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**HAITI**

**WATER MANAGEMENT PROGRAM IN THE ARTIBONITE BASIN**

**(HA-L1087)**

**monitoring and evaluation plan**

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**Abbreviations**

CIA Agricultural Infrastructures Coordination *(Coordination des Infrastructures Agricoles de*

*l’ODVA)*

DGSE Social Water Management Directorate *(Direction de la Gestion Sociale de l’Eau de*

*l’ODVA)*

EDH Electricity of Haiti

FASSIVAL Federation of Water User Associations in the Artibonite Valley

Ha Hectare

HH Household

HTG Haitian Currency (Gourdes)

IE Impact Evaluation

IMT Irrigation Management Transfer

MARNDR Haitian Ministry of Agriculture *(Ministère de l’Agriculture, des Ressources Naturelles et*

*du Développement Rural)*

Mm3 Million Cubic Meters

M&E Monitoring and Evaluation

ODVA Organization for the Development of the Artibonite Valley *(Organisme de*

*Développement de la Vallée de l’Artibonite)*

PIA Agricultural Intensification Project

PMR Progress Monitoring Report

PSM Propensity Score Matching

RCT Randomized Controlled Trial

UEP Studies and Programming Unit *(Unité d’Etudes et de Programmation)*

XPMR Extended Progress Monitoring Report

WUA Water User Association

1. **INTRODUCTION**
   1. The Artibonite watershed is the largest hydrographic basin in Haiti and the Artibonite River is the first source of hydroelectric power and irrigation water in the country. Upstream of Péligre dam, agriculture, livestock farming and charcoal production are the main sources of income for approximately 150,000 rural households. In the Artibonite Valley, 70,000 rural families depend on the 30,000 hectares (Ha) of the irrigation district to cultivate rice (80% of the national production). The upper Artibonite watershed suffers from similar environmental problems as the rest of the country. Deforestation and unsustainable agricultural practices have resulted in severe erosion, which is estimated at 1,305 metric tons per km² per year on average in the watershed. A direct consequence of erosion is the silting of the Péligre reservoir, whose storage capacity decreased from 600 Mm³ to 300 Mm³ in 60 years. The hydro-electrical plant of the Péligre dam is managed by Electricity of Haiti (EDH), whose main objective is electricity generation, and provides 30% of the country’s electricity. As a result irrigation needs and flood mitigation in the lower watershed are given little consideration in water management decisions. Combined with decreased reservoir storage capacity and insufficient water management equipment and automatic control systems, this often results in large water releases that cause flooding and important associated losses in the irrigated district. These problems are compounded by deficiencies in the operations and the maintenance of hydraulic infrastructures in the irrigation district. Its main infrastructures such as the Canneau dam and the primary canals are under the responsibility of the Organization for the Development of the Artibonite Valley (ODVA), but this institution suffers from severe management weaknesses and budgetary restrictions. Operations and maintenance of small irrigation infrastructures such as secondary and tertiary canals, including cost recovery, are theoretically under the responsibility of water user associations (WUAs), recently created by the Agricultural Intensification Program (PIA; HA-0016), but they remain too weak to assume this new function.
   2. In the upper Artibonite watershed, the objectives of the Water Management Program are to decrease erosion as well as to increase farmers’ agricultural productivity in the selected gullies. In the irrigation district, the Program aims at decreasing crop, livestock and infrastructures losses caused by flooding and increasing farmers’ agricultural productivity through better access to irrigation water, drainage and management of hydraulic infrastructures. To meet these objectives the program will be structured into two components: (1) the rehabilitation of water management infrastructures such as canals, drains and gates in the irrigation district and the construction of water and sediment containment infrastructures such as check dams in the upper watershed; and (2) institutional strengthening of the network of institutions involved in the operation and maintenance of hydraulic infrastructures in the irrigation district such as WUAs, ODVA, the Commission for the multi-purpose water management at Péligre dam (hereinafter referred to as Péligre Commission), and the future Artibonite Binational Commission. The program’s logic of intervention is described in the graph below:

**Graph 1**

**The Program’s Logic of Intervention**

**OUTPUTS**

Component 1:

- Rehabilitating canals, drains and water management

Equipment in the lower watershed

- Building water and sediment containment infrastructures

such as check-dams in gullies located in the upper

watershed

Component 2:

- Providing WUAs with basic infrastructures and

equipment, as well as technical assistance

- Providing ODVA, the Péligre Commission and the

Binational Commission with technical assistance

**OUTCOMES**

Component 1:

- Improve water distribution in the irrigation district

- Decrease hydromorphic area in the irrigation district

- Improve water and sediment containment in selected

gullies in the upper watershed

Component 2:

- Improve flood management at Péligre dam

- Improve operations and maintenance of hydraulic

infrastructures and equipment in the irrigation

district

**IMPACT**

- Decrease crop, livestock and infrastructure losses caused

by flooding in the lower watershed

- Increase agricultural productivity

* 1. The Monitoring and Evaluation System will rely on three components:

1. Biannual monitoring reports prepared by a monitoring officer affiliated to the Studies and Programming Unit (UEP) from the Haitian Ministry of Agriculture (MARNDR) with a part-time dedication to the project. The report will compile data collected from:

* Three field coordinators of the executing agency (MARNDR) who will monitor day-to-day progresses of the project.
* Two students affiliated to UEP who will make day-to-day observations and measurements of key technical, economic and environmental indicators in the project area located in the upper watershed.
* Water flow measuring devices located at Péligre dam and in the irrigation district: 56 automatic measuring devices operated by ODVA (including the tele-monitoring device at Canneau dam); 44 manual measuring devices operated by WUAs’ gatekeepers in the pilot area (e.g. gauges); one flood management software at Péligre dam operated by EDH.

