MILLENNIUM CHALLENGE ACCOUNT SENEGAL

Evaluation Design Report

Impact of the Irrigation and Water Resource Management Project - Senegal

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LIST OF EXHIBITS

LIST OF ACRONYMS

ANSD	Agence Nationale de la Statistique et de la Démographie
CNRS	National Ethics Committee for Health Research
CVD	Comité Villageois de Développement
DQR	Data Quality Review
ERR	Economic Rate of Return
GDP	Gross Domestic Product
GoS	Government of Senegal
HVA	Higher Value Agriculture
IHSN	International Household Survey Network
IRB	International Review Board
IRIS	Institutional Reform and the Informal Sector
IWRM	Irrigation and Water Resources Management Project
LTSA	Land Tenure Security Activity
MCC	Millennium Challenge Corporation
MCA-S	Millennium Challenge Account-Senegal
M&E	Monitoring and Evaluation
RCT	Randomized Control Trial
CR	Rural Communities
SAED	Société National D'Aménagement et d'Exploitation des Terres du Delta du fleuve Sénégal et des Valles du fleuve Sénégal et de Falémé
SRV	Senegal River Valley
WUA	Water User Association

1. INTRODUCTION

This report presents the Evaluation Design for the Irrigation and Water Resources Management (IWRM) Project in Senegal. The IWRM project is funded as part of the Millennium Challenge Corporation (MCC) Compact with the Government of Senegal (GoS). In 2011, IMPAQ International was selected by MCC to replace the Institutional Reform and the Informal Sector center (IRIS) at the University of Maryland in implementing a rigorous impact evaluation of the IWRM Project. The evaluation design has undergone significant revisions since its initial design by the IRIS Center.

The rest of this Evaluation Design Report (EDR) is organized as follows: Section 2 provides an overview of the Senegal compact and a detailed description of the program components under evaluation, including an in-depth description of the program logic. Section 3 presents a high level review of existing studies on the links between irrigation interventions and agricultural productivity/poverty, and outlines the main contributions of this evaluation to existing research. Section 4 details the core of the evaluation design including the research questions and research design. Section 5 describes data sources planned for this evaluation, and Section 6 describes the econometric method planned according to the research design, with examples of how we plan to present the results. The report closes with a description of planned compliance to various administrative requirements.

1.1 Overview of the Compact

On September 16, 2009, the Millennium Challenge Corporation entered into a $540 million Compact Agreement with the Republic of Senegal. The Republic of Senegal and the Millennium Challenge Account in Senegal (MCA-S) established an autonomous body to effectively manage the work of this compact. The compact in Senegal entered into force in September 2010, initiating the 5-year timeline for project implementation. Compact funds have been strategically invested in two projects:

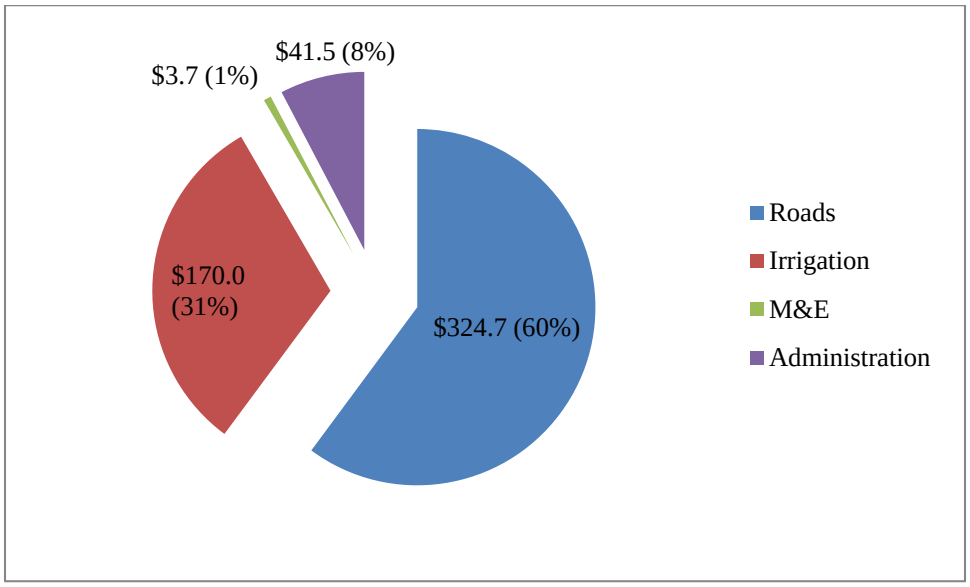
- Roads Rehabilitation Project
- IWRM Project

As indicated in Exhibit 1, $324.7 million, or approximately 60 percent of the total Compact Budget is devoted to the Roads Project, followed by the $170.0 million for the IWRM (31 percent), $41.5 million for Program Administration and Audit (8 percent), and $3.7 million for Monitoring and Evaluation (M&E) (1 percent).

Exhibit 2 depicts the geographic location of the two major Compact activities. The Road Rehabilitation Project funds the rehabilitation of significant segments of two national roads. In the north, the RN2 will be rehabilitated from Richard Toll to Ndioum; in the south, the RN6 will be rehabilitated from Ziguinchor to Kounkané. A separate evaluation design report[1] describes the impact evaluation of the Road Rehabilitation project.

[1] IMPAQ International: *Evaluation Design Report Impact of the Roads Senegal Project Senegal*, submitted to MCC in March 2012.

Exhibit 1. Distribution of Compact Funds, USD Millions



Source: MCC quarterly status report, December 2012

The IWRM Project is located in the northern part of the country in the vicinity of the RN2 as depicted in Exhibit 2. The following Section presents additional detail about the location of this intervention.

1.2 The Irrigation and Water Resources Management (IWRM)

MCC is investing $170 million to help improve agricultural sector productivity in the Senegal River Valley (SRV) in the northern part of Senegal, in particular in the Delta of the Senegal River and in the Podor District (see Exhibit 2 for location of these areas). This region has the potential to benefit from intensive irrigation interventions because of:

- Long experience with irrigation schemes in the Valley;
- Strong support from the Government and the Société National D'Aménagement et d'Exploitation des Terres du Delta du fleuve Senegal et des Valles du fleuve Senegal et de Falémé (SAED) ;
- Capability of farmers' association to manage large irrigation schemes.

The agricultural potential of the SRV has been constrained by the poor quality and limited capacity of existing irrigation and a lack of appropriate drainage systems which raise soil salinity that in turn contributes to low agricultural yields. To overcome these constraints, the IRWM project is investing to improve the:

- Quality and capacity of the irrigation system and reduce the risk of abandonment of land;
- Land tenure regulations to secure the land rights of farmers and mitigate conflicts that might arise from ambiguities about property rights.

The IWRM Project will also enhance the capacity of local institutions responsible for allocating and managing land rights. Specifically, the IWRM Project consists of the following activities:

- Delta Activity
- Podor Activity
- Land Tenure Security Activity
- Social Safeguard Measures

The following sub-sections describe each of these activities.

1.2.1 Delta Activity

The Delta area spans the Saint Louis and part of Dagana departments in northwestern Senegal. Its hydraulic levels are regulated by the Diama Dam, situated at the mouth of the Senegal River (see Exhibit 3). Only approximately 30 percent of the 31,000 hectares (ha) of potentially irrigable land in the Delta are cultivated at any time during the year, due to insufficient water delivery and poor drainage.[2] MCC is investing approximately $154 million in the Delta to improve the conveyance capacity of primary irrigation channels (mainly along the hydraulic axes of Gorom-Lampsar and Kassack North) and to ensure appropriate drainage capacity to the area's middle and southern perimeters. The Delta Activity interventions consist of weed removal, dredging, profiling of berms, increasing levee heights, and rehabilitating or replacing structures and pumping stations along eight irrigation sections. The drainage activity consists of constructing a new drainage channel, pump station, bridge, siphon, elevation of the levees, and constructing compensatory channels.

The goal of this activity is to restore or improve the quality, volume, and reliability of water for agriculture, delivered in existing irrigated perimeters, thus reducing the risk of abandonment of approximately 26,000 ha of land. In addition, this activity has the potential to encourage the creation of new irrigated perimeters (via other donor projects) thanks to the infrastructure improvements that will increase the availability of water.

1.2.2 Podor Activity

In Podor, in north central Senegal, the project will develop primary and secondary irrigation and drainage channels and associated structures at the N'Gallenka site (tertiary system financed by GoS). This activity will create about 440 ha of new irrigated land for a total MCC investment of approximately $6.5 million, including construction supervision. The N'Gallenka site was chosen because of its high potential for rice production, sufficiency of water resources, cost of dikes per hectare, and existing irrigation facilities. In addition, MCC is also funding improvements in project management to support the Delta and Podor activities (approximately $3 million) through a project management unit at SAED.

[2] MCC will send indicator table so we can confirm the latest statistics with MCC/SAED.

Exhibit 2. Senegal Compact Activity Areas

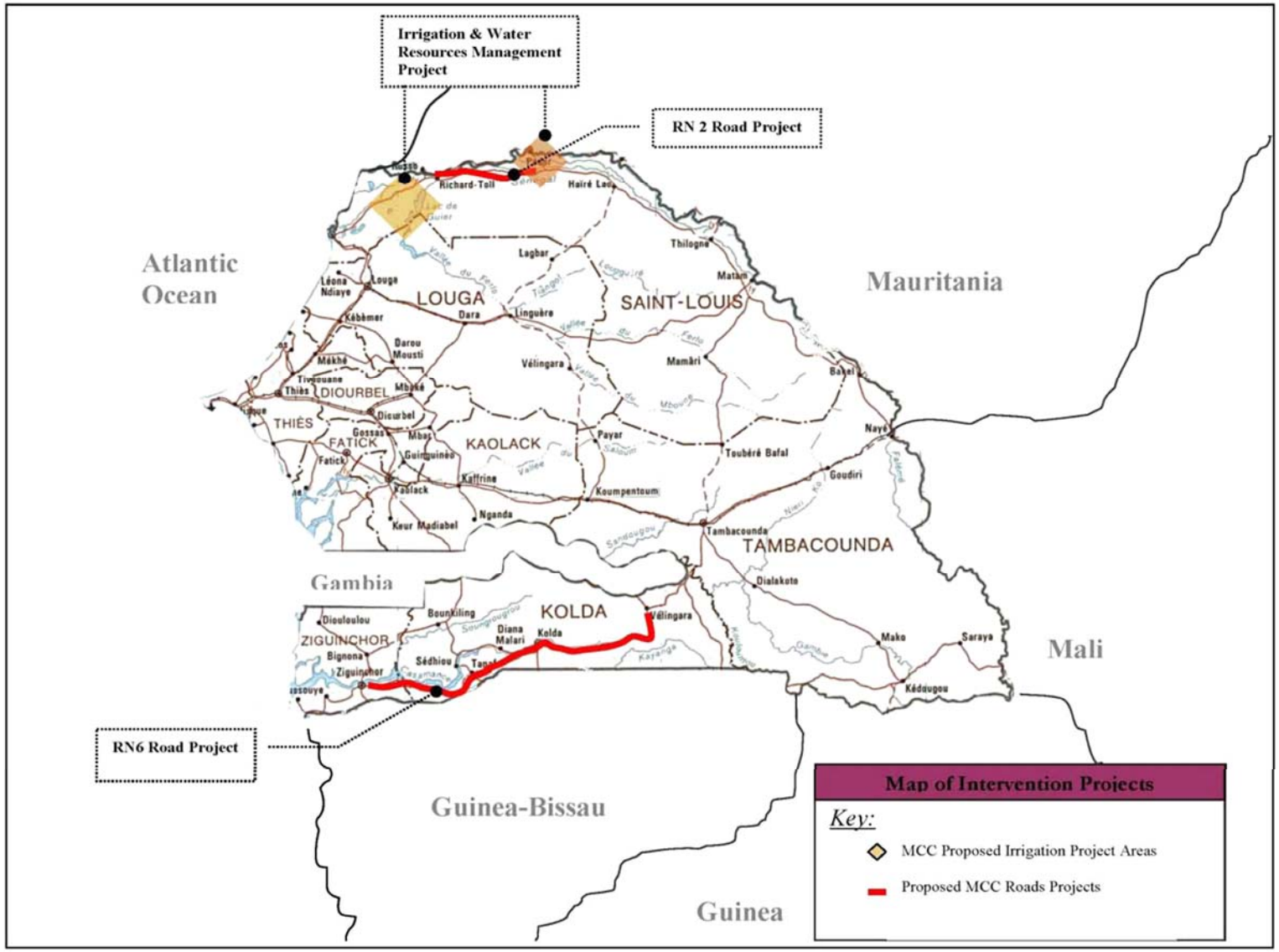
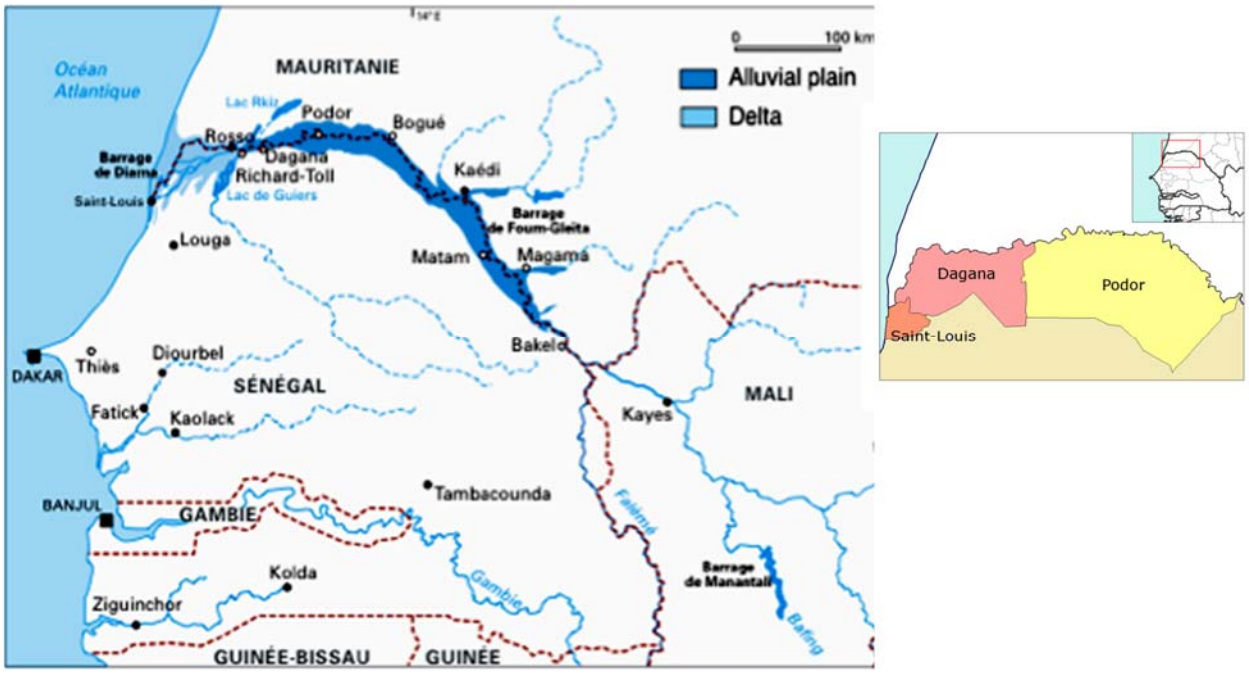


