and DA activities. Below we discuss our quantitative data collection plan as it is related to the three activities described in this report.

Quantitative survey data collection plan

Our design calls for collection of survey data on the ADPs activities' key outcomes directly from households. Survey data will be collected by a local data collection firm procured by Mathematica. We anticipate a common ADP survey with separate modules focusing on the Di perimeter, the Di Lottery, and Farmer Training.

An integrated ADP survey leverages efficiencies across the three evaluations in survey design, testing, training, survey administration, and analysis. For instance, modules on agriculture production, crop choices, yields, irrigation access, farming inputs, and agricultural and household income will overlap between the samples. The questionnaire will then also include specialized modules that relate to specific evaluations. These include a module to capture water user payments for the Di PAP and Di Lottery surveys and a module on land rights in the area of origin for the Di Lottery survey. Table C.1 provides an overview of the sample, rounds of data collection and survey modules by evaluation. The table also highlights common modules and modules specific to each evaluation, and where applicable, the respondent category within an evaluation.

Table C.1. Primary quantitative data collection overview

Sample	Data collection round	Sample size	Modules
ADP survey			
Common modules			
Di perimeter beneficiaries (incl. Di Lottery beneficiaries);	• interim, final	917	• Agricultural practices (crop choice, area planted, input use, agricultural techniques [including particular focus on improved techniques learned under the DA Activity)
Di Lottery applicants;	• Interim, final	2,178	
Farmer training beneficiaries	• interim	600	• Agricultural outcomes (production, sales, total agricultural income)
Additional modules Di perimeter			
Di PAPs	• interim, final	275	• Implementation outputs (titles, leases, training, starter kits) • Employment outcomes (self-employment, off-farm employment), household income • Perceptions of land tenure security • Land investments, land rental or sales • Use of land as collateral • Payments to WUAs • WUA labor contributions • Water availability (part of input use) • Use of rehabilitated markets and MIS
Crop cuttings	• final	253	• Crop cuttings for focus crops
Additional modules Di Lottery			
Di Lottery applicants	• interim, final	2,178	• Employment outcomes (self-employment, off-farm employment), household income • Perceptions of land tenure security • Land investments, land rental or sales • Use of land as collateral • Plot-level information on agricultural outcomes off-perimeter
Di Lottery beneficiaries	• interim, final	503	• Implementation outputs (titles, leases, training, starter kits) • Payments to WUAs • WUA labor contributions • Water availability (part of input use) • Individual outcomes by gender (expenditures, control over resources, education)
Additional modules farmer training evaluation			
Farmer training beneficiaries	• interim	600	• Implementation outputs (training, starter kits) • Employment outcomes (self-employment, off-farm employment), household income • Benefit of other ADP activities
Farmers in Sourou with plot on old perimeters	• interim	171	• Payments to WUAs • WUA labor contributions • Water availability (part of input use)

The timing of our data collection will follow the planting and harvesting seasons in our study sites, and for onions, rice, tomatoes and corn in particular. To maximize efficiencies in travel and interviewer training, we will collect primary data at the same time in all evaluations for each agricultural season. One round of data collection will cover the 2017 agricultural seasons during the beginning of 2018, which will concentrate on medium term outcomes. To evaluate long term outcomes, we will do two rounds of data collection, one to collect information on agricultural production during the 2019 dry season and the second to cover agricultural production during the 2019/2020 rainy season. As part of the 2019/2020 data collection, we will also conduct cuttings for key crops over the course of both agricultural seasons.

To minimize attrition, we will also track respondents in the Di Lottery baseline survey who migrated within the Sourou Valley and to important migration destinations, such as Tougan and Ouagadougou. We will ask neighbors and local authorities for contact information for these migrants and then contact them to set up interviews.

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APPENDIX D

DI PERIMETER EVALUATION

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A. Summary of baseline Di PAP data

As described in Chapter V, some of the sources of data collected for the implementation and evaluation of the Di perimeter suffer from substantial quality issues, as described in Table D.1.

Table D.1. Summary of data sources, limitations, and use in the Di perimeter evaluation

Name of data file	Sample size	Content	Data limitations	Used in baseline report
Di Land Allocation Spreadsheet	1,445 PAPs	• Unique PAP ID • Name, gender, date of birth, and national ID of PAP • Contact information, village, and neighborhood of PAP • Amount of land allocated to PAP	None.	These data are used in the baseline report.
2011 PAP Plot Census Data Set	1,202 PAPs; 2,209 plots	• Unique PAP ID • Name, gender, and national ID of PAP • Name and national ID of the PAP's spouse or relative • Amount of land lost (in hectares), total and by plot • Amount of money the PAP received in compensation for the lost harvest (in FCFA), total and by plot	Based on our understanding, the data collected for the 2011 plot census was not submitted to MCC or MCA in their original form. Instead, a report was submitted with an appendix listing only a handful of variables created from the census data. The data provided to Mathematica were copied from a PDF file into an Excel spreadsheet. There were errors in the conversion from commas (which serve as decimals in French) to decimals. Mathematica resolved most of those issues but was not able to fix the variables that show the amount of compensation money received at the plot level. The land allocation survey was used to correct several incorrect PAP IDs. There are, however, 78 PAPs from the plot census file that do not appear in the land allocation file or cannot be merged and 54 PAPs from the land allocation file that do not appear in the plot census data, after the following steps were taken to combine the data sources. Mathematica originally merged by unique PAP ID and then attempted to match these observations by name and national ID number but was unable to find any matches for these observations. Some of the nonmerging observations may be the result of errors in the census data that were later corrected in the land allocation file	These data are used in the baseline report. We exclude the 78 PAPs that do not appear in the land allocation file.

Table D.1 (continued)

Name of data file	Sample size	Content	Data limitations	Used in baseline report
2013 PAP Census Data Set	279 PAPs; 312 plots	• -Unique PAP ID • Name, gender, and national ID of PAP • Name and national ID of the PAP's spouse or relative • Amount of land lost (in hectares), by plot • Amount of money the PAP received in compensation for the lost harvest (in FCFA), by plot	For the plots covered by the expansion, the original raw data set is available. However, we do not use these data in the report because they cover such a small area of the perimeter and a small number of beneficiaries (neither of which is representative of the larger area and larger set of beneficiaries). Instead, we created variables similar to those available in the 2011 plot census data files.	We use only the Recensement Parcelle tab. We do not use the survey data—the Membre de Ménage, Membre Eligible du Ménage, Ménage spreadsheets—because we do not have the same data for the 2011 PAPs.
2013 PAP Baseline Survey	388 PAPs	• Unique PAP ID • PAP demographics • Household roster • Information on land owned off-perimeter • Use of irrigation • Crop production • Land use on- and off-perimeter • Sources of revenue • Assets • Use of compensation money and land • Credit history • Training experience	The baseline survey data contain information only on a sample of 26 percent of all PAPs. In addition, there was substantial attrition (22 percent) from the original sample. The main limitation of these data is that we and the second evaluator were unable to determine the sampling method. The survey sample was a stratified representative sample. The first evaluator's report indicates that the strata were village, age group, and amount of land lost. However, we do not know if this sampling approach was in fact implemented, as the second evaluator was unable to replicate the process. In addition, the Data Quality Report (DQR) prepared by IMPAQ in 2014 notes the following data quality issues in the baseline survey data, which we also observed: • A few nonmerging observations across data files • Duplicate observations in the data files • Unexplained missing entries and response coding errors • Discrepancies in the age and gender of PAPs between the baseline survey files and the plot census data IMPAQ was able to resolve these issues with the data collection subcontractor (IMPAQ 2014c). However, the updated file was not available to us.	These data are used in the baseline report. However, we exclude 11 PAPs that do not appear in the land allocation file

B. Off-perimeter land use at baseline

The baseline survey collected a large amount of information on PAP's land use and production off-perimeter at baseline. As described in the main report, 65 percent of PAPs reported farming land outside of the perimeter at baseline. Our analyses found that PAPs produced similar quantities annually of rice, corn, and sorghum (2.6-2.7 tons), and produced only small quantities (0.2-0.3 tons), on average of onions and tomatoes (Table D.2). Across all key crops, tomatoes yield the highest annual production per hectare, approximately 8.8 tons/hectare. Production for other crops ranged from 3.9 to 4.9 tons/hectare.

Table D.2. Land value and production of Di PAPs at baseline

	Mean		
	Total	Female	Male
Off-perimeter land production			
Estimated annual household production (tons):			
Onion	0.2	0.1	0.2
Tomatoes	0.3	0.1	0.4
Rice	2.6	0.6	2.9
Corn	2.6	1.5	2.8
Sorghum	2.7	3.9	2.5
Estimate annual production per hectare (ton/ha)[c]:			
Onion	4.9	4.0	5.1
Tomatoes	8.8	7.0	9.0
Rice	4.6	2.6	4.7
Corn	3.9	2.9	4.0
Sorghum	4.0	12.2	3.0
Sample size (PAPs)	**377**	**85**	**292**
Sample size (PAPs farming land off-perimeter)	**246**	**35**	**211**

Source: Di PAP Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample sizes shown are for the full sample; some outcomes may have a smaller sample size because of missing data. All outcomes besides "farmed land outside of the perimeter" are calculated for the subsample for PAPs who reported farming land off-perimeter at baseline.

