Performance Evaluation: Mozambique Farmer Income Support Project

Revised Final Evaluation Design

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Acronyms and Abbreviations

BDF	Business Development Fund
CGF	Competitive Grants Fund
CIRAD	*Centre International de Recherches Agronomiques pour le Développement*
CLYD	Coconut Lethal Yellowing Disease
CVA	Center for Value Addition
EA	Enumeration area
ERR	Economic rate of return
FERA	Food & Environment Research Agency
FISP	Farmer Income Support Project
GIS	Geographic information system
ICC	Intra-cluster correlation
ID	Identification
IIAM	Mozambique Agrarian Research Institute (*Instituto de Investigação Agrária de Moçambique*)
INE	National Institute of Statistics *(Instituto Nacional de Estatística)*
IRB	Institutional Review Board
ITT	Indicator Tracking Table
KAP	Knowledge, attitudes, and practices
M&E	Monitoring and evaluation
MCA	Millennium Challenge Account
MCA-M	MCA-Mozambique
MCC	Millennium Challenge Corporation
MDI	Minimum detectable impact
MINAG	Ministry of Agriculture *(Ministério da Agricultura)*
MSU	Michigan State University
NDVI	Normalized Difference Vegetation Index
PCI	Palm Canopy Index
PCR	Polymerase chain reaction
PDF	Portable document format
PRA	Pest risk analysis
QCP	Quality control plan
R&D	Research and development
RDF	Research and Development Fund
RFP	Request for proposals
RFQ	Request for qualifications
SME	Small or medium enterprise
TIA	Agricultural Labor Survey (*Trabalho do Inquérito Agrícola*)

1. Introduction

The Millennium Challenge Corporation (MCC) signed a five-year, $506 million Compact with the Government of Mozambique in 2007, which ended on September 22, 2013 (MCC 2007). The Compact was designed to "increase the productive capacity of the population in the northern provinces of Cabo Delgado, Nampula, Niassa, and Zambézia with the intended impact of reducing the poverty rate, increasing household income and reducing chronic malnutrition in the targeted intervention districts." The Compact included the Water Supply and Sanitation Project, the Roads Project, the Land Tenure Services Project, and the Farmer Income Support Project (FISP).

FISP, a $20.8 million project implemented by ACDI/VOCA, was intended to "improve the productivity of coconut products and encourage diversification into other cash crop production" within project zones in the provinces of Zambézia and Nampula. FISP commenced with project activities in late 2009 and began fieldwork in early 2010. The fieldwork continued until early 2013, and FISP formally concluded in the fall of 2013. MCC requested that Abt Associates conduct an evaluation of FISP at the end of the project.

This document presents Abt's final evaluation design for FISP, which is based on our review of project documents and two field visits, during which we interacted with the FISP field implementation team and key stakeholders.

2. Overview of the Compact and the Intervention Evaluated

FISP focused on mitigation of the Coconut Lethal Yellowing Disease (CLYD), which threatens one of the primary sources of income for people living in Zambézia and Nampula provinces. No single symptom is diagnostic of lethal yellowing. Symptoms are variable among coconut cultivars. It is the pattern of appearance and chronological progression of symptoms that accurately identifies the disease. It can be verified only through a laboratory test. Despite CLYD-like diseases being reported on coconut trees in many parts of the world and associated with a specific bacterium, very little is known about the epidemiology of CLYD, particularly its disease vector.

FISP's approach for mitigating the disease and its potential negative impact on the current and future incomes of the populations in these provinces was to identify geographic zones based on disease prevalence (epidemic or endemic) and implement slightly different activities in each zone type, but primarily focused on cutting and destroying diseased trees and dead plant material of the diseased tree. Given the lack of information on the vector for CLYD, it is difficult to rule out if alternative hosts for the causal agent of CLYD remain even after cutting diseased trees. Furthermore, the dead palms and cut trunks are a breeding ground for the Rhinoceros beetle, and thus, if uncleared, these populations will increase under CLYD. The foliage and apical growth damage caused by the beetle may predispose/stress a palm with the CLYD agent to develop CLYD – but that is an assumption. If CLYD is vectored by a sap-sucking insect that typically will have a preference for young, vigorous plant parts, then dead or near-dead palms that are burnt are an unlikely habitat for the vector of the CLYD agent, and therefore not a direct driver of CLYD. In summary, even without knowing the disease vector, FISP's underlying program logic for controlling or delaying the disease was to cut and destroy diseased trees so that Rhinoceros beetle is not a threat.

