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The World Bank

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IMPACT EVALUATION CONCEPT NOTE

for

SUSTAINABLE AGRICULTURAL INTENSIFICATION AND FOOD SECURITY

PROJECT (SAIP) - P164520

Development Impact Evaluation

World Bank Research Group

September 2019

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Acronyms

BCC – Behavior Change Communication

FG- Farmer Group

ECD – Early Childhood Development

DEC - Development Economics Vice Presidency

DIME – Development Impact Evaluation

FFS – Farmer Field Schools

GAFSP – Global Agriculture and Food Security Program

GoR – Government of Rwanda

ICC- Intra-Cluster Correlation

IE – Impact Evaluation

ISM – Implementation Support Mission

LWH – Land Husbandry, Water Harvesting and Hillside Irrigation Project

MDES- Minimum Detectable Effect Size

MTR – Mid Term Review

MINAGRI – Ministry of Agriculture and Animal Resources

O&M – Operations and Maintenance

PA – Productive Alliance

PAD – Project Appraisal Document

PDO – Project Development Objective

RAB – Rwanda Agriculture Board

RCT – Randomized Control Trial

SACCO – Savings and Credit Co-operatives

SPIU – Special Project Implementation Unit

PSTA IV – Strategic Plan for Agricultural Transformation

Executive Summary

The Sustainable Agricultural Intensification and Food Security Project (SAIP) aims to increase agricultural productivity, market access, and food security of targeted beneficiaries in the project areas. The project represents a second public window investment by the Global Agriculture and Food Security Program (GAFSP) in Rwanda, following the recently completed Land Husbandry Water Harvesting and Hillside Irrigation Project (LWH). SAIP focuses on consolidating and expanding results from the predecessor projects and schemes developed by the Ministry of Agriculture and Animal Resources (MINAGRI), with an emphasis on building organizational capacity in the sector and supporting linkages to market to create additional livelihood opportunities. The project also aims to scale up efforts related to nutrition-sensitive and climate-resilient agriculture from previous projects.

The Development Impact Evaluation (DIME) team worked closely with teams from the Government of Rwanda and the World Bank on the design and implementation of multiple Impact Evaluations (IE) related to the LWH project. These included evaluations of the impact of the overall approach of the project, and related to the effect of dry-season irrigation on agricultural productivity. Households in LWH sites witnessed large impacts on agricultural production indicators directly attributable to the project – 35-60% higher harvests relative to households in comparable control sites. Access to services, use of inputs and adoption of technologies were all significantly higher for households in LWH sites. Early results in the irrigated sites point at large increases in earnings, on the order of nearly 100%.

In addition to evaluating the impact of large-scale infrastructure investments, DIME's work with the LWH team included running Randomized Control Trials (RCT) to test the operational delivery of two key elements of LWH's approach – rural finance and extension services. The introduction of two innovative savings products through in LWH sites saw fairly typical take-up rates of 25-30%, translating into increased investments in inputs in the primary growing season. Subsequently, the government prioritized building the capacity of SACCOs and strengthening cooperatives. Given LWH's focus on providing farmers with high quality extension, the team set up an RCT to test how feedback mechanisms could help improve the efficiency in delivering extension services. Farmers groups with access to feedback tools were 28 percentage points more likely to attract new members, relative to control farmers groups that had an 8 percent chance to attract new members. The most cost-effective feedback mechanism (a hotline) was adopted and scaled up by a private extension provider throughout Rwanda the following season.

Despite the strong gains made in LWH project sites, there remains significant potential for increased optimization of the investments, and ensuring that all farmers are able to realize increased returns. While take-up of dry-season irrigation has seen steep increases over the last 2 years, more than 50% of surveyed farmers still choose not to adopt irrigation. One potential avenue to increase efficiency and boost productivity and incomes is reducing frictions in the output markets. A key goal of SAIP is to encourage the involvement of the private sector to insure against the risks of adopting the high-value seasonal crops. Finally, while food insecurity reduced dramatically across the sample, there continue to be substantial margins on which to improve dietary and nutrition practices.

The IE presented in this Concept Note represents the continuation of a partnership between the Government of Rwanda and the World Bank that has generated a series of knowledge products and learning over the last six years. A new phase of interventions in the sites presents an opportunity for continued learning and informing implementation modalities. The evaluation closely follows the areas of focus of the new project: irrigation optimization, agricultural commercialization and enhanced nutrition, providing a credible estimate of the overall impact of the investment. The design for the evaluation is the product of close discussions involving senior policy-makers in MINAGRI, the implementing institution – Rwanda Agriculture and Animal Resources Development Board (RAB) and the World Bank’s Task Team; culminating in an IE design workshop in Kigali in December 2018. The strong buy-in from the senior management in RAB and in the supervising entity are key pillars in ensuring alignment between project interventions and research questions. Finally, a key focus for the IE team is on building capacity within the Project Implementation Unit (PIU) to be informed consumers of IE-evidence to help ensure that the data and findings are mainstreamed to improve project delivery.

1. Background

1.1 Strategic Context

Over the last decade, Rwanda's economy has grown at a rapid pace and transformation of the agriculture sector remains a key focus of the government's efforts to reduce poverty and increase employment (National Strategy for Transformation, 2018). Implementing policies including the Crop Intensification Program and land use consolidation beginning in 2007 and 2008 respectively, the government has sought to boost smallholder production, but there remains significant room for improvement. Fractured land-holdings and heavy reliance on rain-fed agriculture remain significant barriers in enabling farmers to maximize earnings and move further up the value chain. Additionally, while stunting and undernourishment have been declining at a steady pace across Rwanda, overall stunting rates are 38%, and 17.8% of children aged 6-23 months do not get the minimum acceptable diet (National Institute of Statistics Rwanda, 2015).

Within this context, the Ministry of Agriculture and Animal Resources (MINAGRI) has been working through a Single Projects Implementation Unit (SPIU) to improve farmer productivity, increase commercialization and boost nutritional outcomes. The Third Rural Support Project (RSSP3) and the Land Husbandry, Water Harvesting and Hillside Irrigation Project (LWH) are two examples of large investments in the rural economy over the last several years and represent the government's desire to drive progress in this sector. The two projects focused on improving productivity in targeted hillside and marshland areas through a consolidated approach to infrastructure development, access to services and information interventions. The projects reached over 150,000 households in 27 Districts.

Against this backdrop, the Sustainable Agricultural Intensification and Food Security Project (SAIP) will focus on consolidating and expanding the results obtained under LWH and RSSP3, and other MINAGRI-developed schemes. The Project Appraisal Document (PAD) emphasizes the need to find pathways to ensure sustainability of these investments including (but not limited to) through building the strength of producer organizations, their negotiation capacity with commodity buyers and other value chain actors and their entrepreneurial capacity. Increased productivity and linkage to markets remain core areas of emphasis of the project, as does scale-up efforts and nutrition-sensitive and climate-resilient agriculture from previous projects. SAIP components aim to deliver on these objectives through a series of interventions divided into three core components (see Section 3 for more details). The impact evaluation (IE) aims to respond to specific research questions directly tied to project interventions, thereby allowing the project to (a) understand the most optimal version of each delivery mechanism, (b) learn what set of interventions works best together and/or stand-alone and (c) use both these pieces of information along with the broader evidence produced by the IE to make scale-up and down decisions. Given the long-term goals of the project focusing on sustainability and institutional capacity, the IE aims to work directly with SAIP in delivering the most effective and efficient set of program interventions.

1.2 Implementation arrangements

The core priority of the IE is to help inform project delivery against the objectives laid out in the PAD. These include highlighting the set of interventions that work to most effectively and efficiently meet the Project Development Objectives (PDO). In order to deliver against this target, successfully implementing the IE involves the following key components:

- Defining key priority areas for the IE and streamlining the same with implementation modalities

- Coordinating and overseeing program implementation
- Ensuring timely and high-quality data collection
- Disseminating findings and evidence to stakeholders on an ongoing basis

These responsibilities will be split across the research team, the task team and the client as follows:

Party/Team/Individual	Point Person	Broad Responsibility
DIME	Florence Kondylis, John Loeser, Saahil Karpe	Co-leading the design of the IE and defining research questions; supervising data collection and analysis; leading the dissemination of IE evidence to all relevant internal and external stakeholders; building IE capacity within the SPIU team and line ministry to ensure greater ownership of the IE.
World Bank SPIU	Jean-Marie Vianney Kagenza	Co-leading the design of the IE; ensuring SPIU participates actively in supervising data collection and analysis, and that the project is implemented on time and according to plan; coordinating the delivery of individual components
World Bank Operational Team	Winston Dawes	Co-leading the design of the IE; providing implementation support for SAIP; coordinating overall implementation arrangements

Working across these tasks and carrying through on the responsibilities involves a high degree of coordination across the aforementioned 3 teams. Aside from ongoing and consistent communication, there are a few key milestones that present opportunities for due diligence on completed tasks and future plans. These include: (a) the finalization of the IE concept note, (b) preparation for the IE survey, (c) presentation of survey results, (d) preparation for the IE follow-up survey, (e) presentation of the IE follow-up results. Detailed roles and value-add for each of the 3 parties in this process are presented below.