Exhibit 3. Senegal River Valley and St. Louis Region Departments



1.2.3 Land Tenure Security Activity

MCC is investing approximately $3.8 million in the Land Tenure Security Activity (LTSA) to improve the investment climate in the IWRM project area and mitigate the potential for land conflict due to increased demand for irrigated land as a result of the project. The LTSA supports development and implementation of transparent, fair, and efficient processes for land allocation and formalization of property rights to ensure equitable and secure access to land in the irrigated perimeters. The LTSA will also equip local authorities with tools, such as manuals of procedures and land registries, to improve land management, and reinforce capacity through communication and training on the newly provided tools as well as existing land management tools.

The first phase of the LTSA entails an exhaustive inventory of existing occupation patterns and property rights in the irrigation project and surrounding areas. The LTSA has completed the documentation of property rights and use patterns for more than 58,000 ha and 15,000 parcels.[3] In the second phase of the LTSA, land in the new irrigated perimeter at N'Gallenka that is being built with compact funds will be allocated based on criteria developed during the first phase with participation of all local stakeholders. Allocation criteria are specific to each community,[4] and MCA-S has been working to ensure that these criteria are transparent and supported by local

[3] The LTSA intervention zone is larger than the IWRM intervention zone. The LTSA targets capacity building of the local government council, and thus extends throughout the government districts (see *Elbow et al, 2012*).

[4] Detailed list of community specific criteria can be found here: *Activité de securisation foncier dans le cadre du projet irrigation et de gestion des resources an eux de MCA Senegal (August 2011).*

communities. Based on discussion with the MCA-S land team, the first allocations were expected to take place in November 2013 at N'Gallenka and involved the 440 ha perimeter developed in Podor by the IWRM Project.

1.2.4 Social Safe Guard Measure Activity

MCC is funding and implementing up to eight day care centers within the irrigation project treatment areas. The day care centers are intended to complement the economic development resulting from the rest of the IWRM investments by allowing women to dedicate less time to child care and more time to economic activities (both agricultural and non-agricultural). It is also anticipated that enrolling young children in qualified day care centers will augment early childhood development, and it is hoped that such participation will lead to a higher rate of on-time enrollment of children in primary school (though the official age of entry into primary school in Senegal is 7 years of age, many children either don't attend at all or start attending school at later ages).

With the support of compact funding and technical support, each of the constructed day care centers will be locally managed by a management committee made up of local community members. This committee will be responsible for the ongoing operations and management of the day care centers and for assuring ongoing sustainability of the centers. Once the day care centers are operational, their ongoing operations and maintenance will be funded by a combination of user fees, community contributions, and support funds from the Government of Senegal.

The day care centers are anticipated to open in early 2015 and are expected to have a capacity of 90 children per center. Each center will be staffed by trained personnel using an established curriculum for early childhood development.

1.3 Program Logic

The IWRM project interventions have the potential to unlock agricultural (and non-agricultural) economic capacities and resources, thereby contributing to reducing poverty in Senegal. The impact evaluation of the interventions will estimate the effectiveness of the interventions in achieving project goals. In this Section, we describe the mechanisms through which the project interventions are expected to contribute to economic growth and poverty reduction. A description of these mechanisms is important to assess whether, how, and to what extent planned interventions achieve the target goals. Exhibit 4 presents this conceptual model summarized in a program logic diagram. Exhibit 5 lists the specific assumptions (A1-A16) underlying the program logic. The assumptions are also depicted in Exhibit 4 adjacent to their respective inputs, outputs, outcomes, and impacts.

Exhibit 4. Program Logic for the Integrated Water and Irrigation (IWRM) Project in Senegal

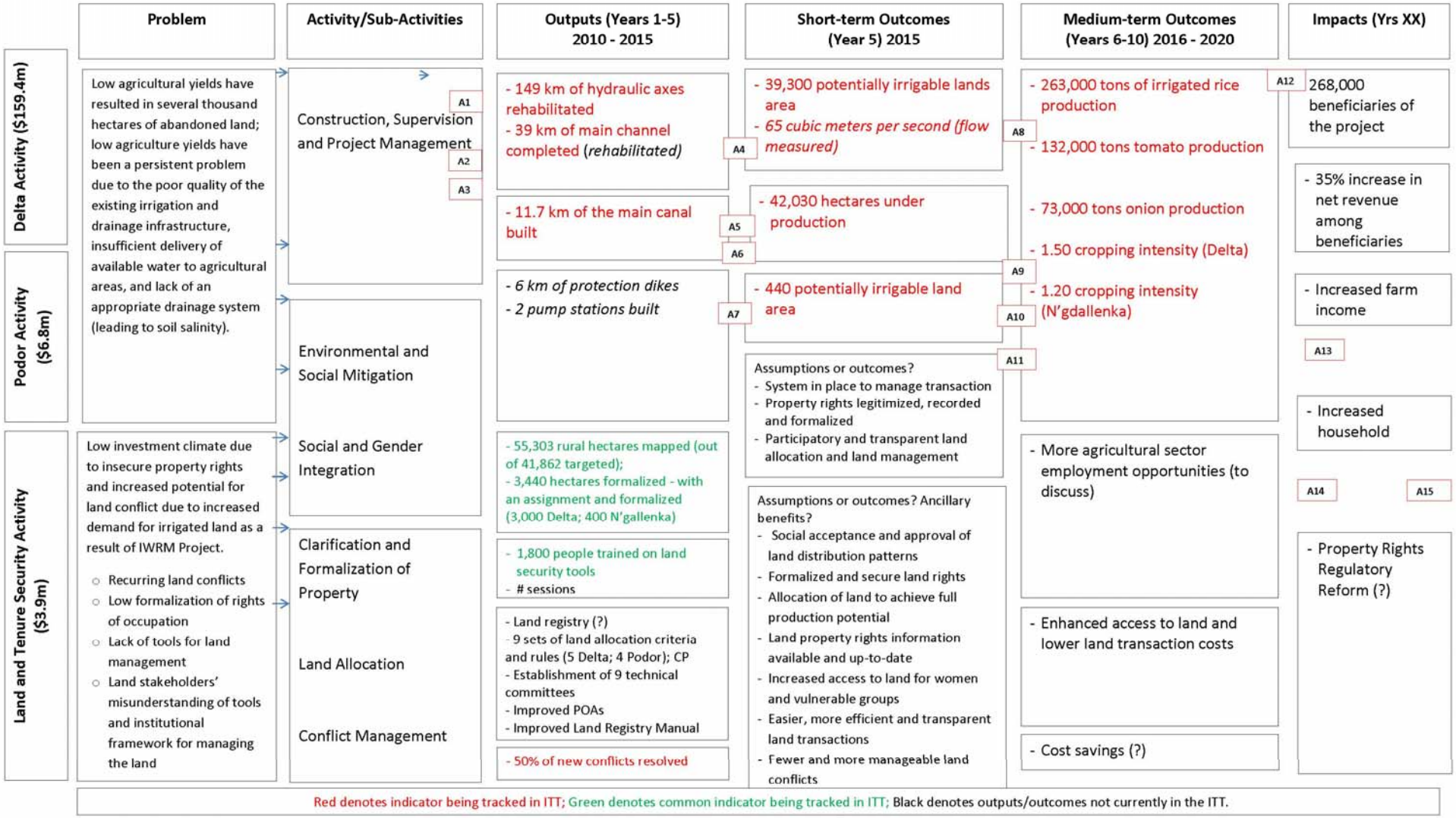


Exhibit 5. Program Logic for the IWRM Project in Senegal[5]

IWRM Project Logic Assumptions (Delta/Podor)	
INPUTS	▪ A1: **Budget.** Construction works budget is sufficient.
OUTPUTS	▪ A2. Budget. Government of Senegal covers any cost overruns. ▪ A3. Maintenance Action Plan. Irrigation Maintenance Action Plan is approved by GoS and institutional framework activities complete.
▪ **IMMEDIATE OUTCOMES**	▪ A4. **Tertiary Canals.** Farmers are willing and able to pay for rehabilitation, expansion and upkeep of tertiary canals and water. In the Delta - collection fee issues are being addressed and a program to reform the maintenance system is in progress (maintenance action plan is being implemented). In N'gallenka, the government is financing the tertiary canals. ▪ A5. **Binding Constraint.** Adequate primary Irrigation infrastructure was the biggest constraint. There are no other significant constraints/barriers to increased production (subject of the Ag Sustainability Plan). Particularly, barriers that local rice faces on the domestic market have been addressed, and there is a market for all crops grown. ▪ People know or have access to information on how to use irrigation and grow HVA. ▪ A7. **IWRM meets LTSA.** Land of N'gallenka perimeter is fully allocated and farmed by trained producer groups holding formal land rights; Delta producers possess formal and up-to-date titling documents; land dispute resolution system is functioning.
INTERMEDIATE OUTCOMES	▪ A8. **Sustainability.** Farmers continue to pay for water and fees are used for efficient and effective maintenance. ▪ People have access to agricultural inputs. ▪ Post-harvest infrastructure and access to markets are not a constraint - rural road system is adequate to carry inputs and outputs. ▪ A11. **Interaction with other Donors.** Other programs/donors/ investors are filling gaps in farmer training (what about technical assistance?), credit, etc.
IMPACT	▪ **Binding Constraint.** Irrigation was the constraint to growth. ▪ Increases in farm income will lead to increases in household income. ▪ Maintenance, land management, allocation and dispute resolution, and fee collection are all continuing to operate. ▪ A15. **Baselines/Targets.** Pre-compact assumptions about baseline were correct. ▪ There are no other major constraints to ag sector growth (particularly volatility in GoS policy for the agricultural sector, including the interface of imports and domestic production, and ethnic barriers to trust and investment between Dakar and SRB).

[5] The IWRM project logic assumptions table presented in Exhibit 5 is to be finalized; MCC is currently updating and finalizing the assumptions.

IWRM Project Logic Assumptions (Land and Tenure Security Activity)	
	▪ Securing of formal land tenure rights increases one's feelings of security in their ownership of land. ▪ Increase confidence in one's land tenure security will cause them to invest more in their land. ▪ Land tenure security tools, documents, and plans are actually implemented, used, and/or practiced. ▪ Water User Associations continue to function effectively after the end of the project (by function, this would mean continue to collect water user fees, continue to provide and plan for ongoing maintenance, and are able to collectively manage their irrigated plots). ▪ Formalized land rights lead to fewer conflicts and that improved capacity of land management institutions would increase the percentage of conflicts that are successfully mediated.