1. Mid-term and final independent evaluations (the latter will include an ex-post economic analysis of the project using the same methodology as the ex-ante economic analysis but actual project data) focusing on the project’s effectiveness, efficiency, sustainability, relevance and coherence.
2. An external impact evaluation based on an experimental method (see Part III).
   1. The executing agency assisted by UEP will be responsible for the operational monitoring of the project at all levels (Components 1 and 2). Consulting firms will be contracted by the executing agency to carry out mid-term and final independent evaluations as well as for the implementation of the impact evaluation.
3. **MONITORING**

A. Output Indicators

* 1. Based on the complete results matrix of the project, the monitoring will consider the following output indicators:

**Table 1**

**Output Indicators**

|  |  |  |
| --- | --- | --- |
| **Indicator** | **Frequency of Measurement** | **Source of Verification** |
| **Component I: Water and Sediment Management Infrastructures** | | |
| **Output 1:** Number of water and sediment containment infrastructures built in gullies in the pilot area of the upper watershed | Biannual | Executing agency reports and IDB inspection visits |
| **Output 2:** Number of electromechanical system (gates and automatic control) at Canneau dam rehabilitated |
| **Output 3:** Number of protection walls preventing the Left and Right Banks Master Canals from collapsing downstream Canneau dam built |
| **Output 4:** Meters of secondary and tertiary irrigation and drainage canals built or rehabilitated in the pilot area of the irrigation district |
| **Output 5:** Meters of primary irrigation and drainage canals dredged in the irrigation district |
| **Output 6:** Number of equipment device to regulate and measure water flow built/installed on the main canals of the irrigation district |
| **Component II: Institutional Strengthening** | | |
| **Output 7:** Number of meetings of the Péligre Commission taking place | Biannual | Executing agency reports and IDB inspection visits |
| **Output 8:** Number of flood management system (composed of water level gauges, flood management software and one computer per dam) operating at the Péligre and Canneau dams |
| **Output 9:** Artibonite Watershed Binational Commission created |
| **Output 10:** ODVA’s procedures manual for operation and maintenance of infrastructure and equipment prepared |
| **Output 11**: Number of CIA-ODVA’s staff trained |
| **Output 12:** Annual technical and financial plan and annual technical and financial report of operation and maintenance of primary infrastructures under ODVA’s responsibility prepared |
| **Output 13:** CIA-ODVA equipped with a package of operating equipment (vehicle, computer, software, furniture…) |
| **Output 14:** Number ofODVA’s administrative and financial staff trained |
| **Output 15:** Accounting software installed at the ODVA’s administrative and financial service |
| **Output 16:** ODVA’s administrative and financial service equipped with a package of operating equipment (computer, furniture…) |
| **Output 17:** DGSE-ODVA equipped with a package of operating equipment (vehicle, computer, software, furniture…) |
| **Output 18:** Number of WUAs equipped with office, IT equipment and motorcycles |
| **Output 19:** Number of DGSE and WUA staff trained |
| **Output 20:** Annual technical and financial plan and annual technical and financial report of operation and maintenance of infrastructures under WUAs’ responsibility prepared |

B. Data Collection and Instruments

* 1. For both Components, the source of information will be on-site visual inspections by the executing agency staff with progresses reported in the activity reports.
  2. All monitoring will be the responsibility of the part-time monitoring officer.

C. Reporting

* 1. The executing agency will prepare and transmit to the Bank a biannual activity report that will include the results of the monitoring of all the output indicators listed above. The preparation by the executing agency and the Bank’s approval of these reports is a contractual condition of the grant. At the end of the project (Y5), the executing agency will prepare a final report.
  2. These reports will provide all the required information for the PMR system of the Bank, to be updated on a biannual basis by the specialist in charge.
  3. The entity contracted to carry out the impact evaluation will submit a biannual report on data collection activities and data analysis. This report will be transmitted to the Bank for approval, which constitutes another contractual condition of the grant.
  4. Biannual monitoring reports are due one month after the end of the each semester (i.e. on January 31st and July 31st).

D. Independent Evaluations

* 1. A mid-term independent evaluation will be carried out at the end of Y3. The objective will be to determine whether execution is satisfactory (if there are delays, overcosts…) and whether the project’s strategy is generating the desired impact, or whether adjustments are needed. For each Component, it will highlight the key issues that are faced and which require responses from the executing agency. It will also provide a set of preliminary insights about the project’s design, implementation, and management.
  2. A final independent evaluation will be carried out a few months before the end of the project at Y5 to determine whether it has reached its objectives. The evaluation team will identify the lessons learned through the project and in particular its key successes and failures. The team will also assess the sustainability of the project’s results and propose a set of recommendations to the various project’s stakeholders in order to reinforce it.