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APPENDIX E

DI LOTTERY EVALUATION

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Table E.1. Di Lottery scoring sheet

Criteria		Points	Maximum in category
Documented number of adults or adolescents age 15 and older available to work on the land, in addition to applicant			20
If first choice is to receive plot for growing rice (2 hectares)			
	At least 4 per hectare (8 total)	20	
	At least 3 per hectare (6 total)	15	
	At least 2 per hectare (4 total)	10	
	Fewer than 2 per hectare	0	
If first choice is to receive polyculture plot (1 hectare)			
	At least 6 per hectare	20	
	At least 5 per hectare	15	
	At least 4 per hectare	10	
	Fewer than 4 per hectare	0	
Ownership of agricultural tools and draft animals			10
	None	0	
	Animal-drawn cart ***[one of list of specific tools]*** [a]	5	
	Animal-drawn cart and plow ***[At least two of list of specific tools]*** [a]	10	
Technical trainings on agricultural production attended by the applicant			5
	None	0	
	Attended at least one	5	
Applicant's technical experience in irrigated agriculture			15
	None	5	
	Less than 2 years	10	
	More than 2 years	15	
Gender			5
	Female	5	
	Male	0	
Age			5
	Between 18 and 30	5	
	Between 31 and 55	3	
	Age 56 and older	1	
Level of debt [b]			10
	No arrears	10	
	Arrears less than or equal to 100,000 CFA	6	
	Arrears of more than 100,000 CFA	0	
Current residence			15
	Village in the rural commune of Di	15	
	Sourou Province	10	
	Mouhoun Region	5	
	Rest of the country	0	
Has a title to a plot in another AMVS perimeter			15
	Yes, at least one	0	
	No	15	
Total/maximum			100

[a] Contrary to the official scoring criteria, based on Mathematica's analysis of the data, applicants received 5 points for ownership of one of a list of specific agricultural tools and 10 points for at least two tools from this list.

[b] Level of debt: None of the eligible applicants is recorded as having debt.

Table E.2. Summary of Di Lottery baseline data sources

File name	Sample size	Content	Data limitations	Use in baseline report
Applicant eligibility data (2013)	(Initial) 2,178; (Revised) 2,206 eligible lottery applicants	• Unique applicant ID • Name, age, gender, and other demographic characteristics of applicant • Other household applicants • Plot preference (polyculture or rice) • Applicant's experience with irrigation • Any ownership of irrigated land in other AMVS perimeters • Participation in MCC-sponsored training activity • Type of agricultural equipment owned by applicant • Level of debt • Location of residence • Applicant's component and composite scores for lottery admission	• The eligibility data that we have on hand do not constitute the final database. The data contain initial and revised information on most but not eligible applicants. • We know from project reports that the final group of eligible applicants totaled 2,229 individuals. The revised list of eligible applicants submitted to Mathematica (N = 2,206) does not overlap perfectly with the initial list of eligible applicants (N = 2,178). Specifically, there are 100 applicants from the revised list not found on the initial list, and 72 applicants from the initial list not found on the final list. The pre-restitution list was used as the sample frame for the Di Lottery baseline survey. As such, there are no baseline survey data for 100 applicants of the final list of eligible applicants, thus reducing the analysis sample of our analyses by that number of observations.	The applicant eligibility data were used in the baseline report to assess the balance of the treatment (lottery beneficiaries) and control (nonbeneficiary lottery participants) groups of the RCT. Specifically, we used t-tests to compare the treatment and control groups' means of the variables used to score eligible applicants.
List of lottery participants (2014)	1,528	• Unique applicant ID • Name • Applicant's composite score for lottery admission	• The list includes the final score of lottery applicants, but not the individual eligibility criteria.	Used to identify those survey respondents who participated in the Di Lottery and who will be part of the Di Lottery RCT.

Table E.2 (continued)

File name	Sample size	Content	Data limitations	Use in baseline report
Scans of published lists of applicants eligible but not admitted to lottery (2014)	561	• Unique applicant ID • Name • Applicant's component and composite score for lottery admission	• The list is not the final list of eligible applicants who are not participants, but it is close to final. Relative to the eligibility database, the number of cases with scores below 60 who are also observed in the list of lottery participants is reduced to one observation.	The applicant scores for the nonadmitted were used for the RD analysis.
Baseline survey data (2013–2014)	2,128 eligible lottery applicants	• Unique applicant ID • Applicant and head-of-household demographic characteristics • Socioeconomic characteristics of applicant's household • Agricultural activities and experience of applicant and applicant's household • Land and agricultural assets of applicant and applicant's household • Applicant's nonagricultural activities • Income sources of applicant's household	• Due to delays in finalizing the group of eligible applicants, the respondents targeted for the baseline survey are based on the initial list of 2,178 eligible applicants. • The observations of the baseline survey data and the revised applicant eligibility data do not overlap perfectly. Because 100 of the eligible applicants on the final list do not appear on the initial list, those observations had no baseline survey data collected and therefore are excluded from the analysis sample of the Di Lottery evaluation. • Limited information on other members of the household. • Limited information on baseline agricultural outcomes of the applicant and other household members. • Limited information on other income sources.	The baseline survey data were used in the baseline report for the descriptive analysis of applicants and their households.
Lottery beneficiary Di land allocation data (2014)	503 lottery beneficiaries	• Unique applicant ID • Applicant's name, gender, and residence • Type of plot awarded (polyculture or rice) • Size of plot awarded in hectares	• None.	The data were used to identify the lottery beneficiaries (and nonbeneficiaries) in the other data sources used in the baseline report.

Table E.3. Access to cultivable land for lottery applicant households

	Mean		
	Total	Female	Male
Land operated by lottery applicant households			
Number of plots owned, rented in, or with communal access rights	2.63	2.65	2.63
Land owned by lottery applicant households			
Household members have property rights (%)	62.9	59.2	63.7
Number of household members with property rights	0.96	0.88	0.98
Amount those owning, Number of plots household members own	2.43	2.29	2.46
Land rented to lottery applicant households from others			
Household members rented in plots (%)	24.7	29.0	23.7
Among those renting			
Number of plots, if renting in plots	1.76	2.26	1.62
Number of plots irrigated	1.54	1.85	1.45
Contract type (%)			
Sharecropping	16.2	21.2	14.8
Rent	79.6	72.6	81.6
Both	4.2	6.2	3.6
Total area of plots (%)			
<0.5 ha	37.5	30.1	39.6
≥0.5 to <1 ha	39.8	41.6	39.3
≥1 to <1.99 ha	11.4	15.9	10.2
≥2 to <2.99 ha	6.9	6.2	7.1
≥3 to <3.99 ha	1.2	0.9	1.3
≥4 ha	3.2	5.3	2.5
Cultivated plots (last 12 months) (%)	95.8	94.7	96.2
Hired labor on cultivated plots (last 12 months) (%)[b]	57.3	58.9	56.9
Method of payment for land rented (last 12 months) (%)			
Cash	83.6	79.6	84.8
In kind	11.8	14.2	11.2
Both cash and in kind	4.5	6.2	4.1
Total value of payments per hectare (FCFA/ha) [a]	114,181	95,091	119,451
Communal land operated by lottery applicant households			
Household members have communal land rights (%)	38.4	39.7	38.1
Among those with communal plots: number of communal plots	1.74	1.6	1.8
Sample Size	**2,049**	**390**	**1,659**

Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means. Sample size is 1286 (231 / 1055) for those owning plots (female subgroup / male subgroup), 507 (113 / 394) for those renting and 787 (155 / 632) for those with communal land

[a]Total area of plots was collected as a categorical variable in which each category represents an area range. To calculate total value of payments per hectare we used the midpoint of the category for the denominator. Total value of payments per hectare was not calculated for observations with plot areas falling within the four hectares and larger range, because a midpoint cannot be calculated for that category.

[b] The sample size for this indicator is restricted to applicants cultivating owned, rented, or communal plots, respectively.

Table E.4. Balance tests for scoring variables for female Di Lottery participants[a]

Scoring criteria	Treatment group mean	Control group mean	Difference	*p*-value of difference
Number of active household members	3.78	3.92	-0.09	0.51
Applicant owns one piece of agricultural equipment	20.8	11.6	9.0	0.04**
Applicant owns at least two pieces of agricultural equipment	67.0	71.8	-4.2	0.46
Applicant received technical training in agriculture	38.7	35.2	1.7	0.77
Applicant has no experience in irrigated agriculture	23.6	31.5	-6.6	0.23
Applicant has less than two years of experience in irrigated agriculture	4.7	6.6	-2.3	0.42
Applicant has two years or more of experience in irrigated agriculture	71.7	61.9	8.9	0.13
Female	100.0	100.0	0.0	0.00
Age of applicant - 18 to 30	34.3	42.5	-9.3	0.13
Age of applicant - 31 to 55	64.8	54.7	11.0	0.07*
Age of applicant - 56 or older	1.0	2.8	-1.7	0.34
Applicant has debt	1.0	1.1	0.4	0.75
Applicant is from village in the rural Di commune	55.7	51.4	2.0	0.74
Applicant is from Sourou province	89.6	92.3	-2.4	0.49
Applicant is from Boucle du Mouhoun region	0.0	1.1	-0.5	0.59
Applicant does not have title to a parcel on AMVS perimeters	100.0	100.0	0.0	0.00
Total applicant eligibility score	73.96	73.30	0.63	0.57
Joint test of significance[c]				0.13
Number of observations	**106**	**181**		

Source: Di Lottery applicant eligibility data (2013-14)

Note: All outcomes are percentages except number of active household members.

[a] The sample for this table is restricted to the applicable female lottery participants that also completed the baseline survey because only lottery participants with baseline data will be included in the analysis sample of the impact evaluation. There were a few inconsistencies in applicant gender between the applicant eligibility and baseline survey data, which we resolved using the applicants' first names as an indication of the applicants' sex. We will reconfirm the gender of these individuals in the interim data.