The project defined endemic zones as areas with CLYD prevalence (ratio of diseased trees to total coconut trees) greater than 75 percent (this level of disease prevalence is technically called post-endemic) and epidemic zones as areas with disease prevalence less than 10 percent. The specific activities of the project included:

- In endemic and epidemic zones, cut and destroy diseased trees and the dead plant material of diseased trees.
- In endemic and epidemic zones, replant these areas with a CLYD-tolerant variety of coconut, the Mozambique Green Tall.
- In the endemic zones only, provide technical assistance to farmers for the cultivation and commercialization of high-value crops as an alternative source of income during the period when the replacement trees are reaching maturity (five to seven years).
- Support small grants to small and medium enterprises (SMEs) that contribute to the value chains of the coconut industry and to alternative crops introduced by the project.
- Support research and development to maintain and augment screening for resistance to CLYD; develop, test, and utilize practical techniques for early detection and diagnosis; and conduct epidemiological analyses of large-scale control operations.

2.1 Program Logic

2.1.1 Compact-Level

The Compact's goal was to reduce poverty in Mozambique through economic growth and increase economic opportunities for Mozambicans living in the northern region. FISP's objective was to increase the productive capacity of the population in selected provinces in northern Mozambique, with the intended impact of reducing the poverty rate, increasing household income, and reducing chronic malnutrition in the targeted districts.

2.1.2 Project-Level

The objectives of FISP were to improve the productivity of coconut products and encourage diversification into production of other cash crops. The project was designed to eliminate biological and technical barriers hindering economic growth among farms and targeted enterprises located in the Compact area's eastern coastal belt (Zambézia and Nampula provinces). It aimed to reduce the prevalence and economic impact of CLYD by supporting (1) the cutting and burning of infected trees; (2) the planting of new, less-susceptible seedlings; (3) community education and awareness programs to assist coconut growers in preventing the disease in the future and to provide technical assistance in crop diversification; (4) business development grants to promote SMEs in coconuts and alternative crops; and (5) research and development to improve disease-resistant varieties.

FISP included the five activities described below and as summarized in Table 2-1.

Table 2-1: FISP Activity, Expected Impacts, and Expenditure on Activity[1]

Activity	Tasks	Outputs	Intermediate Outcomes	Expected Impacts	Value (USD)[1]
Rehabilitation of Endemic Zones	Clear farmers' land of dead palms Replant with selected Mozambique Green Tall coconut palm seedlings, which are more tolerant to CLYD Plant alternative short-term crops (groundnuts, cowpeas, pigeon peas, and/or sesame) to supplement income loss during the replacement palm regrowth period (five years for the dwarf variety and seven years for the tall variety)	8000 hectares cleared 503,709 coconut seedlings planted 7,686 hectares of alternative crops under production 8,958 farmers trained in alternative crop production	Increased % of total household production coming from crops other than coconut Continued production of alternative crops by smallholders Seedling survival rate and improved seedling care	Increase in household income from alternative crop production (income diversification)	$7,122,186
Assumptions	This activity assumes that providing seeds and clearing land will improve income diversification by creating a way for smallholders to generate agricultural income in the short-run (while coconut seedlings are growing.) This will ultimately lead to an increase in income, since the alternative crops are considered to be cash crops in Mozambique. Furthermore, an important assumption is that the Mozambique Green Tall coconut palm is tolerant to CLYD. There are no scientific studies establishing this claim, and this claim needs to be tested once these trees reach adult age.				
Control of Epidemic Disease	Provide training to farmers on identification of disease and best practices to manage/prevent the disease Provided tolerant variety seedlings Manually cut and burned diseased trees with consent of owner	600,000 trees felled 278,900 seedlings planted 28,830 farmers trained in planting and post planting management of coconut palms 25 manual felling teams formed	Household and/or village coconut surveillance Seedling survival rate Continued cutting and felling of diseased trees Improved farmer knowledge of disease identification	Reduction in disease prevalence Improvement of tolerance to disease through planting new varieties Improvement in farmer knowledge of disease management	$6,281,590
Assumptions	The epidemic zone is still considered to be a productive coconut growing area, so the main focus of this activity is to mitigate disease spread. The assumption being that if farmers are trained and educated on the importance of cutting diseased trees and how to identify the disease, then the entire region will benefit from losing fewer trees (i.e. lower disease prevalence). At the same time,				

[1] These numbers come from the project's final Indicator Tracking Table (ITT). It is worth noting that almost all numbers in the final ITT are greater than those in the M&E closeout plan provided by MCC. The numbers reported by MCC were the project's targets, and in the cases were the numbers from the ITT are greater, the project exceeded the target.

