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SUSTAINABLE AGRICULTURAL DEVELOPMENT PROGRAM

(GY-L1060)

EVALUATION PLAN

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EVALUATION PLAN SUMMARY

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1. INTRODUCTION

In the Co-operative Republic of Guyana, 70% of the rural population still relies on agriculture as their main source of income (GBS, 2016). Agriculture remains, with exception of a few key export crops, largely a subsistence activity and farming practices are only modernizing slowly. Although Guyana harvested a record amount of rice in 2014/15 with a national average yield of 4.99 MT/Ha, agricultural productivity is generally low even in the export-oriented farms (FAS/USDA, 2016). For instance, sugar and rice yields are lower than Guyana’s closest competitors (33.9% rice; and 78.5% for sugar; FAOSTAT, 2016). Furthermore, climate change is increasing the need to facilitate adaptation and mitigation measures, both for large and small farmers, as climate and agricultural models forecast significant drops in productivity for rice and tubers in Guyana because of temperature rise (IFPRI, 2009).

It is unsurprising that agricultural productivity has remained low in the country, since research and extension services are largely absent (Ramrattan, 2015). Guyana’s agricultural sector lacks the public services, especially research, innovation and extension services necessary to create the required R&D output that could inform effective agricultural extension packages (Trigo, et. al., 2013). Crop-specific research remains limited to key export crops such as sugarcane and rice, and access to technologies and training for the predominantly small and medium sized farmers do not exist. Livestock production is focused on poultry, with cattle and small ruminants produced mainly in small farms, with similarly low productivity and little available research (FAO, 2012). The Ministry of Agriculture (MoA) does not have a formal, operational extension service, and government authorities and private investors lack enough data upon which to base agricultural policies, strategies and investments decisions. The last agricultural census dates to 1952 and data on production or production costs at the farm level is not available.

To address these issues, the S*ustainable Agricultural Development Program* was proposed in June 2016 with the objective of increasing the productivity of Guyana’s agricultural sector while maintaining a sustainable and climate resilient use of natural resources. The Program intends to achieve this objective through a combination of institutional strengthening, research, extension and support to farmers for technology adoption. In this manner, it is expected that higher productivity will also reduce pressure on forest and fragile ecosystems, and at the same time, increase incomes for small and medium-sized farmers. Overall, activities will be concentrated in Regions 5, 9 and 10, where agricultural potential and availability of natural resources is greater and more than 10,300 farmers, including Amerindian communities representing more than 89% of the population of Region 9, will benefit from the Program.

The objective of this document is to describe in specific detail the plan for conducting the impact evaluation of the Program. Accordingly, the next section provides the underlying theory of change of the project and the primary evaluation questions that emerge. This is followed in Section III by a description of the key indicators for the evaluation, which of course correspond to those included in the Results Matrix. Section IV then provides the overall strategy for creating a counterfactual to ensure that any estimate of impact is unbiased. Given the nature of the project, a non-experimental approach is proposed. Section V then provides the technical and practical details of the evaluation plan.

1. MAIN EVALUATION QUESTIONS

Figure 1 provides the theory of change for the Program and includes the overall causal logic of the project. As can be seen under Activities, the Program contains three primary components to improve the productivity and sustainable use of natural resources among small and medium sized farmers in Regions 5, 9, and 10. To this end, **Component 1** focuses on generating the necessary information and data to enable evidence-based policy making and natural resource management. Specifically, the component includes the review and design of an appropriate Agricultural Information System (AIS), including the preparation and implementation of an Agricultural Census; and the strengthening of the Monitoring and Evaluation capabilities of the Ministry of Agriculture (MoA).

**Component 2** encompasses the strengthening of the agricultural innovation and extension system that is crucial to increasing productivity. To this end, the Program will finance the establishment and upgrade of agriculture centers in Region 9 and Region 10 that will offer technology transfer, demonstration and training services to local farmers. In collaboration with national and international centers, the centers will further implement select research and demonstration programs that will help identify specific beneficiary groups, technology packages and monitoring and evaluation mechanisms and focus on reducing vulnerability to climate change through multiplication and conservation of genetic material, including drought resistant varieties and protection of traditional knowledge as local adaptation strategy.

Lastly, **Component 3** will provide support for compliance with sanitary and phytosanitary standards by providing access to markets and infrastructure and increasing the value and sales volume of meat and dairy products. To this end, the Program will finance: (i) the review and update of standards and codes related to products destined for export markets as well as local markets, both current and potential; (ii) the implementation of pilot facilities (infrastructure and equipment) for meat processing in regions 5 and 9 to evaluate the feasibility and unit costs of complying with standards; and (iii) training and technical assistance for the GLDA and producer associations.

**Figure 1.** Theory of Change



As a direct result of these activities and inputs, investments in research and agricultural extension services should lead to a series of outputs or products. If the investments occur as planned, outputs under Component 1 include a comprehensive and updated national agricultural census, a comprehensive management plans for wetlands and savannahs in Region 9, and an increased number of capacitated MoA staff to support the coordination of agricultural research and service delivery. Under Component 2, expected outputs include the completion of two functional agricultural centers, through which a number of research programs are expected to be implemented, and through which an increased number of farmers in Region 9 and 10 receive agricultural extension assistance. Furthermore, an increased number of staff of the National Agricultural Research & Extension Institute (NAREI) and of the Guyana Livestock Development Agency (GLDA) will be trained in supporting and coordinating the research and extension work at these agricultural centers. Lastly, expected outputs under Component 3 include two functioning pilot facilities for meat processing in Regions 5 and 9, as well as an increased number of GLDA staff trained in the application of updated food safety standards.