E. Monitoring Coordination, Work Plan and Budget

* 1. Table 2 provides details on the responsible entities for the implementation of the monitoring plan, monitoring activities, budgetary allocations for each activities and sources of funding.

**Table 2**

**Monitoring Work Plan**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Activity** | **2014** | | | | **2015** | | | | **2016** | | | | **2017** | | | | **2018** | | | | **Responsible** | **Cost (currency)** | **Source of Funding** |
| **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| Mid-term evaluation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | MARNDR | US$ 50,000 | Project Budget (M&E category) |
| Final evaluation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | MARNDR | US$ 80,000 | Project Budget (M&E category) |
| Inspection visits |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | IDB | US$10,000 | IDB Transactional Budget |
| Day-to-day supervision by executing agency |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | MARNDR | Cannot be disaggregated | Project Budget (tehcnical team of the executing unit) |
| Consultant for technical assistance to the executing unit on monitoring and evaluation |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | MARNDR | US$192,500 | Project Budget (M&E category) |

**Total Cost of the Monitoring Plan: US$ 332,500**

1. **EVALUATION**

A. Main Evaluation Questions

The evaluation will be divided in two main parts. The first part aims at identifying the impact of the intervention in the upper watershed while the second part aims at identifying the impact of the project in the irrigation district as a whole.

**a) In the upper watershed**

950 water and sediment containment infrastructures distributed in over 130 gullies will be built by the project in a pilot area of 15 km² located in the Thomonde sub-watershed. More specifically, the project will finance the construction of:

* + 1. 80 gabion basket check dams
    2. 200 concrete check dams with water retention tanks
    3. 70 concrete check dams without water retention tanks (**Picture 1**)
    4. 100 loose stone/rock dams
    5. 500 biological dams

The impact of the last two dams will only be environmental (decrease erosion; reduce water flows). They will not create any opportunity for agricultural intensification. However the three check dams (i, ii and iii) will not only retain flood water but also intercept soil sediments coming from upstream. With time (varying from 6 months to 2 years: the speed of sedimentation depends on the type of soil, the ravine’s slope, the quantity of rainfalls and the land use upstream), the quantity of soil sediments accumulated on the upstream part of the check dam will be such that it will form a flat, humid and highly fertile area (an area hereinafter referred to as “terrace” or “market garden”) on which highly profitable crops such as bananas can be grown.[[1]](#footnote-1) The estimated average area of terrace created by these three check dams is 1.6 Ha.[[2]](#footnote-2)



**Picture 1: A concrete check dam without water retention tank**

There are three key evaluation questions that will help assess the project’s impact in the upper watershed:

* 1. What will be the project’s impact on agricultural productivity for the estimated 350 farmers who own and cultivate the land on which check dams will be built (hereinafter referred to as “direct beneficiaries”)?
  2. Will these water and sediment containment infrastructures improve soil conservation (i.e. reduce erosion)?
  3. What will be the impact of building concrete check dams with water retention tanks (**Picture 2**) on access to water for direct beneficiaries (350 farmers) as well as for families living in the nearby area (about 2000 households)?



**Picture 2: A concrete check dam with a water retention tank**

Using gullies as the unit of randomization, a randomized phase-in will be implemented to answer questions 1 and 3 in a rigorous manner. Each year, based on the selected construction firm’s capacity, a group of gullies that are to be treated (a treated gully is one in which water and sediment containment infrastructures such as check dams have been built) will thus be randomly selected, while the others serve as controls. All the 130 selected gullies will eventually be incorporated into the project, which implies that this methodology will only allow for a rigorous measurement of check dams’ medium-term impacts on agricultural productivity and access to water in the gullies (up to 2.5 year).

The expected environmental impact of these water and sediment containment infrastructures is significant, mainly with regard to erosion. However, at least 5 years of pre-project measures of sediment load at the outlet of a gully would be needed in order to make meaningful comparison with post-dam construction data. As a result, no rigorous evaluation can be performed to answer question 2. Instead, the two students in agronomy working under the supervision of UEP will perform day-to-day on-site observations and measurements of key technical and environmental outcome indicators such as the volume of sediment contained on the upstream side of a check dam. They will also be in charge of administering qualitative surveys in order to assess the project’s smaller socio-economic impacts and indirect effects. For instance, in an area in which the opportunity cost of time spent on getting water is high, the 200 concrete check dams that will be built with water retention tanks will provide a new and close source of water not only to direct beneficiaries and their households (HH), but also to an estimated 2,000 extra HH (an average of 10 extra HH by water retention tank). This water can be used for HH (drinking and cleaning water) as well as agricultural purposes (livestock and micro-irrigation). Also, the majority of the people that will be hired to build these check dams will be locals and the wages distributed (especially to women) could have an impact on human capital and agriculture investment levels.

**b) In the irrigation district**:

The rehabilitation of canals, the dredging of drains and the installation of gates by the Component 1 of the project should improve water distribution. The Component 2, on the other hand, will finance the provision of technical assistance to the network of institutions in charge of water management such as ODVA and the three pilot WUAs of Lower Benoît, Bidone and Laville in an effort to improve their operational practices in the short-run, and their efficiency and viability in the medium- to long-run.