The left side of **Exhibit 4** identifies the problem and the investment rationale of the various project activities.

- *Problem* column identifies the long-term goal of the compact to reduce poverty and enhance economic growth through improvement in agricultural productivity and land security. The program logic presents the components of the IWRM project and the causal pathways through which the project activities can lead to economic growth and poverty reduction.
- *Activities* column presents the actions in the project, i.e. construction and rehabilitation, project management, land allocation, and social safeguard measures described above.
- O*utputs* column presents the direct results of these activities. These outputs consist of rehabilitated primary canals and improved primary drainage infrastructure in the Delta zone. In Podor/N'Gallenka perimeter, outputs consist in the construction of - main and secondary irrigation systems, as well as land leveling for smallholders (tertiary system financed by GoS in Podor). For the LTSA activity, outputs consist of land mapped and formalized, as well capacity building in terms of people trained on land security tools. Most of these outputs are tracked by the Indicator Tracking Table (ITT) that enables following the progress of the expected outputs over the compact years.

The right side of the exhibit indicates the results (*outcomes*) likely achieved by the beneficiaries. Some of the outcomes may be realized shortly after project completion (*short run outcomes*) while others may take longer to materialize (*medium term).* Finally, the exhibit presents the *impacts* that are expected to be realized following project completion. Below, we describe the mechanism for achieving the project's short- and medium-term goals.

Land productivity is significantly higher for irrigated land when compared to rain-fed land (World Bank, 2008a).[6] Thus, water management and irrigation activity should provide more reliable irrigation sources to farmers and a potential to improve agricultural productivity and agricultural incomes. Under the assumption that farmers are willing and able to pay for rehabilitation of tertiary channels (Assumption 4 or A4) and land in N'Gallenka is fully allocated

[6] FAO (1996) reviews the irrigation literature for Asia and report elasticities of crop yields with respect to irrigation in the range of 1 to 4. http://www.fao.org/docrep/x0262e/x0262e01.htm#a.

and land rights in Delta are formalized (A7), we should observe an expansion in irrigable land and more land area placed under production (A5) in the *short term.*

At the same time, we expect the land tenure activity to formalize land tenure rights and improve the efficiency of local land institutions. Because the lack of formal land tenure rights is a major component of land insecurity, formalizing land tenure rights should increase farmers' feelings of security, which in turn should lead to greater investments in land. Formal land tenure rights, coupled with better and more efficient institutions and land management tools, should help reduce the incidence of land conflicts (*medium*- and *short-term outcomes*).

As immediate outcomes of irrigation and LTSA activities materialize, farmers will have incentives to invest in land and agricultural production activities. In particular, as farmers feel more secure on their land, adapt their agricultural practices to greater availability of water, and gain flexibility to respond to market conditions because of more reliable access to water (off-season), we should expect a change in the amount of agricultural production, increases in productivity, and/or shift to higher value agriculture (HVA) (*medium term outcomes*). We expect these outcomes to materialize in the medium term provided farmers know or have access to information on how to use irrigation and how to grow HVA (A6) and provided they continue to pay for water and maintenance (A8). We assume that no other structural constraints to agricultural expansion exist, i.e., access to markets and availability of other agricultural inputs are adequate. We also assume that other donors/investors fill gaps in farmers' training (A9, A10, and A11). In addition, it is assumed that formalization of land rights and the building of land institutions' capacity to manage land tenure issues should enable farmers to have easier and greater access to land.

- For people who earn their living through agricultural production, growth in agricultural productivity should mean higher incomes (A13), which, when paired with the regularity provided by improved irrigation, should lead to a greater ability to sustain household basic needs. However, these outcomes are based on the assumptions that fees are collected continuously, that maintenance is managed through water fees, and that land management and conflict resolution improvements are sustained over time, (A14).
- Partly as a result of poor agricultural infrastructure, longstanding underinvestment in agriculture, and an inhibiting policy environment, Senegal has experienced low economic growth rates in recent years. MCC's investments in improving Senegal's agricultural productivity is designed to help promote Senegal's overall economic growth. The connection between agricultural growth and overall economic growth is well established with evidence suggesting that growth of agricultural output and wages can be an effective means of reducing poverty in the poorest countries (Bezemer and Headey, 2006).
- Thus, assuming that irrigation was (one of the) major constraints to the expansion of agricultural production and productivity (A12 and A16), and that uncertainty about land rights was a major constraint in access to land and land investments, we expect all the project short-term and medium-term outcomes to unlock economic opportunities of households and individuals living in areas affected by the projects (*impacts*).

1.4 Economic Rate of Return (ERR) and Beneficiary Analysis

1.4.1 Economic Rate of Return (ERR) and Cost-Benefit Analysis

The IMPAQ team will use the results from the impact evaluation to recalculate the Economic Rate of Return (ERR) for comparison to the ERRs that were used to inform the Compact investment decisions. The ERR is the discount rate at which the discounted benefits equal the discounted costs. MCC calculated the *ex-ante* ERR at the start of the project using the model presented in Exhibit 6. We will use the benefits estimated from the impact evaluation together with cost data to calculate the *ex-post* ERR using the same model that was used by MCC.

Using the same data sources, we will also estimate the costs and benefits of the project and produce a cost-benefit analysis. We will also conduct a cost-effectiveness analysis to compare the effects per dollar invested with comparable measures of other typical irrigation and land tenure investments.

Exhibit 6. ERR Model

ERR Model[7]
(**REVENUE – COSTS**)$_{\text{WITH PROJ}}$ * (**HA Cultivated**$_{\textbf{WITH}\ \text{PROJ}}$) minus (**REVENUE – COSTS**)$_{\text{WITHOUT PROJ}}$ * (**HA Cultivated**$_{\textbf{WITHOUT}\ \text{PROJ}}$)

1.4.2 Beneficiary Analysis

The Senegal Compact consists of investments in the areas of road rehabilitation, irrigation, and water management. Together these interventions are expected to raise the incomes of approximately 1.7 million Senegalese over the project's 20-year lifespan. Exhibit 7 presents the methodology used to estimate the number of beneficiaries, with the resulting estimates presented in Exhibit 8.

Beneficiary calculations are based on the number of discrete individuals whose individual incomes are expected to rise from an investment project, as well as the members of their households, who are assumed to share in those benefits.

[7] The ERR formula comes from MCC's Power Point *Presentation Overview of Economic model for Delta Irrigation Project* (August 2013), by Benjamin Bryant.

Exhibit 7. Methodology for Estimating Beneficiaries

Methodology for Estimating Beneficiaries		
Project	**Activity**	**Estimation Methodology**
Roads Rehabilitation	RN2 and RN6	All people living within 5 km of the rehabilitated road
IWRM Project	The Delta and N'Gallenka	Households, owners or shareholders of farming enterprises, and households that have individuals employed in the operation of enterprise farms in the Delta and N'Gallenka regions.

Most activities are assumed to generate benefits for beneficiaries across a 20-year project lifespan. During this time, the underlying population will grow, and therefore beneficiary counts were adjusted by the national population growth rate over the project lifespan.[8] This growth-adjusted figure provides the estimate of cumulative activity beneficiaries.

Some individuals will benefit from more than one Compact activity. The RN2 Activity and the IWRM Project are both located in the SRV, and we expect some overlap between the beneficiaries. Total beneficiaries will therefore be less than the sum of beneficiaries by project.

Exhibit 8. Estimated Beneficiaries in Year 20, by Project Activity

Estimated Beneficiaries in Year 20, by Project Activity				
Project	**Activity**	**Estimated Beneficiaries***		
Roads Rehabilitation	RN2	251,000	1,350,362	1,536,491
	RN6	1,098,000		
IWRM	The Delta	265,291	268,029	
	N'Gallenka	3,366		

***** *Individuals*

The IMPAQ team will also conduct the *ex-post* Beneficiary Analysis by examining the distribution of benefits by subgroup (e.g., gender and income group). The Beneficiary Analysis is intended to answer the following questions:

- How many people are expected to benefit from increased household incomes as a result of the project?
- What proportion of the beneficiaries is poor?
- How much on average will each individual beneficiary gain from the project?
- For each dollar invested by MCC, how much will be gained by the poor?

[8] Assumptions from MCC Beneficiary Analysis.

2. LITERATURE REVIEW

The existing literature on irrigation and its impacts on poverty is mixed. Some projects have shown positive impacts while others have shown little impact. While many studies have attempted to measure the effect of irrigation on poverty, irrigation is often only a sub-component of a much larger program (Saleth et al., 2003). The following review is not meant to be exhaustive; rather, it presents some of key features of previous research that has attempted to measure the impact of irrigation investments.

Prior studies have attempted to measure the impact of agricultural infrastructure improvements on agricultural growth and poverty reduction. The results of these studies, however, have provided mixed results and, as a result, there is no consensus in the literature on the impact of irrigation investments. Below, are a few of the studies that examined these issues and their major findings.

Fan et al. (2000) analyzed the differential impact of six different types of public investments on growth and poverty reduction in rural China. The results of this study showed that government investment in the rehabilitation and expansion of irrigation systems had only a modest impact on agricultural production growth and even less impact on reduction in rural poverty and inequality. In contrast, spending on rural education and agricultural research and development (R&D) had larger impacts on agricultural growth and poverty reduction. The study also found large regional variations in the returns to different types of government investments.

Pender et al. (2002) investigated changes in agriculture and land management practices between 1991 and 1998 in the highlands of Tigray in Ethiopia. The authors found that irrigation was an important factor underlying different livelihood strategies, favoring production of perishable cash crops. Furthermore, the authors found that irrigation contributed to intensified land use and changes in crop choice. Nonetheless, they found that irrigation investments resulted in less improvement in yields than expected. To improve the returns to irrigation investment in Tigray, the authors recommend increasing the priority of extension activities in irrigated areas and increasing the emphasis on promotion of high-value crops in such areas. Complementary investments in roads or other infrastructure may also be important in some areas.

Dillon (2010) investigated if differences in the scale of irrigation projects are related to different impacts on poverty and production in Mali. In this study, Dillon used propensity score matching to identify a counterfactual comparison group. However, while this approach can improve the measurement of program impacts, the author acknowledges that the results may be biased by household or individual unobservable characteristics. Nonetheless, the results of the study showed that small-scale irrigation schemes had larger effects on agricultural production and agricultural income than large-scale irrigation schemes.

In another recent study, Seyoum (2013) used a multivariate analysis to evaluate the effects of the construction of large scale irrigation schemes on poverty and income distribution in five villages in Ethiopia. The study found that irrigation was a significant determinant of total income of rural households, and contributed to reducing income inequality among rural households. However, the study's lack of a rigorous counterfactual and small sample size limits the inferences from the findings.

Studies conducted in the Sub Saharan Africa region found positive effects of irrigation on poverty alleviation. Minten & Barrett (2006), for example, used a unique, spatially-explicit dataset to study the link between agricultural performance and rural poverty in Madagascar. Results showed that communes with higher rates of adoption of improved agricultural technologies and broader access to improved irrigation infrastructure enjoyed lower real food prices, higher real wages for unskilled workers, greater profitability for farmers, and better welfare indicators. The authors noted that while access to improved irrigation infrastructure leads to higher uptake of improved technologies, the coefficient estimates were small, indicating that irrigation alone would not stimulate rapid uptake of improved technologies.

While these studies have contributed to our understanding of investments in irrigation, they do not provide definitive conclusions about the impacts of investments in irrigation in developing countries. To overcome the deficiencies in some of the previous studies, we will develop a rigorous counterfactual that can isolate the effect of investments in irrigation on agricultural and economic outcomes. Thus, the results of this study will add to our knowledge and understanding the impacts of investments in irrigation.

There have been few studies on the effect of land reform policies on outcomes such as land conflict, women's rights, and land tenure. One study conducted in the Brazillian Amazon assessed the implications of land reform on conflict (Alston, Libecap and Mueller, 1999). The study found that a policy to redistribute land actually increased violent competition and wasteful resource use. Another study in Rwanda examined the effect of protecting and enforcing land holders' rights without discrimination against women (Uwayezu and Mugiraneza, 2011). The study concluded "that the implementation of a new land policy and associate regulations are having a positive impact in safeguard, protection and enforcement of land rights for widow and female orphans....However, there is a need to continuously and widely empower widow and female descendants for defending themselves against practices of land grabbing and/or land deprivation through sensitization and reinforcement of land related laws and regulations in place."