In order to verify the successful implementation of these activities and resulting products, the monitoring system of the project will capture the necessary information. The outcomes and impacts identified in Figure 1 then note the expected effects of the project if farmers and households in the intervention regions respond in the anticipated manner. Given that the results and final impacts are not under the direct control of the intervention and depend on the behavioral change of Program beneficiaries, a number of assumptions must be made in order to ensure the logical connection from project products to project outcomes: These assumptions include that i) the national agricultural census is completed and disseminated, ii) key staff of responsible government agencies, including the MoA, NAREI, and GLDA participate and engage in training activities, iii) an increased number of local crop and livestock farmers have access to and take advantage of agricultural extension programs, and iv) pilot facilities for meat processing are functional and used for a significant share of meat production.

If these assumptions hold, the following outcomes can be expected to result from the Program: First, a main outcome should be a significantly improved, comprehensive national Agricultural Information System (AIS) as the basis for any policy decisions in the agricultural sector. In this sense, activities executed below Component I are necessary to inform the most efficient implementation of Component II based on the generated information about agricultural activity in the regions. Second, one can expect an increased number of local farmers that, as a result of agricultural extension, adopt and implement innovative and sustainable farming practices, including the use of sustainable irrigation practices related to the identified water catchment sites. Lastly, we can expect an improved quantity and quality of meat products rendered by livestock production in the area. Given that these outcomes can be achieved, the following final impacts should be measurable with the help of a rigorous impact evaluation: Under the implementation of modern and sustainable farming practices, beneficiary farmers should experience not only increases to their annual crop and livestock production, but also increases of productivity and gross margins, as well as income generated from agriculture. The final and long-term impact is then in line with the overall objective of the Program, namely increased productivity and sustainability of Guyana’s agricultural sector, with a focus on rural small and medium sized farmers in regions 5, 9, and 10.

Given the causal logic from Program inputs to its desired outcomes and impacts, the key evaluation questions that will be addressed in this impact evaluation will be the following:

* What is the impact of agricultural extension services provided through newly constructed agriculture centers on the production, productivity, and income of beneficiary farmer households?
* Specifically, what is the impact on production, productivity, and profitability of different types of beneficiary farmers, including:
  + Crop farmers (annual and perennial crops)
  + Livestock farmers (including aquaculture)
  + Amerindian farmers (where production is often undertaken as a communal activity)
* What is the impact of agricultural extension services on the use of sustainable farming and livestock practices among beneficiary farmer households?
* What is the impact of the pilot meat processing facilities on the production and gross margins of beneficiary livestock farmers?

Before moving to the key outcome indicators, first it is important to discuss the existing knowledge linked to these questions. The idea that improved agricultural research and extension services can lead to the aforementioned benefits has indeed been considered in similar projects/studies from other developing countries. As such, it is beneficial to further discuss some of the associated literature.

A large body of research has examined the economic, social, and environmental impacts of agricultural research and extension services. In general, the public provision of agricultural extension services is motivated by the presence of market failures, including asymmetric information, limited access to credit, and inadequate or incomplete market infrastructure, among others (Feder, Just and Zilberman, 1985). If this is the case and there exists a gap between the currently employed technology and the best technology for farms in a particular region, extension services can bridge this gap and accelerate the diffusion process of improved technology, thereby bringing about a faster growth of yields and rural incomes (Birkhaeuser et al., 1990).

In the case of Guyana, it appears that technology adoption is restrained by two major factors. The first is restricted access to credit which restrains farmers from making the necessary investments to adopt more efficient farming practices. A survey conducted for the preparation of this project suggests that only 8% of farmers in regions 5, 9, and 10 have obtained loans from a formal credit institution. A share of 60% of farmers stated that the adoption of more productive farming techniques was not possible due to financial constraints. Evidence has shown that credit constraints, especially among poor, rural farmers, can delay the speed of technology diffusion (Miyata and Sawada, 2007; Foster and Rosenzweig, 2010).

The evidence mentioned in the previous section also suggests a lack of research as a second important market constraint that is inhibiting technology diffusion in Guyana. Existing evidence tends to support the hypothesis that agricultural innovation can effectively improve productivity and income of farmers: In a comprehensive review of a number of rigorous studies on the effects of agricultural research, Alston et al. (2000) find a median rate of return to investment of 58%. Fuglie and Rada (2013) evaluate the technological improvements introduced in Sub-Saharan Africa by the Consultative Group for International Agricultural Research (CGIAR) and estimate that for the 34 million hectares on which these technologies had been implemented (representing 21% of cropland in the region), output increased by 65%. Other important effects of agricultural extension services include increased food security (Rosegrant and Cline, 2003; Aramburu et al., 2014), and improved climate change adaptation (Lybbert and Summer, 2012).

Similar to the various technology packages offered under the proposed project, agricultural extension services can take a number of forms, from farmer schools that teach producers how to apply certain inputs or technologies, to the simple provision of improved seed varieties. With regards to farmer schools that attempt to improve knowledge about the use of technologies, evidence reveals that such services can successfully improve knowledge about farming practices among farmers. For such a program in Peru, Godtland et al. (2004) find that potato farmers who participated in farmer schools achieved significantly higher scores in an exam about farming practices. Similarly, Bentley et al. (2009) observe that Bolivian farmers who visited one of nine plant clinics and followed recommendations used pesticides more effectively and improved the quality and quantity of their harvest and consequently saw increases in their income. In a systematic meta-analysis of the evidence available on farmer field school implementation, Waddington et al. (2014) find consistent positive effects on intermediate outcomes such as improved knowledge and adoption of beneficial practices, as well as significant longer-term impacts on agricultural production and farm income, but note that the pool of rigorous impact evaluations of such interventions remains small and that all have a significant risk of bias.