There are four key evaluation questions stemming from these two complementary interventions:

1. What will be the project’s impact on agricultural productivity and income for the 6,400 farmers working in the pilot area (3,300 Ha or 10% of the irrigation district) as well as for the 41,600 farmers who work in the rest of the irrigation district?
2. Will we observe a decrease in the total crop, livestock and infrastructure losses caused by flooding in the entire irrigation district?
3. How will the program perform in setting up a new and sustainable water management system operated by WUAs in the pilot area? First, will the three pilot WUAs’ improved material, financial and technical capacity translate into better operations and maintenance of secondary and tertiary hydraulic infrastructures? Then will that lead the 6,400 water users of the pilot area to trust WUAs enough to pay the water tariff?
4. Will the project improve ODVA’s internal management in a sustainable manner? Then, will that translate into better operations and maintenance of the Canneau dam as well as primary hydraulic infrastructures?

It is not possible to implement a rigorous IE to answer these evaluation questions as we do not have a proper counterfactual to identify the project’s impact. The improvement of ODVA’s internal management will for instance benefit all 48,000 farmers of the irrigation district (question 4). Similarly, since the rehabilitation of irrigation infrastructures will benefit all 48,000 farmers of the irrigation district to varying degrees and cannot be randomly phased-in due to technical constraints (i.e. the rehabilitation of canals must follow a hydraulic logic: the upstream water intake must be shut down and rehabilitation work in canals located downstream must take place all at once), there is no control group that could be used to answer questions 1 and 2.. Last but not least, there is a selection bias because the three pilot WUAs have been selected for the following two specific reasons: they are the three WUAs located at the most upstream point of the irrigation district and thus have the best access to water; their hydraulic infrastructures are the most developed of the irrigation district and thus can become fully operational with only limited additional investments in canals and water flow regulating equipment (question 3).

These evaluation questions will thus be answered using a non-experimental method focusing on a before and after comparison. In August 2013, a small qualitative survey was administered by Artelia, a consulting firm, to 100 farms and 200 rural and urban HH distributed over the entire irrigation. In order to reduce sampling error, the « farm » sample was stratified by plot sizes and level of access to irrigation water, while the “HH” sample was stratified by population density and flood vulnerability. The survey gathered data on a number of relevant indicators such as agricultural productivity, access to water and economic losses caused by flooding. In order to observe how those indicators have evolved over time with the project, a follow up panel survey will be administered at the end of Y5. Specific attention will be given to members of the pilot WUAs in order to measure their satisfaction with the reform.

WUAs’ registries, which will provide data on water tariffs and agricultural practices of water users, as well as water flow measuring devices, which will indicate whether water distribution in the irrigation district is improving, will be used to assess the sustainability of the reform. The firm in charge of providing technical assistance to ODVA (in particular to its sub-units: the Agricultural Infrastructures Directorate (DIA) and the Social Water Management Directorate (DGSE)) will also be in charge of preparing a report assessing the impact of the assistance it provided on the institution’s performance. ODVA will also be audited annually in an effort to monitor its progresses toward better governance and management.

B. Literature Review

Empirical research on Irrigation Management Transfer (IMT) worldwide has shown that it can improve water delivery and the maintenance of hydraulic infrastructures, as well as reduce the cost of water.[[3]](#footnote-3) Garcés-Restrepo, Muñoz and Vermillion (2007) has emphasized the importance of providing sustained training and assistance to WUAs in order to allow them to function effectively. Empirical evidence has also demonstrated the IMT’s positive impact on agricultural productivity, but despite this, it has warned that it may often take years before farmers are in an economic position to take full responsibility for the operation and maintenance costs of an irrigation system.

In Haiti, a 2013 PIA Unit Report shows that the main reasons why irrigation fees are currently not being paid by water users in the Artibonite Valley are the following: bad service quality (hydraulic infrastructures are damaged and water turns not implemented); lack of understanding from water users of the purpose of paying irrigations fees (i.e. operation and maintenance of the infrastructures); lack of trust in water management committees; lack of authority from WUAs.[[4]](#footnote-4)

Research on the impact of check dams worlwide has focused on their hydrological and geomorphological effects and provides little to no insights on the economic impact of terraces.[[5]](#footnote-5) In the Loess plateau of China for instance, Xu Xiangzhou (Xu et al. 2002-2004) has shown that the construction of check dams was one of the most effective means of soil conservation. On average, it was estimated that the sediment reduction ratio could reach up to 60%. However, as previously described, it will not be possible to implement such a rigorous methodology to measure the environmental impact of this project.

Between 2006 and 2011, a French NGO called SOS Enfants Sans Frontières has built 42 check dams (gabion check dams, concrete check dams with water retention tanks and concrete check dams without water retention tanks) in 11 different gullies in the area of Gros Morne located in the Haitian high plateau. An ex-post economic analysis was carried out in June 2013 by Budry Bayard in order to estimate the project’s environmental and economic impacts. Among other things, it showed that the combination of a better access to water and the creation of terraces had a significant impact on crop diversification and agricultural productivity in the gullies, as well as on livestock husbandry conditions.