Activity	Tasks	Outputs	Intermediate Outcomes	Expected Impacts	Value (USD)[1]
	replanting cut trees with CLYD tolerant seedlings provides for a future stock of trees that are less vulnerable to CLYD.				
Improvement of Productivity	Support demonstration trials Strengthen producer organizations' marketing capacities Provide extensive on-farm training in intercropping methods and CLYD surveillance capabilities	15,607 farmers trained in surveillance and CLYD control 106 demonstration plots created 25 CVAs (Centers for Value Addition) created 105 CVA staff trained 868 beneficiaries trained at agribusiness workshops	Improved farmer knowledge on alternative crop cultivation techniques Increased percentage of total farmland using intercropping Improved producer organization marketing	Improvement in production practices and management for farmers Established CVAs Increased income due to improved production and increased commercialization	$1,415,977
Assumptions	The underlying assumption for this activity is that training and improved marketing will compliment activity 1 and provide viable outlets for the alternative crops. The ability to sell the crops is a fundamental assumption behind activities 1 and 3 resulting in increased income.				
Business Development Fund	$1 million fund to support entrepreneurship Mostly awarded as small grants to SMEs that contributed to value chains of coconut industry	119 grantees, 2,716 direct beneficiaries	Increased number of households participating in value addition of coconut byproducts Market for new products exists	Increase in incomes due to income diversification Stronger value chain for coconut byproducts	$1,138,000
Assumptions	The small grants are assumed to be catalysts to spur innovation and create markets for coconut by products, especially wood and other parts of the coconut that are not typically used. The value addition of coconut byproducts is assumed to lead to increased incomes.				
Research and Development Support[2]	Maintain and augment screening for resistance to CLYD Develop, test, and utilize practical techniques for early detection and diagnosis Conduct epidemiological analyses of large-scale control operations Commissioned projects under the Competitive Grants Fund (CGF)	Annual and/or Final reports for each task area (note no evidence of reports from CGF has been disclosed)	Continued research and funding for CLYD-tolerant variety identification Improved methodologies for testing and diagnosing CLYD	Increased institutional capacity for disease detection and diagnosis Establishment of trial to assess CLYD resistance/tolerance Data base for monitoring frontline and prevalence of CLYD Formative knowledge on CLYD epidemiology and farmer awareness	$2,318,463

Activity	Tasks	Outputs	Intermediate Outcomes	Expected Impacts	Value (USD)[1]
Assumptions	The underlying assumption for this activity is increased effort in research and development can provide long term solutions to the CLYD problem in Mozambique by establishing scientific protocols for testing, as well as tolerant varieties of coconut. This activity is assumed to ultimately reduce disease prevalence in the long run by improving tolerance of palm varieties and the accuracy of identifying the disease at an early stage.				

[1] Dollar value by activity was not specifically tracked by the FISP Service Provider. Therefore, the Abt team has compiled these costs from our desk review of the project documentation and interviews with former project staff.

[2] Note that our preliminary interviews with the activity lead (Dr. Marcos Freire) have indicated that several of the tasks under the Research and Development activity were not implemented as implied by their name. This will be discussed and analyzed as a part of our evaluation of the activity.

Activity 1: Rehabilitation of Endemic Zones

CLYD control and mitigation strategies were tailored to different degrees of disease prevalence. FISP activities in the endemic zones, where the disease prevalence was very high, were considered likely to be most effective either during the active spread of the disease or in anticipation of the active spread of the disease. In these areas, FISP helped farmers clear their land of dead palms. The project also supplied coconut seedlings and seeds for alternative crops (discussed further under the third FISP activity, "Activity 3: Improvement of Productivity"). Infected or dead trees were culled, since they attract Rhinoceros beetle populations, which breed in dead palm trunks and kill or damage replacement palms. Continuous and collective action by all growers is needed over a sustained period to prevent infection from moving from diseased to healthy palms and to destroy dead palm trunks.