[b] The joint test of significance is from a regression of the treatment indicator on all scoring criteria as well as strata fixed effects. F-test for the hypothesis that the coefficients on all scoring criteria are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table E.5. Balance tests for scoring variables for Di Lottery participants excluding households with multiple lottery applicants[a]

Scoring criteria	Treatment group mean	Control group mean	Difference	*p*-value of difference
Number of active household members	4.07	4.25	-0.15	0.04**
Applicant owns one piece of agricultural equipment	15.5	13.0	2.4	0.23
Applicant owns at least two pieces of agricultural equipment	74.7	74.4	0.1	0.97
Applicant received technical training in agriculture	40.0	39.0	0.2	0.95
Applicant has no experience in irrigated agriculture	25.3	28.3	-2.7	0.30
Applicant has less than two years of experience in irrigated agriculture	5.2	7.1	-1.8	0.19
Applicant has two years or more of experience in irrigated agriculture	69.5	64.6	4.5	0.10*
Female	22.4	18.2	4.5	0.05*
Age of applicant - 18 to 30	39.6	43.0	-4.2	0.14
Age of applicant - 31 to 55	56.2	52.9	3.8	0.19
Age of applicant - 56 or older	4.3	3.9	0.5	0.65
Applicant has debt	0.9	1.1	-0.1	0.86
Applicant is from village in the rural Di commune	57.4	54.8	1.2	0.68
Applicant is from Sourou province	93.3	94.3	-1.3	0.33
Applicant is from Boucle du Mouhoun region	1.1	0.9	0.5	0.37
Applicant does not have title to a parcel on AMVS perimeters	99.3	99.1	0.2	0.72
Total applicant eligibility score	71.83	71.87	-0.3	0.94
Joint test of significance[b]				0.28
Number of observations	**446**	**918**		

Source: Di Lottery applicant eligibility data (2013-14)

Note: All outcomes are percentages except number of active household members.

[a] The sample for this table is restricted to the applicable lottery participants who also completed the baseline survey, because only lottery participants with baseline data will be included in the analysis sample of the impact evaluation.

[b] The joint test of significance is from a regression of the treatment indicator on all scoring criteria as well as strata fixed effects. F-test for the hypothesis that the coefficients on all scoring criteria are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table E.6. Balance tests for scoring variables for female Di Lottery participants excluding households with multiple lottery applicants[a]

Scoring criteria	Treatment group mean	Control group mean	Difference	*p*-value of difference
Number of active household members	3.80	3.93	-0.08	0.60
Applicant owns one piece of agricultural equipment	21.0	12.6	8.3	0.07**
Applicant owns at least two pieces of agricultural equipment	69.0	70.7	-1.4	0.82
Applicant received technical training in agriculture	37.0	36.7	-1.1	0.86
Applicant has no experience in irrigated agriculture	25.0	31.7	-5.5	0.35
Applicant has less than two years of experience in irrigated agriculture	5.0	7.2	-2.6	0.39
Applicant has two years or more of experience in irrigated agriculture	70.0	61.1	8.1	0.19
Female	100.0	100.0	0.0	0.00
Age of applicant - 18 to 30	33.3	41.9	-9.6	0.13
Age of applicant - 31 to 55	65.7	55.1	11.5	0.07*
Age of applicant - 56 or older	1.0	3.0	-1.9	0.32
Applicant has debt	1.0	0.6	1.0	0.36
Applicant is from village in the rural Di commune	56.0	53.3	0.7	0.91
Applicant is from Sourou province	89.0	92.8	-3.6	0.31
Applicant is from Boucle du Mouhoun region	0.0	1.2	-0.7	0.55
Applicant does not have title to a parcel on AMVS perimeters	100.0	100.0	0.0	0.00
Total applicant eligibility score	74.01	73.39	0.62	0.59
Joint test of significance[b]				0.10
Number of observations	**100**	**167**		

Source: Di Lottery applicant eligibility data

Note: All outcomes are percentages except number of active household members.

[a] The sample for this table is restricted to the applicable female lottery participants who also completed the baseline survey, because only lottery participants with baseline data will be included in the analysis sample of the impact evaluation. There were a few inconsistencies in applicant gender between the applicant eligibility and baseline survey data, which we resolved using the applicants' first names as an indication of the applicants' sex. We will reconfirm the gender of these individuals in the interim data.

[b] The joint test of significance is from a regression of the treatment indicator on all scoring criteria as well as strata fixed effects. F-test for the hypothesis that the coefficients on all scoring criteria are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table E.7. Balance tests for scoring variables for male Di Lottery participants excluding households with multiple lottery applicants[a]

Scoring criteria	Treatment group mean	Control group mean	Difference	*p*-value of difference
Number of active household members	4.15	4.32	-0.15	0.07**
Applicant owns one piece of agricultural equipment	13.9	13.0	0.7	0.75
Applicant owns at least two pieces of agricultural equipment	76.3	75.2	0.8	0.78
Applicant received technical training in agriculture	40.8	39.6	0.6	0.85
Applicant has no experience in irrigated agriculture	25.4	27.6	-2.1	0.47
Applicant has less than two years of experience in irrigated agriculture	5.2	7.1	-1.7	0.29
Applicant has two years or more of experience in irrigated agriculture	69.4	65.4	3.8	0.22
Female	0.0	0.0	0.0	0.00
Age of applicant - 18 to 30	41.3	43.3	-2.6	0.43
Age of applicant - 31 to 55	53.5	52.5	1.5	0.65
Age of applicant - 56 or older	5.2	4.1	1.2	0.36
Applicant has debt	0.9	1.2	-0.3	0.61
Applicant is from village in the rural Di commune	57.8	55.1	1.2	0.71
Applicant is from Sourou province	94.5	94.7	-0.5	0.73
Applicant is from Boucle du Mouhoun region	1.4	0.8	0.8	0.20
Applicant does not have title to a parcel on AMVS perimeters	99.1	98.9	0.2	0.78
Total applicant eligibility score	71.19	71.54	-0.34	0.51
Joint test of significance[b]				0.81
Number of observations	**346**	**751**		

Source: Di Lottery applicant eligibility data

Note: All outcomes are percentages except number of active household members.

[a] The sample for this table is restricted to the applicable male lottery participants who also completed the baseline survey, because only lottery participants with baseline data will be included in the analysis sample of the impact evaluation. There were a few inconsistencies in applicant gender between the applicant eligibility and baseline survey data, which we resolved using the applicants' first names as an indication of the applicants' sex. We will reconfirm the gender of these individuals in the interim data.

[b] The joint test of significance is from a regression of the treatment indicator on all scoring criteria as well as strata fixed effects. F-test for the hypothesis that the coefficients on all scoring criteria are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table E.8. Balance tests for baseline survey variables for Di Lottery participants (excluding multiple-applicant households)

Baseline survey measure	Treatment group mean	Control group mean	Difference	*p*-value of difference
Characteristics of lottery applicants and lottery applicant households				
Age	35.26	34.76	0.65	0.31
Female (%)	22.4	18.2	4.5	0.05**
Can read and write (%)	31.6	29.2	3.1	0.25
Married, including polygamous	86.3	84.1	2.4	0.25
Married, polygamous only	23.8	22.8	0.7	0.79
Number of dependent children (under age 18)	3.85	3.85	-0.02	0.92
Number of children in school (ages 6 to 17)	2.12	2.05	0.09	0.46
Applicant is head of household (%)	59.2	65.3	-5.4	0.05*
Number of household members	11.43	11.18	0.17	0.65
Number of household members that applied to the lottery (self-reported)	1.26	1.25	0.00	0.91
Agricultural and work experience of lottery applicants and applicant households				
Currently works as farmer (%)	86.8	86.4	-0.4	0.85
Years of experience as farmer, if ever worked as farmer	15.88	15.10	0.79	0.15
Number of other household members that are farmers	22.6	24.4	-1.8	0.48
Received training in vegetable production	24.4	26.0	-1.8	0.47
Received training in irrigation	18.2	18.6	-0.9	0.68
Received training from AD10 (%)	22.4	22.0	0.9	0.70
Currently performing a paid activity (%)	5.52	5.10	0.38	0.14
Household member migrated for work (last 12 months) (%)	25.3	22.5	2.5	0.30
Agricultural assets of lottery applicant households				
Agricultural inputs used—traditional seed	83.9	81.7	2.0	0.37
Agricultural inputs used—enhanced seed	51.3	49.8	1.3	0.65
Agricultural inputs used—fertilizer	73.5	71.9	1.5	0.57
Agricultural inputs used—herbicide	69.0	65.1	3.3	0.23
Agricultural inputs used—pesticide	65.9	64.2	0.7	0.79
Agricultural inputs used—compost	61.7	62.4	-1.0	0.71
Agricultural inputs used—manure	75.3	74.2	0.9	0.71
Agricultural inputs used—other input	2.5	2.1	0.3	0.70
Agricultural inputs used—two or more advanced techniques	76.0	72.0	3.5	0.17
Agricultural equipment owned—plow	77.4	76.0	1.5	0.55
Agricultural equipment owned—cart	73.3	74.2	-0.8	0.76
Agricultural equipment owned—motor pump	8.3	8.2	-0.2	0.92
Agricultural equipment owned—tractor	1.8	1.3	0.5	0.49
Agricultural equipment owned— electronic equipment	44.8	44.6	-0.2	0.96
Agricultural equipment owned— wheelbarrow	29.1	30.4	-1.9	0.47
Farm animals owned—traction bovine	70.4	71.0	-0.7	0.79
Farm animals owned—other bovine	31.6	33.2	-2.5	0.35
Farm animals owned—traction donkey	61.9	61.5	0.4	0.88
Farm animals owned—other donkey	21.1	22.8	-1.5	0.55
Farm animals owned—traction horses	1.8	1.3	0.4	0.53
Farm animals owned—other horse	1.1	1.1	0.0	1.00
Farm animals owned—sheep	50.7	53.6	-3.2	0.27