Currently, we are not aware of any study that has focused on demonstrating the impact of check dams on agricultural productivity and income in Haiti or elsewhere using a rigorous impact evaluation methodology such as the one proposed here.

C. Impact and Outcome Indicators

Table 3 gives the impact and outcome indicators that will be part of the project’s evaluation. The impact evaluation (IE) will also investigate the mechanisms underlying these impacts by measuring intermediate impacts, such as agricultural investment (adoption of new crops and practices; farm assets), natural resource management (tree planting) and livestock breeding.

**Table 3**

**Impact and Outcome Indicators**

|  |  |  |  |
| --- | --- | --- | --- |
| **Indicator** | **Formula / Definition** | **Frequency of Measurement** | **Means of Verification** |
| **Impact** | | | |
| Agricultural productivity in gullies | Total gross margin by hectare in gullies (US$) | At baseline and follow up | Household survey |
| Agricultural productivity in the irrigation district | Total gross margin by hectare (US$) | Y1; Y5 | Qualitative survey for economic analysis (Artelia for baseline) |
| Crop, livestock and infrastructure losses caused by flooding | Annual crop, livestock and infrastructure losses caused by flooding (US$) | Y1; Y5 | Qualitative survey for economic analysis (Artelia for baseline) |
| **Component 1** | | | |
| Improve water and sediment containment in selected gullies | Total volume of sediment contained by check-dams (in m3) | Permanent (consolidation of data once a year) | Day-to-day observations and measurements performed by field-based students affiliated to MARNDR’s Studies and Programming Unit (UEP) |
| Area of terrace created in the gullies (in Ha) | Permanent (consolidation of data once a year) | Day-to-day observations and measurements performed by field-based students affiliated to MARNDR’s UEP |
| Total annual volume of water stored by water retention tanks (in m3) | Permanent (consolidation of data once a year) | Day-to-day observations and measurements performed by field-based students affiliated to MARNDR’s UEP |
| Number of farmers who benefit from new cultivable area and better access to water | Annually | Household surveys performed by field-based students affiliated to MARNDR’s UEP |
| Improve water distribution in the irrigation district | Area of the irrigation district that benefits from optimal water flows (in Ha) | Permanent (consolidation of data once a year) | Waterflows measurement devices installed by the program |
| Number of farmers who benefit from a better water distribution in the pilot area of the irrigation district | Annually | WUA’s registry of members. |
| Decrease hydromorphy in the Artibonite irrigation district | Area cultivated on formerly hydromorphic land | Annually | Measures of areas with GPS during field visits. |
| Number of farmers cultivating on formerly hydromorphic land | Annually | WUA’s registry of members. |
| **Component 2** | | | |
| Improve flood management at Péligre dam | Days with water level at Péligre dam above the maximum limit for flood management | Permanent (consolidation of data once a year) | EDH operation report at Peligre dam, flood management software |
| Days with water flows released by the Péligre dam above 400m3/sec | Permanent (consolidation of data once a year) | EDH operation report at Peligre dam, flood management software |
| Improve ODVA's internal management | Financial statements issued with an unqualified opinion | Y4; Y5 | Annual audits prepared by external auditors.. |
| Improve operations and maintenance of hydraulic infrastructures and equipment in the irrigation district | Secondary and tertiary canals and drains dredged (manually) by the three pilot WUAs (in meters) | Annually | WUAs annual reports on operations, maintenance and collection of water tariffs |
| Rate of cost recovery in the three pilot WUAs (in %) | Annually | WUAs annual reports on operations, maintenance and collection of water tariffs |

D. Rigorous Impact Evaluation Methodology for the Upper Watershed

The focus of this IE will be on the check dams which are expected to have significant economic impacts. The expected increase in agricultural productivity in the selected gullies is the result of the ability of direct beneficiary farmers to start cultivating highly profitable crops such as bananas in the terraces created by check dams. In the absence of check dams, the bottoms of gullies are traditionally used to grow corn and beans, whose average estimated gross margins is 2,950 HTG/Ha (**Table 4**). [[6]](#footnote-6)

**Table 4**

**Operating Account for bean-corn association (per Ha)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Unity** | **Quantity** | **Unitary Cost** | **Total Cost HTG** | **Total Cost USD**[[7]](#footnote-7) |
| Soil preparation |  |  |  | 4,850 | 110.89 |
| Bean seeds | Marmite (about 3 kg) | 32 | 150 | 4,800 | 109.75 |
| Corn seeds | Marmite (about 3 kg) | 9 | 100 | 900 | 20.58 |
| Planting | Days of work | 25 | 100 | 2,500 | 57.16 |
| Weeding | Days of work | 25 | 100 | 2,500 | 57.16 |
| Harvest | Days of work | 15 | 100 | 1,500 | 34.30 |
| **Total Cost** |  |  |  | **17,050** | **389.83** |
| Value of bean production | Marmite (about 3 kg) | 158 | 100 | 15,800 | 361.25 |
| Value of corn production | Marmite (about 3 kg) | 140 | 30 | 4,200 | 96.03 |
| **Total Gross Proceeds** |  |  |  | **20,000** | **457.28** |
| **Gross Margin** |  |  |  | **2,950** | **67.45** |