This activity in the endemic zones helped farmers:

- Clear their land of dead palms
- Replant with selected Mozambique Green Tall coconut palm seedlings, which are more tolerant to CLYD (503,709 seedlings planted)
- Plant alternative short-term crops (groundnuts, cowpeas, pigeon peas, and/or sesame) to supplement income loss during the replacement palm regrowth period (five years for the dwarf variety and seven years for the tall variety)

Activity 2: Control of Epidemic Disease

In the epidemic zones, FISP controlled the spread of the disease by prompt removal and destruction of infected trees, accompanied by provision of new planting material using Mozambique Green Tall coconut palm seedlings (278,900 seedlings planted), which are more resistant to CLYD. The culling teams were trained to identify diseased trees based on visible symptoms, such as yellowing or bending of the leaves. Unlike in the endemic zones, in the epidemic zones FISP did not support any alternative intercropping interventions (e.g., improved planting techniques, training, and distribution of improved seeds for high-value crops).

Activity 3: Improvement of Productivity

In conjunction with tree removal and replacement, the project assisted farmers in the endemic zones to adopt new cropping systems and to develop alternative sources of cash income during the time it takes for the coconut trees to reach a productive age (five to seven years). Crops such as groundnuts, pigeon peas, cowpeas, and sesame are compatible with rehabilitation of coconut. Through diversification of farming systems, these crops have the potential to generate alternative income for farm enterprises, reduce risks, and improve livelihoods. Like coconuts, these crops are suited to the sandy and loamy soils that are dominant in the coastal region; they are also advantageous because they fix nitrogen in the soil.

Crop yields in the region are extremely low due to poor practices, including lack of crop rotation, poor seed selection, inadequate field preparation, and lack of weeding (COWI 2013). The hypothesis for FISP was that technical support to introduce better production practices for these crops would significantly increase yields and corresponding household income and would reduce food insecurity.

The Improvement of Productivity activity emphasized the creation of producer groups, community value addition centers, and farmer training. The trainings focused on improved farming practices that would increase yields and, together with the value addition centers and producer groups, would link farmers to processors and other buyers in the supported value chains. Farmers were provided with options to diversify their production in response to proven market demand, which would lead to additional revenue streams. Experienced field agents disseminated improved farming practices and market linkages to:

- Support demonstration trials
- Strengthen producer organizations' marketing capacities
- Provide extensive on-farm training in intercropping methods, integrated pest management practices, and CLYD surveillance capabilities[2]

Through this activity the FISP implementers expected to increase farmer's knowledge about alternative crops, intercropping methods, integrated pest management, and CLYD surveillance capabilities, and consequently increase farmers' adoption of alternative crops and use of improved methods, resulting in increased income.

Activity 4: Business Development Fund

This activity was intended to raise agricultural productivity through novel, innovative, and profit-oriented approaches in both zones. The Business Development Fund (BDF) was a $1 million fund to support small grants, accompanied by market analysis, to SMEs that contributed to the value chains of the coconut industry and to intercropped products in the coconut belt of northern Mozambique. BDF investments aimed to strengthen weaknesses in the coconut and intercropping value chains and to add value to the targeted primary products with consequent increase in farmer incomes from these value chains.

Activity 5: Research and Development Support

The Mozambique Agrarian Research Institute (*Instituto de Investigação Agrária de Moçambique*, or IIAM) administered research and development activities that were directly related to FISP's Rehabilitation of Endemic Zones (Activity 1) and Control of Epidemic Disease Activity (Activity 2). Under FISP, IIAM emphasized germplasm resistance screening, epidemiological analysis, and early disease detection. The Research and Development Support Activity supported the administration of two research funds: (1) the Research and Development Fund (RDF), which provided applied research services that addressed priority issues to support Activities 1 and 2 under FISP, and (2) a Competitive

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2 Although originally intended to be a component of Activity 3, integrated pest management is not possible in this context due to the general lack of knowledge surrounding CLYD and its vector(s).