Table E.8 (continued)

Baseline survey measure	Treatment group mean	Control group mean	Difference	*p*-value of difference
Farm animals owned—goat	48.9	46.2	2.0	0.49
Farm animals owned—pig	11.0	9.2	2.1	0.22
Farm animals owned—chicken	90.4	88.5	2.1	0.25
Farm animals owned—guinea fowl	19.3	19.1	0.4	0.88
Farm animals owned—other poultry	8.7	9.6	-0.5	0.76
Farm animals owned—other animals	11.9	11.1	1.1	0.56
Access to cultivable land for lottery applicants				
Number of plots owned, rented in, or with communal access rights	1.63	1.72	-0.09	0.35
Number of irrigated plots owned, rented in, or with communal access rights	0.60	0.70	-0.11	0.06*
Land ownership by lottery applicants[a]				
Owned plots (%)	44.4	45.1	-0.7	0.80
Number of plots	0.93	0.91	0.03	0.76
Number of plots irrigated	0.21	0.22	-0.01	0.82
Cultivated plots (last 12 months) (%)	43.7	44.1	-0.5	0.87
Hired labor on plots (last 12 months) (%)	27.8	29.7	-1.7	0.52
Land rental to lottery applicants from others[a]				
Rented in plots (%)	26.2	30.9	-5.0	0.06
Number of plots	0.35	0.46	-0.12	0.01
Number of plots irrigated	0.31	0.40	-0.10	0.03**
Cultivated plots (last 12 months) (%)	24.2	29.5	-5.6	0.03**
Hired labor on plots (last 12 months) (%)	14.6	18.6	-4.0	0.07*
Communal land accessed by lottery applicants[a]				
Has communal access rights to plots (%)	25.6	25.3	0.6	0.80
Number of plots	0.35	0.35	0.00	0.95
Number of plots irrigated	0.07	0.07	-0.01	0.58
Cultivated plots (last 12 months) (%)	24.4	24.5	0.2	0.93
Hired labor on plots (last 12 months) (%)	11.8	14.5	-2.5	0.21
Access to cultivable land for lottery applicant households				
Number of plots owned, rented in, or with communal access rights	2.86	2.60	0.25	0.07*
Land ownership by lottery applicant households[a]				
Household members have property rights (%)	67.9	59.4	8.4	0.00***
Number of household members with property rights	1.24	0.83	0.40	0.00***
Number of plots household members own	1.68	1.45	0.22	0.06*
Land rental to lottery applicant households from others [a]				
Rented in plots (%)	23.3	28.6	-5.4	0.03**
Number of plots	0.38	0.48	-0.11	0.07*
Number of plots irrigated	0.35	0.44	-0.09	0.10
Cultivated plots (last 12 months) (%)	22.2	27.4	-5.3	0.04**
Hired labor on plots (last 12 months) (%)	12.0	16.4	-4.6	0.03**
Communal land accessed by lottery applicant households[a]				
Household members have communal land rights (%)	41.0	39.5	1.8	0.52
Number of plots	0.78	0.66	0.13	0.10

Table E.8 (continued)

Baseline survey measure	Treatment group mean	Control group mean	Difference	*p*-value of difference
Sources of income for lottery applicant households				
Income source—production sale in rainy season (FCFA)	169,306	166,856	-4,028	0.89
Income source—production sale in dry season (FCFA)	307,276	470,797	-180,078	0.04**
Income source—trade (FCFA)	140,914	181,397	-46,769	0.57
Income source—animal sale (FCFA)	102,742	95,973	11,118	0.58
Income source—paid labor (FCFA)	159,557	244,335	-88,295	0.23
Income source—other (FCFA)	69,971	59,616	11,648	0.56
Total income (FCFA)	949,766	1,218,973	-296,405	0.12
Joint test of significance[c]				0.35
Number of observations	**446**	**918**		

Source: Di Lottery Baseline Survey (2013)

Note: Statistics shown are unadjusted means.

[a] All values are unconditional on owning, renting in, or having communal access rights to plots.

[b]Total area of plots was collected as a categorical variable in which each category represents an area range. Because the precise value of total area was not collected, we used the midpoint of the category recorded for each observation as the denominator of total value of payments per hectare. Total value of payments per hectare was not calculated for observations with plot areas falling within the four hectares and larger range because a midpoint cannot be calculated for that category.

[c] The joint test of significance is from a regression of the treatment indicator on all unconditional survey variables included in the table as well as strata fixed effects. F-test that the coefficient on all unconditional survey variables included in the table are jointly equal to zero.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

Table E.9. Discontinuity tests for baseline survey variables for RD analysis

Baseline survey measure	*p*-value of estimated level change at cutoff			
	Parametric linear specification	Parametric quadratic specification	Local linear regression (bw = 20)	Local linear regression (bw = 25;35)
Characteristics of lottery applicants and lottery applicant households				
Age	0.86	0.67	0.94	0.91
Female (%)	0.33	0.64	0.97	0.48
Can read and write (%)	0.55	0.90	0.66	0.55
Married, including polygamous	0.72	0.35	0.42	0.64
Married, polygamous only	0.74	0.95	0.84	0.93
Number of dependent children (under age 18)	0.62	0.65	0.98	0.81
Number of children in school (ages 6 to 17)	0.19	0.40	0.52	0.12
Applicant is head of household (%)	0.58	0.39	0.92	0.74
Number of household members	0.51	0.10	0.54	0.40
Agricultural and work experience of lottery applicants and applicant households				
Currently works as farmer (%)	0.10	0.25	0.33	0.17
Years of experience as farmer, if ever worked as farmer	0.68	0.90	0.93	0.92
Number of other household members that are farmers	0.06*	0.05**	0.15	0.05*
Received training in vegetable production	0.94	0.64	0.98	0.92
Received training in irrigation	0.41	0.34	0.41	0.37
Received training from AD10 (%)	0.22	0.59	0.98	0.45
Currently performing a paid activity (%)	0.78	0.94	0.53	0.93
Household member migrated for work (last 12 months) (%)	0.30	0.33	0.19	0.21
Agricultural inputs used—traditional seed	0.12	0.59	0.64	0.31
Agricultural inputs used—enhanced seed	0.46	0.79	0.38	0.53
Agricultural inputs used—fertilizer	0.76	0.65	0.53	0.77
Agricultural inputs used—herbicide	0.53	0.97	0.64	0.55
Agricultural inputs used—pesticide	0.39	0.46	0.38	0.48
Agricultural inputs used—compost	0.95	0.32	0.62	0.76
Agricultural inputs used—manure	0.90	0.72	0.39	0.82
Agricultural inputs used—other input	0.84	0.41	0.61	0.57
Agricultural inputs used—two or more advanced techniques	0.21	0.36	0.28	0.22
Agricultural equipment owned—plow	0.21	0.42	0.08*	0.13
Agricultural equipment owned—cart	0.94	0.38	0.71	0.93
Agricultural equipment owned—motor pump	0.13	0.92	0.43	0.13
Agricultural equipment owned—tractor	0.51	0.87	0.54	0.37
Agricultural equipment owned— electronic equipment	0.99	0.86	0.68	0.94
Agricultural equipment owned—wheelbarrow	0.61	0.54	0.93	0.56
Farm animals owned—traction bovine	0.68	0.61	0.69	0.41
Farm animals owned—other bovine	0.88	0.94	0.94	0.81
Farm animals owned—traction donkey	1.00	0.98	0.93	0.94
Farm animals owned—other donkey	0.03**	0.14	0.02**	0.03**
Farm animals owned—traction horses	0.37	0.97	0.75	0.38
Farm animals owned—other horse	0.46	0.79	0.45	0.40
Farm animals owned—sheep	0.54	0.58	0.45	0.76

Table E.9 (continued)

Baseline survey measure	*p*-value of estimated level change at cutoff: Parametric linear specification	Parametric quadratic specification	Local linear regression (bw = 20)	Local linear regression (bw = 25;35)
Farm animals owned—goat	0.86	0.81	0.81	0.80
Farm animals owned—pig	0.37	0.73	0.58	0.36
Farm animals owned—chicken	0.66	0.64	0.59	0.34
Farm animals owned—guinea fowl	0.39	0.43	0.48	0.60
Farm animals owned—other poultry	0.33	0.42	0.39	0.31
Farm animals owned—other animals	0.59	0.37	0.39	0.40
Access to cultivable land for lottery applicants				
Number of plots owned, rented, or with communal access rights	0.86	0.72	0.97	0.77
Number of irrigated plots owned, rented in, or with communal access rights	0.05*	0.08*	0.08*	0.07*
Land ownership by lottery applicants[a]				
Owned plots (%)	0.35	0.63	0.80	0.37
Number of plots	0.14	0.08	0.18	0.12
Number of plots irrigated	0.08*	0.40	0.18	0.15
Cultivated plots (last 12 months) (%)	0.32	0.51	0.68	0.33
Hired labor on plots (last 12 months) (%)	0.38	0.18	0.34	0.23
Land rental to lottery applicants from others[a]				
Rented plots (%)	0.43	0.16	0.20	0.35
Number of plots	0.38	0.30	0.33	0.41
Number of plots irrigated	0.27	0.23	0.27	0.28
Cultivated plots (last 12 months) (%)	0.45	0.14	0.21	0.37
Hired labor on plots (last 12 months) (%)	0.72	0.15	0.35	0.77
Communal land accessed by lottery applicants[a]				
Has communal access rights to plots (%)	0.78	0.97	0.96	0.85
Number of plots	0.53	0.70	0.50	0.57
Number of plots irrigated	0.05*	0.03**	0.05*	0.05*
Cultivated plots (last 12 months) (%)	0.57	0.92	0.86	0.62
Hired labor on plots (last 12 months) (%)	0.78	0.79	0.99	0.83
Access to cultivable land for lottery applicant households				
Number of plots owned, rented, or with communal access rights	0.02**	0.03**	0.09*	0.02**
Land ownership by lottery applicant households[a]				
Household members have property rights (%)	0.24	0.26	0.65	0.32
Number of household members with property rights	0.10	0.14	0.14	0.13
Number of plots household members own	0.03**	0.04**	0.09*	0.04**
Land rental to lottery applicant households from others[a]				
Rented plots (%)	0.98	0.55	0.40	0.87
Number of plots	0.96	0.85	0.72	0.93
Number of plots irrigated	0.39	0.22	0.13	0.34
Cultivated plots (last 12 months) (%)	0.91	0.55	0.38	0.79
Hired labor on plots (last 12 months) (%)	0.95	0.78	0.64	0.99
Communal land accessed by lottery applicant households[a]				