Once the terraces are ready to be cultivated, farmers can start growing bananas, whose gross margin per hectare when grown intensively is 44 times higher (129,000 HTG/Ha or 2,949.25 US$).[[8]](#footnote-8) Other typical crop associations that are grown by farmers in terraces are banana-corn-sorghum-bean, whose gross margin per hectare is 71,000 HTG (1,623 US$), and banana-tomato-eggplant-chili, whose gross margin per hectare is 86,300 HTG (1,973 US$) (**Table 5**).[[9]](#footnote-9) The choice of crop will depend on the cost of agricultural inputs (e.g. plants of bananas are expensive) but also on the HH food preferences since most of the HH farm production is consumed by the HH itself.

**Table 5**

**Operating Account for banana-corn-sorghum-bean association (per Ha)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Unity** | **Quantity** | **Unitary Cost** | **Total Cost HTG** | **Total Cost USD** |
| Soil preparation (plowing) | Days of work | 46 | 100 | 4600 | 105 |
| Seeds |  |  |  |  |  |
| Corn | Kg | 10 | 30 | 300 | 7 |
| Sorghum | Kg | 9 | 25 | 225 | 5 |
| Bean | Kg | 4 | 45 | 180 | 4 |
| Banana | Plant | 1,100 | 5 | 5,500 | 126 |
| Planting | Days of work | 36 | 100 | 3,600 | 82 |
| Weeding | Days of work | 56 | 100 | 5,600 | 128 |
| Harvest | Days of work | 32 | 100 | 3,200 | 73 |
| **Total Cost** |  |  |  | **23,205** | **531** |
| Value of corn production | kg | 460 | 12 | 5,520 | 126 |
| Value of sorghum production | kg | 480 | 10 | 4,800 | 110 |
| Value of bean production |  |  |  | 6,885 | 157 |
| Value of banana production | Bunch | 385 | 200 | 77,000 | 1,761 |
| **Total Gross Proceeds** |  |  |  | **94,205** | **2,154** |
| **Gross Margin** |  |  |  | **71,000** | **1,623** |



**Picture 3: Banana associated with subsistence crops less than a year after the construction of the check dam**

Within an area chosen by MARNDR for its environmental vulnerability, half of the 130 project gullies have already been selected based on the following criteria:

* 1. Slope: it must lie between 5 and 20% so as to remain suitable for agriculture as well as for the construction of solid and sustainable check dams.
  2. Proximity of construction materials: Rocks, sand and water must be available from a relatively short distance in order to keep the cost of construction reasonable.
  3. Proximity of roads: Roads will be used not only to carry all construction materials and equipment which cannot be found directly on site, but also later on to transport harvests to the market place.

These 65 gullies are located along the Thomonde River.[[10]](#footnote-10) Following the same criteria, the remaining 65 gullies will be identified during the first semester of Y1.

Similarly, construction sites for the check dams have already been identified in the 65 gullies already selected. The type of soil was a key factor as it must be able to sustain these heavy infrastructures for a long period of time (at least 20 years). Land tenure was also an important factor. Plots on which the owner is also the farmer have been prioritized over sharecropping as it increases the potential for long term economic maximization of these plots. Once the remaining 65 gullies are identified, the selection process of construction sites will carry on based on the very same criteria. In total, an average of 7.3 water and sediment containment infrastructures will be built in each gully. More specifically, an average of 2.7 check dams will be built in each gully.

The construction of check dams must take place during the dry season which, in Haiti, extends from November to the end of April.[[11]](#footnote-11) Based on this, the following construction schedule has been prepared:

**Table 6**

**Check dam Construction Schedule**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Y1** | | | **Y2** | | | **Y3** | | | **Y4** | | | **Y5** | | | **TOTAL** |
|  | Jan-Apr | Mar-Oct | Nov-Dec | Jan-Apr | Mar-Oct | Nov-Dec | Jan-Apr | Mar-Oct | Nov-Dec | Jan-Apr | Mar-Oct | Nov-Dec | Jan-Apr | Mar-Oct | Nov-Dec |
| Number of check-dams built | 15 | RAIN | 83 | | RAIN | 83 | | RAIN | 84 | | RAIN | 85 | | RAIN |  | 350 |
| Number of gullies treated | 5 | 31 (A) | | 31 (B) | | 31 (C) | | 32 (D) | |  | 130 |

January to April of Y1 will be spent on the practical training of the selected construction firm, which will be conducted by the experienced staff of SOS Enfants Sans Frontières. During that training, approximately 15 check dams will be built in about five different gullies.

The evaluation methodology proposed is a randomized phase-in of the 125 remaining gullies, starting from November of Y1. Given that the remaining 335 check dams cannot all be built at the same time because of practical feasibility, a randomized phase-in of gullies is appropriate both for a fair allocation and for the impact evaluation.