Development Impact Evaluation (DIME) is a department within the Development Economics Vice Presidency (DEC) of the World Bank Group. DIME generates high-quality and operationally relevant data and research to transform development policy, help reduce extreme poverty, and secure shared prosperity. It develops customized data and evidence ecosystems to produce actionable information and recommend specific policy pathways to maximize impact. The work is based on a co-production model aimed at transferring capacity and know-how to partners to make mid-course corrections and scale up successful policy instruments to achieve policy outcomes. The department conducts research in 60 countries with 200 agencies leveraging a \$180M research budget against \$18B in development finance.

DIME worked very closely with the LWH Project on multiple rigorous Impact Evaluations (IE) over the span of 2012-2018 to generate evidence in relation to key impact channels for the project. The results from this report were shared with the project team, operational colleagues and the GoR at-large during the final implementation mission for LWH. Findings from the Overall Impact of the LWH project are presented in Annex 1. All members of the DIME research team involved with the SAIP IE have worked closely with the project team on the IE of the LWH project. Additionally, DIME's portfolio of agriculture IEs in Rwanda now stands at 5 active evaluations. Leveraging the expertise across IEs has already served to benefit each

of them individually. The continued accumulation of contextual knowledge and relevant skills across the portfolio serves to help each project significantly, and SAIP is no exception in leveraging those economies of scale. This makes DIME the ideal technical partner to work to lead the design and implementation of the IE(s) related to SAIP.

SAIP will be implemented by MINAGRI, supervised directly by one of the Ministry's implementing agencies – the Rwanda Agriculture and Animal Resources Development Board (RAB). The DIME team has been working closely with operational and management staff from both the GoR and the World Bank (WB) project management from the inception of this IE. Discussions around an evaluation for the project are the result of a request from the Director-General of RAB in October 2018. Following this request, the DIME team travelled to Kigali to work with the RAB-SPIU and the World Bank Task Team during a one-day IE design workshop that was focused on developing a research agenda and ensuring alignment with client-driven operational questions.

The Operational Team (Winston Dawes and Esdras Byiringiro) were key contributors to the IE design through their participation in the workshop and subsequent contribution to this Concept Note. The continuity and support from the SPIU and the supervising entity will serve as an asset to the implementation of the SAIP IE and the use of evidence it generates.

As the project moves towards implementation, the research team aims to work closely with the operational and government teams to ensure that IE elements are streamlined into program rollout in a way that knowledge generated can feed back into design during every phase of planning and implementation. This will involve full-time presence in Kigali and close collaboration with the SPIU through an in-country Field Coordinator. The TORs for the Field Coordinator can be found as Annex 3. The research team will coordinate closely with the task team to find avenues to provide insights into operational Implementation Support Missions (ISMs) throughout the life-cycle of the project to provide inputs into the supervision process.

1.3 Audience for the Research

The learning agenda related to the LWH project is an exceptional example of how governments can take a sector-wide approach to impact evaluation. What started as one GAFSP-financed evaluation – the overall impact of LWH – has evolved into a large portfolio of IEs in the agricultural sector, driven by keen interest from MINAGRI to systematically learn from robust evidence. Studying the overall impact of LWH presented the GAFSP and DIME with an entry-point into a large infrastructure investment with the capacity to profoundly transform the rural sector. DIME has worked closely with the SPIU, MINAGRI staff, the World Bank Task Team, as well as technical partners, in designing IEs aimed at answering questions related to the delivery, sustainable maintenance and use, and overall impact of this flagship program.

Since 2012, DIME worked with partners to collect 5 rounds of data across 1000 households in 9 sites for the Overall Impact Evaluation and an additional 3 rounds of data across 1200 households in 4 sites. These rich panel datasets allowed the team to provide feedback to the government and supervising entity during key parts of the operational process. At the end of every survey and during the project's Mid Term Review (MTR), DIME contributed to analytical discussions through a combination of presentations and reports. The results from the evaluations were also shared with the project during the final implementation mission. In addition, results from the LWH evaluations directly fed into the design of the SAIP project

(including through references in the PAD) and have been cited in the government's forward-looking agenda – specifically, in the government's Strategic Plan for Agricultural Transformation (PSTA IV).

Building off gains made over the last 5 years, findings from the evaluation questions related to the SAIP will inform the operational delivery of the project across its many components. The IE targets questions at each stage of implementation cycle – intervention take-up, component implementation and causal impact on a range of outcomes. The primary audience for the results of the SAIP IE will be

1. The technical and operational staff supporting implementation of the project (the TTL and other members of the operational team and GP management)
2. Policy-makers and government officials in Rwanda (including but not limited to the Director General, RAB; Permanent Secretary, MINAGRI and the Director General Crop Production, MINAGRI)
3. Donors and development partners in Rwanda (including those that are part of the Agriculture Sector Working Group)

The specific aim IE dissemination is to ensure that learning happens throughout the life-cycle of project delivery, while changes in implementation modality can still be implemented; as opposed to waiting for implementation to be complete. Relatedly, a key goal of the IE is to deliver findings across a subset of research questions for discussion and decision during the project. This local dissemination will happen through workshops held during missions, involving coordination with the operational team to ensure that IE missions and operational missions are planned concurrently. Two key points at which preliminary and final results will be shared are the project's-Term Review (MTR) and at closing. The MTR is a key mission in World Bank supervised projects that aims to take stock of all lessons learnt, failures and successes to that point and make key decisions on scale up and down. The evidence from the IE aims to help feed into those decisions. At closing, World Bank supervised projects aim to systematically document the performance of the project on a series of technical and financial indicators. Data and findings from the IE are a natural fit to inform these processes.

In addition, GAFSP Steering Committee meetings and other dissemination events organized by the GAFSP Coordinating Unit are ideal platforms for sharing rigorous evidence around the impacts of SAIP. This includes donor coordination meetings, the GAFSP website and any related public-facing blogs and/or events. One key output that for these fora is to ensure that IE findings are shared both in technical and academic formats and in policy-oriented reports and briefs. This will ensure a wider reach of the findings and evidence, and a broader impact on a crucial area of development practice.

In addition to delivering evidence on key operational and policy questions, this IE contributes to a large, global research agenda on effectiveness of agriculture interventions (DIME-aadapt), which includes 29 projects in 17 countries across Africa, South Asia, Latin America, and the Caribbean. DIME's agriculture portfolio is embedded in a larger cross-sectoral impact evaluation agenda including more than 150 impact evaluations across the world. Representatives from MINAGRI and the Bank operations team have already participated in capacity building and dissemination events of this global community (Dakar – 2011, Naivasha - 2012, Kigali – 2014 and Lisbon - 2017), and will share the results and experience from the SAIP IE in future events, thus reaching a wide audience of policymakers worldwide.

The IE team will produce high-quality research papers for presentation at research BBLs at the World Bank and outside (e.g. DECRG and DIME seminar series, and at research universities around the world), events

and trainings as well as international development conferences. The findings will be published as DIME policy briefs and submitted to peer-reviewed economics journals, thus reaching a wide audience of researchers, practitioners, and graduate students worldwide. All data will be made available online on the databank for IE, following the Bank's open data policy.

2. Motivation and Literature Review

The Government of Rwanda (GoR) considers agriculture a crucial engine for the economy (cf. Rwanda Vision 2020; Rwanda's National Strategy for Transformation) and aims to reduce poverty and achieve food security through commercialized agriculture. This calls for improved and sustainable productivity. SAIP is one of the important projects of MINAGRI designed to meet this objective through a multi-pronged approach to increasing farmer capacity, improving last-mile market access and enhancing food and nutrition security.

Investments aimed at improving the optimal use of irrigation and increase farmers' connections to markets have enormous potential to improve the lives of smallholder farmers in the Rwandan context. There are three agricultural seasons in Rwanda. In season A, rainfall is sufficient for production in most years. In season B, rainfall is sufficient in an average year but insufficient in dry years. In season C, rainfall is insufficient for agricultural production. Irrigation therefore has the potential for large impacts on farmers lives – increasing yields across all seasons, eliminating risk in Season B, and adding cultivation in Season C. This is reflected in MINAGRI's ambitious expansion and scale-up plans for hillside irrigation: between 2017/20 and beyond, MINAGRI plans 15,300 ha of planned hillside irrigation development. Hence, the lessons learned from the SAIP experience have the potential to not only affect ongoing investment, but to massively affect returns to irrigation investment in the coming 5 years.

Our study is unique in combining an estimate of the overall benefit of productivity-enhancing mechanisms with randomized evaluation of complementary interventions. A major focus of SAIP is to deliver interventions through farmer and water-user groups and will involve careful consideration of the associated public good and agency concerns. We build on a literature that studies the role of different governance structures in achieving public good provision (Alesina, Baqir, and Easterly 2000; Galliani, Gertler, and Schargrodsky 2005; Glennerster, Miguel, and Rothenberg 2013). Our contribution includes a randomized design, and the fact that we are able to carefully measure an important, homogeneous public good with nearby natural variations in the underlying governance structure across contiguous plots.