3. EVALUATION DESIGN

The goal of the current evaluation is to estimate the impacts of the IWRM activities and use the results to answer specific research questions. The questions are derived from the program logic outlining pathways through which impacts results are expected to be achieved. As described in the following sections, a rigorous *impact evaluation* needs to link the observed changes in outcomes to the actual intervention. A rigorous evaluation must identify a *counterfactual* to compare the outcomes of those who receive the program benefits with similar individuals who do not receive the program benefits. Such an evaluation implies using experimental or quasi-experimental evaluation methods that compare those affected by the program and those not affected. In addition to the impact evaluation, MCC has requested that IMPAQ design and conduct a qualitative evaluation of program activities. Such an analysis would require the collection ofqualitative data from focus groups, key beneficiaries, and stakeholders. A qualitative evaluation would enhance our understanding of the causal pathways of the program impacts.

3.1 Evaluation Questions

A key role of the program logic is to provide guidance for identifying key research questions that the evaluation should aim to address. Based on the IWRM program logic, we will address questions that fall under the following categories:

1. Use and availability of water
2. Agricultural production
3. Household income and its component parts
4. Perception of land security
5. Land conflicts and effectiveness of land administration
6. Social safeguard measures

In addition to addressing the impact of the IWRM program on these outcomes, we will examine unintended consequences of the program. We will also analyze the extent to which program impacts vary by gender, age, and income group. The research questions are described in more detail below, together with the discussion of the evaluation methodologies and data that we will use to answer these questions.

Note that our ability to address these research questions clearly depends not only on the evaluation methods used, but also on when we expect the various outcomes to materialize (per the program logic), which in turn depends on the progress of the project implementation. These factors help determine timing for various data collection efforts (described in more detail in Section 4).

3.1.1 Research Questions Related to Use and Availability of Water:

- Has there been a change in the main source of water/type of irrigation used?
- Has there been an increase in the amount of land that is irrigated and the intensity to which it is irrigated?
- Has there been a change in the total costs to provide adequate irrigation to the land?

To address these questions, we will use household survey data on the amount of land (irrigated or not) available to households, the main source of water for irrigation, the irrigation techniques used, farmers' estimated irrigation costs, and farmers' overall satisfaction regarding the availability and reliability of water for irrigation. These outcomes are the expected short term results of improved irrigation.

The logic model assumes (via the A4 and A8 assumptions) that farmers are willing and able to pay for rehabilitation, expansion, and upkeep of tertiary canals and water. If this assumption doesn't hold, the project is unlikely to achieve its expected results. To test this assumption, we will ask beneficiaries about their willingness to pay for the maintenance and expansion of tertiary canals and water.

3.1.2 Research Questions Related to Agricultural Production

- Has there been a change in farmer behavior?
- Have there been changes in investments?
- Has there been an increase in the land area under production and in the level of intensity of the land area under production?
- Has there been an increase in the volume of agricultural production and yields?
- Has there been an increase in the volume of high value crops (for example vegetables) or crops that are very intensive in water use (rice)?

To address these questions, we will use data collected from household surveys on total available land area, how much of that land is used, which crops, and in what seasons the land is under production. Because the survey also collects information on the types of crops that are planted and levels of production, we can analyze whether households shift production practices (for example, shift toward crops that require more reliable and effective source of water). We expect these outcomes will be affected after farmers adapt their production choices and techniques to the new irrigation system. To disentangle the fluctuations in the types of crops that are planted (and/or the yields) that are due to regular fluctuations versus changes that are due to the project, we will compare crop fluctuations for the treatment and comparison groups.

The logic model assumes (in assumptions A5, A6, A9, and A10) that a lack of adequate primary irrigation infrastructure is the main constraint to land cultivation. However, other significant constraints or barriers to increased production may exist. For instance, if the market demand for certain crops is low or nonexistent, if farmers lack the technical skills to properly manage or grow HVA crops, or lack adequate agricultural output, they may not be able to increase their production. To test these assumptions and deepen our understanding of the causal pathways of the program effects on agricultural production, we will collect data from in-depth interviews with a sample of beneficiary farmers that will help to answer the following questions:

- Do farmers face other constraints or barriers to land cultivation? If so, what are these barriers or constraints? For example, what are the available market opportunities in the area, can farmers sell their products on these markets, and have the markets changed over time? Do farmers have the technical skills to grow HVA crops?
- Why did (or didn't) farmers shift to high value crops?

3.1.3 Research Questions Related to Household Income

- What is the impact of the project activities on the components of household income?
- What is the impact on the level of household income?

The household surveys will collect data on agricultural production revenues, other agricultural income (e.g., livestock), and other sources of household income (e.g., transfers, non-agricultural employment income, etc.). We will use the income data to estimate, to the extent possible, changes in overall household income as well as changes to its component parts. From the survey, we will obtain information about net income from the following sources:

- Income receipts from selling agricultural products and livestock/fishery and forestry products (agricultural revenues)
- Revenues from renting out land or buildings
- Revenues from renting out agricultural equipment/animals
- Investments in agricultural inputs for each parcel cultivated, including seeds, fertilizers, irrigation, labor, mechanical work

We also have information on non-agricultural income components:

- Wage income (for work outside the household)
- Social transfers (e.g. pensions, etc.)

The survey questions on income include various types of earnings that households may receive, including income from informal labor and buying and selling non-agricultural products. This information will enable us to understand the origins of any changes in income and to see whether a change in one income component leads to a change in total income. For example, as land becomes more productive, household members may shift from non-farm activities to farm activities. This shift may increase agricultural income but decrease non-agricultural income, which may or may not offset the agricultural income gains.

We will also analyze whether people re-allocate time to various productive activities within the household. For example, as land becomes more productive, household members may devote more time to cultivation and agricultural activities in general, rather than working outside the household. We can partially address this aspect with the data collected, as we obtain information on whether each household member is engaged in agricultural activities, crafting, commerce, and whether they are directly engaged in cultivating land, fishing, forestry activities, etc. However the data is collected using binary questions; thus, we will only observe changes on the "extensive" margin (i.e. any changes from "Yes" to "No" or vice versa) but not on the "intensive" margin, (i.e. whether the amount of time allocated changed).

3.1.4 Research Questions Related to Perception of Land Security

- Is there an improvement in perception of land security? If so, why?
- Is there an impact of enhanced land security on investments in land?

To address this question, we will use household survey data capturing individual perceptions of security about the land. We expect that improvements in the perception of land security will also impact farmers' investments in land and in agricultural equipment.

Perception of land security will be affected by whether there has been institutional strengthening, including improved documentation of land titles, improvements in ability to resolve land conflicts, and improvements in administration. These issues could be investigated in a comprehensive provcess analysis which is beyond the scope of the impact evaluation.

3.1.5 Research Questions Related to Land Conflicts

- Is there a reduction in the number of land conflicts?
- Is there an impact of reduced land conflict on investments in land?

Using the survey, we will also obtain information on the conflicts that households experienced on the land. To measure the impact of reduced land conflicts, we will compare investments in land for the treatment and comparison groups. As the LTSA allocates and secures land rights, it is expected that farmers will feel more secure, experience fewer conflicts, and invest greater amounts in their land.[9]

3.1.6 Research Questions Related to Social Safeguard Measures

Detailed research questions for the Social Safeguard Measure Activity have not yet been developed. However, the two main outcomes of interest are:

- Women's allocation of time to productive activities.
- Children's development (potentially)

IMPAQ is currently collaborating with MCC to further refine and specify the evaluation questions. At this point, we anticipate that the study will investigate the following questions:

- Do the day care centers allow women to dedicate less time to child care and more time to economic activities both agricultural and non-agricultural?
- To what extent are the day care centers sustainable?
- Do the day care centers augment early childhood development?

The specific questions to be analyzed and the design for this evaluation will be developed over the next few months in collaboration with MCC.

[9] Regarding investments in land, however, the questionnaires do not ask for enough information to measure investments in land. We can know whether households used seeds and total costs to make the parcel operational, but not whether they made more "longer-term" investments such as planting trees, constructing buildings, buying tractors to work land, etc.

3.1.7 Research Questions Related to Unintended Consequences

Even the most carefully thought-out and well-planned program may face unforeseen obstacles or produce unintended side effects when ultimately implemented. We will examine unintended consequences by addressing the following questions:

- Were there any unintended consequences of the IWRM project? If so, why did they occur?
- Who was affected by unintended consequences?
- Could any negative unintended consequences have been mitigated? How?

To address these questions, we will gather qualitative data from a sub-sample of beneficiary households, firms, and other key stakeholders during the process of monitoring the progress of the IWRM project via in-person interviews and telephone or electronic communications. We will also add open-ended response questions as part of the follow-up surveys to shed light on unintended consequences of the project.[10]

3.2 Methodology

Impact evaluations focus on answering questions on the program's impact on beneficiary outcomes. In principle, to accurately measure program impacts, researchers need to observe the outcome of interest (Y) for each individual i in two situations:

1) Where the individual receives the intervention (*treatment status* Y_{1i})

2) Where the individual does not receive the intervention (*control status* Y_{0i})

Because, at a *given time*, an individual is either exposed to the program or not, we cannot obtain an estimate of the program for a given individual. However, we can obtain an estimate of the *average* impact of the program on a group of individuals by comparing them to a similar group not exposed to the program (*comparison group*). The average of the differences in outcomes between the two groups —$E(Y_{1i} - Y_{0i})$— provides an estimate of the average impact of the program on the outcome of interest. However, to obtain a reliable estimate of program impacts, the comparison group should be a valid *counterfactual*, i.e. credibly represent what the outcome of the treatment group would have been in the absence of the program.

The underlying impact evaluation problem is that the individuals in the two groups are often different. For example, programs may be implemented in specific locations on the basis of certain area characteristics (poverty, socio-economic, or environmental features etc.). As a result, a simple comparison between treated and non-treated areas may capture both the program effects and pre-existing differences between individuals in the two areas. This problem is often referred to as *selection bias.*

[10] In addition, for Podor, because we will be interviewing all households in the treatment area regardless of whether they will receive land (as explained in the next Chapter) it may be possible to have a more direct measure of some positive (e.g. increase in income) or negative (decrease in income) externalities as a result of the project if some of these untreated households are interviewed at follow-up.

A robust way to address the problem of selection bias is through random assignment, also called a randomized control trial (RCT). Random assignment helps ensure that treatment status is independent of the characteristics of the units being assigned. With random assignment, individuals in the treatment and control groups are similar, on *average*, along both observables and unobservable characteristics. As a result, comparing the outcomes of the treatment group and the control group provides a reliable estimate of the program impacts.

Random assignment, however, is not always feasible. For example, in the context of the IWRM project, the selection of areas to receive the project interventions was not random; rather, the selection was based on a variety of factors, including political, social, and environmental. Thus, in the absence of random assignment, estimating the impact of a program becomes more complicated due to the selection bias.

When random assignment methods are not feasible, researchers generally turn to quasi-experimental methods. In a quasi-experimental approach, program impacts are estimated by comparing treatment group outcomes with outcomes from a comparison group. To enhance the accuracy of quasi-experimental evaluation results, comparison groups should be as similar as possible to the treatment (or program group) on all characteristics that might affect the outcomes. The main challenge of quasi-experimental impact evaluations is to identify comparison groups that represent a reasonable counterfactual to the treatment group.

In the context of the IWRM project, areas were selected to receive program interventions based on a variety of factors. Given that the selection process was non-random, researchers and program administrators made an effort to identify and select comparison areas that are as similar as possible to the treatment areas (i.e., to represent the counterfactual). For the Delta, the treatment area comprises the Saint Louis and Dagana departments, in the northwest St. Louis region (see Exhibit 3), and in particular the Rural Communities (CR) of Diama, part of Ronk and Rosso in Dagana department, and Gandon in St. Louis department. The comparison area was chosen from CRs in the Dagana department similar to those located in the treatment area but sufficiently far away from the project intervention zones. The comparison areas include the CR of Gae' and part of Rosso. In Podor, the treatment area comprises the N'Gallenka site (which occupies part the CR of Ndiane Pendao). The comparison area is located in the Podor department as well, but outside the N'Gallenka site (another part of CR Ndiane Pendao). Based on documentation provided by MCA, the selection of comparison areas seems to have been based on a combination of objective criteria, including similarity of geographical location, irrigation and drainage conditions, distance to road, land tenure, and parcel size. However, IMPAQ has not been able to access the details of this selection process. IMPAQ will use the baseline data to assess the comparability of the two groups, particularly in terms of the groups' irrigation situation. It may also be feasible to collect additional information and documentation through discussions with officials who were responsible for the selection process.

Despite careful selection of comparison areas, in the absence of random assignment, households located in the treatment areas may be different from those located in comparison areas in a way that also affect outcomes. For this reason, a simple post-program comparison of outcomes between households in areas that did and did not receive the intervention could be confounded by the initial differences between the groups. One way to address this problem is to use a

Difference-in-Difference approach (DID). This method compares the *before-after* changes in outcomes between households in intervention areas (treatment group) and households in comparison areas (comparison group).