Grants Fund that generated and funded research proposals. Specific research initiatives were funded covering the following activities:

- Maintain and augment screening for resistance to CLYD
- Develop, test, and utilize practical techniques for early detection and diagnosis
- Conduct epidemiological analyses of large-scale control operations

These activities are expected to impact farmers in the long run through CLYD-resistant coconut varieties and early detection techniques to allow for early mitigation measures, which would help farmers mitigate the adverse impacts of CLYD on income from coconut farming.

2.1.3 Project Participants

FISP is expected to have benefited 277,763 farmers in the coconut belts of Zambézia and Nampula by 2028. Of these, it is estimated that 119,373 farmers are in the endemic zones and 158,390 are in the epidemic zones (Colon 2013). Among the beneficiaries, more than 3,000 farmers received targeted technical assistance from FISP to mitigate significant income loss due to CLYD and to assist in improving the quality of other crops planted on their holdings. The farmers who did not receive technical assistance were expected to benefit from reduced disease prevalence. According to the program logic, the estates or the palm plantations did not receive direct technical assistance, although they were expected to benefit from the disease eradication by means of lower CLYD prevalence rates (and therefore spread).

2.1.4 Geographic Coverage

The project worked in the Compact area's eastern coastal belt in Zambézia and Nampula provinces covering eight districts: Angoche, Chinde, Moma, Nicoadala, Namacurra, Maganja da Costa, Inhassunge, and Pebane. These two provinces are the key producers of coconut and coconut products. Disease-affected areas in Zambézia have expanded considerably since 2003, and new foci are present in Nampula as well. At the beginning of project activities in 2010, the project conducted a biophysical survey to both determine the baseline and to draw a north-to-south phytosanitary barrier around 10 percent disease prevalence. This barrier was not a perfect one, and was guided by physical "boundaries" such as roads and water bodies. This meant that on either side of the barrier there could be areas with prevalence higher or lower than 10 percent. However, in the epidemic zones FISP used this barrier to guide the implementation: the activities were implemented only west of the phytosanitary barrier, away from the coast, where the disease prevalence was expected to be on average less than 10 percent because the disease progressively gets worse closer to the coast.[3] As we later discuss, we exploit this barrier to identify counterfactual areas. FISP re-assessed the phytosanitary barrier once a year (a total of five times) during the project, based on the findings from the biannual disease inventories.

FISP worked in a small set of the endemic zone—regions with more than 75 percent disease prevalence—which was selected by FISP implementers based on soil quality (to support activities promoting alternative crops), proximity to one another (for easier project logistics), high prevalence