Studying the set of SAIP interventions that aim to improve farmer linkages to output-markets has the potential to add to a growing literature that has heretofore focused on contract farming. Contract farming most commonly takes the form of an agreement between growers and processors of agricultural commodities with stipulations that include quality and quantity, amongst others. Traditionally, arrangements between buyers and sellers exist in two main forms – production and marketing (Bellemare and Lim, 2018). In the former, the processor takes over production decisions and supplies inputs, while the growers deliver agricultural. Under marketing contracts, the grower has greater ownership over production decisions, while the processor stipulates price and quantity, generally in advance of the growing cycle (Eaton and Shepherd, 2001).

One major advantage of contract farming is its ability to connect small-scale farmers – who in equilibrium face coordination and information challenges in finding commercialization avenues – to domestic and

foreign markets (World Bank, 2004). Limitations in market access often prevent small-scale farmers from diversifying crop cultivation, and contract farming can offer a solution by securing market opportunities (Eaton and Shepherd, 2001). While the literature on market-linkages and contract-farming is wide-ranging, many studies rely on non-experimental survey data – raising issues of endogeneity and worries on causal inference (Barret et. al., 2012; Bellemare and Bloom, 2018). In evaluating the roll and value of efficient output-markets, the evaluation of SAIP takes the underlying theory into account and aims to contribute to the experimental literature and evidence in the space.

Field experiments overcome the issue of endogeneity, but there remain areas for increasing the evidence-base. A contract-farming field experiment in Madagascar used random variation of participation prices to back out willingness to pay and account for unobservable difference. The study indicated that a 1 percent increase in the propensity of participation in contract farming increases household income by 0.5 percent (Bellemare, 2012). The study that most closely follows the motivation and design of SAIP interventions is an RCT in Kenya studying the impact of cashless microfinance, while facilitating connections between smallholder farmers and export markets in Europe. Treated farmers were 19 percent more likely to grow export commodities, but the scheme collapsed in year 2 as farmers were not able to comply with new European regulations (Ashraf, Gine and Karlan, 2009). Our study is strongly informed by this work, and will aim to understand the relative timing of resource allocation in the design of potential contracts to overcome the underlying constraints.

Given the multi-pronged and holistic approach of SAIP, understanding the link between output markets, increased farmer earnings and improved farmer welfare (including food and nutrition security) is crucial to informing our research agenda. Unfortunately, experimental evidence investigating these mechanisms and pathways is sparse. Limited non-experimental evidence – using repeated cross-sectional data and proxies for transaction costs related to contract implementation – points at a positive correlation between production contracts and income, and between marketing contracts and improved food security (Soulier and Moustier, 2018). Another case study using a nationally representative survey dataset from Tanzania points at a statistically significant correlation between crop income and commercialization, but not with household dietary diversity (Hermann, Nkonya and Fabe, 2018). Finally, survey data from a World Bank study on contract farming in Madagascar finds that on average, contract farming reduces the duration of the hungry season by eight days, and that contracted households are 18 percent more likely to end their hungry-season at any time (Novak and Bellemare, 2016). Rigorous and experimental evidence on the effects of contract farming on nutritional intake is even more scarce. Our study aims to build on the limited experimental evidence linking agricultural commercialization and nutritional intake which indicates positive correlations with zinc and iron consumption (Ogotu, Dodecke and Qaim, 2017). Recent cross-country work suggests that food security must be dealt through a multi-pronged approach (All Hands on Deck, 2018). SAIP involves a unique opportunity to add to this growing literature given the large set of interventions directed to a specific intervention area.

A major operational modality of SAIP interventions is the use of matching grants to ensure that farmers and farmer-groups have “skin in the game”. Matching grants are an increasingly popular development tool, appearing prominently in over 60 World Bank-supported projects and totaling USD 1.2 billion in investment (Campos et. al, 2012). Unfortunately, rigorous evidence to support their effectiveness in promoting take-up of innovative technology is scarce. Common issues that have prevented the implementation of RCTs include continued project delays, lack of political will to randomized assignment, and low project take-up (Campos et. al, 2012). Despite these constraints, the limited rigorous evidence on

matching grants does indicate positive impacts on technology investment, management decisions, long-term employment and return on assets (Mckenzie, Assaf and Cuolito, 2017; Bruhn Karlan and Schoar, 2013). Our study interventions take each of the potential constraints into account and aims to contribute to the evidence-base on the impacts of matching grants in the sphere of agricultural productivity and commercialization.

These knowledge gaps impose different sets of constraints across levels of policy-making. At the local level, the SAIP project team has a pressing need to test what fee structure, contractual arrangements, and self-demonstration can lead to higher technology adoption and overall productivity increase. At the international level, donors including the GAFSP and multilateral agencies like the World Bank are anxious for evidence on not only the returns, but also the sustainability of these productivity-enhancing investments. Finally, the project design allows for us to investigate overlapping and interlinked components that build off one another. Our proposed research will shed light on these central issues, and aim to inform local and international policy dialogues.

3. Description of the Interventions

The Project Development Objective (PDO) of SAIP is to increase agricultural productivity, market access, and food security of the targeted beneficiaries in project areas. The project will operate in selected, existing LWH and RSSP3 project areas: Muyanza, Rwamagana-34, Karongi-12, Karongi-13, Kayonza-4, Nyanza-23, Gatsibo-8, and Nyabihu. These sites are in eight districts: Rulindo, Rwamagana, Karongi, Rutsiro, Kayonza, Nyanza, Gatsibo, and Nyabihu. The primary mode of implementation for project interventions will be to reach farm households through SHGs of 20-30 members each.

The project consists of the following complementary components:

1. Institutional Strengthening, Agriculture Productivity Enhancement, and Nutrition Improvement
2. Irrigation and Water Use Efficiency
3. Market Linkages and Value Addition Investment Support
4. Project Management and Technical Assistance

Component 1 focuses on strengthening farmers organizations, analysis of productivity enhancing opportunities in selected value chains, and improving nutritional outcomes at the household level. The interventions under this component will aim to work closely with the FAO technical assistance team. The nutrition-component will be implemented in close collaboration with the World Bank-funded Stunting Prevention and Reduction Project, which was approved in FY18, and other Government initiatives. This will involve ensuring coordination with the project in areas of co-location with these interventions to understand the potential for studying food security and nutrition-related outcomes. ***In relation to this component, the IE aims to test the effectiveness of the project in improving smallholder's food and nutrition security and awareness. This will include identifying the indicators that are most directly relevant to the design of the complimentary and co-located interventions. In addition, there will be a focus on understanding the overlap between increased agricultural productivity, improved access to markets and behavior change interventions in improving nutritional and dietary practices and adoption of nutrition-sensitive agriculture.***

Component 2 is expected to promote technology and best practice for increased availability and efficient use of water for irrigation, to increase crop productivity and boost farmers' resilience to climate volatility. Specifically, the SAIP project interventions will build on the existing infrastructure by providing matching grants for small-scale irrigation equipment to the farmers including sprinklers, drip, gated-pipes, or hose-furrow technologies and creating awareness on how to use that equipment effectively and efficiently. The project will also fund on-farm training in the handling, assembling, and proper use of different irrigation equipment to improve adaptation rates and irrigation practices among farmers. Finally, through collaboration with Banks and SACCOs, the project aims to create an enabling environment to relax credit constraints and enable take-up. ***Under this component, the IE aims to understand (a) the optimal enabling environment in incentivizing the take-up and utilization of these technologies and (b) the impacts of the improved technologies, including mechanization, on farmer productivity and income.***