Table E.9 (continued)

Baseline survey measure	*p*-value of estimated level change at cutoff: Parametric linear specification	Parametric quadratic specification	Local linear regression (bw = 20)	Local linear regression (bw = 25;35)
Household members have communal land rights (%)	0.89	0.80	0.89	0.84
Number of plots	0.16	0.14	0.20	0.15
Sources of income for lottery applicant households				
Agricultural revenue—sum of production sale in dry and rainy seasons (FCFA)	0.28	0.02**	0.17	0.27
Income source—production sale in rainy season (FCFA)	0.71	0.78	0.82	0.70
Income source—production sale in dry season (FCFA)	0.15	0.00***	0.08*	0.13
Income source—trade (FCFA)	0.41	0.63	0.28	0.34
Income source—animal sale (FCFA)	0.74	0.86	0.75	0.78
Income source—paid labor (FCFA)	0.50	0.49	0.52	0.57
Income source—other (FCFA)	0.40	0.90	0.49	0.45
Total income (FCFA)	0.38	0.27	0.38	0.43
Number of tests of significance	80	80	80	80
Number significant p<0.1	7	9	7	6
Number significant p<0.05	3	6	1	3
Number significant p<0.01	0	1	0	0
Number of observations	**1,179**	**1,179**	**1,179**	**1,179**

Source: Di Lottery Baseline Survey (2013)

Note: Control group are observations who were not admitted to the lottery. The treatment group observations are the winners of the lottery as well as lottery participants placed on the waiting list because they did not accept the rice plot and that was the only plot type available when they were selected.

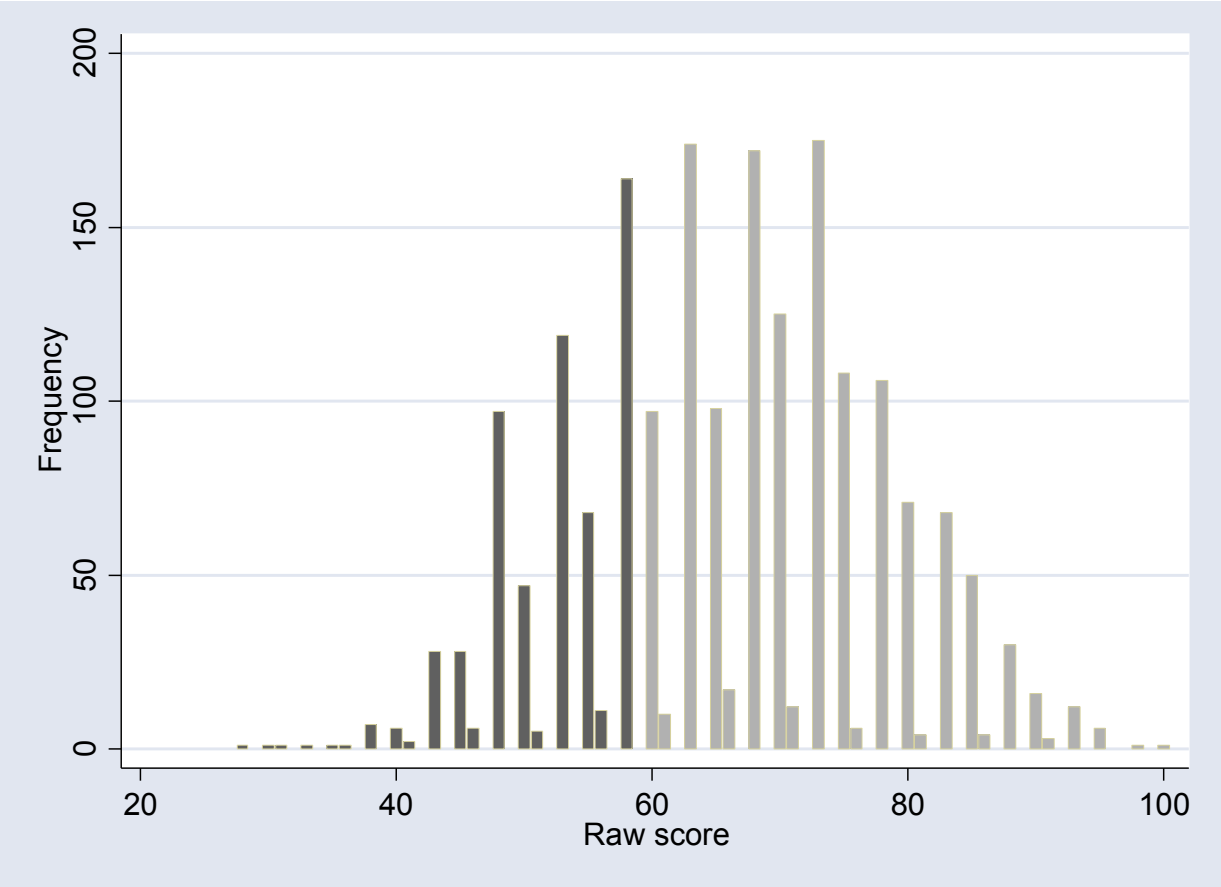
[a] All values are unconditional on owning, renting in, or having communal access rights to plots.
[b]Total area of plots was collected as a categorical variable in which each category represents an area range. Because the precise value of total area was not collected, we used the midpoint of the category recorded for each observation as the denominator of total value of payments per hectare. Total value of payments per hectare was not calculated for observations with plot areas falling within the four hectares and larger range because a midpoint cannot be calculated for that category.

*Significantly different from zero at the .1 level, two-tailed test.

**Significantly different from zero at the .05 level, two-tailed test.

***Significantly different from zero at the .01 level, two-tailed test.

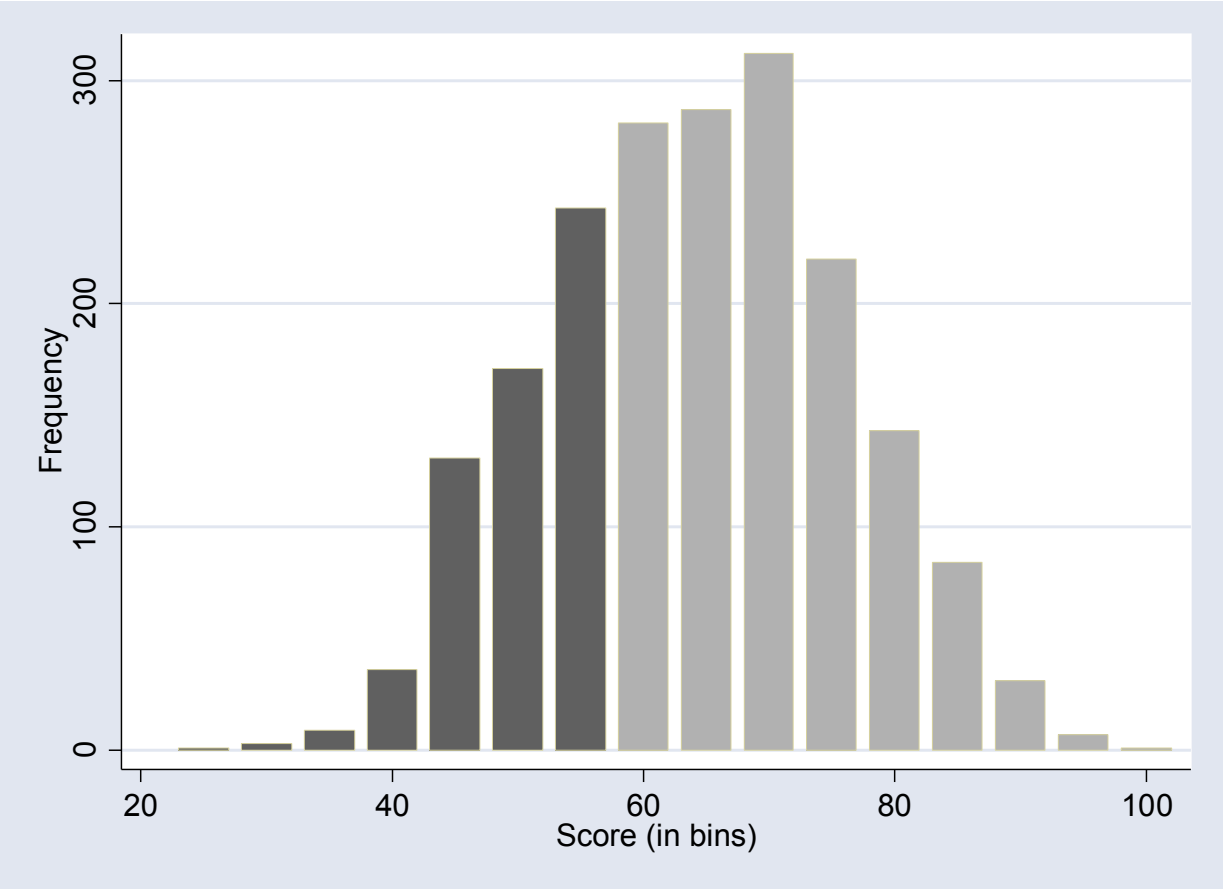
Figure E.1. Distribution of raw eligibility scores of lottery applicants



Source: Di Lottery applicant eligibility data (2013-14)

Note: Raw scores of applicants to the Di Lottery, excluding multiple applicants and applicants without baseline survey information. The light gray bars indicate applicants with a score of 60 and above who were admitted to the lottery. The dark gray bars indicate applicants with a score of less than 60 who were not admitted to the lottery.