Other extension programs that focus on the provision of inputs and improved varieties have also observed positive, but mixed results. For such an extension program targeting grape farmers in Mendoza, Argentina, Cerdán-Infantes, Maffioli, and Ubfal (2008) find that yields increased by 40%, but only for those farmers whose production had exhibited low productivity prior to the program. Evaluating a technological extension package in Bolivia, Aramburu et al. (2014) find that the program had a positive impact on short- and medium-term indicators including crop diversification, sales, agricultural income from sales, as well as the longer term indicator of food security. Using propensity score matching to account for unobservable differences between adopters and non-adopters of an extension program in the Dominican Republic, Gonzalez et al. (2009) detect significant positive effects on the productivity of rice producers and breeders, but no other type of producer, suggesting that the effectiveness of different technologies may vary in the short run. This suggests that it is important that the proposed technologies, practices and inputs are selected carefully to address the specific needs of farmers in the region and are well adapted to climatic and environmental conditions.

1. KEY OUTCOME INDICATORS

**Table 1.** Key Outcome Indicators

|  |  |  |  |
| --- | --- | --- | --- |
| **Indicator** | **Formula / Definition** | **Freq. of Measurement** | **Source** |
| Yields / productivity | Value of output divided by the quantity of land operated | Baseline survey  Follow-up survey | Household questionnaire |
| Gross margins | Returns to fixed factors of agricultural production | Baseline survey  Follow-up survey | Household questionnaire |
| Production | Total harvest of farm’s annual agricultural production | Baseline survey  Follow-up survey | Household questionnaire |
| Agricultural income | Income from agricultural activities | Baseline survey  Follow-up survey | Household questionnaire |
| Profitability | Total value of crops sold annually | Baseline survey  Follow-up survey | Household questionnaire |
| Agency / empowerment for women | Employment / occupation / time use, participation in household decisions, access to extension services, etc. | Baseline survey  Follow-up survey | Household questionnaire |
| Sustainability | Share of irrigated cropland area with efficient irrigation practices in place, share of land used for pasture out of total land holdings | Baseline survey  Follow-up survey | Household questionnaire |

Given the above discussion of the main evaluation questions, it is beneficial to specify in detail the key outcome indicators to be used in the analysis. Table 1 defines the proposed indicators, provides the associated frequency of measurement, as well as the expected data source. Of course, in providing an overall assessment of the Program, it is important to consider the mechanisms of impact so that a complete impact evaluation will include a number of intermediate indicators that are also necessary to calculate final impact indicators. These will reflect the causal logic of the Program as laid out in the theory of change (Figure 1) and are included in the monitoring approach for this project.

Given the focus of the project on expanding agricultural production through agricultural research and extension services, the key indicators appropriately focus on agricultural outcomes. An additional question of interest is how the provision of extension services and proposed new technologies affects the intra-household allocation of time, labor, and decision-making power. To reflect the interest in this mechanism, we include an indicator that measures the agency of women in the household. Similarly, a main concern of the project is the sustainability of farming practices, which will be specifically targeted in the research topics to be undertaken at agricultural centers. Therefore, we include a number of indicators that attempt to measure the sustainability of agricultural farming techniques.

1. EVALUATION METHODOLOGY

*Selection of Beneficiary Farmers and Program Roll Out*

Any effective evaluation methodology must be closely linked to the design of the Program, so that it is important to understand the process with which beneficiary farmers are selected to participate in the Program. Specifically, the selection process will unfold as follows: Once agricultural research centers in regions 9 and 10 have been set up, the Ministry of Agriculture will promote the Program, and in particular the selected technology packages, through public announcements, including radio, printed press and television, in which farmers will be asked to register if they are interested in participating. In this sense, participation in the Program depends on the self-selection of farmers, which will be an important feature for the evaluation methodology.

Once farmers have registered, beneficiaries are selected based on a set of eligibility criteria, including (i) their residency status (farmers have to reside in regions 5, 9, or 10 to participate), (ii) the size of their farm (area under production must not exceed 5 ha[[1]](#footnote-1)), (iii) their willingness to be registered with the MoA, and (iv) agreement to a co-financing scheme that includes monetary incentives for technology implementation.

The farmers who have registered then constitute the pool of Program beneficiaries. Note that the Program will also permit ineligible farmers who exceed the 5 ha farm size threshold to participate in technical assistance and training activities, but will not receive any monetary incentives for technology adoption. The recently completed agricultural household survey suggests that about 4% of farmers operate medium size farms (5-10 ha), while about 7% operate large farms (more than 10 ha). In total, it is expected that about 5,000 farmers will participate in the Program, 550 of which are medium and large farmers (i.e. 11% of all farmers). Of the eligible small farmers, a randomly selected subgroup of 2,000 farmers will receive an additional monetary incentive of US$500. Therefore, treatment under the Program can occur at two levels: (i) eligible smallholder farmers who receive a monetary incentive to implement technologies and participate in technical assistance and training activities; (ii) eligible smallholder farmers and ineligible medium- and large farmers who receive no incentive, but participate in technical assistance and training activities. It is expected that impacts among the first group of beneficiaries will be larger, as small and credit constrained farmers are likely to currently produce at significantly lower levels relative to their potential production and productivity.

**Table 2.** Cohorts of Program Roll-Out by Region

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Region** | **Type of farmer** | **Year 1** | **Year 2** | **Year 3** | **Year 4** | **Total** |
| Region 5 | Small with incentives | 135 | 315 | 404 | 0 | 854 |
| Small without incentives | 165 | 385 | 496 | 0 | 1,046 |
| Medium / large | 50 | 50 | 100 | 100 | 300 |
| *Total* | *350* | *750* | *1,000* | *100* | *2,200* |
| Region 9 | Small with incentives | 90 | 315 | 404 | 0 | 809 |
| Small without incentives | 110 | 385 | 496 | 0 | 991 |
| Medium / large | 20 | 30 | 10 | 0 | 60 |
| *Total* | *220* | *730* | *910* | *0* | *1,860* |
| Region 10 | Small with incentives | 67 | 112 | 157 | 0 | 337 |
| Small without incentives | 83 | 138 | 193 | 0 | 413 |
| Medium / large | 35 | 30 | 50 | 75 | 190 |
| *Total* | *185* | *280* | *400* | *75* | *940* |
| **Total** | Small with incentives | 292 | 742 | 966 | 0 | 2,000 |
| Small without incentives | 358 | 908 | 1,184 | 0 | 2,450 |
| Medium / large | 105 | 110 | 160 | 175 | 550 |
| ***Total*** | ***755*** | ***1,760*** | ***2,310*** | ***175*** | ***5,000*** |