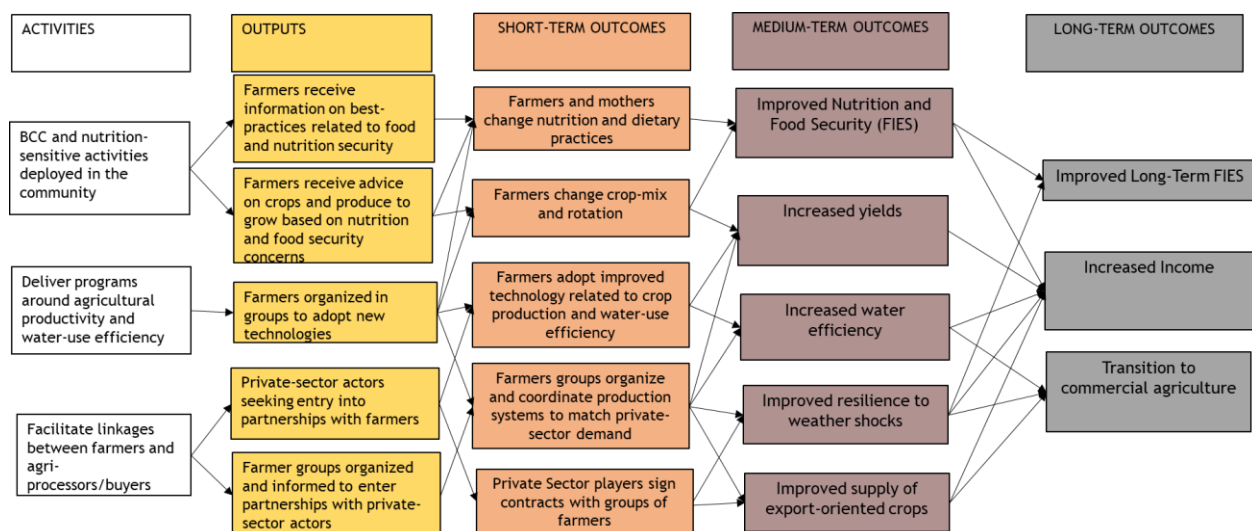
Component 3 aims to enhance market linkages and value addition by strengthening the capacity of farmers' organizations and other value chain actors and by improving their access to finance and markets. Interventions under this component are expected to complement Components 1 and 2, supporting farmers' last-mile market access. This component covers a range of interventions including capacity building for post-harvest handling, support in quality certification, and matching grants for packing and processing equipment. Finally, it aims to work with SACCOs to build capacity and improve overall management. Many of the specific interventions implemented under this component will be designed by the project in close collaboration with the Food and Agriculture Organization (FAO). The planned consultations aim to focus on the specific role of the project in facilitating linkages between groups of farmers and agri-food processes and buyers. This includes coordination of inputs, adoption of technology and production systems. The FAO TA aim at enhancing market linkages and value addition by strengthening the capacity of farmers' organizations and other value chain actors and by improving their access to finance. This will be done through increased performance and commercialization of selected value chains. The component will work in tandem with Component 1, supporting farmer organizations to improve their market orientation; and connecting farmers to markets, thus channeling the productivity gains made in component 1 and 2. With the understanding that strong and sustainable business plans ensure sustainability of market linkages, FAO TA will also use the RuralInvest software which is a toolkit for preparing sustainable agricultural and rural investment projects and business plans.

The focus of the IE under this component will follow from discussions with the FAO and is in understanding the optimal contractual relationship between farmer groups and agri-processors or buyers to build linkages and reduce up-front risk.

5. Theory of Change

Each component of the project has a key constraint that the related intervention is attempting to alleviate. The figure below presents a simplified version of a theory of change, and is followed by a description of key assumptions.

Figure 1: Theory of Change



First, we hypothesize that key barriers to increased nutrition include awareness and availability. One avenue for this insight includes the fact that in the predecessor LWH project, almost 60% of households across sites cited having kitchen gardens (traditionally thought of as channels to reduce food insecurity). However, differences in food security levels between the treatment and control sites were not precisely estimated. One key intervention part of this component of SAIP is Behavior Change Communication (BCC), and connections to Early Childhood Development (ECD) centers that aims to improve adoption of improved nutritional practices, dietary enhancements and nutrition sensitive agriculture; amongst others. The theory of change is grounded in the multivariate analytical approach put forth through *All Hands on Deck: Reducing Stunting through Multisectoral Efforts in Sub-Saharan Africa (2018)*.

Second, we postulate that there is a range of informational and incentive-driven factors that will change farmers decisions on whether and when to invest in efficiency-generating infrastructure. Investment in these technologies is only fiscally sensible when farmers adopt high-value crops. This is confirmed by numbers from the predecessor LWH project, in which observed horticultural revenue per hectare is double or more revenue from traditional crops. However, adoption of high value crops requires learning and higher up-front investments. Additionally, farmers may not experiment with adoption of high-value crops if the gains from adoption are not clear and/or if they have no potential de-risking mechanism on the back-end. Access to irrigation infrastructure enables off-season cultivation of high value crops and reduces the yield risk associated with cultivating high value crops the rest of the year. In addition, thin output markets and the lack of guaranteed buyers might prevent take-up. The IE tied to this component takes these concerns seriously, and aims to understand the enabling environment that would boost take-up of irrigation technology; and measure impacts on agricultural productivity and household welfare.

Third, we assume that the overall efficiency of the irrigation infrastructure will be sub-optimal as long as farmers have limited access to markets for their high-value crops. Unlike staples, the high value crops that dry-season irrigation are best suited to can only be maximized in the presence of access to national and international markets. We also assume that from the buyer and/or agri-processor side, coordinating

connections with individual farmers in the irrigated sites can be costly. We think about the project's goals of connecting the buyers and farmer-groups in irrigated areas as enabling win-win outcomes.

The remainder of the theory of change follows from these two assumptions. A virtuous cycle occurs when farmers begin to efficiently use water in producing high value crops – productivities improve as farmers learn how to cultivate high value crops, they gain access to markets as a result of connections to buyers, and are in a strong position to reduce food and nutrition insecurity as a result of increased production and better information. The critical assumptions underlying the theory of change are that interventions have sufficient levels of take-up on both the demand and supply side and are implemented in a way that meet the targeted objectives. Take-up of interventions related to coordination, facilitation and capacity-building is challenging to predict and both the project and the IE face an inherent risk of not meeting the targets set out. These factors are mitigated by the long-term involvement of the project team working in these sites and having developed relationships with farmers. Additionally, many project components are directly linked to LWH interventions and are looking to consolidate these gains; ensuring that the project is not starting from stage 0 in addressing these concerns.

6. Research Questions

The proposed research questions look to inform project targeting and delivery, and to measure impacts as they relate to the PDO and relevant RF indicators. The most important driver for the questions were the government's priorities and identifying key areas for learning. An additional consideration for the design of the questions was important gaps in the literature, with a view towards informing the larger community of practice within the GAFSP portfolio and across implementing institutions.

Overall Question: What is the impact of the SAIP program in improving agricultural productivity, market access and food and nutrition security in selected project sites?

- a. What behavior change interventions within agriculture programs are most impactful and most cost-effective to change dietary practices? Additionally, given the potentially large modifying effect of market development and access on agriculture, how do different types of markets support improvements in diets and nutrition?
- b. What set of factors contributes to the environment that efficiently enables take-up of small-scale irrigation infrastructure and the adoption of efficiency-generating and improved agricultural technology investments? What is the effect of these technologies on farmer productivity and commercialization and marketed share of produce?
- c. How can output-market linkages induce farmers' adoption of improved technologies while re-enforcing private sector interest in engaging with farmers?

7. Main Outcomes of Interest

Given how closely the research questions are tied to the project's interventions, it follows that the project's core PDO indicators lie at the heart of the IE. They are:

- Harvested yield of targeted crops;
- Produced commodities in targeted value chains marketed by participating producers;
- Food Insecurity Inexperience Scale and Food Consumption Score;
- Number of farmers adopting improved agricultural technology, disaggregated by gender.
- Household Income

These indicators feed into the IE's central questions including program take-up, improved agricultural productivity and income, and improvement along the food insecurity experience scale . Data will be collected through a set of combined IE-M&E surveys – in 2 rounds. In addition to the indicators above, surveys will also focus on:

Outcome Type	Outcome Name	Definition	Level
Primary	Gross Agricultural Yield	Total value of output per hectare	Agricultural plot
Primary	Net Agricultural Yield in each targeted value chain	Total value of output per hectare minus total value of inputs (including labor) per hectare	Agricultural plot
Primary	Income and Expenditures	Household income and expenditures in the past month (frequent) and year (infrequent)	Household
Secondary	Adoption of efficiency-generating irrigation systems	Type of small-scale irrigation adopted, price of optimal subsidy	Agricultural plot
Secondary	Connection to markets	Type of contract with buyer initiated, follow-through on contract	Farmer Group
Primary	Food and Nutrition Security	FIES, improved knowledge of nutrition practices, FCS	Household Member

Figure 2: Key indicators

8. Evaluation Design and Sampling Strategy

8.1 Treatment and Control Groups

The identification strategy for each of the three components of this impact evaluation is a Randomized Control Trial (RCT). The unit of randomization varies across individual RCTs, but all three interventions are at the group-level:

- a. Component 1 – Nutrition: Behavior-change communication is a key part of this intervention and will be targeted to a subset of groups in the project areas. The project also aims to improve nutritional practices, take-up of innovative dietary enhancement and adoption of nutrition-sensitive agriculture that complement the increased productivity at the heart of the project PDO. Specific interventions implemented under this component will be based on close collaboration with the Stunting Prevention Project to determine and finalize precise intervention components and related outcomes of interest. In addition, the specific target audience for these programs will be determined based on coordination with the World-Bank supported Stunting Prevention project. Based on the specific materials and target audience, units of randomizations could be farmer groups, women groups and/or ECD centers in the project sites. A subset of these groups will be randomly selected to receive treatment in order to understand the impact of the same.
- b. Component 2 – Small Scale Irrigation: This intervention will be targeted towards farmer and water user groups within the command area in the existing irrigation sites. One key goal of this intervention is to induce take-up of the technology. The project team has engaged consultants to carry out feasibility studies of the potential constraints and barriers to adoption. The IE will aim to coordinate closely with the project team to test the set of incentives that induces take-up boosts to productivity. This set of incentives and constraints will include understanding the role of improved output-market linkage in increasing take-up of the technology. Testing multiple modalities side-by-side will allow the project to understand relative effectiveness and cost-benefit.
- c. Component 3 – Market Access: Similar to Component 2, this intervention is targeted at farmer groups, with the goal of serving as an intermediary to increase private sector involvement in the sites. The project has begun investigating specific interventions under this component in each of the selected value chains and will aim to design interventions within each. The IE will follow the project's approach, working to help the project understand the impact of the VC-specific design.