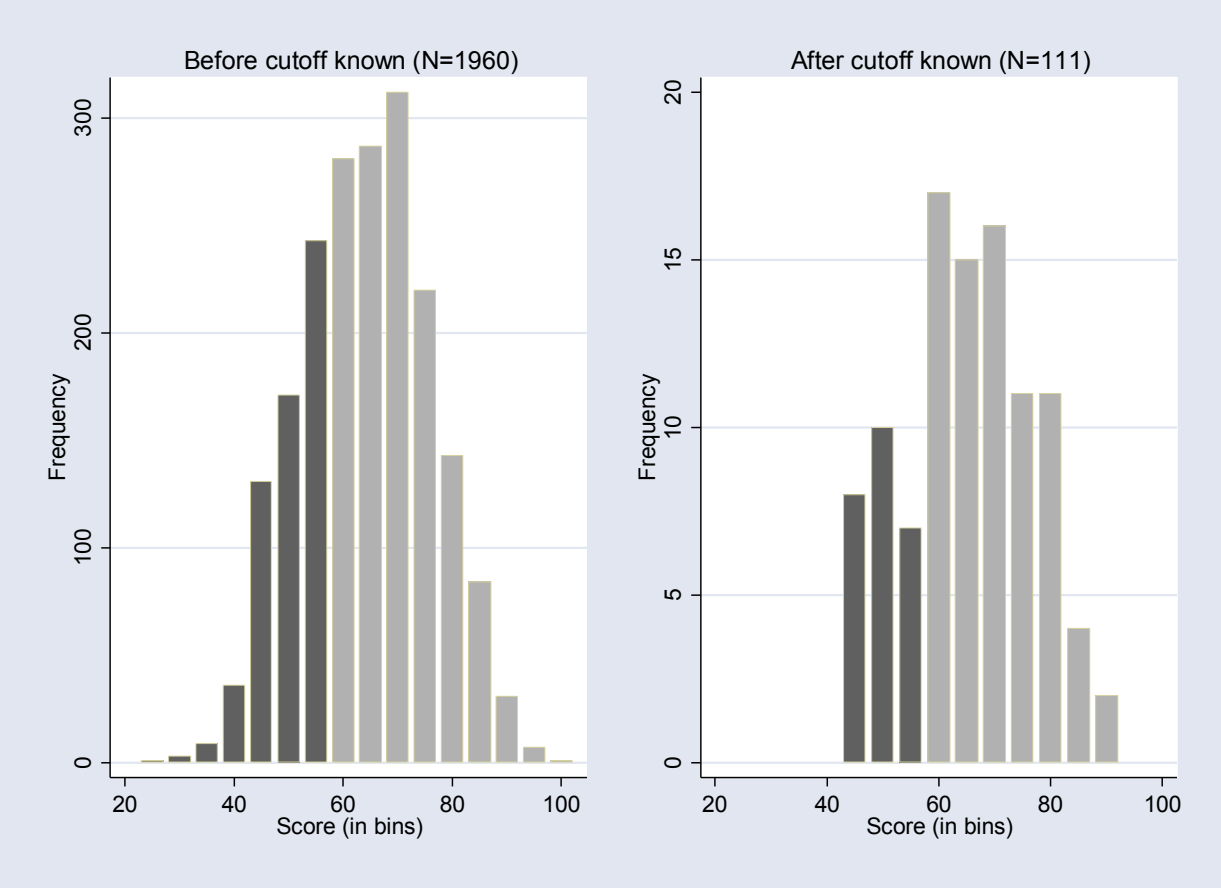
Figure E.2. Distribution of eligibility scores of lottery applicants (in bins)



Source: Di Lottery applicant eligibility data (2013-14)

Note: Scores of applicants to the Di Lottery, excluding multiple applicants and applicants without baseline survey information. Scores presented in bins of width 5 (starting with a multiple of 5). This is equivalent to stacking the cutoffs for the different age categories such on a common cutoff of 60 points. The light gray bars indicate applicants with a score of 60 and above who were admitted to the lottery. The dark gray bars indicate applicants with a score of less than 60 who were not admitted to the lottery.

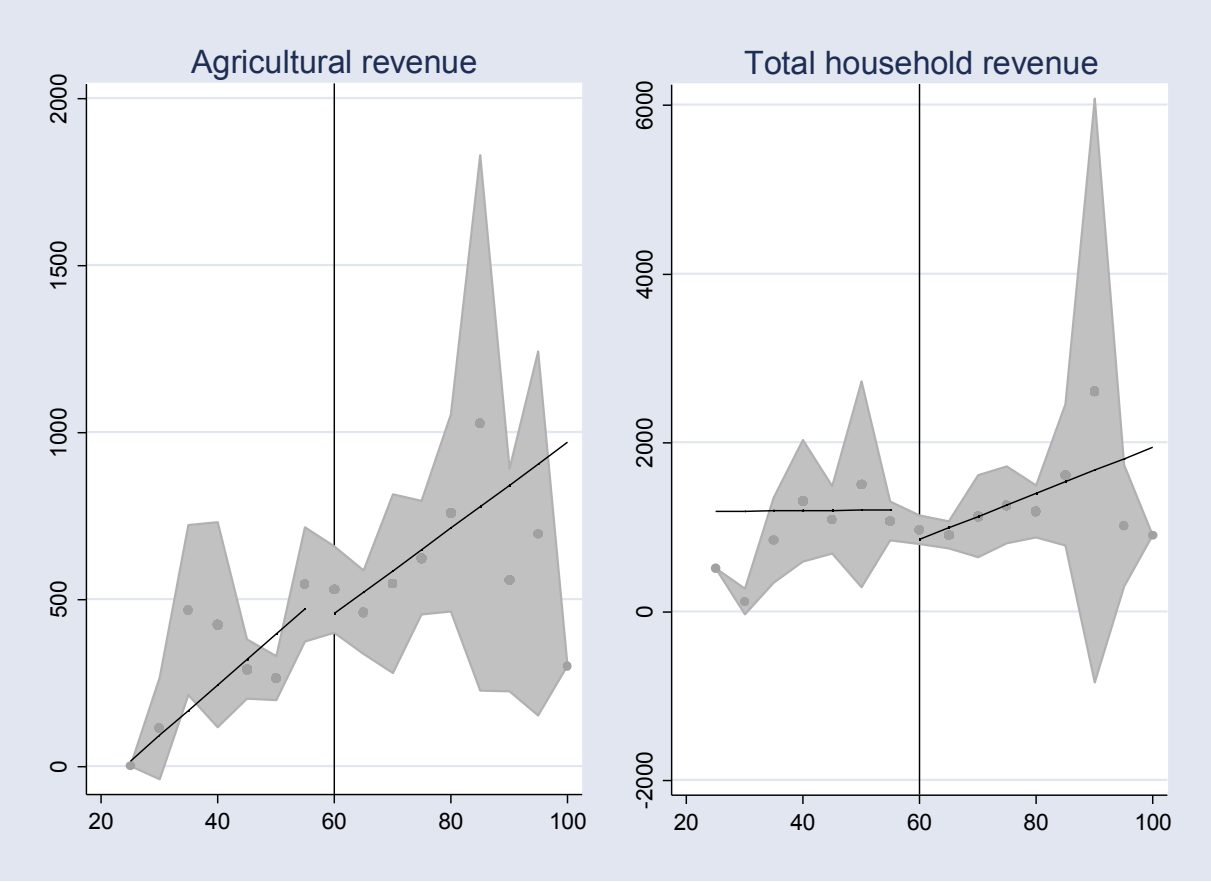
Figure E.3. Distribution of eligibility scores before and after the cutoff was known



Source: Di Lottery applicant eligibility data (2013-14)

Note: Left panel presents a graph of scores for applicants whose applications were reviewed before the cutoff for participation in the lottery was known. The right panel presents a graph of scores for applicants where the review of applications was completed after the cutoff for participation in the lottery was known.

Figure E.4. Eligibility scores and baseline agricultural revenue and household revenue



Source: Di Lottery applicant eligibility data (2013-14)

Note: The left graph presents means and 95 percent confidence intervals for agricultural revenue by score, as well as the predicted values from a linear regression of agricultural revenue on scores separately for applicants below and above the cutoff. The right graph present the same information for total household revenue.