Once this selection process has resulted in a final list of all Program beneficiaries, the provision of extension services can begin. Since the Ministry neither has the resources nor the capacities to provide extension services to all beneficiary farmers at once, implementation is set to be rolled out over the course of four years. The evaluation will focus on the first 3 years of program implementation, since only medium and large farmers will receive benefits in year 4. Specifically, the Program currently foresees that approximately 2,000 farmers in total – 850 farmers from region 5 and 800 farmers from regions 9 and 350 farmers from region 10, respectively – will receive extension services with a monetary incentive, while an additional 2,450 small farmers will participate in technical assistance and training activities (without incentive). As previously mentioned, approximately 11%, or 550 of all targeted farmers are expected to have medium- to large landholdings. The final number may change of course depending on the demand among this type of beneficiaries. Therefore, the proposed Program roll-out is divided into the following four cohorts, by region, and by type of beneficiary, as displayed in Table 2.

To facilitate the implementation process and to capture potentially important spillover effects (to be discussed in more detail below), the random selection of beneficiaries into cohorts will occur at the community/village level. Specifically, since the list of registered farmers will contain information about the community they reside in, the MoA will randomly select a number of communities based on this list until the target number of beneficiaries for each cohort and region is reached.

*Selection of Control Group*

In order to assess the impact of agricultural research and extension on the household-level indicators described above, the evaluation needs to be able to identify the counterfactual, or rather answer the question the following question: “What would have happened to agricultural production and productivity among beneficiary farmers if the Program had not been implemented?” Of course, this question is merely hypothetical and can only be answered by identifying a group of farmer households who are identical to beneficiary farmers across a distribution of characteristics relevant to project outcome. Since beneficiaries are chosen from a pool of farmers who have indicated their interest in receiving extension services, it is not possible to randomly select a control group from the universe of farmers in the targeted regions, since it is likely that farmers who registered in response to the Ministry’s public announcement possess some intrinsic characteristics, such as their entrepreneurial abilities, or higher motivation to improve farm productivity that will probably affect outcome indicators. Due to this self-selection bias, it would be impossible to determine impact based on a comparison of outcomes between farmers who registered and a control group of farmers who did not, since differences in farm production, yields, and income may have resulted not from Program participation but rather from differences in farmer characteristics.

In this context, the selection of a valid control group takes advantage of the fact that the Program faces certain budget limitations that prescribe a phase-in of benefit distribution over a number of years. The proposed experimental procedure, dubbed “Randomized Order of Phase-In” by Duflo, Glennester, and Kremer (2008), uses as the control group those beneficiary farmers who have been randomly assigned to the later cohorts of the roll-out schedule. Since all beneficiary farmers have indicated their interest in the Program, self-selection bias is not a concern if a control group is selected in this manner. Furthermore, the roll-out over three years allows the estimation of impact at two points in time and may reveal interesting insights about the length of time it takes for proposed technologies to bring about improvements in production and productivity.

Since the evaluation strategy is relying on later beneficiaries as the counterfactual, it is important to ensure that strategic behavior among this group is avoided. As noted in Winters et al. (2015), such strategic behavior can occur if later beneficiaries, knowing that they will receive extension in a few years, will purposefully delay technology adoption as they wait for government support. Since this may severely bias any impacts found for the Program, it is important to verify that such strategic behavior is not systematic or widespread. However, based on the profile of a large majority of beneficiaries and the known credit constraints that such smallholder farmers encounter, it can be argued that farmers would not be able to adopt technologies without monetary support. In this case, strategic behavior does not pose a serious bias concern.[[2]](#footnote-2)

Another serious concern that occurs for most agricultural extension Programs are spillover effects from beneficiary farmers, for two reasons: First, if it is the case that neighboring beneficiary farmers have been selected into different cohorts, it is possible that the control group (the later cohorts) may experience some contamination as later beneficiaries observe extension services and change their own production practices prior to receiving treatment. Second, a spillover to neighboring, ineligible farmers is often a desired indirect effect of technology adoption and as such should be captured in any comprehensive evaluation so as not to underestimate impact. For both of these reasons, it is important to randomly assign farmers to the three distinct cohorts at a higher geographical level in order to avoid contamination of the control group, and capture indirect effects on ineligible farmers that are located in close proximity to beneficiaries. In the Program context, it is therefore advisable to randomly assign cohort membership at the community level until the number of beneficiaries required by region and cohort is reached.

**Figure 2.** Double Randomization Strategy

*Communities assigned to early treatment Communities assigned to late treatment*

= Direct beneficiaries

= Indirect beneficiaries

Additionally, the sampling strategy for the impact evaluation should include the selection of a number of ineligible farmers in each community to capture said indirect spillover effects. It is expected that not all farmers in each community will participate in the Program, either because they are ineligible or because they choose not to register for the program. Living in close proximity to farmers participating in the project, it can then be assessed whether these non-participants are indirectly benefiting through spillover effects. In order to assess the potential spillover effect, the sampling procedure relies on the so-called “double randomization strategy”, in which both participants and non-participants are sampled for each targeted community. This results in four distinct groups for the purpose of the evaluation: i) direct beneficiaries in communities assigned to early treatment, ii) direct beneficiaries in communities assigned to late treatment, iii) indirect beneficiaries in communities assigned to early treatment, iv) indirect beneficiaries in communities assigned to late treatment. Note that direct beneficiaries may include such farmers that receive both training and an incentive, as well as such farmers that only receive training, but no incentive.