The key identifying assumption in the impact evaluation is that randomization into treatment and control is exogenous. This exogenous variation ensures balance across treatment and control on observable and un-observable characteristics. There are two potential risks the IE faces in studying the impacts of each project component. The first is that the project is extended and/or modified, but the IE team continues on with the plan as originally designed. First, the task team seeks to mitigate these operational risks through the variety of safeguards in place as per the PAD. Second, in the event that implementation is indeed modified or delayed, the IE will aim to work closely with the operational team to ensure that implementation plans (and related delays) are closely tracked and accounted for in IE analysis. The IE aims to be a flexible instrument for learning, providing relevant and timely feedback that helps with operational and implementation decisions; and not be an external research-project that operates in isolation of the project. Specifically, survey timing and specific survey modules might need to be adjusted to account for specific timing of each project components in order to accurately capture changes in key outcomes of interest. This will be done through close in-country cooperation between the IE Field Coordinator and frequent travel of the PIs to Rwanad. A second potential source of risk is that project interventions are implemented in a way that undermines the original assignment to treatment. Once again, close coordination with the implementing agency is key to ensuring that implementation plans are appropriately aligned with the IE design and identification strategy.

8.2 Sample Size Calculations

The basis for power calculations is existing data in this site, collected as a part of the evaluation of irrigation on farmers in LWH sites. Given the cross-cutting nature of the evaluations, we use farmer revenue (proxied through agricultural production) as the top-line outcome to conduct power calculations. This also serves the purpose of being a plausible benchmark for the 'overall' impact of SAIP. The large datasets collected as part of previous evaluations will allow us to understand heterogeneity implications of SAIP interventions. Not all farmers are expected to be affected by project interventions equally, and the unique extent of previously collected data in this context allow us to tease out these heterogeneous effects.

The power calculations were done using the *sampsi* command in STATA with an assumed power of 80%, alpha of 5% and three rounds of surveys. Given the three surveys, we will implement a difference-in-difference specification, exploiting the randomized assignment to treatment to evaluate the effect of each intervention. Power calculations are done using a modified difference-in-difference approach that accounts for the baseline value of the outcome variable. This follows the literature on power gains from this approach (Mckenzie, 2012).

The outcome of interest is agricultural production in RWF/hectare, which in our baseline has a mean of RWF12,761 and standard deviation of RWF24,233. Taking into account two rounds of planned follow-up surveys, we find a minimum detectable effect size (MDE)S between 0.09 and 0.15 (depending on the assumed level of autocorrelation. See the table attached as Annex 4 for detailed sample size calculations. Given the range of interventions that seek to boost productivity and connections to markets, these are plausible estimates of program impact.

The main goal of the IE is to provide the project with rigorous and internally valid estimates on the effect of various project components to enable evidence-driven scale-up and down decisions. In order to do so, the research team will work with the project to identify farmer groups to target for the evaluation. In selecting the groups that will fall into the IE sample, the research team will strive for representativeness of the groups within the site, as far as the secondary and administrative data on these groups allows. Further, within the farmer groups in the IE sample, individual farmers will be randomly sampled.

9. Data Collection

9.1 Quantitative Instruments

Adoption of technologies and interventions

One immediate goal of the project is to understand the optimal delivery mechanism of each intervention being evaluated. This includes the delivery of the behavior-change programs, the investment in small-scale technology and the signing of contracts connecting farmers to markets. The research team will aim to work closely with project M&E staff to collect this data to track progress and take-up.

Household Surveys

Multi-module agriculture household surveys are planned for a sample of farmers in project sites. Given the overlap between SAIP and LWH sites, we plan to utilize data from the LWH project to set the baseline

for SAIP. The most recent data collection in the sites was in late 2018 and covered all the indicators that are part of the results framework that were demarcated as being sourced from farmer surveys. Given the comprehensive instruments used, data from the LWH surveys also sets a baseline for all the indicators part of the research questions in the SAIP evaluation. Following discussions with the WB Task Team and the SPIU, it was agreed that DIME will provide technical assistance in fielding an agile data collection effort across sites to add one season of data - the primary season in 2019; which was not part of the aforementioned data collection. Pursuing a strategy of utilizing existing data collection in the overlapping sites is a consequence of the team's desire to optimize the use of limited resources, and maximize the use of the existing data infrastructure. The rich datasets generated in the large-scale household surveys will enable the team to present a credible estimate of individual project components and of the overall impact of the project.

Two large scale surveys are planned: a midline survey is expected to go to the field preceding the project's Mid Term Review and an endline in time to inform the project closure. These household surveys present a one-time snapshot of the overall effect of the project interventions, and serve as a compliment to the monitoring data collected over the course of project interventions and take-up. The household survey will closely mirror the surveys used in LWH sites – with a draft version of the same presented in Annex 2.

Focus Group Discussions and Qualitative Work

Quantitative data collection will be combined with focus group discussions and qualitative work to shed light on mechanisms that drive the impacts of SAIP interventions. This will accompany each stage of the IE design and delivery process, with a subset of focus groups preceding the finalization of IE questions and design. The qualitative data will be useful in informing IE findings and helping understand issues related (but not limited) to take-up and adoption decisions. See Section 10.3 for more details.

9.2 Management of Data Quality

All data collection activities will be supervised by the Kigali-based IE field coordinator in partnership with the SAIP team. This will include working with project M&E staff to finalize and program the survey instrument for the android platform. The agriculture data collection instruments will be piloted extensively in the field prior to going starting the data collection to ensure they are appropriate for the local context. Enumerators will participate in multi-week training of the questionnaire and functioning of the tablets. Training will include classroom and field training. Enumerators will be selected based on their performance during the training. Since the data will be collected electronically, we will program consistency checks and quality assessments on a daily basis. Audits will be performed by recording parts of the interview and performing back-check interviews by a different team of interviewers. Cross-checking of the data will allow us to provide immediate feedback to the field teams in case of divergences or other problems. All data will be made available based on the Bank's Open Data policy.

9.3 Ethical Issues

Randomization of project interventions entail that some farmers and/or farmer groups will receive the intervention while others will not. However, this "issue" would have arisen despite the presence of randomization, given that the SAIP is not a country-wide, universal project. In other words, due to budgetary and operational constraints, SAIP interventions were never going to reach all farmers in all of the sites, and the project would have had to make some decisions on who should receive which

intervention. In this sense, randomization presents the SAIP team with a transparency mechanism in “selecting” beneficiaries and ensures that there is no elite capture. DIME has worked with the GoR and the LWH team on the randomized allotment of water-fee subsidies and horticultural mini-kits in the past, with high levels of implementation success.

In relation to the larger waves of household data collection, all survey participants will be carefully informed about the data that will be collected throughout the study, the purpose of the surveys and the fact that their participation is voluntary. Only after participants provide consent will their data be collected. Strict protocols will be put in place to ensure data remains confidential. Any information that can link data to specific households will be removed for data analysis after assignment of a unique identifier.

10. Data Processing and Analysis

10.1 Data processing

All survey data will be collected electronically to enable daily monitoring and consistency checks. The primary agriculture data will be collected using a survey-format based on a household agriculture survey. The primary data collection methods have been tested and have an established track record. All data will be collected by a survey firm competitively selected within Rwanda for this purpose who will be responsible for recruiting, training, and supervising the data collection under the guidance of the DIME field coordinator. Data will be synced from the field to servers protected by passwords so that individual enumerators do not have access to the data. The data will be de-identified for analysis.

10.2 Quantitative Data Analysis

There are two statistical models which will be used for analysis.

For the interventions related to market-access and technology adoption, assignment to the program is randomized at the group level. Conditional on a group’s willingness to enter into the contracts, whether the group receives the intervention T is random. We can therefore use the following specification to get causal specification:

$$Y_b = \beta T_b + \delta X_b + \epsilon_b$$

For individual i in group b , T_b is an indicator for treatment status and X_b are covariates that yield an unbiased estimate of β . For observations which vary at the individual level, we will cluster at the level of the group. The treatment effect of interest is β , the average effect on a variable of interest such as the agricultural production or income of household i . The data that we have already collected as a part of the LWH evaluations contain extremely rich information on farm production and profits, income, nutritional status and demographic variables which will be used to test balance and evaluate the performance of the RCT approach.

We also will test robustness of errors to potential spatial correlations between nearby farmer groups using Conley (1999) clusters. We will additionally test for heterogeneity in treatment effects depending on characteristics of the block, including inequality and number of farmers. For these questions, we will also

test for spillovers by examining whether the treatment status of upstream blocks affect outcomes for the immediate downstream blocks.