The key assumption in the DID methodology is that *trends* in outcomes between the treatment and comparison group should be similar. This assumption cannot be directly tested (especially with data for only two points in time). However, inspecting the data can help to roughly gauge its appropriateness. For example, if pre-program *observable* characteristics of the treatment and comparison groups are very different, we may be concerned that comparison households may experience dissimilar changes in their outcomes, independent of the intervention (i.e. a violation of the common trend assumption). This could lead to biased estimates of program impacts. One way to improve on this is by means of a combination of DID with matching.

Combining the DID methodology with matching of treatment and comparison group members can sometimes reduce bias in program impact estimates. Using a DID with matching approach compares changes in outcomes of treatment group households with the outcomes of comparison group households that are *matched* based on *observable* characteristics. After matching each household with an *observationally* similar comparison household, the pre-program difference in observable characteristics between treatment and comparison group become smaller. Under the assumption that treatment status is close to random after controlling for observables, matching can better choose the counterfactual and make the results more credible.[11]

The choice of a non-experimental method like DID requires an extensive data collection effort, i.e. obtain primary data on the economic agents (households)[12] living in the treatment and comparison areas, before (i.e. baseline) and after (follow-up) project implementation. As in most impact evaluations, this data collection is necessary given the lack of existing data covering the project's areas of interest and/or the variables needed to answer the relevant research questions for the required time periods. Section 4 (Data Sources) provides more details about data needs and survey instruments to collect these data. Given the different nature of the interventions in Delta and Podor, a direct comparison of impact estimates across these sub-populations would be difficult to interpret. However, we can compare the cost effectiveness of the two interventions – the construction of the new irrigation in Podor and the rehabilitation of the existing irrigation systems in Delta – to the extent that project cost data are available.

The impact evaluation could incorporate qualitative components to answer the qualitative questions outlined in the previous Section. Qualitative methods would allow us to collect in depth information on the progress, causes, and factors that influence observed program effects through using semi-structured interviews, observations, and focus groups. We would use the principle of multilateral triangulation to implement the qualitative component of the evaluation. This strategy allows us to develop a detailed and nuanced understanding of the issues at hand by exploring the research questions outlined in the previous Section from the perspective of multiple sources. For instance, similar questions are asked to respondents such as

[11] Smith and Todd (2005).

[12] The initial design called for studying the effect of the project also on enterprises. However, difficulties in obtaining accurate estimates of the number of enterprises located in these areas as well as lack of appropriate sampling frames led to us to advice MCA-S to exclude enterprises from the data collection efforts.

representatives of WUAs, community development associations, beneficiary households and farmers, etc., to collect their different perspectives. The analysis will capture conflicting positions. In cases in which triangulation of information sources is not feasible, the report will clearly state that the findings are based on just one information source.

The interview will be organized in the form of free discussion and the applied techniques (such as involving questions, listing) will obtain comprehensive and in-depth information.

3.2.1 Delta

To estimate the impact of the IWRM project in the Delta area, we plan to use DID with *ex-ante* matching. Matching *ex-ante* means matching prior to the full survey based on the variables collected at the *enumeration* stage,[13] as opposed to matching after the baseline survey data collection, i.e. *ex-post*. This method gives a greater probability of finding a match for each treated household based on the large pool of comparison households obtained at the enumeration stage, and thus reduce sample size requirements. Section 4 explains how we sampled from the enumeration list and matched treatment and control households.

In addition, at the design stage, we had to decide whether to try to estimate separately the impact of the irrigation and land interventions. This decision had to take into account budgetary and technical constraints. Preliminary computations showed that trying to disentangle irrigation and land components would require very large sample sizes and much higher data collection costs. In addition, in the Delta, land holdings are often derived from land rights that originated with central or local governments rather than from custom, meaning that most parcels within the existing irrigated perimeters have already been officially allocated to farmers sometime in the past, although records of these land rights may be outdated or lost (see *Elbow et al, 2012*).[14] The LTSA activity will contribute to secure these land rights. Furthermore, as result of the project, some land that is currently abandoned because of salinity may be recuperated and eventually (re)allocated. In the Delta treatment area, most households will be affected by both the irrigation and land components of the project, although to a different degree depending on whether they already own formal land rights or not, and whether new land will be made available (and allocated) because of the project. We will collect these different rights levels as part of the survey to conduct exploratory analysis on the issue.

For these reasons, a decision was made prior to IMPAQ's involvement to estimate the combined impact of the irrigation and land interventions in the Delta area. IMPAQ reviewed these decisions and agreed to proceed with this design.

3.2.2 Podor

[13] An *enumeration* is a listing (census) of households carried out in the areas covered by the project (both treatment and comparison areas). This census is necessary to construct the sampling frame (universe) from which a given number of households will be sampled and included in the survey.

[14] In Podor, instead, the land tenure system is dominated by informal arrangements that are primary inheritance based and typical of customary land systems in Sub-Saharan Africa.

The original design called for using DID with ex-ante matching for Podor. However, as described in more detail in Section 3.2, at the time of sampling, we found that there was no clear way to plausibly identify which households would receive irrigated land in Podor. We could not implement ex-ante matching for Podor and we will use a DID with no matching. The irrigation and land activity must be evaluated together because the construction of a new irrigation perimeter in N'Gallenka and the distribution of the 440 ha are part of the same activity.

MCC also considered a randomized control trial for the new perimeter. However, based on a careful review of the requirements for the new perimeter in Podor, we recognize many obstacles to implementing a rigorous random assignment design. One of the key obstacles is that several groups will receive land but the land area available for distribution is relatively small. If MCA implements separate random assignment for each group, we will not have sufficient sample sizes to evaluate program impacts by group. Furthermore, many unknowns currently exist about how the land will be allocated (e.g., by individual or household, size of plots to be distributed, if there will be quotas for groups or subgroups, etc.).

As a result of these unknowns, we cannot begin to design a random allocation procedure that is practical and produces sufficient sample sizes. We believe that a DID design is a more appropriate option for evaluating the impact of allocation of new perimeter land in Podor. MCA has stated that the treatment group will receive the land and the irrigation activity while the control group will receive only the land activity. This arrangement will allow us to estimate the incremental effect of irrigation relative to the receipt of land.

3.2.3 Risks of Contamination

Based on discussions with the director of the land project during a field visit in August 2013, we were informed that some of the households in the comparison area would receive the same type of land intervention as households in the treatment area (e.g., capacity building, formalizing their existing land rights, and/or receiving new land, etc.). The result of providing similar services in both treatment and comparison areas has the potential of diluting the impact of the program and biasing the impact estimates.

To guard against this potentyial bias, researchers must have accurate documentation from MCC/MCA-S on exactly what was implemented in the treatment and control areas for both Podor and Delta and who received program services. If this data is not available or is not accurate, we will have another opportunity to collect retrospective data in the follow-up survey. Specifically, we can include questions in the follow-up survey to gather information on the level of services received by treatment and control group sample members.

To the extent that some treatment group did not receive treatment and/or some control group members did receive treatment services, we can correct for these issues and correct for the potential bias in the impact estimates by using the Bloom adjustment methodology.15,16 This

[15] Howard S. Bloom, "Accounting for No-Shows in Experimental Evaluation Designs." *Evaluation Review*, 8 (1984): 225-246.
[16] Howard S. Bloom, *The Core Analytics of Randomized Experiments for Social Research*,MDRC, August 2006.

adustments is designed to correct impact estimates when not all sample members comply with their assigned treatment/control status.

3.2.4 Qualitative Methodology

MCC has requested that IMPAQ consider adding a qualitative study to the impact evaluation activities of the project. While the impact evaluation would address whether the project achieved the expected impacts, a complementary qualitative implementation study would provide insights as to why some of the impacts were or were not achieved. The qualitative study would also allow us to test some of the assumptions in the logic model.

To investigate qualitative research questions, the project would need to incorporate multiple qualitative data collection methods. These methods should include:

- Document reviews
- In-depth interviews
- Group interviews

Document review includes an analysis of program documents that will provide information on the project design and the progress in implementing the intervention. *In-depth interviews* will collect views and attitudes of beneficiaries on the program and its progress. The interviews will be organized as semi-structured interviews by trained interviewers asking standardized open-ended questions. *Group interviews* will be conducted with groups of beneficiary households, beneficiary communities, and key community groups, such as the WUAs and *Comités Villageois de Développement* (CVDs), to understand residents' attitudes, needs, expectations, and perception. The group discussions will be organized as focus group interviews and community interviews. Focus group interviews will be carried out with small groups of people with similar background and experience to elicit their ideas, insights, and experiences in a social context where they can stimulate each other and consider their own views along with the views of others. We will conduct these interviews several times with different groups to identify trends in the perceptions and opinions expressed. The community interviews will be conducted as public meetings in which the whole community will be consulted on a set of factually-based fairly close-ended questions.

Before beginning to implement a qualitative study, we would review with MCC the options that may be available to expand the current impact evaluation to include a qualitative study. One option for a qualitative study might be to select a sample of households in the Podor and Delta regions and conduct in-depth interviews with members of these household. Another option is to employ focus groups with farmers, community stakeholders such as Water Use Associations (WUA) and Village Development Committees, and implementing agencies. These interviews and/or focus groups could address the following questions:

a. Farmers

- Changes in farmers' attitudes:
  - Do farmers have a better perception of rights related to water use and how WUAs work?
  - Did the project influence the adoption of new irrigation technologies?

- Changes in farming activities:
  - Did farming change their farming practices (e.g. choice and rotation of crops)?
  - Did farmers change their use of resources (e.g., more efficient use of water, reduced water loss, and better control of water)?
  - Did farmers shift their use of agricultural inputs (e.g., savings time devoted to obtain water and/or maintenance of irrigation systems)?
  - Was there a change in household relationships (e.g., role of women and children in agriculture)?
  - Were there unintended consequences?

- Changes in other factors:
  - Were there political and/or environmental changes in the region during the implementation period?
  - Were there other interventions in the area by the government or other donors?

b. Communities

- Changes in community agricultural practices:
  - Has there been a change in the main crop in the village?
  - Has there been a change in commercialization of products?

- Change in land conflicts:
  - Have there been conflicts regarding use of irrigated land?
  - Have there been conflicts regarding use of water?
  - Have there been conflicts regarding boundary, land access, secondary use?

- Other changes:
  - Were there any social or economic changes during the implementation period?

c. Implementing Agencies

- Have services strengthened the capacity of WUAs?
- Has scheduling of the water release improved?
- Has maintenance of the channels improved?
- Has the role of women in WUAs changed?
- Have there been changes in land administration?
- Have there been changes in effectiveness of conflict resolution at the community level?

3.3 Sample Requirements

To implement the DID analysis, we needed to draw the sample of households for the study from both the treatment and comparison areas. The previous evaluation contractor determined that the sample size needed to estimate the combined impact of the irrigation and land intervention in the Delta was 2,612 households: 1,306 from the treatment area and 1,306 from the comparison area). Power computations showed that a sample size of 2,612 households could identify a 10

percent change in agricultural income with 80 percent power (at 5 percent significance level).[17] All households were scheduled to be interviewed three times during the baseline (corresponding to Senegal's three agricultural seasons) and again at the follow-up (i.e. a panel design).[18] IMPAQ reviewed these power computations and found sample sizes appropriate for the scope of the evaluation.

For Podor, the sample size was initially constrained by the amount of land available for distribution i.e. approximately 400 ha. MCA-S expected to distribute approximately 1 ha per household, meaning that the household sample size is approximately equivalent to the number of hectares available for distribution. The final sample size for Podor is 440 households in the treatment area and 440 households in the comparison area. Power computations show that with a sample of approximately 880 households we can expect to detect a change in agricultural income of approximately 19 percent with 80 percent power and 5 percent significance level.[19] The same households will be interviewed at the baseline and at the follow-up.

3.3.1 Household Sample Selection-Delta

As described in Section 3.2, to implement DID with ex-ante matching, households should be matched *before the survey*. This required a detailed enumeration in the treatment and comparison areas to collect a set of variables that could match treatment and comparison households. In the spring of 2012, the Agence Nationale de la Statistique et de la Démographie (ANSD) conducted extensive enumeration in the Delta area, including the Saint Louis and Dagana departments, for a total of about 11,600 households. IMPAQ used the enumeration files to sample and match households. The MCA-S approved sample sizes for the Delta are 1,306 treatment households and 1306 matched comparison households. We provided slightly larger samples to ANSD to allow for some survey non-response and because the survey effort may not complete interviews with 100 percent of the sample.[20] Specifically, we selected 1,637 treatment and 1,637 comparison households (about 25 percent more than the proposed sample sizes).

From the enumeration file, we randomly sampled 1,637 treatment households; then matched each treatment household with a comparison household identified as the most similar in relevant pre-treatment characteristics. The basic idea of matching is to find a sample of comparison households that are on average similar to the treatment sample.