In this manner, any potential spillover effects can be measured by comparing the outcomes of indirect beneficiaries in communities that receive extension services in the beginning to the outcomes of those who live in communities receiving extension services later on. This will be incorporated into the regression framework discussed below. Lastly, note that medium and large farmers as potential beneficiaries will be excluded from the evaluation strategy due to the small number of such farmers relative to the targeted population. In the following, the identification strategy will focus on smallholder farmers only.

*Identification Strategy: Difference-in-Difference*

In order to identify the causal impact of the agricultural extension services provided under the Program and to address any remaining concerns about the validity of the control group, the impact evaluation design will employ a difference-in-difference, or double difference (DD) strategy. Under this strategy, three surveys will inform the analysis: (i) a baseline survey administered to a sample of all beneficiary farmer households from the three cohorts prior to the implementation of the project, (ii) a follow-up survey administered to the same farmer households at the end of year 1 (before the second cohort receives treatment), and (iii) a second follow-up survey administered to the same farmer households at the end of year 2 (before the third cohort receives treatment).

The basic intuition behind the DD strategy is that Program impact can be measured by comparing the change in the mean of the outcome variable(s) between the treatment and control households. In this manner, the strategy controls for bias from two sources: (i) systematic differences in time-invariant characteristics between households in treatment and control group, and (ii) general time trends over the period of the Program. The DD can then be estimated in a regression framework as follows:

(1)

where:

outcome variable of interest for household *i* in community *c* at time *t;*

binary variable that equals 1 for year 2 (year 1 as baseline is excluded category);

binary variable that equals 1 for year 3 (year 1 as baseline is excluded category);

binary variable that equals 1 for households that are beneficiaries in community *c;*

vector of farm-level covariates;

vector of community-level covariates;

errorterm; and

parameters to be estimated.

The key parameters of interest are and , where represents the double-difference estimator for the average Program effect for year 2 (relative to year 1 as the baseline period), and the double-difference estimator for the average Program effect for year 3 (relative to year 1). To control for any time-variant observable characteristics, the specification also includes farm- and community-level variables that may affect outcome.

Since participation in the program is demand-driven, it is likely that compliance or rather adoption rates are less than 100%. This implies that some beneficiaries may be offered the program (training and/or incentives) but may choose not to implement the new technologies. Therefore, the estimated impact will likely not render the average treatment effect (ATE), but rather the intention-to-treat effect (ITT), which has some implications for the external validity of the analysis. In order to respond to all the relevant evaluation questions stated in the previous section, the sample design has been set up in a way that the following heterogeneities can be assessed:

* 1. *By treatment level:* Since there are two levels of treatment – with and without monetary incentive – an important heterogeneity analysis concerns the differential impact observed for those farmers who receive a monetary incentive, and those who do not;
  2. *By region:* Given the distinct nature of farmers and production activities in regions 5, 9, and 10, impact should be assessed separately for each of the three regions;
  3. *By type of farmer:* It should be assessed how impact varies among individual farmers and indigenous farmers who tend to conduct communal agricultural activities;
  4. *For indirect beneficiaries:* The inclusion of non-beneficiaries that live in the same communities as treated farmers allows the estimation of a spillover effect, which is estimated as the impact on indirect beneficiaries in cohort 1 in comparison to indirect beneficiaries in later cohorts.

With regards to heterogeneity by type of farmer, it is important to highlight that the majority of indigenous farmers are located in region 9. Therefore, it is likely that a separate analysis of farmers in region 9 will render the heterogeneity of impact for Amerindian farmers.

Lastly, the program anticipates the concurrent implementation of a similar agricultural intervention by IFAD in region 9. At this stage, the design of said program is still in its early stages, so that it was not possible to integrate their targeting approach into this evaluation design. However, in order to disentangle potential effects of the IFAD program on targeted beneficiaries, the questionnaire will include a number of questions about any participation of the farmer in the IFAD program so as to identify beneficiaries that may have received additional assistance and training.

*Evaluation of Component III*

Under Component III, the Program will build two pilot facilities for meat processing (abattoirs) that are expected to increase the quality and quantity of meat products for a number of farmers organized in livestock production associations. At this stage of the Program design, the implementation envisions the participation of two such producer associations with approximately 160 members in total, 80 per producer association. During the first year of implementation, these farmers are to receive the necessary training to adjust their livestock practices in a way that allows the processing of their livestock products in the pilot facilities. Beginning in year 2 of the implementation, the pilot facilities will be ready for processing and livestock producers will begin having their livestock products prepared through these abattoirs.

Given the small target population of the activities below this Component, and the very unique characteristics of beneficiaries, including their close proximity to the abattoirs and their organization within producer associations of which there are only 3, it is not possible to apply the more rigorous methodologies that are used for the evaluation of the first two components. Following conversations with the executing unit, it is deemed unfeasible to identify a valid counterfactual for beneficiaries, specifically livestock producers that are organized in associations and located close to the newly constructed abattoirs. Therefore, the proposed methodology to evaluate the impact of Component 3 is a simple reflexive approach that compares the indicator of impact among beneficiary farmers prior to and after the implementation of the intervention. Of course, this approach relies on the very strong assumption that no other changes occurred during the time of the implementation that may have affected outcomes. If other changes have occurred over time, changes in the outcome indicators cannot be clearly attributed to the impact of the Program. Therefore, the estimated impact resulting from this reflexive approach comes with the stipulation that it is likely a biased estimator.

Under this strategy, two surveys will inform the analysis: (i) a baseline survey administered to a sample of the beneficiary livestock producers prior to the implementation of Component III, (ii) a follow-up survey administered to the same livestock producers at the end of year 2. These surveys can be conducted in parallel to the data collection for the evaluation of extension services under the project and will rely on the same questionnaire.