For impacts on the access to irrigation, we will complete a spatial regression discontinuity design following Conley and Udry (2010), Goldstein and Udry (2009), and Magruder (2012). This approach suggests that for plots sufficiently close together, access to the irrigation system for one's plots is close to random. More specifically, for each individual i with plot p , we define $R(p)$ to be the set of plots within radius R of plot p . Suppose there are $n_{R(p)}$ plots in set $R(p)$. The spatial fixed effects used in this approach are specific to the plot and thus cannot be represented by a block diagonal set of binary variables as conventional fixed effects can; however the within estimator is still achievable.

$$(Y_{ip} - \frac{1}{n_{R(p)}} \sum_{p' \in R(p)} Y_{ip'}) = \beta (T_{ip} - \frac{1}{n_{R(p)}} \sum_{p' \in R(p)} T_{ip'}) + (X_{ip} - \frac{1}{n_{R(p)}} \sum_{p' \in R(p)} X_{ip'}) + u_{ip}$$

For time-varying variables, we will complement this analysis by including plot-level fixed effects to use the difference in spatial differences estimator suggested in Magruder (2013). In all cases, errors will be spatially clustered following Conley (1999).

We will complement this analysis with a more traditional distance to the border estimation which ignores the two-dimensional nature of space but does allow a more conventional graphical representation. In our context, where control group areas are not evenly dispersed along the boundary, this approach has some severe limitations which motivates the preference for the spatial fixed effects approach.

Both of these approaches estimate LATE. We are collecting extremely rich baseline data on farm production and profits, income, and demographic variables which will be used to test balance and evaluate the performance of the spatial RD approach.

The primary source of bias that could affect our estimation would happen if farmers endogenously sort in or out of particular contract or irrigation regimes. To test for this, we are following a panel of plots, and collecting retrospective data. We will know whether there was immediate sorting prior to the completion of irrigation, or subsequent sorting that takes place after the water starts flowing through land sales or rentals. In all cases, we will follow the plot's owners who may sort into other local areas. We will take steps to guarantee low attrition, including collecting multiple contact numbers and are well-enough integrated into the community to be encouraged of a high success rate in finding individuals who move.

10.3 Qualitative Data Analysis

Household survey data and administrative data on program implementation will be complimented with qualitative data through focus group discussion and key informant interviews. Particular themes of interest in this area includes collecting information that can directly inform program and IE design and implementation. For example, despite large documented returns to hillside irrigation, many farmers in the existing sites still choose not to adopt dry-season irrigation. There are a number of supply and demand-side constraints that constrain adoption. Many of these constraints are at the heart of SAIP interventions including but not limited to encouraging adoption of labor saving and water-optimizing irrigation technologies and facilitating linkages to markets and buyers, amongst others. The goal of this

project and the underlying IE is to test a series of these constraints and qualitative work can play a key role in uncovering these mechanisms. The team will plan to run a series of these discussions in advance of the IE surveys to inform questions asked during the survey and feed into implementation details on various components.

10.4 Understanding the Gender Dimensions of the Project

One key goal reflected throughout the PAD is the fact that FANSEP aims to work with women on each of the components. This is especially true in the case of Component 1 that focuses on nutrition-sensitive behavior and information. The IE will work closely with the project to identify and evaluate the impacts of these interventions on women. One key area of focus in all past surveys that is set to continue is that all food security modules will be administered to an adult female in the household. In the context of SAIP, given that it is a core indicator, the FIES instrument will focus on an adult woman in the household or the head of the household if it happens to be a woman.

The IE will work with the project team to ensure that all project indicators are disaggregated by gender. This includes all indicators captured through the survey in addition to the M&E indicators captured by the project's routine M&E tasks that the research team will provide technical assistance in analyzing. This is a first-pass at tracking how the program is being implemented and whether trends in individual indicators and in program implementation differ by gender.

The identifying assumption underlying project components that will allow the research team to estimate impacts of the project is assignment of key project interventions at the farmer group level. While this first-level randomization does not explicitly account gendered randomization, the research team will aim to shed light on treatment effects by gender. At worst, the team will be able to provide descriptive evidence on whether program impacts on household income, agricultural productivity and food security change by gender from one year to the next.

11. Policy Impact

The research team has strong reasons to expect results from this impact evaluation program to have deep policy impacts. Given the existing and planned investment in these sites, the government is extremely concerned with both the cost-effectiveness and the sustainability. Given the stated goals of scaling up several components at the heart of the project to other parts of the country, these issues are particularly salient to high-level policymakers in MINAGRI.

The research builds on an ongoing program of impact evaluation with the Government of Rwanda. The first generation of trials focused on the rural finance and agricultural extension components of the LWH project; they were designed over the course of a DIME workshop during which training was provided to the World Bank operational team and government counterparts on rigorous evaluation methods. Each trial was conducted over the course of 1-2 years, with results informing the project design as it scaled up to new watersheds. For instance, based on these results a hotline to register farmers' feedback on

extension visits was scaled up to the entire service area, country-wide, boosting attendance and demand for the service. Now that the irrigation infrastructure construction is completed in four of the watersheds, the government is interested in testing strategies to secure higher sustainability of their investment, boost productivity for farmers in the sites, increase linkages to markets and improve food and nutrition security.

The influence of the proposed IE on policy will be secured through three main channels:

1. Building ownership within the implementation team and line ministry, from permanent secretary down to lead farmer level. Policy influence is secured by building ownership of the program at all levels of government implementation and decision making, from farmers to minister level. As described above, this is done by including all levels in the conception of the IE design. As the results come out, all levels, from farmers to minister, have ownership of the findings and appropriate them to take decisions. Engagement at all levels are done through day-to-day engagement with the teams on the ground, as well as periodical missions during which dissemination events are organized and briefs are delivered to high-level ministry staff, up to Permanent Secretary and Minister.
2. Ensuring that findings are incorporated in joint donors-GoR strategies, working with a coalition of actors in Rwanda and beyond. The research team is working closely with the WB Country Management Unit in Rwanda to build ownership of the activity and ensure its impact in the policy dialogue both at the country and sector levels. Brown-bag seminars are regularly held by the team at the CMU to ensure that the country office staff is aware of the work and learning coming out of this program, and that the IE work is aligned and informs to the Bank's agricultural strategy in Rwanda. Similar efforts are made to communicate research findings to other donors in Rwanda, including DFID, the Netherlands, and the EU.
3. Building international awareness of the findings. High-quality research papers based on this research will be disseminated in international policy and academic circles (e.g. UC Berkeley, WB, international conferences, etc), in the form of events, trainings, as well as international development conferences. Finally, the findings will be published in working paper series and submitted to peer-reviewed economics and field journals, thus reaching a wide audience of researchers and graduate students worldwide. All data will be made available online on the databank for IE, following the Bank's open data policy, influencing empirical work beyond this specific research effort.

MINAGRI is an informed consumer of IE and has a demonstrated commitment to using impact evaluation results to inform policy design and scale-up. The government team receives day-to-day technical support of DIME staff and STCs based in Kigali, as well as periodical visits from the research team. This ensures full communication between researchers and policy actors and a high level of buy in and commitment from the government team to use research insights to shape their policies. Through this process, policymakers become informed consumers of IE and learn how to use it as a management tool. The research program is designed to yield actionable, just-in-time recommendations, with tangible impact on policy decisions. Surveys are collected using computer assisted personal interviewing technology which significantly shortens the field-to-analysis period. Missions are organized around main dissemination dates and ahead of season planning to ensure the absorption of the analytical findings into the operational schedule.

One key priority for the IE is to help inform the policy dialogue across multiple sectors, given the project's intervention approach touching on the work of multiple line ministries and implementing agencies. Findings on potential high-value mechanisms to increase the water efficiency of the existing systems are of high priority to MINAGRI and RAB; on market linkages and private-sector involvement to MINAGRI and NAEB and on food security to multiple ministries working in the sector. Each component of the IE therefore has the potential to affect the dialogue in different policy areas – thereby increasing the base of evidence across sectors. Key outputs from the IE will include findings preceding the project's mid term review and before project closing. Please see Section 13.2 for more details.

12. Study Limitations

SAIP is a large and multi-faceted program that aims to affect farmers lives in several ways. While the impact evaluation being presented in this Concept Note studies an intervention from each of the three main components of the project, it is not studying every single sub-component. The chosen interventions were based on a prioritization structure by the government and the task-team, based on priority areas for learning and deployment. However, there remain many other elements and interventions within SAIP that the limited resources of the impact evaluation will not cover.