APPENDIX F

FARMER TRAINING EVALUATION

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Table F.1. Data sources farmer training evaluation

Evaluation	Data source	Sample size	Content	Data limitations	Use in baseline report
Farmer training	Household survey (2010–2011)	1,082 treatment and 1,082 comparison households	The survey collected data from the 1,082 pairs of matched households (formed under the previous evaluation) during the 2010–2011 agricultural dry and rainy seasons to serve as the baseline of the evaluation of the DA Activity. The survey included the following modules: • Household • Agriculture • Livestock • Forestry • Credit and expenditures • Food security • Health	• Only the data for our analysis sample—that is, the 624 treatment households that in time received training—are useful for the current pre-post evaluation design.	The household survey data were used in the baseline report for the at-baseline descriptive analysis of households that in time received training and assistance from the farmer training sub-activity.
Farmer training	Identification survey (2013)	1,082 treatment households of the household survey sample	The survey identified the beneficiaries of the Farmer Training Sub-activity with which beneficiaries and their households can be identified in other baseline data sources. The survey collected the following information: • Household roster • Identification of training beneficiaries • Type of training received • Trainee ID • Household ID	• The identification survey data include unique household IDs and beneficiary trainee IDs. Given that the same household IDs are used in the household survey data, households with beneficiaries can be identified in the household survey data by using the identification data. However, the household survey data did not include a globally unique ID for each household member or the beneficiaries' AD10 trainee IDs. As such, the identification data cannot be used to identify specific beneficiaries in the household survey data.	These data are used to identify in the household survey data the households comprising the analysis sample of the farmer training evaluation (the 624 treatment households that in time received training and assistance from the farmer training sub-activity).
Farmer training	Baseline crop yield survey (2010–2011)	Dry season (2010): 167 measurement squares placed on land of 85 farmers in treatment areas Rainy season (2010–2011): 159 measurement squares placed on land of 143 farmers in treatment areas	To serve the program monitoring objective, the survey collected the following types of information from a sample of households in treatment villages: • Crops grown • Plot area • Location of measurement squares • Crop yields within measurement squares	• The previous evaluator expressed serious concerns about the accuracy of the crop yield data, citing methodological errors in implementation of the measurement squares. • The plot and plot operator listings for this sample of treatment households are misaligned with our analysis sample.	These data were not used in the baseline report.

Table F.1 (continued)

Evaluation	Data source	Sample size	Content	Data limitations	Use in baseline report
Farmer training	Baseline crop yield survey (2010–2011)	298 households of the household survey sample	The survey collected the following information during the 2010–2011 rainy season from a subsample of households to correct self-reported crops yields in the household survey data: • Crops grown • Plot area • Location of measurement squares • Crop yields within measurement squares	• The previous evaluator expressed serious concerns about the accuracy of both sets of crop yield data, citing methodological errors in implementation of the measurement squares. • The plot and plot operator listings for this subsample of treatment households are misaligned with our analysis sample.	These data were not used in the baseline report.
Farmer training	Fishing survey	842 fishermen from 35 sites across the two intervention regions	The survey was administered to a sample of households in treatment areas that earned income through fishing. The households were not part of the household survey treatment sample.	• The fishing survey data were collected for the program monitoring objective before the activities of the ADP were fully specified, not for program evaluation.	These data were not used in the baseline report.
Farmer training	Institutional survey	Targeted institutions in communes and villages within treatment areas	The institutional survey collected data on the following topics from 56 sampled institutions: • Livestock • Fishing • Forestry • Access to markets	• The institutional survey data were collected for monitoring purposes, not for program evaluation. • Because the 56 sampled institutions are spread across eight types of institutions with different questionnaires, the number of completed surveys for type of institution is too small for meaningful quantitative analysis.	These data were not used in the baseline report.
Farmer training	Census of household plots (2013)	1,866 plots of 972 treatment households and 5,375 plots of 795 comparison households of the household survey sample	The census of household plots included all plots operated by households cultivating at baseline. It served as the sample frame for the collection of interim crop yield data. The census data included the following information: • Plot characteristics • Method of plot acquisition • Crops planted • Growing methods (single crop or intercrop)	• None.	These data were not used in the baseline report.

Table F.1 (continued)

Evaluation	Data source	Sample size	Content	Data limitations	Use in baseline report
Farmer training	Interim crop yield survey (2013)	1,201 plots of treatment households and 3,438 plots of comparison households of the household survey sample	The survey collected follow-up crop yield data from plots of the household plot census. The survey collected the following types of data: • Crops grown • Plot area • Location of measurement squares • Crop yields within measurement squares	• Interim crop yield data were collected from only about half of the 624 households in our analysis sample from any of the households' plots. • The data do not include global household member and parcel identification variables with which to match the interim crop yield data to the baseline data at the plot level. Although we could match and analyze the crop yield data at the household level, our review of the data revealed substantial differences between the baseline and interim samples. In particular, differences in the number of plots operated and the number of farmers operating plots within each household suggest that the baseline and interim operator and plot listings are substantively different thus invalidating a meaningful comparison of crop yields as initially planned. • The list of main crops that were the focus of interim data collection does not include some of the key focus crops in our baseline analysis (e.g., tomatoes).	These data were not used in the baseline report.
Farmer training	Supplemental household survey (2013)	1,082 treatment households	The survey collected data on the training and assistance farmers had received from AD10, including the following: • Participation in AD10 training • Types of training received • Application of learned practices • Receipt of incentive kits • Contents of kits and their use	• Only about half of the 624 households in our analysis sample self-reported participation in training, even though AD10 listed these households in the identification survey data as having participated.	The supplemental household survey data were used in the baseline report to provide an early description of the training and assistance received by households in the evaluation's analysis sample.

Table F.2. Agricultural inputs used by households cultivating crops[a]

	Dry season (Mean)			Rainy season (Mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Use of inputs (%)						
Urea	97.7	98.3	96.6	83.4	73.9	97.6
NPK	96.8	98.6	93.2	87.8	82.7	95.2
Manure	66.7	56.7	86.4	15.8	13.2	19.7
Compost	25.2	27.0	21.8	66.5	71.7	58.6
Herbicides	69.5	75.1	58.5	74.9	67.3	86.1
Insecticides	90.1	90.3	89.8	47.5	46.8	48.6
Improved seeds	89.7	88.9	91.2	49.2	46.4	53.4
Quantity used (kg or L)[b]						
Urea	89.48	99.04	70.68	141.25	132.06	154.80
NPK	153.70	179.91	102.16	171.89	160.43	188.83
Manure	1193.08	1148.50	1280.72	452.00	436.35	475.31
Compost	468.15	571.05	265.84	2199.47	2701.81	1451.00
Herbicides	1.25	1.50	0.78	3.29	2.15	4.97
Insecticides	0.96	1.09	0.72	0.53	0.43	0.67
Improved seeds	17.96	18.89	16.14	28.02	23.50	34.72
Quantity used per hectare (kg/ha or L/ha)[b]						
Urea	110.60	108.07	115.58	48.54	53.31	41.50
NPK	187.28	197.91	166.37	57.99	64.56	48.28
Manure	1929.00	1684.87	2408.96	119.02	112.69	128.45
Compost	611.93	674.06	489.77	679.82	887.50	370.38
Herbicides	1.30	1.43	1.04	0.94	0.78	1.17
Insecticides	1.42	1.46	1.33	0.16	0.16	0.16
Improved seeds	26.48	19.85	39.51	9.91	10.23	9.43
Expenditure on inputs (FCFA)						
Total expenditure, all inputs[c]	178,528	216,377	104,118	163,983	160,185	169,626
Urea	31,466	34,640	25,225	49,641	45,939	55,112
NPK	54,876	64,214	36,519	60,434	56,008	66,975
Manure	2,129	1,339	3,682	652	288	1,195
Compost	69	104	0	1,547	486	3,129
Herbicides	5,159	6,276	2,965	12,706	8,899	18,317
Insecticides	7,538	8,387	5,868	4,058	3,287	5,195
Improved seeds	74,682	98,496	27,864	31,345	43,191	13,835
Expenditure on inputs per hectare (CFA/ha)						
Total expenditure, all inputs[c]	267,699	296,045	211,972	54,745	62,990	42,493
Urea	39,002	37,829	41,308	16,995	18,543	14,708
NPK	66,550	70,092	59,587	20,344	22,521	17,128
Manure	3,238	1,249	7,150	242	88	471
Compost	22	34	0	439	119	916
Herbicides	5,255	5,909	3,968	3,644	3,249	4,227
Insecticides	11,153	11,296	10,872	1,232	1,240	1,219
Improved seeds	137,348	164,794	83,391	11,346	16,966	3,039
Sample size	436	289	147	622	371	251

Source: Agricultural module of baseline household survey- dry and rainy seasons (2010-2011)

Note: Statistics shown are unadjusted means. Sample sizes are restricted to those households cultivating crops in each season.

Table F.2 (continued)

[b]Herbicide and insecticides quantities are measured in liters (L). All other input quantities are measured in kilograms (kg).