The reflexive difference can then be estimated using the following regression framework:

(2)

where:

outcome variable of interest for household *i* at time *t;*

binary variable that equals 1 for year 3 (year 1 as baseline is excluded category);

vector of farm-level covariates;

errorterm; and

parameters to be estimated.

The key parameters of interest here is coefficient , since it represents the change in outcome over time for livestock producers. If the meat processing facilities had a positive effect on livestock production and income, we would expect to be positive and statistically significant. To control for any time-variant observable characteristics, the specification also includes farm-level variables that may affect outcome.

1. TECHNICAL AND PRACTICAL ASPECTS OF THE EVALUATION

This section discusses a number of considerations of technical and practical relevance to the evaluation of the Program. This includes discussion of the definition of treatment and control groups, a presentation of the sampling frame strategy, the questionnaire design, and data collection procedures, among other considerations.

*Treatment and Control Groups*

According to the above description of the selection strategy of beneficiaries for the Program, farmers are selected based on their interest and eligibility to participate, and then placed randomly in three cohorts according to the 3 year roll-out of the program. Farmers placed in the two later cohorts therefore represent the control group for the evaluation. Furthermore, farmers are stratified by region (regions 5, 9, and 10), as a heterogeneity of impact is likely to occur at the regional level.

*Sample Frame*

The sample frame is the list of the population of interest. For the evaluations of Components I and II of the Program, the population of interest for both treatment and control group are all farmers in regions 5, 9, and 10 that comply with the eligibility criteria noted above and show interest in participation by registering with the MoA. For Component III, the population of interest is a sub-group of these farmers in regions 5 and 9 that are part of the targeted livestock producer associations and want to take advantage of the newly constructed meat processing plants. Therefore, the sample frame should be constructed (for all Components) either from the newly conducted agricultural census (to be completed under Component I), or based on the list of registered farmers and complementary data to confirm compliance with eligibility criteria, which will be created as part of the selection strategy described in the previous section.

Given the sample frame, it is necessary to determine the number of surveys (at the household and implicitly, the community level) required for the evaluation. It was initially hoped that the data collected for the loan preparation could be used to conduct a number of power calculations to determine adequate sample size. Unfortunately, standard deviations for all main impact indicators were so large that no sensible estimation within the given sampling framework is possible. Instead, sample sizes are determined based on the population of potential beneficiaries as identified in Table 2.

Since the evaluation envisions a clustered randomized assignment at the community level, it is further pertinent to present the number of communities per region: There are 151 communities in region 5, 51 (Amerindian) communities in region 9, and 114 communities in region 10. In the context of any clustered sampling approach, it is key to select an adequate number of clusters so as to avoid issues of small sample size. Therefore, the random selection procedure will have to be designed carefully so as to select a sufficient number of communities in every cohort, and in every region. In this context, the priority is to have a large number of clusters (communities) rather than a large number of farmers in each community. As a benchmark, at least 60 communities should be randomly selected for each round of treatment.

Once communities have been randomly selected for each cohort, it will be important to sample not only beneficiary farmers in this community, but also include a reasonable number of non-participants (indirect beneficiaries) from the same community in order to measure any potential spillover effects. In this context, the following sample sizes are proposed as a benchmark for the random selection process:

**Table 3.** Sample Sizes by Region and Cohort

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Region** | **Type of farmer** | **Year 1** | **Year 2** | **Year 3** | **Total** |
| Region 5 | Direct beneficiaries | 100 | 100 | 100 | 300 |
| Indirect beneficiaries | 80 | 80 | 80 | 240 |
| *Total* | *180* | *180* | *180* | *540* |
| Region 9 | Direct beneficiaries | 80 | 80 | 80 | 240 |
| Indirect beneficiaries | 60 | 60 | 60 | 180 |
| *Total* | *140* | *140* | *140* | *420* |
| Region 10 | Direct beneficiaries | 100 | 100 | 100 | 300 |
| Indirect beneficiaries | 80 | 80 | 80 | 240 |
| *Total* | *180* | *180* | *180* | *540* |
| **Total** | Direct beneficiaries | 280 | 280 | 280 | 840 |
| Indirect beneficiaries | 220 | 220 | 220 | 660 |
| *Total* | ***500*** | ***500*** | ***500*** | ***1,500*** |
| **Region** | **Type of farmer** | **Year 1** | **Year 2** | **Year 3** | **Total** | |
| Region 5 | Direct beneficiaries | 100 | 100 | 100 | 300 | |
| Indirect beneficiaries | 80 | 80 | 80 | 240 | |
| *Total* | *180* | *180* | *180* | *540* | |
| Region 9 | Direct beneficiaries | 80 | 80 | 80 | 240 | |
| Indirect beneficiaries | 60 | 60 | 60 | 180 | |
| *Total* | *140* | *140* | *140* | *420* | |
| Region 10 | Direct beneficiaries | 100 | 100 | 100 | 300 | |
| Indirect beneficiaries | 80 | 80 | 80 | 240 | |
| *Total* | *180* | *180* | *180* | *540* | |
| **Total** | Direct beneficiaries | 280 | 280 | 280 | 840 | |
| Indirect beneficiaries | 220 | 220 | 220 | 660 | |
| *Total* | ***500*** | ***500*** | ***500*** | ***1,500*** | |

Thus, for each round of data collection, it is recommended to survey 1,500 households for a total of 4,500 surveys. Note that the exact number of community surveys administered will depend on the geographic distribution of beneficiaries, and cannot be determined until farmers have registered for participation in the Program. Assuming that about 60 communities will be randomly selected for each cohort, one can expect that about 180 community surveys will be administered for each round of data collection, for a total of 540 surveys.