To identify similar comparison households, we employed a commonly used method of matching: *the propensity score method*. A propensity score is an estimate of the probability of being selected into the treatment group based on observable characteristics. Specifically, we derived a propensity score for each household based on the following logit model:

[17] Without reliable data of agricultural income for Senegal, the data on agricultural income per capita used to perform power computations come from the PNGT2 rural household survey conducted in Burkina Faso in 2005. According to the data, the average agricultural income per capita (net income: harvest value minus input costs) is 39,627 FCFA, and the standard deviation of agricultural income per capita is 57,143 FCFA. Computations assumed a baseline-end line autocorrelation in outcome of 0.75, a 0.05 statistical significance, and 0.80 power, and were performed using STATA.

[18] In a panel design, the same set of households is followed throughout time.

[19] The same data on agricultural income used to perform power computations for Delta have been used for Podor.

[20] Our goal is to achieve at least an 80 percent response rate.

$$P(y_{ht} = 1) = \frac{\exp(\beta X_{ht})}{1 + \exp(\beta X_{ht})}$$

The dependent variable y_{ht} is an indicator equal to one (1) if the household *h* is in the treatment group at time *t* (baseline) and zero (0) otherwise. The probability *P* of being in the treatment group is modeled as a *logistic* function of the observable household characteristics (X_{ht}) obtained from the enumeration. The coefficients ($\boldsymbol{\beta}$) of the logit model capture the effect of the observable household characteristics on the probability of being selected.

We used the following variables from the enumeration as independent variables in the logit regression model:

- Age
- Household size
- Number of male workers
- Number of female workers
- Number of male workers in agriculture
- Number of female workers in agriculture
- Sex
- Ethnicity
- Literacy
- Socio-administrative status
- Status of land of household head
- Participation on OP (*organisation paysanne*)
- Nature of roof
- Nature of floor
- Nature of walls

After we derived a propensity score for each household, we matched each treated household to a comparison household whose propensity score was closest to the treated household's propensity score. When multiple households had the same propensity score, we randomly selected one of these households as the best match. After completing the sampling and matching process, IMPAQ provided the final sample to be surveyed to MCA-S and the survey agency. The final sample included a list of treatment households and their associated (matched) comparison household. Appendix A provides a description of the final samples.

3.3.2 Household Sample Selection-Podor

In the spring of 2012, ANSD completed an extensive enumeration in the Podor area. Specifically, 1,617 households were enumerated in the treatment area and 585 in the comparison area. For the impact evaluation, it is important for the treatment group to include *households that will actually get the treatment (irrigation and land)*. However, at the time of sampling, we could not find a clear way to plausibly identify which households would receive irrigated land in Podor. Because the enumeration data includes 1,617 households in the treatment area and we need to identify the 440 households that will receive land, a random sample will not ensure that we get enough households that actually receive land.

We considered using the information available on the land allocation criteria that will be used when the plots become available. However, we concluded that we could not find a clear way to

plausibly identify households that will get land. We discussed this issue with MCC/MCA-S land team during a meeting in spring 2012. We concluded that it was not possible to obtain a list of households that would get land. This list will probably become available only in spring 2014. Furthermore, even trying to oversample from enumeration data according to the proposed selection criteria will be very risky because many land allocation decisions have not yet been made. The MCA-S land team agreed that it was not possible to know, with a sufficient degree of certainty, who will get land. Thus, oversampling groups that have priority in the land allocation likely will not fully solve the fundamental problem of finding a sufficient number of households that will receive land.

Given the urgency of selecting the samples and proceeding with the survey, MCA-S and IMPAQ agreed to survey all households (1,617) in the enumerated treatment area. This approach ensured that we capture the households that will receive land (treatment group). In addition, we agreed to survey a random sample of 440 households in the Podor comparison area (out of a total of 585 households in the enumeration). Moving forward quickly was very important to avoid wasting time and resources. Furthermore, waiting until spring 2014 (when land decisions are expected to be finalized) could have endangered our ability to have useful baseline data because the intervention may take place before the baseline data collection.

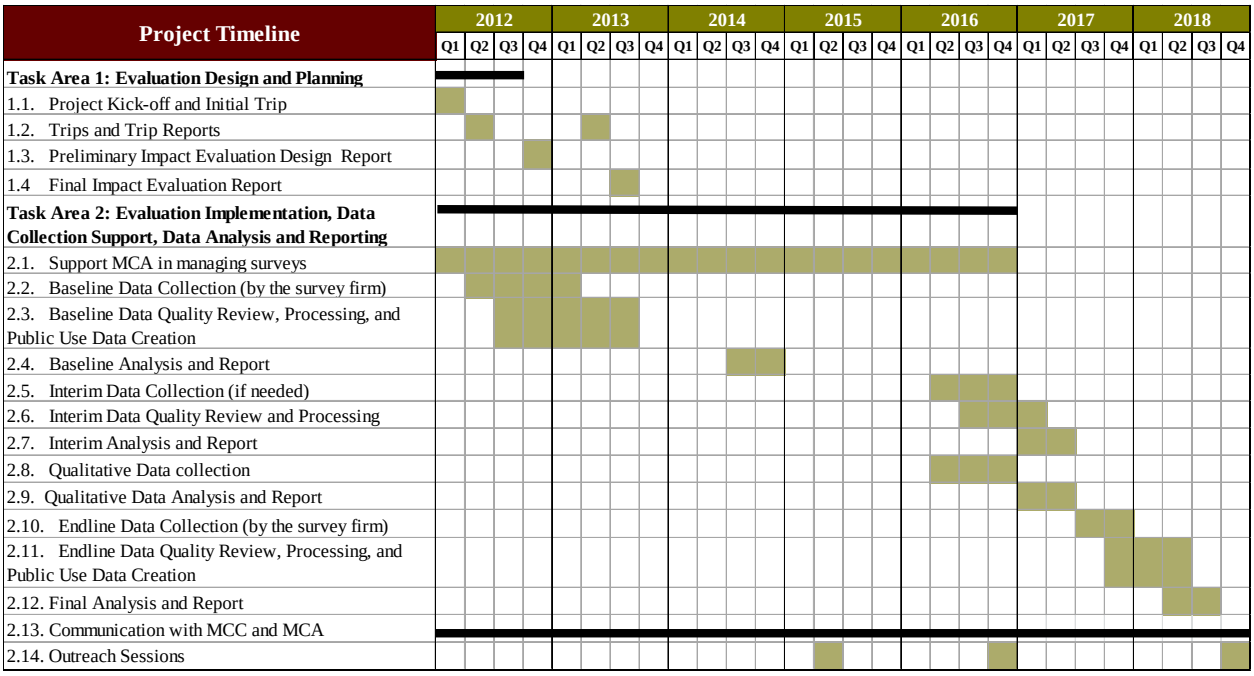
3.4 Timeframe

Successful implementation of the project requires simultaneous implementation and management of several activities and close coordination with MCA-S survey contractor. In Exhibit 9, we present our proposed schedule for major project activities. As indicated in the exhibit, we have organized the project into two major task areas, each with several tasks:

(1) Evaluation Design and Planning
(2) Evaluation Implementation, Data Collection Support, Data Analysis and Reporting

Some of the early tasks have been completed or are currently in progress. Other tasks are scheduled for implementation in 2014 and beyond. As indicated, some of the tasks will need to be implemented after the close of the Senegal Compact.

Exhibit 9. Project Gantt Chart



There is still uncertainty about the implementation status of various project activities. As a result, a firm schedule for surveys is difficult. For example, we believe it desirable to collect an interim as well as a final follow-up survey to capture short-term (interim) and medium/longer-term outcomes (follow-up). MCC must confirm the decision to collect an interim survey.

Based on the most current information, we believe that the implementation schedule will be:

- Delta Irrigation Works tentative completion July 2015
- Podor/N'Gallenka Works tentative completion Mid-2014
- Land Rights, July 2015

For Delta, if everything is completed by July 2015, then the scheduled data collection in 2016 would allow only one year after the end of construction. One year after the completion of the construction is not likely to provide farmers sufficient time to capture the full benefit of the improvements. Consequently, we suggest keeping the currently scheduled survey in 2016 and using this survey for an interim data collection to capture short-term program impacts. This interim data collection survey could capture such outcomes as changes in farmers' investments in land and equipment, changes in production techniques, changes in crop allocation, etc. One clear rationale for the interim survey is that it can shed light on who received treatment services. This is critical to the accuracy of the impact evaluation. This interim survey would not need to replicate the three passages that were collected in the baseline survey. Rather, we would propose a single survey that would capture information on these outcomes retrospectively (one-year period). While these intermediate outcome changes may not impact farmers' income, they may be precursors and provide insights on potential future benefits of the intervention.

To capture the steady-state program impacts, IMPAQ will assess (in conjunction with MCC) the appropriate timing for such a survey. One option, is to implement an end line survey

approximately two years after the interim data collection. These surveys would provide the data needed to measure program impacts approximately two years after the completion of the irrigation works. If we were to collect the data in three passages (similar to the baseline survey), then the timing of the data collection would stretch to the end of 2018. However, if we assume a single retrospective survey (as in Exhibit 9) the survey would be completed approximately at the end of 2017.

It should be noted that a single retrospective survey (versus a three passage survey) would preclude a comparison of impacts by season. In summary, our proposed timeline depends heavily on realization of the Delta and Podor irrigation and water resources management activities and land tenure activities. We based the proposed data collection timeframe on the project implementation work plan and discussions with MCC. We will finalize the evaluation work plan in collaboration with MCC, MCA-S and other stakeholders.

4. DATA SOURCES

Primary data collection to support the evaluation will be carried out by means of household and community surveys in the *treatment* and *comparison* areas. The surveys will be implemented *before* (baseline) and *after* (follow-up) the implementation of the project. Data will be collected on key outcomes (e.g., earnings, agricultural production, etc.) as well as household demographic characteristics, socioeconomic status, and other background characteristics that will serve as control variables in regression models.

MCA-S has contracted with ANSD to collect the relevant data on households/communities living in the project intervention and comparison areas for the IWRM project. The initial evaluation design called for studying the effect of the project on enterprises located in the project areas. However, difficulties in obtaining accurate estimates of the number of enterprises located in these areas as well as lack of appropriate sampling frames led us to advise MCA-S to exclude enterprises from the data collection efforts.

Because most of the key outcome variables relate to agricultural production, they are season-dependent. Senegal has three cropping cycles. To obtain reliable farm production/yields estimates, MCA-S decided to interview producers shortly after each harvest. As a result, three waves of data have been planned for the baseline and follow-up surveys in the Delta and Podor areas to cover the different agricultural seasons. The three seasons are:

- Passage 1 - December 1, 2011 - March 31, 2012 [*Contre Saison Froide*]
- Passage 2 - April 1, 2012 – July 31, 2012 [*Contre Saison Chaude*]
- Passage 3 - August 1, 2012 – November 31, 2012 [*Rainy season*].

4.1 Household Survey

Exhibit 10 summarizes the key data elements in the baseline and follow-up household surveys. As indicated in the exhibit, the household survey incorporates a household questionnaire and an agricultural questionnaire. A community questionnaire will also be administered to community leaders to gather information about the community infrastructures, incidence of land conflicts, and other community characteristics.[21] If additional data collection is authorized by MCC, IMPAQ could collect additional administrative data from land administration institutions and conflict resolution bodies. The data from the community questionnaire will also be used in combination with household data to control for community characteristics in the analysis.

The household questionnaire includes information on household composition as well as the activities of each household member, nonagricultural revenues, consumption, and expenditures. The agricultural questionnaire is designed to collect detailed information on crops, irrigation techniques, and land use. In addition, the agricultural survey will collect information on perception of land security and experience with land disputes.

[21] The community includes some information on the existence of some organizations in the village, such as produce organizations and WUAs, but does not include information on their functioning. The questionnaire is administered in the same communities occupied by the households. However, community data are collected during the first season only.

Exhibit 10. Main Variables for IWRM Questionnaires

Questionnaire/Variables Descriptions
HOUSEHOLD QUESTIONNAIRE
Household members' relationships to household head, age, gender, education, marital status
Activities of the various household members
Household assets, participation in peasant organizations
Non-agricultural revenues
Consumption and expenditures
AGRICULTURAL QUESTIONNAIRE
Plots size, agricultural production on the plots by crop
Land conflicts and perception of land security
Irrigation techniques
Labor inputs and other agricultural inputs and equipment
Amount obtained by commercialization of crops, amount of production lost
Livestock-type and number of animals and value
Production and commercialization of animal products
Household involvement in fishing and revenues
COMMUNITY QUESTIONNAIRE
Health and education
Community projects
Agriculture and livestock
Coping strategies
Land conflicts
Prices

Following our analysis of the data collected at baseline, we will assess whether the survey should be adjusted for follow-up data collection. We will assess whether individual questions should be adjusted to improve data accuracy. We will also assess whether the final survey should repeat the three passage format or of the baseline survey or consolidate the data collection into a single data collection period. Ideally, repeating the baseline data collection is preferable; however, timing and resources may require adjusting the format.