In November of Y1, a first batch of 31 gullies will be selected at random (Treated A in **Table 6**). Between November of Y1 and April of Y2, approximately 83 check dams will be built in these selected gullies. The other 94 gullies which are not selected for this first phase will serve as controls (Non-treated B, C and D). This process will repeat itself until all 125 gullies are incorporated into the project:

* In November of Y2, a second batch of 31 gullies will be selected at random (Treated B) and the remaining 63 gullies will serve as controls (Non-treated C and D).
* In November of Y3, a third batch of 31 gullies will be selected at random (Treated C) and the remaining 32 gullies will serve as controls (Non-treated D).
* Starting from November of Y4, the remaining 32 gullies will be incorporated into the project (Treated D).

The randomized selection of gullies prevents any selection bias and thus ensures that control gullies will be truly comparable to treatment gullies. The identification of the project’s causal effect will then come from comparing farmers (the unit of analysis) working in non-treated gullies to those working in treated gullies. In the absence of the project, the impact and outcome indicators for both groups would be equal on average. Thus we would have:

*Yi (t=1, P=0) = Yj (t=1, P=0)*

Where,

*Y* is an outcome indicator

*i*  represents farmers in treated gullies at time X (i.e. direct beneficiaries)

*j*  represents farmers in non-treated gullies at time X

*t=0* is before the start of the project

*t=1*  is after the start of the project

*P=0* indicates no participation to the project

*P=1* indicates participation to the project

This comparability between treated gullies and non-treated gullies will allow us to identify the causal effect of the program using a difference-in-differences methodology. This methodology can be estimated in the following manner:

*Y = α + γG + βT + δ (G \* T) + ε*

Where,

*Y* is the outcome of interest

*α*  is a constant

*G*  is a dummy variable equal to 1 if the farmer is a direct beneficiary

*T*  is a dummy variable equal to 0 before a gully is treated and equal to 1 after

*ε*  is a the error term

Here, the coefficient *γ* controls for the initial differences between the treatment and the control groups. The coefficient *β* captures the trend and the coefficient *δ* represents the estimated impact of the project.[[12]](#footnote-12) Using this methodology, we will estimate the project’s 1.5 year effect and 2.5 year effect in the following manner:

* 1.5 Year Effect: It will be estimated in two ways: by comparing Treated A with Non-treated C and D in October-November of Y3; by comparing Treated B with Non-treated D in October-November of Y4.
* 2.5 Year Effect: It will be estimated by comparing Treated A with Non-treated D in October-November of Y4.

As suggested before, it might take up to two years after the construction of a check dam before the terrace becomes fully suitable for agriculture. In the case of bananas, it would then take an extra year before the first harvest can take place, which implies that in a few instances it might take up to three years total before the full impact of a check dam can be observed. In such cases, measures of the 2.5 year effect should detect preliminary signs of farmers’ transition to the use of new and more profitable crops and thus will still provide a good indicator of the project’s ability to put beneficiary farmers onto a path to higher agricultural yields and income.

**E. Technical Aspects of Selected Methodology**

1. **Power Calculations**

The expected number of direct beneficiaries from check dams is 335 (excluding the 15 direct beneficiaries of check dams built during the training). With such a small number, no sampling is needed and instead all the 335 direct beneficiaries will be surveyed (census).

Power calculations have been performed based on the following assumptions:

* Four waves of incorporations: 31 gullies in each of the first three phases; 32 in the last.
* Three beneficiary HHs per gully on average in the current scenario.
* Complete take-up (i.e. all farmers who are offered participation to the project will accept).

The data used for HH agricultural income in rural areas was taken from the Survey of Living Condition in Haiti (ECVH, 2001). This data indicates that the average agricultural income per HH in rural areas of the Artibonite department is 3,865 HTG, with a standard deviation of 6,948 HTG.[[13]](#footnote-13) Based on this, we estimated the following:

**Table 7**

**Power Calculations**

|  |  |
| --- | --- |
|  | **Current Scenario** |
| Nb of gullies « treated » | 130 |
| Nb of beneficiary HHs per gully | 3 |
| Minimum Detectable Effect Size (MDES) | 0.30 |
| Equivalent % change in household income | 0.54 |
| MDES with 10 % attrition | 0.32 |
| Equivalent % income change with 10 % attrition | 0.57 |

In the current scenario, the design would allow sufficient power to detect increases in HH agricultural income of 54% or more. Based on the expected increase in gross margins per hectare at the bottom of gullies resulting from the construction of check dams (from 2,950HTG/Ha for a corn-bean association to 129,000 HTG/Ha for bananas grown in terraces), such an increase in agricultural income is realistic.

1. **Data Collection**

There will be three rounds of surveys: baseline (in October-November of Y1) and two follow up (in October-November of Y3 and in October-November of Y4). In wet mountainous areas such as Thomonde, the cropping calendar indicates that harvesting for beans, corn and banana takes place in September, October and November respectively (**Table 8**). As a result, in order to coincide with cropping calendar as well as the construction schedule (**Table 6**), surveys should be administered between October and November of Y1, Y3 and Y4.