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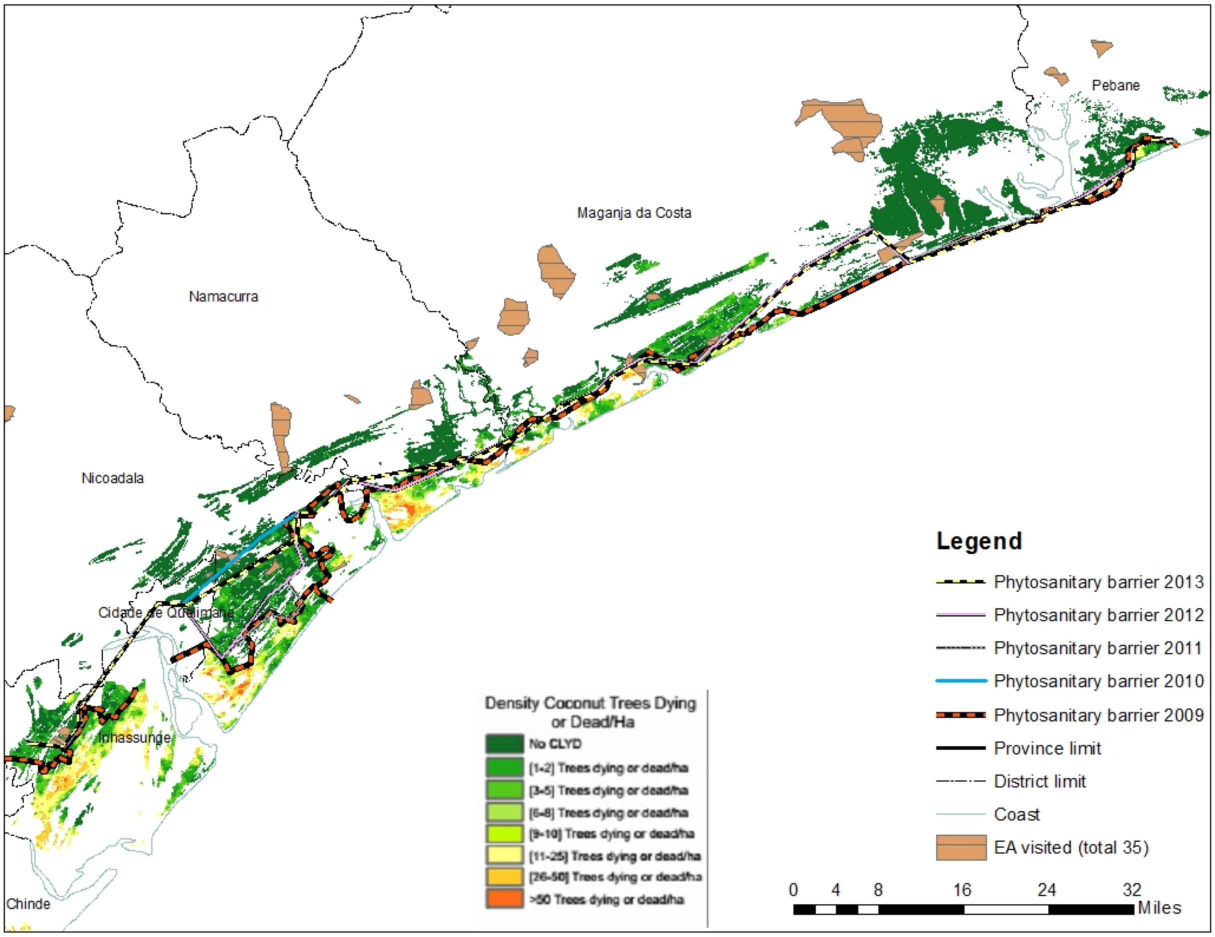
[3] In 2008, FISP commissioned aerial photography of the region to determine baseline disease prevalence. FISP worked in all epidemic areas west of the phytosanitary barrier covered by the aerial photographs, and went slightly further beyond the photographed areas (away from the coast).

rate (for high impact), and willingness of surrounding communities to participate. These factors were combined qualitatively in selecting the specific areas.

Figure 2-1 presents the FISP implementation areas in the epidemic and endemic zones, and also the movement of the phytosanitary barrier during project implementation. The total area of the epidemic zones was approximately 67,900 hectares, while the endemic zones focused on about 10,000 hectares. The movement of the barrier affected only the epidemic area; the biggest shift added approximately 10,000 hectares to the total area.

Figure 2-1: FISP Implementation Areas and the Phytosanitary Barrier



Source: Colon (2013).

Note: the enumeration areas (EAs) shown on this map are not the EAs that will be used for this evaluation. These EAs are the shapefiles obtained by Verde Azul for their 2012 study, and were inventoried by the Abt GIS Specialist in order to determine their use for our evaluation. We concluded they would not be useful because they lay outside the boundaries of the aerial photography performed by TTI Production (TTI Production 2008).

2.2 Evaluation Questions

The evaluation is tasked to answer 14 evaluation questions aimed at understanding whether the FISP worked, and if it should be scaled up. These evaluation questions inform the overarching calculation of economic rate of return (ERR), but will also inform our substantive knowledge of the promise of the FISP activities. The results of this evaluation will therefore be relevant to Mozambique in designing future programs to control CLYD and to the international communities that are affected by CLYD.

The evaluation will answer several research questions, some of which apply to specific FISP activities, assessing whether each FISP activity achieved its key outcomes, and if those outcomes resulted in any impact. Some questions cut across the five activities and assess the overall impact of the project. Some of the evaluation questions have been modified from their original version based on a review of the FISP activities to assess the relevance of the question, and based on a review of available data to assess whether there is adequate information to answer the question. Below is a list grouping the evaluation questions by focus; text in italics describes any modifications that were made:

The evaluation will address the following overarching questions:

- What is the impact of the technical assistance provided by the project on coconut production [question 1]?
- How did the evolving program logic affect the scope of implementation activities [question 2]?
- What is the potential increase in coconut supply in the Zambézia and Nampula provinces over a 20-year investment period [question 4]?
- What are the results of the ERR with variable CLYD infestation rates and other determinants of survival rates of coconut trees [question 9]?
- What is the impact of the project on the incomes of participating farmers in the endemic and epidemic zones? Are the changes in outcomes associated with the project different for male and female heads of households [question 11]?