4.2 Baseline Data Collection Status

IMPAQ received the first version of complete raw baseline data in the spring of 2013, following several delays. IMPAQ is currently working with ANSD to conduct extensive quality reviews on the datasets. Given the complexity and length of this data, several rounds of revisions were necessary to troubleshoot the errors. The datasets for all three seasons are expected to be cleaned and finalized by August 2014. Exhibit 11 summarizes the data collection status of the three surveys as of January 2014.

Exhibit 11. IWRM Data Collection Status

Season	Reference Period	Data Collection Period	Data Collection Completed
First Season	December 1, 2011 – March 31, 2012	May 12, 2012 – June 08, 2012	YES
Second Season	April 1, 2012 – July 31, 2012	October 1, 2012 – November 20, 2012	YES
Third Season	August 1, 2012 – November 31, 2012	January 29, 2013/end of March 2013	YES

4.3 Monitoring and Evaluating Data Quality

While MCA-S is responsible for contracting the data collection, IMPAQ will work closely with MCA-S and will provide technical assistance. Additionally, once the data is collected, we will assess the reliability of the data collected. Specifically, we will:

- Check consistency between data and questionnaires (e.g., whether all Sections/variables in the questionnaires are present in data).
- Check variable accuracy (e.g. ensure variables are appropriately labeled, missing values, data consistency with skips among variables, etc.).
- Check internal consistency among various data Sections (e.g. ensuring a Section addressed to household members age 10 and above does not include those below age 10).
- Prepare memos listing all data issues identified and share memos with MCA/ANSD, with recommendations to correct issues.
- Re-check the data after ANSD reviews the dataset.

5. ANALYSIS PLAN

To estimate the impacts of the IWRM project in Senegal, we will specify quasi-experimental models that compare outcome changes over time for the treatment group as compared with the comparison group. Below, we review the methodology that we plan to use in measuring program impacts and our plans for analysis and report preparation.

5.1 Difference-in-Differences

We will capture the impact of the IWRM project using a multivariate DID regression. This method compares pre-post changes in outcomes of households in the treatment areas with pre-post changes in outcomes of households in the comparison areas. Using the baseline and follow-up data collected for the treatment and (matched) comparison groups, DID can be expressed in the following regression:

$$\text{Outcome} = \alpha + \beta T + \gamma F + \delta(T \cdot F) + \lambda X + \varepsilon \quad (1)$$

The left-hand side of the equation is the project outcome variable of interest, such as land area under cultivation, agricultural production, household income, etc. Section 3 describes the project outcomes of interest in detail.

The right-hand side of the equation includes the following variables:

- A dummy variable T that equals 1 if the observation is in the treatment group and zero otherwise. The estimate of β captures the average group effect of being in the treatment group.
- A dummy variable F that equals 1 in the follow-up year and 0 in the baseline year. The estimate of γ captures the time effect. F controls for any changes in the outcome variable that occur over time and are common for treatment and comparison group members.
- An interaction term (T · F) that equals 1 if the observation is in the treatment group and in the follow-up year, and 0 otherwise (i.e., for comparison group members in both the baseline and follow-up years and for the treatment group in the baseline year). The estimate of δ captures the impact of the project on the outcome variable. This is the parameter of interest.
- A vector X of other relevant explanatory variables that may relate to the outcome of interest and will help control for baseline household characteristics. At a minimum, for household models, X will include the education, gender, and age of the household head.

The parameters to estimate are α, β, γ, δ, and the elements of the vector λ. All else being equal, positive parameter estimates will indicate that the corresponding right-hand side variable is associated with an increase in the outcome measure. Likewise, negative parameter estimates will indicate a negative association. We will use t-tests to measure the statistical significance of the parameter estimates. Where we find statistically significant differences, we can be confident that the corresponding right-hand side variable has an effect on the outcome variable.

As described in Section 3, we will use the DID method to identify program impacts in Podor and Delta. The DID will be estimated separately for Delta and Podor using the regression model

described in equation (1), including the same outcome and control variables, because the data for Delta and Podor were collected using the same survey instruments.

5.2 Subgroup Analysis

We will also examine whether the impacts of the projects differ by subgroups, such as gender and income. We can expand the basic regression model to include terms that capture potential subgroup effects:

$$\text{Outcome} = \alpha + \beta T + \gamma F + \xi S + \delta_1(T \cdot F) + \delta_2(T \cdot S) + \delta_3(F \cdot S) + \delta_4(T \cdot F \cdot S) + \lambda X + \varepsilon (2)$$

As before, the left-hand side variable is the outcome of interest. The right-hand side variables are the same as in the basic regression model, except for the explanatory variables, added for the subgroup models:

- A dummy variable S that equals 1 if the observation is in the subgroup and 0 otherwise. The estimate of ξ accounts for differences in outcomes associated with the subgroup of interest.
- An interaction term $(T \cdot S)$ equals 1 if the observation is in the treatment group and the subgroup of interest, and 0 otherwise. The estimate of δ_2 captures the incremental treatment group effect for observations in the subgroup.
- An interaction term $(F \cdot S)$ that equals 1 if the observation is in the follow-up period and the subgroup of interest, and 0 otherwise. The estimate of δ_3 captures the incremental time effect for observations in the subgroup.
- An interaction term $(T \cdot F \cdot S)$ that equals 1 if the observation is in the treatment group, in the follow-up period, and in the subgroup of interest. The estimate of δ_4 captures the potential differential effect of the IWRM project for the subgroup. This is the parameter of interest.

For the subgroup models, we will estimate the parameters α, β, γ, the elements of the vector λ, and the parameters ξ, δ_1, δ_2, δ_3, and δ_4. In these models, the expected outcome for individuals in the subgroup is equal to the expected outcome for non-subgroup individuals plus: (1) a subgroup effect (ξ), (2) an incremental treatment group effect (δ_2), (3) an incremental time effect (δ_3), and (4) the incremental effect of the project (δ_4). Thus, our estimate of δ_4 will indicate whether the impact of the project is different for the subgroup of interest. If δ_4 is positive, then the program has a greater impact on the outcome for the subgroup, all else equal. Likewise, if δ_4 is negative, then the program has a smaller effect on the outcome for the subgroup. We will use a t-test to evaluate whether our estimate of δ_4 is statistically significant. If so, we can be confident that the impact of the program is indeed different for the subgroup of interest.

5.3 Baseline Analysis

IMPAQ will analyze the baseline data and produce a baseline report after the data collection is completed and the datasets cleaned. This report will include a brief description of the project, the evaluation design, and the data collection activities. The report will then summarize the data available (overall and by season) for Delta and Podor and include descriptive statistics of household characteristics and differences between the treatment and comparison groups of the main variables of interest. We will present the results of the analysis in a variety of formats, including charts and tables. Exhibit 12 presents an illustrative outline of the baseline report, and Exhibit 13 presents a table shell that will be used to present characteristics of the treatment and comparison groups. The results of the baseline analysis will be shared with stakeholders in DC and Senegal.

Exhibit 12. Example of Baseline Report Outline*

1. Introduction
    a. Description of the program activities
    b. Evaluation design
    c. Overview of the household surveys
2. Household characteristics and outcome measures at baseline
    a. Household characteristics: treatment and comparison group at baseline
        i. Overall and by season, Delta
        ii. Overall and by season, Podor
    b. Outcome measures: treatment and comparison group at baseline
        i. Overall and by season, Delta
        ii. Overall and by season, Podor
    c. Implications for key values underlying the cost-benefit analysis
3. Overall assessment of data quality
4. Conclusions
    a. Summary
    b. Lessons learned

* For illustrative purposes only. A complete outline will be developed after data are received and ready to use for analyses.

The survey included questions to collect data on agricultural production using local measurement units (e.g. sacs etc.). This approach facilitated data collection in the field; however, the local units must be converted into standard measurement units (kilos or tons) for the analysis. ANSD developed a method that uses unit prices for local units to provide IMPAQ with a clean data set where the local units have already been converted into standard units.[22] We will carefully review the data from ANSD and present the data on agricultural production in tabular format using

[22] The steps (Described in more detail in ANSD methodology memo: Note Methodologique_Conversion-UMLen UMS_22aout2013.doc) are:

- Obtain the price per unit (kilo). If this price varies within the village, compute the average price per kilo (PUm).
- For each product measured in local units, get the average price within the village (PUmL).
- Convert local unit (e.g. tas) as follows: 1 tas (gramme) = 1000 grammes * UP_mL(tas) /UP_m(1kg).

standard measurement units. We will organize this data and present it in a baseline report that prepares the reader for the Final Analysis report.

Exhibit 13. Example of Table of Sample Characteristics, Baseline

	Treatment Group	Comparison Group	Difference
Total [% of Total]	**N [%]**	**N[%]**	**Statistical Significance***
Demographic Characteristics			
Men			
Women			
Age: Less than 15 years			
Age: 15-24 years			
Age: 25-34 years			
Age: 35-44 years			
Age: 45-54 years			
Age: 55+ years			
Agricultural income			
Amount of production			

5.4 Final Analysis

After follow-up data collection is completed, we will combine all baseline and follow-up data to produce a final analysis report. The final report will include a description of the analysis samples for both baseline and follow-up and the full results from the DID estimation. The analysis will combine the baseline and follow-up data for all three seasons, for both Delta and Podor. The report will include a variety of tables and figures with descriptive statistics, and will focus on the impact estimates of the IWRM project. Exhibit 14 presents a possible outline for the follow-up report. IMPAQ will deliver a draft final report to MCA-S and MCC, and will convene a meeting with MCA-S and MCC to review comments and suggestions on the report. IMPAQ will incorporate comments and suggestions in the final report.

Exhibit 15 gives an example of the presentation of impact evaluation results. We will provide contextual narratives for all analyses. In addition, because most of the outcome survey questions (e.g., income, agricultural production and crops, and perception of land security) are asked separately for adult members of the household, we can analyze and present impacts by gender and other major subgroups.

Exhibit 14. Example of Follow-up Report Outline*

1. Introduction
    a. Description of the program activities
    b. Implementation of the IWRM
2. Evaluation approach and data
    a. Research questions
    b. Sampling approach
    c. Surveys
    d. Description of analysis sample: Summary statistics
3. Impacts on outcomes
    a. Delta
    b. Podor
    c. Sub-group analyses
4. Qualitative analysis
5. Cost-benefit analysis
6. Cost-effective analysis
7. Limitations of the data
8. Conclusions
    a. Summary
    b. Lessons learned
9. Next steps

* For illustrative purposes only. A complete outline will be developed after data are received and ready to use for analyses

Exhibit 15. Example of Table for Impact Estimates

	Treatment Group			Comparison Group			Program IMPACT		
	Baseline Mean	Follow-up Mean	Mean Difference	Baseline Mean	Follow-up Mean	Mean Difference	Impact Estimates		
	(A)	(B)	(C= B-A)	(D)	(E)	(F= E-D)	(C-F)	t-test	p-value
Household									
Income									
Agricultural Inputs									
Area of Irrigated land									
Notes: * p<0.05; **p<0.01; ***p<0.001.									

Impact estimates are regression-adjusted to account for differences in characteristics of the two groups.

5.5 Qualitative Analysis

The qualitative analysis could enable the testing of some of the key assumptions in the logic framework to understand the causal pathways of the observed program effects. The qualitative evaluation could include three types of qualitative data:

- Document reviews data
- In-depth interviews data
- Group interviews data

To analyze these data, IMPAQ could design an iterative process that coincides with the proposed interim data collection and analysis period (approximately 15 months). The process consists of three key steps: noticing, collecting, and thinking (Xue, 2009). The qualitative data would be collected during site visits through the use of interview, focus group, and observation protocols. Data would be triangulated from difference sources and common themes of categories will be identified. The use of theme identification methods would allow us to reduce the large volume of qualitative data gathered to a manageable number of topics/themes/categories pertinent to our research questions.

IMPAQ would code all qualitative data sources, including in-depth interview and group interviews. Early in the data collection period, we would develop a coding scheme for the various data collection sources. The coding scheme aligns with the research questions for each category in the evaluation. We would pretest codebooks and estimate the final intercoder agreement. We expect to reach and maintain an intercoder agreement of at least 80 percent. To facilitate the organization and synthesis of the data from interviews, IMPAQ would use the qualitative analysis software package *Nvivo* (non-network version for maximum data security). After coding the qualitative data, IMPAQ would retrieve all data on a particular research question and compare the responses across multiple waves of data collection and multiple data sources. We would use a within-beneficiary perspective, followed by a cross-beneficiary perspective, to identify themes and patterns discernible to an individual beneficiary, a set of beneficiaries, and all beneficiaries.