Even though this manner of determining sample size is not ideal, it is expected that, given a careful implementation of data collection activities that allows for a more precise estimation of impact indicators, the proposed sample sizes will be sufficient to estimate and detect program impact with reasonable confidence. Specifically, it is expected that cassava and bean yields will increase to 35% of benchmark yields provided by NAREI, while cattle yields increase by 70%.[[3]](#footnote-3)

As previously mentioned, the analysis estimates the intention-to-treat (ITT) effect to account for compliance rates that are likely below 100%. In order to determine the extent of compliance, it will be important to measure adoption and compliance rates among beneficiary farmers. Using these compliance rates, it may be possible to retrieve the average treatment on the treated (ATT) effect from the ITT estimate.

Lastly, it should be noted that even though the collected data could not be used to conduct a rigorous power analysis, the data collection experience rendered a number of important lessons learned about the state of agricultural production in Guyana. Therefore, it is hoped that these lessons can be applied to the indicated future data collections by redesigning part of the questionnaire and posing questions in a way that are appropriate for the Guyanese context. Additionally, the sample frame will likely rely on the results of the agricultural census to be implemented next year in order to prepare a more rigorous sample framework that is based on actual power calculations.

*Data Collection Instruments*

**Table 4.** Data required

|  |
| --- |
| ***Intermediate household indicators*** |
| * Diversification of crop and livestock portfolio * Expenditures on key inputs such as fertilizers and land preparation * Implementation of sustainable farming practices (irrigation, crop varieties, fertilizer use) * Investment in fixed and movable farm assets, including natural resource investments * Placement of women in decision-making positions (time use, participation in household decisions, access to extension services) * Farming and livestock production |
| ***Final household indicators*** |
| * Farm yields * Gross margins * Profitability * Agricultural and total household income |
| ***Geographic information*** |
| * Region and community of the household * Access to infrastructure (e.g. distance of the household from nearest major road or primary/secondary school, location of nearest water source, etc.), preferably through the use of geographic position systems (GPS) |
| ***Household characteristics*** |
| * Age, gender, relationship to household head, marital status, etc. for each household member * Literacy and years of schooling of each household member * Receipt of remittances |
| ***Agricultural assets*** |
| * Land holdings * Agricultural equipment * Existence of production issues (e.g. infestation, flooding, etc.) |
| ***Other assets*** |
| * Non-agricultural assets * Conditions of the household’s dwelling. |
| ***Organization/association*** |
| * Participation in other government programs * Participation in producer organization, cooperative, etc. * Receipt of technical assistance |
| ***Community-level information*** *(obtained from community survey)* |
| * Population size * Common agricultural activities (type of crops, livestock) * Communal agricultural production activities |

The objective of the survey of farmer households in select communities of regions 5, 9, and 10 is to obtain information pertaining to the impact/outcome variables of interest as well as a number of conditioning variables that are hypothesized to affect the outcome variables. The primary justification for the inclusion of conditioning variables is to improve the precision of the impact estimates. A detailed list of the outcome and conditioning variables is provided in Table 4. As discussed, the household-level impact indicators can be classified into two groups: intermediate and final. The consistent estimation of the project impact also requires gathering information on select control variables, which are noted in Table 4 following the indicators.

**Table 5a.** Modules of household questionnaire

|  |
| --- |
| ***Module 0: Basic Information*** |
| * Section A.1: Identification of the household/production unit (e.g. name of respondent, location of household, project beneficiary status, etc.) * Section A.2: Identification of the interview/interviewer (e.g. name of interviewer, time started and finished of the interview, etc.) * Section A.3: GPS coordinates and related information |
| ***Module 1: Household Demographics, Dwelling and Locality Access Information*** |
| * Section 1.1: Household members (e.g. age, gender, relationship to household head, marital status, years of schooling, etc. of each household member) * Section 1.2: Living conditions (e.g. type and condition of dwelling, access to electricity, sanitation, ownership status) * Section 1.3: Locality (e.g. knowledge of and distance to various facilities incl. main highway, schools, health facilities, agricultural markets, etc.) |
| ***Module 2: Agricultural Parcels*** |
| * Section 2.1: Characteristics of owned parcels (e.g. location, area, use, tenure status/security, irrigation, irrigation technology, soil type/quality, etc.) * Section 2.2: Land conflicts (conflicts and solution) * Section 2.3: Agricultural problems (type of problem and how it affected production) * Section 2.4: Agricultural and livestock practices |
| ***Module 3: Assets*** |
| * Section 3.1: Agricultural assets (e.g. type, quantity, and source of assets) * Section 3.2: Non-agricultural assets (e.g. type, quantity, and source of assets) |
| ***Module 4: Livestock*** |
| * Section 4.1: Inventory (e.g. number and value of animals owned, investment in last year) * Section 4.2: Livestock production (e.g. sales, household consumption, etc.) * Section 4.3: Livestock costs * Section 4.4: Aquaculture (inventory, production, costs) |
| ***Module 5: Agricultural Production*** |
| * Section 5.1: Temporary crops (area, planting/harvesting time, technology used, costs of seeds, fertilizers, pesticides, equipment, sale, consumption, storage, etc. of processed and unprocessed harvest) * Section 5.1: Permanent crops (area, harvesting time, technology used, costs of seeds, fertilizers, pesticides, equipment, sale, consumption, storage, etc. of processed and unprocessed harvest) * Section 5.3: Forestry products (area, harvesting time, cost of equipment and processing, sale, consumption, storage, etc. of processed and unprocessed harvest) |
| ***Module 6: Agricultural Assistance*** |
| * Type of assistance, provider, frequency, inputs provided, etc. * Assistance received from IFAD |
| ***Module 7: Economic Activity of Household Members*** |
| * Section 7.1: Time use (hours and days spent in various agricultural activities by household members, unpaid community members, and paid labor) * Section 7.2: Employment (type of occupation, days worked, salary, remittances) * Section 7.3: Loans, credits, and savings (type of loan, amount, reason for loan) |

Given the variables required for the analysis, it is then possible to outline the questionnaires by which the data is to be collected. Table 5a provides an overview of the modules of the household questionnaire, while Table 5b outlines the modules of the community questionnaire. Each section of the questionnaires can be justified through its link to the variables noted in Table 4.