**Table 8**

**Cropping Calendar in Wet Mountain Areas**[[14]](#footnote-14)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Beans | Harv. 3 |  | Seed. 1 |  |  | Harv. 1 | Seed. 2 |  | Harv. 2 | Seed. 3 |  |  |
| Corn |  |  | Seed. 1 |  |  |  | Harv. 1 / Seed. 2 |  |  |  | Harv. 2 |  |
| Banana | Seed. |  |  |  |  |  |  |  |  | Harv. |  |  |

1. **Questionnaire**

The main data collection instrument for the experimental evaluation will be a household survey with detailed plot-level and crop information (**Table 9**).

**Table 9**

**Survey Instrument**

|  |
| --- |
| **SECTION** |
| **Section 1: HH information** |
|  |
| Section 1.1: Identification of HH members |
| Section 1.2: Information on education, health and work |
| **Section 2: Plots information** |
|  |
| Section 2.1: List of plots |
| Section 2.2: Information about plots owned |
| Section 2.3: Information about plots rented |
| Section 2.4: Information about leased plots |
| Section 2.5: Information about purchase and sale of land |
| Section 2.6: Information about the use of agricultural technologies on plots |
| **Section 3: Crop information** |
|  |
| Section 3.1: List of annual crops |
| Section 3.2: Seeding of annual crops |
| Section 3.3: Use of agricultural inputs on annual crops |
| Section 3.4: Labor used for annual crops |
| Section 3.5: Annual crops production |
| Section 3.6: Annual crops storage and commercialization |
| Section 3.7: Production of perennial crops and fruits |
| Section 3.8: Labor used for perennial crops |
| Section 3.6: Perennial crops storage and commercialization |
| **Section 4: Livestock information** |
|  |
| Section 4.1: Livestock inventory |
| Section 4.2: Livestock production |
| **Section 5: Farmers organization membership** |
| **Section 6: Housing:** |
|  |
| Section 6.1: Status of housing occupancy |
| Section 6.2: Physical characteristics of the house |
| Section 6.3: Water and sanitation |
| Section 6.4: Electricity |
| **Section 7: Assets, Income and expenditures** |
|  |
| Section 7.1: HH assets |
| Section 7.2: HH incomes |
| Section 7.3: HH expenditures |
| Section 7.4: Food expenditure and consumption |
| **Section 8: Access to finance** |
|  |
| Section 8.1: Informal savings |
| Section 8.2: Bank accounts |
| Section 8.3: Credit |
| **Section 9: Food security** |
|  |
| Section 9.1: Dietary diversity |
| Section 9.2: HH hunger scale |
|  |

1. **External Validity**

The one factor that could threaten the external validity of this design is that farmers living in the Thomonde area tend to earn higher incomes and own more land than the average Haitian farmers.[[15]](#footnote-15) Although this factor must be taken into account when drawing conclusions from this study, it should still provide a reliable indicator for the success of similar projects.

**F. Evaluation Work Plan and Budget**

**Table 10**

**Evaluation Work Plan and Budget**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Activity** | **2014** | | | | **2015** | | | | **2016** | | | | **2017** | | | | **2018** | | | | **Responsible** | **Cost (currency)** | **Source of Funding** |
| **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** | **1** | **2** | **3** | **4** |
| Two students making day-to-day observations and measurements of key indicators in the upper watershed (i.e. data collection of environmental outcome indicators) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | UEP | US$100,000 | HA-L1087 Project budget |
| Questionnaire design and pilot survey |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant | US$20,000 | HA-L1087 Project budget |
| Data collection for baseline survey |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant | US$40,000 | HA-L1087 Project budget |
| Baseline report |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant; BID; MARNDR | US$20,000 | HA-L1087 Project budget |
| Data collection for follow up survey #1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant | US$40,000 | HA-L1087 Project budget |
| Intermediate evaluation report with analysis of follow up #1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant; BID; MARNDR | US$20,000 | HA-L1087 Project budget |
| Data collection for follow up survey #2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant | US$40,000 | HA-L1087 Project budget |
| Final evaluation report with analysis of follow up #2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Consultant; BID; MARNDR | US$20,000 | HA-L1087 Project budget |

**Total Cost of the Evaluation Plan: US$ 300,000.00**

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5. Xu Y. D. et al. (2012). *Assessing the hydrological effect of the check dams in the Loess Plateau, China by model simulations.* [↑](#footnote-ref-5)
6. Budry Bayard, *Ibid*. [↑](#footnote-ref-6)
7. Exchange rate used : 1 US$ = 43.74 HTG. Source: Haitian Republic Bank. <http://www.brh.net>. Official exchange rate of reference for September 19th. [↑](#footnote-ref-7)
8. Budry Bayard, *Ibid*. [↑](#footnote-ref-8)
9. Budry Bayard, *Ibid*. [↑](#footnote-ref-9)
10. Alex Bellande. *Ibid*. [↑](#footnote-ref-10)
11. Alex Bellande. *Ibid*. [↑](#footnote-ref-11)
12. Winters, Salazar and Maffioli (2010) [↑](#footnote-ref-12)
13. The standard deviation used for power calculations is likely to be overestimated because the area in which the project is taking place is relatively small and HH living there tend to be similar. [↑](#footnote-ref-13)
14. Budry Bayard, *Ibid*. [↑](#footnote-ref-14)
15. Alex Bellande. *Ibid*. [↑](#footnote-ref-15)