6. PROJECT REQUIREMENTS AND STAFFING

6.1 Summary of Institutional Review Board Requirements and Clearances

The National Ethics Committee for Health Research (CNRS) requires all researchers/research firms to submit all research protocols in their original and complete version in French. Twenty copies of each protocol must be submitted no later than 21 days before the next CNRS session. IMPAQ has already acquired all of the necessary documents for the Institutional Review Board (IRB) clearance from CNRS, including the CNRS Guidelines for IRB Approval, the Verification Sheet of the Completeness of the IRB proposal, and the Senegalese Act on the Code of Ethics for Social Research. IMPAQ will develop the IRB proposal for the follow-up surveys and will obtain IRB clearance for the project upon MCC's formal approval of this additional work and of the resources necessary to complete it. IMPAQ did not secure the IRB approval for the baseline data collection, as it was not required by MCC.

6.2 Data Access, Privacy, and Documentation Plan

In compliance with MCC's Data Documentation and Anonymization Guidelines (March 2012), IMPAQ will ensure that all project data delivered to MCC are easily usable by two distinct audiences: (1) MCC staff and contractors, for internal analysis and decision-making, and (2) public users, including academic researchers, policy analysts, and peer institutions. We will achieve these goals by providing the following deliverables:

- Internal use survey package that includes:
  - All relevant datasets/data files that are complete, not anonymized, and documented according to MCC guidelines
  - All relevant supplementary documentation

- Public use survey package that includes:
  - All relevant datasets/data files that have been anonymized and documented according to MCC guidelines
  - All relevant supplementary documentation
  - Completed "Anonymization Worksheet"

The baseline data produced for the evaluation will be available after it is cleaned and the final baseline report is produced. The expected timeframe is 6 to 12 months following the end of the data collection activities. The mid-term or follow-up data produced for the evaluation will be available after it has been cleaned, the final report is produced, and the evaluation team has completed initial analysis for any proposed publications. The timeframe for this is 12 to 18 months following the end of the data collection.

All text documents, including reports, manuals, questionnaires, and codebooks will be available in their original editable format (*Word*, *Excel*, etc.) and in Portable Document Format (PDF), according to MCC's guidelines.

Command file and data file formats will be the same and submitted in the Stata format. The data files will include variable names, labels, response value labels or formats, and clearly defined associations between survey questions and the variables containing the responses.
Metadata will be provided in formats compliant with the International Household Survey Network (IHSN)'s Metadata Editor, which includes ".nesstar" and DDI compliant ".xml" files (as exported by the IHSN Metadata Editor).

6.3 Dissemination Plan

IMPAQ will produce draft and final evaluation reports to present the results of the analysis. One report and set of presentations will be produced after the first round of data collection, and a second report and set of presentations after the second wave of data collection. In Senegal, audiences will include MCA-S and MCC staff, project implementers, local academics, government statisticians, government ministries, development professionals, and other interested parties. In Washington D.C., outreach sessions will be provided to MCC, development professionals, and other interested parties.

All reports will include technical/academic Sections, as well as easy to understand Sections for broader circulation. All evaluation reports will include an executive summary (less than 10 pages) in both English and French; presentations of results in Senegal will be in French.

6.4 Evaluation Team

IMPAQ's evaluation team is composed of:

Dr. Jacob Benus *Ph.D., Economics, University of Michigan*, is IMPAQ's Executive Director of Research. Dr. Benus is an economist with more than 30 years of experience directing studies that evaluate employment and job training programs and in implementing rigorous evaluation projects. Dr. Benus will act as the project's senior research associate and provide overall technical guidance. Dr. Benus has completed many important and highly regarded international poverty and labor research projects. For example, he completed evaluation projects for the World Bank, the Inter-American Development Bank, the Czech Republic, China, South Africa, Jordan, Turkey, and Armenia. Many of these projects have involved designing new social safety net programs and evaluating their cost-effectiveness. He is also the principal researcher in the Millennium Challenge Georgia Fund Data Quality Review (DQR) and in the Millennium Challenge Account-Ghana Mid-Term Review. He has led and completed projects in China, Senegal, Turkey, South Africa, Bosnia, Czech Republic, Romania, Kyrgyzstan, Peru, and Armenia and provided training on M&E methodology for researchers and government officials in many countries. Dr. Benus is the principal investigator in the MCC Impact Evaluation of the Burkina Faso and Senegal Roads project and provides technical lead for all home and field based activities for the IWRM project.

Dr. Harounan Kazianga, *Ph.D. Agricultural Economics, Purdue University*, is a Professor of Economics at Oklahoma State University, specializing in development economics, agricultural economics, health, and education in Sub-Saharan Africa. Dr. Kazianga will act as the project's Program Manager and will lead the evaluation's technical components. For the past 10 years, he has conducted extensive field research in Africa on the impact of scaling up access to HIV/AIDS

treatment, the impact of food and cash transfers on health and education, technological change in agriculture, and gift exchange and risk coping strategies. He worked as consultant for the World Bank on several projects, including urban and land titling projects in Burkina Faso. He is part of IMPAQ's evaluation team for all Burkina Faso and Senegal MCC projects. Dr Kazianga provides technical assistance in research and survey design, as well as specific content knowledge of agricultural and land related issues in developing countries. Dr. Kazianga is a national from Burkina Faso and a French native speaker.

Dr. Alisú Schoua-Glusberg, *Ph.D., Cultural/Linguistic Anthropology, Northwestern University*, is a social science researcher with nearly 30 years of experience in survey design and implementation, data analysis and processing, training for interviewers and supervisors, training materials development, and in the use of qualitative research to support the design of instruments for quantitative research. She will act as the project's survey specialist, design data collection protocols, and oversee the implementation of surveys. Currently, Dr. Schoua-Glusberg serves as IMPAQ's Senior Director of Survey Operations, where she has brought her extensive knowledge of survey methodology to studies such as Project GATE, the Job Corps National Data Collection Project, and the Unemployment Insurance Benefits study, as well as a variety of international projects. Dr. Schoua-Glusberg has extensive experience in quantitative and qualitative research, and has an international reputation in survey instruments' translation and preparation of culturally appropriate instruments and materials. She has served on the Expert Panel on Translation at the US Census Bureau, collaborating in a project aimed at drafting best practices and guidelines for Census Bureau translations. Since 2002, she is one of the four members of the Translation Taskforce for the European Social Survey. Dr. Schoua-Glusberg is fluent in French.

Dr. Bambio Yiriyibin, *Ph.D. Economics, University of Ouagadougou* is a Professor of Economics at the University of Ouagadougou, a national from Burkina Faso, and a French native speaker. Dr. Yiriyibin will act as the project's Field Program Manager and will support the implementation of the evaluation in the field. He is currently involved with IMPAQ as local consultant in the MCC evaluation projects in Burkina Faso and Senegal. He collaborates in impact evaluation design, trainings and workshops, presentations on impact evaluation for local stakeholders of MCA projects, and provides support and guidance to MCA's survey activities. Dr. Bambio also worked as coordinator for other World Bank projects in Burkina Faso.

Dr. Geena Kim, *Ph.D., Economics, University of Pennsylvania*, is a research associate at IMPAQ International. She will act as a research associate on the project and provide technical and financial oversight, including data quality review and analysis and reporting and budgeting. Dr. Kim has experience designing and implementing impact evaluations of international and national government policy projects. She currently holds responsibility for designing, implementing, and analyzing the impact evaluations of the MCC's roads rehabilitation and agricultural development and irrigation projects in Senegal and Burkina Faso, and leads the impact evaluation of the U.S. Department of Health and Human Services, Centers for Medicare & Medicaid Services' (CMS) Acute Care Episode Demonstration program on the volume of the medical services performed and beneficiaries' use of the services. Her areas of research expertise include applied econometrics, health economics, labor economics, and public policy. Dr. Kim has a strong background in quantitative analysis and data programming. She has analyzed and worked with several large and complex datasets, including the National Longitudinal Surveys of

Youth, Panel Study of Income Dynamics, Health and Retirement Study, Current Population Surveys, and Medicaid claims data.

Dr. Sara Borelli, *Ph.D., Economics, University of Illinois at Chicago*, is a research associate at IMPAQ International. She will act as a research associate on the project and provide technical oversight, including data quality review and analysis. Dr. Borelli has expertise in health economics, labor, economics of the household, and impact evaluation. She has a strong background in quantitative analysis and extensive training in applied econometrics acquired during her graduate studies in Italy and France, and during her Ph.D. studies in the U.S. Dr. Borelli also has extensive experience managing, gathering, cleaning, and analyzing administrative, survey, and secondary data for several domestic and international research projects, including the U.S. Census, American Community Survey, National Center of Health Statistics, and World Bank Living Standards Measurement Study (LSMS) surveys, among others. Dr. Borelli has authored research papers in health economics, economics of the household, and public policy. Dr. Borelli currently works on domestic projects in health economics including the impact evaluation of the Physician Quality Reporting System program (PQRS) for CMS, and on international projects including designing the impact evaluation of the Workers Rights Center Project in Colombia (DOL-ILAB), and the quantitative analyses of MCC roads and irrigation projects. Dr. Borelli is fluent in French.

Laurence Dessein, *Ed.M., International Education Policy, Harvard University, Cambridge MA*, is a senior research analyst at IMPAQ International, specializing in international and education research. She will act as a project manager/research associate on the project and provide technical support and corporate and contractual oversight. Ms. Dessein has more than 9 years of experience conducting and managing the implementation, research, and evaluation of complex education and health policies and programs in developing countries. She has experience in conveying research from the concept through design, implementation, and report stages. Her technical areas of research expertise include early grade learning, social and emotional development, gender equity, life skills, and teacher professional development. Methodologically, Ms. Dessein works across quantitative and qualitative approaches, often building a mixed-methods design to maximize the utility of both. She has managed and implemented several impact evaluations of education initiatives, and is also experienced in using interview, focus group, observation, and document-review techniques. To date, she has conducted work for a variety of clients, including the U.S. Agency for International Development (USAID), the United Nations Children's Fund (UNICEF), the Children's Investment Fund Foundation (CIFF), the Raikes Foundation, the MCC, the World Bank, and foreign governments. She is bi-lingual in French-English and proficient with STATA.

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APPENDIX A: DELTA SAMPLING

In the spring of 2012, the ANSD conducted extensive enumeration in the Delta area, covering the Saint Louis and Dagana departments, for a total of about 11,600 households. IMPAQ used the enumeration files to sample and match households, and provided a memo to MCA-S explaining the methods used and a file containing the specific households to be interviewed in the treatment and comparison areas.

MCA agreed to sample sizes of 1,306 treatment households matched to 1,306 comparison households. In the sample file attached, IMPAQ included larger samples than the target sample sizes. Specifically, the household sample file contains 1,637 treatment and 1,637 comparison households (about 25 percent more than the proposed sample sizes). We provided the larger samples because the survey firm may not be able to interview 100 percent of the sample. Our goal is for at least an 80 percent response rate.

As described in the memo to MCA-S (and in Section 3) IMPAQ randomly sampled 1,637 treatment households from the enumeration files, then matched each treatment household with a comparison household most similar to the treated household in its relevant pretreatment characteristics. The following table presents descriptive statistics that compare the treatment sample with the matched comparison sample. IMPAQ also presents statistics for the full sample of comparison households from the enumeration file. As indicated in the table, the matching process improved the similarity between treatment and matched comparison samples relative to full comparison group.

Exhibit 16: Household Characteristics in the Delta Samples

Matching Variables	Treatment Sample	Matched Comparison Sample	Full Comparison Group
Household (HH) head's age			
Mean (year)	47.0	47.0	48.1
HH size			
Mean (number)	8.7	8.8	9.4
Number of active male HH members			
Mean (number)	2.1	2.2	2.3
Number of active female HH members			
Mean (number)	1.4	1.4	1.6
Number of male HH members working in agriculture			
Mean (number)	2.5	2.2	2.0
Number of female HH members working in agriculture			
Mean (number)	1.2	0.86	0.82
HH head's sex			
Male (%)	82.8	83.1	83.2
HH head's literacy			
Literate (%)	59.2	63.4	64.2
HH head's Ethnicity			
Oulouf (%)	47.4%	56.5%	67.4%
HH head's socio-administrative position			
Yes (%)	23.6	23.7	23.7
Land status of HH head			
Landless (%)	19.7	29.4	35.7
Titre d'affectation (%)	20.3	14.4	8.4
Customary Law (%)	22.3	19.8	12.9
Applicant for land regulation (%)	9.8	5.3	2.9
Affecté par un projet (%)	15.8	17.3	26.1
Participation in – Paesant Organization			
Yes (%)	44.3	41.2	41.6
Nature of roof of the house			
Concrete / cement / tile / slate (%)	40.3	34.5	21.0
Zinc (%)	40.8	54.9	73.0
Nature of floor of the house			
Tiles / cement (%)	79.1	83.8	84.5
House has walls			
Yes (%)	28.3	21.1	20.0
Total Number of Households	**1,637**	**1,637**	**2,968**