13. IE Management

13.1 Evaluation Team and Main Counterparts

Name	Role	Organization/Unit
Florence Kondylis	IE TTL	WBG/DECIE
Saahil Karpe	Research Analyst	WBG/DECIE
John Loeser	Economist	WBG/DECIE
Christophe Ndahimana	Field Coordinator	WBG/DECIE
Winston Dawes	Project TTL	WBG
Esdras Byiringiro	Project co-TTL	WBG
Mr. Jean-Marie Vianney Kagenza	Ag. Coordinator of SPIU of World Bank & KOICA Projects	RAB SPIU
Mr. Jean Hitimana	Ag. Head of MIS Department	RAB SPIU

13.2 Work Plan and Deliverables

Milestones	Completion Date
Baseline Report and consultations on key findings	September 2019
Intervention Rollout and Tracking	Beginning June, 2019
Sharing of IE Findings during ISMs	Beginning Dec, 2019

Midline Survey and consultation on key action points	May, 2021 (preceding MTR)
Endline Survey	May, 2023
Endline Report and Sharing Overall Results with key stakeholders	November 2023

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13.3 Budget

Outputs	Activities	Units	No. of years	Unit Rate (US\$)	Estimated Cost (US\$)
Data Collection and Coordination					
	Fees: In-country field coordinators	1	3.5	\$ 45,000.00	\$ 157,500.00
	Travel	4	4	\$ 6,000.00	\$ 96,000
	Midline data collection (2021)	1	1	\$ 250,000.00	\$ 250,000.00
	Endline data collection (2023)	1	1	\$ 250,000.00	\$ 250,000.00
	<u>Other Expected Expenses:</u>				
	e.g. Translation, materials, etc...				\$ 10,000.00
SUB-TOTAL 1					\$ 827,500.00
Portfolio management and coordination. Workshops. Dissemination of results					
	Fees: Senior Economist (GG)	1/4	4	\$ 210,000.00	\$ 210,000.00
	Fees: Research Analyst (GE)	1/3	4	\$ 175,000.00	\$ 233,333.33
	Fees: Administrative time (GD)	1/8	4	\$ 75,000.00	\$ 37,500.00
	Workshop/Seminars	2	2	\$ 3,500.00	\$ 14,000.00
	Publication and Knowledge Dissemination	500	1	\$ 10.00	\$ 5,000.00
SUB-TOTAL2					\$ 499,833.33
TOTAL GRANT COST					\$ 1,253,333.33

A budget with further information on costs for individual components of data collection is provided as Annex 5.

Annexes

Annex 1: Findings from the Overall Impact Evaluation of LWH

The Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) project is a flagship initiative aligned with Rwanda's Ministry of Agriculture and Animal Resources (MINAGRI) sector-wide strategy, and is a key pillar of the World Bank's portfolio in the region. The project emphasizes increased productivity in selected sites through investments in developing terraces, hillside irrigation, combined with the promotion of improved farming technologies and practices. The suite of LWH interventions is integral to MINAGRI's strategy under PSTA-III and PSTA-IV and the goal of transforming the rural economy.

This report presents causal estimates of the *overall* impact of the LWH program. The design, rollout and implementation of this evaluation results from a long-term partnership between the LWH project team (SPIU), MINAGRI, the World Bank's Operational Impact Evaluation (DIME) teams. Over the span of 6 years, the impact evaluation tracked a number of project-related input and outcome indicators. Aligned with the project's development objective and built around core areas of the implementing team's focus, the evaluation sheds light on the overall impact of the program.

Prior to program implementation, during pre-feasibility, the LWH, DIME and the World Bank's Task team designed a prospective impact evaluation to plausibly capture the causal impact of the program. In each phase of implementation, the project targeted a certain number of sites in which to intervene. The impact evaluation tracked outcomes across several sites that were identified during pre-feasibility, including a subset of eligible sites that were left out of program implementation due to budgetary constraints. In other words, of the set of sites that passed pre-feasibility, a number that were otherwise identical to the project sites were not assigned to the LWH intervention offer a good reasonable counter-factual (comparison) to the sites that received the program. This allows the impact evaluation to measure what *would have happened* in the absence of the LWH interventions. Data were collected across the intervention (*treatment*) sites and these *comparison* sites - **implementing a non-experimental matched difference-in-difference strategy to estimate project impact.**

Working together, DIME and the LWH team worked to collect data across approximately 600 households in 1B sites over 6 years, and 5 sets of agricultural seasons. This panel dataset is unique, both in its length and in the richness of demographic, agricultural and household data it brings together. A dataset of this volume is uncommon in the policy landscape and allows the research team to investigate impacts of a complex program in a way that would have been otherwise impossible. The dataset covers three key sets of indicators that form the focus of analysis: agricultural productivity - the core of LWH's focus; project inputs and delivery mechanisms that influenced agricultural outcomes; and non-agricultural indicators of household welfare.

Households in LWH project sites witness large and statistically significant impacts on agricultural production indicators that can directly be attributed to project interventions. While these impacts started to materialize in the early phase of the project, they increased in magnitude over the course of the project. The primary indicator of production - value of harvests - is higher for treatment households relative to comparison households across years and seasons. Predictably, the value of harvests in Season A is consistently higher than in Season B. In 2017 Season A, harvest in treatment areas is about 36% higher than in the comparison areas. The largest effect of the program is in 2017 Season B, when the treatment

households' value of harvest is about 60% more than the comparison group, which harvests RWF 75,000 in this season.

In addition, the treatment group has a significantly higher share of its harvests sold in markets - with value of sales and share of agricultural production commercialized both significantly larger for the treatment group relative to the comparison. In 2017 Season A, the effect of LWH on sales value is 50% more than a comparison group mean of approximately RWF 40,000. In addition, in 2017 Season B, LWH causes an increase in commercialization share of 7 percentage points more, relative to a comparison average of 22%. Plot-level analysis reveals that the project leads to an increase in productivity - in 2017 treatment households have about 42% higher net yield relative to the comparison group mean of RWF 330,000. The analysis suggests that when making farming decisions, farmers tend to allocate resources across plots in an efficient way and that the plot is a more appropriate unit of analysis than the household for this set of indicators.

Across the board, households in LWH sites report higher access to services, use of inputs and adoption of technologies. This result holds across seasons and years, as LWH causes a 26 percentage-point impact on households likelihood of receiving public extension, relative to a comparison group rate of 9%. A similar result holds true for access to Tubura services. The adoption of agricultural and land-management technologies including erosion control, fertility management and enhanced productivity is consistently and significantly higher for LWH households than their comparison counterparts. In the case of erosion-control, for example, LWH increases the likelihood of adopting this technology by 60 percentage points in 2018, relative to the comparison group's adoption rate of 50%.

In terms of non-agricultural outcomes, LWH households outperform comparison households in terms of rural finance and total income, with food security reducing drastically across all surveyed households. Access to banks and savings behavior show significant positive impacts for LWH households relative to comparison households, with LWH causing a 50% point impact on likelihood of having a bank account, relative to a comparison group mean of 80%. Food security in 2017 shows drastic improvements over the previous year across the sample. Further analysis of this outcome points at the fact that households' food security status is subject to drastic variation across years. Going against conventional wisdom, analysis shows that food security is a risk for a range of farmers, as many experience significant changes from one year to the next.

Overall, LWH significantly improved farmers lives primary through the channel of increased agricultural productivity. Tracked over the course of 6 years, farmer welfare - as measured both by agricultural and non-agricultural indicators - is higher at endline relative to the pre-program levels. **The Overall Impact Evaluation of the LWH program is an example of how an implementation team can work to learn lessons on program impacts through a non-experimental Impact Evaluation design that relies on natural constraints related to program design and delivery.** The multi-year, rich panel dataset that tracked almost 1000 households across 5 survey rounds points at the government team's commitment to strong data systems and decisions grounded in evidence; and a commitment to learning and improving the program at every stage.

Annex 2: Outline of Draft Household Questionnaire

Module	Content	Level
Identification	Identification of enumerator and respondent; informed consent	Household
Household Roster	Sex, age, education, employment, migration	Household member
Plot Roster	Plot identification, ownership status, cultivation by season, past land transactions	Plot
Crop Production	Crops produced, amount of seed, amount harvested, amount consume, amount sold, amount lost to spoilage	Crop, by plot and by season
Irrigation Use	Use of irrigation, source, method, frequency	Sample plot
Farm Labor	Use of household and hired labor for agriculture	By plot and by season
Agricultural Inputs	Quantity, source, and amount spent on all organic and chemical inputs	By plot and by season
Irrigation (general)	Experience with irrigation, knowledge of maintenance, participation in maintenance activities, participation in trainings	Household
Extension	Interaction with public, private, and not-for-profit sources of agricultural extension	Household, by season
Housing	Construction material of walls and floors, source of drinking water, sanitation	Household
Farmer Group	Participation in farmer group, cooperative, water user group, and water user association	Household
Social Networks	Interactions, transfers to/from, and loans to/from, community work with neighbors and members of water user groups	Household
Income & Expenditures	Disaggregated income over the past 1 year; disaggregated expenditures over the past 1 month (frequent categories like communications and transportation); disaggregated expenditures over the past 1 year (infrequent categories like school fees and health insurance)	Household
Animals & Assets	Total owned; sales and purchases over the past one year for: cows, goats, pigs, poultry, radios, mobile phones, furniture, bicycles, hoes and shovels, and other agricultural equipment	Household
Rural Finance	Bank accounts; formal savings; contributions to ROSCAs	Household
Credit	Number of loans requested; amount and purpose of loans received	Household
Shocks	Crop failure in the past year associated with drought; amount of loss and means of coping	Household, by season
Future Expectations	Future expectations and perceptions of agricultural production, household wellbeing, impacts of irrigation, asset purchases, participation in contract farming	Household
Food Security	Food Consumption Score and Food Insecurity Experience Scale	Household
Plot mapping	Plots are mapped, soil judged for evidence of effective irrigation use	Plot

The questionnaire will be closely based on the one used in the impact evaluation of the LWH to allow for comparability across the two rounds and to take advantage of contextual learning that has already been incorporated. The full questionnaire from the LWH evaluation can be provided on request

Annex 3: Field Coordinator TORs

TERMS OF REFERENCE: M&E and Impact Evaluation Consultant

1. Summary

Development Impact Evaluation (DECIE), which is a unit of the World Bank's Research Group (DECRG), is looking for a consultant who will work as a Field Coordinator for the agriculture portfolio of evaluations in Rwanda. Working in collaboration with various partners, the consultant's work will primarily consist of supervision and management of the rollout of randomized project activities as well as the planning and supervision of quantitative data collection to be carried out by a professional survey firm. The Consultant will also supervise qualitative fieldwork and report on implementation progress to the research team. The Consultant will be responsible for ensuring that every part of the impact evaluation is carried out according to the study design and protocols. On the major field coordination and supervision issues, the consultant is expected to work independently and to engage with internal and external counterparts with minimum guidance.