**Table 5b.** Modules of community questionnaire

|  |
| --- |
| ***Module 0: Basic Information*** |
| * Identification of the community and respondent information (e.g. region, community, neighborhood democratic council, name, gender, and age of respondent, role in community, etc.) * Community information (e.g. type of community, number of households, number of farmers) |
| ***Module 1: Economic Activity and Public Infrastructure*** |
| * Major economic activities (e.g. main occupations in community) * Locality (e.g. accessibility from community to various facilities incl. main highway, schools, health facilities, agricultural markets, etc.) |
| ***Module 3: Agricultural Characteristics*** |
| * Main types of crop and livestock products produced in community * Agricultural organizations in community (e.g. farmer associations, cooperatives, etc.) * Community owned assets (e.g. type, quantity, and source of assets) * Agricultural production assistance (number of farmers with access to assistance, type of assistance, provider, etc.) * Climate change (how climate change has affected production among farmers) |
| ***Module 4: Community Production*** |
| * Livestock (inventory, production, costs, labor days of community members) * Crop farming (type of crop, area, harvest, consumption, sales, labor days of community members) * Forestry production (type of product, harvest, consumption, sales, labor days of community members) |

*Timing of Data Collection*

Based on the design and the roll-out of the evaluation, the plan proposes that data is collected in three waves. The baseline survey should be administered in 2017 prior to the implementation of the Program for a sample of all three cohorts. The first follow-up survey will be administered at the end of harvest season in 2018. At this point, cohort 1 will have received treatment for one year, while cohort 2 will start receiving treatment after the first follow-up survey has been administered. All data collected at this point constitutes the basis for the midterm evaluation, which should be conducted as soon as Year 2 data are ready for analysis. The final follow-up will be administered once cohort 2 will have received one year of treatment and before the third and final cohort begins receiving benefits, which will be at the end of harvest season in 2019. At this point a panel data set covering three years will be available for the final evaluation of the Program. It is important to stress that untreated farmers that eventually will be treated serve as control groups only so long as they have not yet received any benefits and whenever a survey is conducted, the data collected corresponds to the preceding agricultural year. Given that harvesting season for the staple crop Cassava takes place in May and June, the best time for fieldwork in Guyana is the month of July, for each round of surveys. Table 6 presents and summarizes the timing and expected costs of the evaluation plan, where costs are based on the proposed sample size and an approximate cost of US$75 per survey:

**Table 6.** Evaluation Work Plan

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Year** | | | | | | | | **Cost (US$)** | | |
| **Activity** | 2017 | |  | 2018 | |  | 2019 | | Household Surveys | Community Surveys | **Total** |
| Baseline |  |  |  |  |  |  |  |  | 112,500 | 13,500 | 126,000 |
| Baseline Analysis |  |  |  |  |  |  |  |  |  |  | 7,000 |
| First follow-up |  |  |  |  |  |  |  |  | 112,500 | 13,500 | 126,000 |
| Mid-term evaluation |  |  |  |  |  |  |  |  |  |  | 7,000 |
| Second follow-up |  |  |  |  |  |  |  |  | 112,500 | 13,500 | 126,000 |
| Final impact evaluation |  |  |  |  |  |  |  |  |  |  | 8,000 |
|  |  |  |  |  |  |  |  |  |  | **Total** | **$400,000** |

*Responsibilities and reporting*

The M&E unit of the MoA will be in charge of implementing the impact evaluation. They will receive support from RND and SPD on the administration of the plan as well as the subsequent analysis of the data.

Four reports will be completed as part of the impact evaluation. The dates of completion will depend on the specific dates of implementation of the impact evaluation and so the expected dates are noted relative to the data collection (see Table 6).

1. **Impact evaluation plan:** This document will provide a detailed design of how the impact evaluation will be administered. It will be largely based on this plan with changes made as necessary to adjust for changes in the project and with more detail on the implementation of the survey.

*Completion:* Two month prior to the administration of the baseline survey.

1. **Baseline report:** This document will provide details of how the baseline was administered, including any deviations that occurred from the impact evaluation design. The report will include all documents associated with the baseline administration including the questionnaire, enumerator guidelines, etc. Basic descriptive statistics of the data will also be included as well as an assessment of the success of the evaluation to create a reasonable counterfactual.

*Completion:* Three months after the baseline survey administration.

1. **Follow-up survey report:** Like the baseline report, this document will provide details of how the follow-up survey was administered, including any deviations that occurred from the impact evaluation design. The report will include all documents associated with the post-treatment survey administration including the questionnaire, enumerator guidelines, etc. Basic descriptive statistics of the data will also be included.

*Completion:* Three months after the follow-up survey administration.

1. **Impact evaluation report:** Using data from both rounds of data collection, this report will provide an assessment of the impact of the program on the key indicators noted earlier in this plan. The ultimately objective of the report is to answer the questions posed earlier in the plan, provide an overall assessment of the effectiveness of the project and to offer lessons learned. *Completion:* Nine months after the follow-up survey administration.

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1. Survey results indicate that about 89% of all farmers operate on less than 5 hectares of land. [↑](#footnote-ref-1)
2. It will have to be verified whether strategic behavior did occur among medium and large farmers who are less likely to be limited by credit constraints. However, this type of beneficiary constitutes only a small share of the sample, so that strategic behavior is unlikely to pose a systemic issue. [↑](#footnote-ref-2)
3. The ex-ante economic analysis (Optional Annex 9) assumes an adoption rate of 10% among cassava and bean farmers, and a full adoption rate for cattle farmers. [↑](#footnote-ref-3)