[c] The sum of input expenditures may not equal total input expenditure because all expenditure variables were top- coded to three standard deviations from the mean to account for outliers and total input expenditures was set to missing if any component input expenditure was missing in the sum.

kg = kilograms, L = liters, ha = hectares, CFA = Communauté financière d'Afrique

Table F.3. Harvest values of households' crop yields

	Dry season (Mean)			Rainy season (Mean)		
	Total	Sourou	Comoé	Total	Sourou	Comoé
Harvest value (FCFA), focus crops						
Corn	10,697	9,247	12,834	316,325	354,477	260,006
Cowpeas	187	165	219	2,786	4,614	0
Onions	376,714	575,164	84,178	6,919	7,389	6,226
Rice	101,862	145,128	38,175	97,282	94,157	101,820
Soybeans	0	0	0	448	751	0
Tomatoes	52,471	66,068	32,534	3,862	240	9,207
Harvest value per hectare (CFA/ha), focus crops						
Corn	547,389	692,693	463,916	571,993	552,799	596,771
Cowpeas	428,819	309,895	666,667	458,824	458,824	NA
Onions	2,254,452	2,199,154	2,495,749	149,329	126,536	368,971
Rice	576,092	574,525	582,505	261,653	242,124	283,232
Soybeans	NA	NA	NA	53,108	53,108	NA
Tomatoes	668,848	671,395	649,738	332,459	315,000	333,051
Sample size	621	370	251	624	372	252

Source: Agricultural module of baseline household survey- dry and rainy seasons (2010-2011)

Note: Statistics shown are unadjusted means. The sample sizes of focus crop outcomes per hectare are restricted to households cultivating each of the focus crops that season.

tons = U.S. ton (907 kilograms), ha = hectares, CFA = Communauté financière d'Afrique

NA = not available

Table F.4. Point of sale of focus crops[a]

	Mean		
	Total	Sourou	Comoé
Dry Season			
Onions			
On-farm	71.3	84.8	9.6
Home	4.2	3.8	5.8
Local market	20.8	11.8	61.5
Other market	5.9	2.1	23.1
Other	0.0	0.0	0.0
Rice			
On-farm	17.9	14.8	30.8
Home	10.4	13.0	0.0
Local market	23.9	20.4	38.5
Other market	13.4	9.3	30.8
Other	34.3	42.6	0.0
Tomatoes			
On-farm	50.3	64.7	13.0
Home	4.8	5.0	4.3
Local market	41.2	31.9	65.2
Other market	4.8	0.0	17.4
Other	0.0	0.0	0.0
Rainy Season			
Corn			
On-farm	0.8	1.3	0.0
Home	36.1	52.0	9.1
Local market	51.3	38.7	72.7
Other market	5.9	1.3	13.6
Other	2.5	2.7	2.3
Rice			
On-farm	2.0	2.3	0.0
Home	32.0	34.9	14.3
Local market	44.0	41.9	57.1
Other market	4.0	0.0	28.6
Other	18.0	20.9	0.0
Tomatoes			
On-farm	2.0	100.0	0.0
Home	2.0	0.0	2.0
Local market	64.7	0.0	66.0
Other market	31.4	0.0	32.0
Other	0.0	0.0	0.0

Source: Agricultural module of baseline household survey- dry and rainy seasons (2010-2011)

Note: Statistics shown are unadjusted means. Sample sizes are restricted to households selling each of the focus crops that season.

[a]The sample of this table are restricted to the households selling each focus during that season.

APPENDIX G

CLIENT COMMENTS

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Reference (Page/Section #)	Comment	MPR response
Cover Page	Date of submission is February 28, 2018, not 2017.	This is corrected.
Page iii	The table of contents does not match the outline, which was approved in October.	The major changes between the outline and the report are the following: We refer the reader to the design report for evaluations that are not discussed in the baseline report, to keep the latter report focused on the evaluations with baseline data. • We dropped the literature review to keep the length of the report reasonable. The literature review can be found in the design report. • For each of the evaluations, we combined evaluation objectives, questions, and methodology into one section and referred readers to the design report for details. As a result, the sections are concise, but still contain essential information. • We moved the discussion about sources of data we did not use because of data quality issues to the appendix. This streamlines the discussion while giving the interested reader a way to find this information. • Because the early interim data for the farmer training evaluation were of limited use and fit better into the logic of the interim report, we moved the presentation of analysis relying on the early interim data to the interim report. Overall, we deviated from the approved template when we found that, in practice, it was not an effective and concise way of meeting the objectives of the report. We are happy to walk through the approved table of contents to explain in detail the changes that we made.
Page xv	Why are the key findings on Di Lottery only about PAPs?	This is corrected. We indicate that the table covers the entire baseline report.
Page 10, A. Background	I suggest including the dollar value of Di perimeter construction.	Thanks. We have included the cost in the latest version.
Page 17	Is BERD an acronym?	Yes, we now spell it out for its first mention and include it in the list of acronyms.

Reference (Page/Section #)	Comment	MPR response
Page 24, Table III.9	When PAPs were asked about training they had received, were they asked to ignore training they may have already received from the MCC program? That affects how one interprets this table.	Unfortunately, the only question in the survey is about whether the PAPs received the training mentioned on a list of topics. We don't have the manual, and there is no additional information in the final survey report on how they might have understood this question.
Page 28, first paragraph	This suggests that a larger proportion of women than men would likely (need to) shift farming practices on the newly constructed perimeter, which may require more irrigation training. – "may have required"	We clarify this as follows: "This suggests that a larger proportion of women than men would likely (need to) shift farming practices on the newly constructed perimeter, which could indicate a need for more irrigation training for women."
Page 33, Table III.14.	Constraints analysis at MCC has a specific meaning. It refers to constraints to economic growth. This table seems to be more what we would now call root causes.	We changed the title of the table to: "Assessment of constraints underlying the program logic."
Page 45, Table IV.5.	It's interesting that more than twice as many women are engaged in trade than men. I assume this relates to trade of agricultural products.	Unfortunately, neither the survey nor the manual can offer a definitive answer to this.
Page 48, Table IV.7.	It's interesting that the overwhelming majority of rented plots were small.	Yes, it is interesting that the overwhelming majority of rented plots are small and irrigated (also note that only 20 percent of applicants rent plots). We will certainly be able to understand whether Di plots are too large by looking at the proportion of Di plots that are cultivated.
Page 53, last paragraph	Instead of saying "…slightly larger percentage of beneficiaries are female", consider including the exact percentage.	The only significant differences are that Di Lottery beneficiary households list 0.15 fewer household members on their application than control households do, and lottery beneficiaries are 4 percentage points more likely to be female (though the latter difference is only marginally significant).
Page 68	Have you obtained or created a map of the farmer training intervention areas? It would be really helpful to see. Were there geographic identifiers in the analysis sample beyond whether it was in Sorou or Comoé?	We add a map of project areas in Appendix A. We include references in the Di perimeter and farmer training sections. (Page 10): "The perimeter is located on the east bank of the Sourou River, on the border with Mali (See Figure A.1 in the Appendix)." (Page 68): "The sub-activity trained over 12,000 farmers, about half of whom were women, from 30 villages in the Sourou Valley and Comoé Basin (Figure A.1 in the Appendix shows the DA intervention areas)." Yes, there are additional geographic identifiers: we know the village and neighborhood within a village. In the final round, we will collect GPS data.

Reference (Page/Section #)	Comment	MPR response
Page 86, Table V.15.	"Received loan(s) (%)" – is that of those who applied for a loan? It seems odd that it is 100% across the board in the rainy season.	We clarify that it is conditional: "Received loan(s)*, if applied for* (%)" We cannot be sure why this result is 100 percent, but it's likely that a loan provided for the rainy season is not very risky.
Page 90, Table V.18.	For rows 1, 2 ,6, and 7, can you say whether the beneficiaries in your sample would have benefited from those other projects?	Part of the goal of the interim evaluation is to understand the overlap. Here we outline the additions we feel comfortable making in the baseline report. • **Access to irrigated land.** We know that 17 percent of lottery applicants received AD10 training, and so some farmer training beneficiaries would become lottery beneficiaries, but we don't know what proportion of our farmer training sample. We think a small number overlap between the two samples, because AD10 provided farmer training to around 12,000 households. We do not include that conjecture in the report. • **Land tenure.** Based on what our local research coordinator told us, all farmer training project areas received the intervention, but that does not mean they received titles. We clarify our understanding of this: "The compact's Rural Land Governance Project (RLGP) planned to increase households' access to land tenure documents in the two farmer training project areas. This assistance falls outside the scope of Mathematica's evaluation." • **Limited value added and market access**. The Di and Lanfiera markets received investments under the ADP, which we evaluate. We are not clear on the overlap with the value-added activity. "MCC-funded investments in rural markets and value-added activities in the Sourou Valley might help improve market access for farmer training beneficiaries in the Sourou Valley. This could improve farmers' prospects for securing market prices for their agricultural production rather than the lower farm-gate prices." • **Access to finance.** "MCC-funded assistance with land tenure documents under the RLGP could overcome the constraints some farmers face in acquiring' constraints to credit—to the extent that farmers face such constraints and benefit from access to land tenure documents."
Page 93, first paragraph	You mention producing de-identified data files for the interim and final evaluations, but you don't mention what you will do for the baseline data. Why is that?	We have clarified this: "After producing and finalizing the interim and final evaluation reports, we will prepare de-identified data files, user manuals, and codebooks for the corresponding baseline, interim, and final data sets."

Reference (Page/Section #)	Comment	MPR response
Page 94, Timeline	This seems to suggest you will have a draft interim evaluation report in June, although there is not a square for that deliverable. This timeline suggests a data collection report will be submitted in March. Please confirm and/or clarify.	The black triangle (for trip) should have been a square (for deliverable). This is now changed. We have also updated the timeline.
Page 94, Timeline	You have a line for anonymize Di lottery data. However, there will be other public use data sets. Your recent memo suggests the following: (1) Di PAP baseline survey, (2) Di Lottery baseline survey, (3) farmer training baseline household survey, (4) livestock ("barymetric") survey, (5) farmer training interim crop yield survey (IMPAQ), and (6) farmer training supplemental household survey (IMPAQ).	This was actually an error. It should have referred to the *farmer training* data, because we propose to submit baseline and interim farmer training data this option period. We have corrected this. The data sources for the Di Lottery and Di perimeter evaluations would be anonymized in option period 2, together with the interim and final data we propose to collect. We updated the timeline with this information. Because we have not yet come to an agreement on which of the other baseline data sources would be submitted as public/restricted use files, we have not named those additional data sources in this timeline.

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