2. Scope of Work/Tasks and Responsibilities

The consultant will work under the supervision of the impact evaluation task team leader (IE TTL) as well as the Principal Investigator(s) and Co-Principal Investigator(s). The PIs are based at DECIE, and might seek partners from other institutions. The consultant will oversee the day-to-day implementation of the impact evaluations and liaise with the survey firm, the implementing partner organization and the evaluation team. This will include dialogue with the governments and other stakeholders, supervision of data collection activities, analysis, and preparation of papers and reports. Specifically, the position of Field coordinator will involve the following elements:

Effective Cooperation

- Provide daily coordination between the impact evaluation team and local counterparts (including the data collection firm and project implementing partners), ensuring that concerns are effectively communicated between parties, flagging emerging issues that may be of potential concern to one or both parties, and ensuring that effective and productive collaboration is maintained.
- Help ensure that targets are met on time, and that all activities are carried out in accordance with the study design.
- Cooperate effectively with all co-workers, as well as national, provincial, and local government officials, and any other stakeholders or external collaborators.
- Interact with the line Ministry staff and partner on evaluation-related issues.
- Interact with local authorities on matters related to the impact evaluation.

Impact Evaluation Field Coordination and Supervision

- Work closely with the implementing organization to ensure compliance with randomization protocols and treatment assignments are administered according to the agreed up-on protocols and plans.
- Ensure that evaluation activities that need to take place prior rollout of interventions (e.g., baseline data collection; randomization) are effectively carried out.
- Visit as many study communities as possible to ensure that they have the assigned program status and gather general information about the implementation process.
- Attend training sessions (as relevant); take notes on discussions/participation.
- Monitor implementation activities so that the evaluation team understands and has documented the details of implementation across study areas.
- As requested, gather observational data on key contextual factors (e.g., data on other development organizations operating in study communities).
- Take notes on problems with implementation issues and challenges that deviate from the study protocols and alert the evaluation team as soon as possible.

Quantitative Survey Design and Data Collection Supervision

- Assist in the design and revision of quantitative survey questionnaires for baseline and follow-up data collection as well as survey manuals; and liaise with technical support staff for survey software as necessary.
- Participate in training and sensitizing of enumerators and field-testing of questionnaires.
- Run pilot survey exercises, provide feedback on field operations and survey instruments, and make and monitor improvements.
- Conduct daily monitoring and supervision of the firm contracted to carry out data collection, helping to ensure that sampling strategies are implemented adequately and that activities are carried out in a timely manner per the TOR.
- Assist the survey firm to prepare weekly progress reports of field work.
- Assist the survey firm in setting up data entry
- Verify that data entry is following a double-entry protocol and provide data quality control—conduct spot-checks, household re-visits, and cleaning of data.
- Ensure data quality, integrity of analysis, and adherence to budget throughout the fieldwork and data entry phases.
- As requested, conduct data analysis of the baselines and support drafting of the baseline reports.
- As requested, clean collected data with accompanying Stata do-files and documentation and contribute to reports, academic papers, and policy briefs.

Support to qualitative data collection

- Provide logistical support for qualitative research, including recruitment of qualitative research assistants and arranging for travel to field sites. If a local research firm is engaged to manage the research logistics, monitor and supervise the firm's activities.
- Contribute to the design of qualitative data collection tools and training of the qualitative research assistants.

- Supervise the qualitative data collection: ensure proper identification of selected respondents, gathering of high-quality data, tracking of fieldwork progress, secure management of data, and respect for the confidentiality of respondents.
- Participate in analysis of the qualitative data and translate findings of the qualitative research into recommendations regarding the design and analysis of the follow-up quantitative survey.

3. Deliverables

1. S

4. Requirements

The consultant should present the following minimum requirements, all required:

- Master's degree in economics or a related field, including training in econometrics, microeconomics, and development economics.
- Strong oral and written communication skills in English.
- Work experience on managing impact evaluations of aid and development interventions in East Africa, specifically in Rwanda.
- Specific experience managing large-scale data collection in Rwanda.
- Ability to work independently and as part of a team.
- Ability to work in very challenging and volatile settings, including organizing own transportation and field lodging in remote rural areas.
- Well organized, detail-oriented, and able to prioritize and manage multiple tasks simultaneously with minimal supervision.
- Experience in providing research assistance and record of strong performance.
- Demonstrated coordinate multiple teams of people, organizations and activities concurrently.
- Experience in the analysis of quantitative survey data.
- Experience using Stata.
- Willingness to undertake regular and extended field visits and interact with different stakeholders

Annex 4: Sample Size Calculation Details

We conduct power calculations using data from previous data collection in SAIP sites to be able to estimate means. All MDES calculations are doing using standard deviation increases from these means. Working with 150 farmer groups in the evaluation and surveying 7 farmers per group, MDES is in the range of 0.08 and 0.15 with 33% improvements through using ANCOVA.

α	0.05	0.05	0.05	Significance level	Assumption
β	0.8	0.8	0.8	Desired power of the test	Assumption
Tail	2	2	2	One-tailed or two-tailed test	Detect either an increase or a decrease in yields
μ	12761	12761	12761	Pooled mean of outcome variable (yield in RWF/ha)	Baseline survey in the ongoing sites
σ_y	24233	24233	24233	Pooled standard deviation of outcome variable (yield in RWF/ha)	Baseline survey in the ongoing sites
K	152	152	152	Number of clusters	Actual sample size in the three ongoing sites (expected to ~double with 3 new sites)
n	7	7	7	Number of observations per cluster	
ρ	0.75	0.50	0.50	Correlation between baseline and follow-up measurements	Assumption

icc	0.05	0.05	0.15	Intraclass correlation	Based on icc for agricultural yield data for two of the three ongoing sites, from a 2013 household survey run by the same research team. .
stata code	<i>clustersampsi, detectabledifference mu1(12761) sd1(24233) m(7) k(152) rho(0.05) base_correl(0.75)</i>	<i>clustersampsi, detectabledifference mu1(12761) sd1(24233) m(7) k(152) rho(0.05) base_correl(0.5)</i>	<i>clustersampsi, detectabledifference mu1(12761) sd1(24233) m(7) k(152) rho(0.15) base_correl(0.5)</i>	stata package: clustersampsi	<i>** note that estimates are conservative. clustersampsi doesn't allow for imbalanced treatment/control, so assumes comparing 76 tmt v. 76 ctl. Also only allows for 1 follow-up (unlike sampsi, which has post option). Alternative that does allow for imbalance is 'clsampsi' but that does not allow for baseline correlation. Using clsampsi and low icc gives estimate of .18 standard deviations.</i>
δ	0.09	0.12	0.15	Minimum detectable effect (in standard deviations)	Calculation
Improvement in power from ANCOVA	14.29%	33.33%	33.33%		http://blogs.worldbank.org/impactevaluations/why-difference-difference-estimation-still-so-popular-experimental-analysis
δ ANCOVA	0.08	0.09	0.11	Minimum detectable effect (in standard deviations)	

Annex 5: Data Collection Detailed Budget (tentative)

Activity	2019		2020		2021		2022		2023		Unitary Costs	Units	Total Costs
Providing TA to project team to support baseline											25000	1	25000
Working with project team on baseline report											25000	1	25000
Questionnaire Design at midline											5000	1	5000
Pilot of the questionnaire to 250 farmers											100	250	25000
Midline data collection											100	2200	220000
Midline supervision											15000	1	15000
Gender analysis at midline											5000	1	5000
Midline analysis											10000	1	10000
Questionnaire Design at endline											5000	1	5000
Pilot of the questionnaire to 250 farmers											100	250	25000
Endline data collection											100	2200	220000
Endline supervision											15000	1	15000
Gender Analysis at Endline											5000	1	5000
Endline Analysis											10000	1	10000