The following questions assess the impact of Activity 1 and Activity 2 combined:

- What is the present rate of CLYD prevalence in adult trees in the epidemic FISP project area [question 5]? *The question was modified to cover only epidemic zones because FISP cut all the trees in the endemic zones, making this question irrelevant for the endemic zone.*
- What is the present survival rate of adult trees in epidemic areas [question 6]? *Modified to focus only in epidemic area because FISP cut all the trees in endemic zones and dropped disaggregated by age band it is not possible to do this disaggregation without significant resources.*
- What is the impact of FISP in reducing CLYD prevalence [question 7a]? *In coordination and agreement with MCC, this question was modified to remove reference to measuring the impact of "compact-funded chainsaw cut and burn technique" because FISP also used manual felling and the resources are limited for the evaluation to assess the differential impact of chainsaw approach from manual felling. In addition, there is a change in wording from CLYD "incidence" to CLYD "prevalence." Also modified to break question 7 into two parts. In this part, we will assess the impact of FISP on disease prevalence, or the ratio of diseased trees to total trees.*
- What is the impact of FISP in reducing the CLYD disease spread rate [question 7b]? *Modified to remove reference to specifically measuring the impact of compact-funded chainsaw cut and burn technique because FISP also used manual felling and given the resource constraints the evaluation cannot assess the differential impact of chainsaw approach from manual felling. Also modified to break question 7 into two parts.*[4] *In this part, we will assess the impact of FISP on*

[4] See equation [1] in Section 2.3.1.

disease spread rate, which is a function of the disease prevalence over time (see equation [1] for more detail on its definition.

- To what degree must post-Compact (September 2013) felling activities be scaled up to keep the disease spread rate below 2 percent [question 8]?
- What is the impact of the project on the post-planting care of coconut seedlings [question 10a]? *Modified to break question 10 into two parts.*
- What is the impact of FISP on the present survival rate of the seedlings [question 10b]? *Modified to break question 10 into two parts.*

The following questions assess the impact of Activity 3—Improvement of Productivity:

- What is the impact of the technical assistance provided by the project on income diversification due to the introduction and adoption of high-value crops [question 3]?
- How has the promotion of high-value crops affected household incomes in communities that grew them before, compared to those that did not grow them prior to project intervention [question 12]?

The following question assesses the impact of Activity 4—BDF:

- What was the impact of BDF activities on the aggregate income of the beneficiary population [question 13]? *Added question to evaluate BDF activity.*

The following question assesses the impact of Activity 5—Research and Development

- How have research and development activities aided in the development of CLYD-tolerant seedlings [question 14]? *Added question to evaluate research and development (R&D) activity.*

2.3 Link to Economic Rate of Return and Beneficiary Analysis

The overarching evaluation framework aims to place a value on the FISP activity that accounts for all project costs and expected benefits. Table 2-1 displays the expenditures of each FISP activity, and the goal of the evaluation is to measure the benefits of each activity. With an estimate of the benefits, we can estimate an ERR of FISP activities. The ERR is a way to summarize the streams of costs and benefits of an investment over time. As described in Table 2-1, to mitigate the impact of CLYD on the incomes of coconut farmers, the major FISP investments consisted of three activities (Activities 1-3) out of the total five activities. The ERR is the discount rate that makes the discounted investment costs and benefit streams over the life of the project equal to zero. To develop the ERR estimates, we will update MCC's calculation of the ERR to include the results of the impact evaluation, which will estimate the benefits. There are several challenges in estimating the ERR for FISP in estimating both the costs and the stream of benefits expected from FISP.

With respect to costs, the investment costs are easily obtained from Millennium Challenge Account (MCA) records. The original MCC analysis did not consider the opportunity cost of the land maintained in coconut production, which corresponds to assuming that the land has negligible value outside of coconut production. There are some informal reports that commercial coconut plantations have shifted to other crops. If confirmed by the household survey, this implies that—for the plantations, at least—the land *does* have an alternative use. This does not necessarily hold true for coconut smallholders. We will include questions in our qualitative and quantitative survey instruments to assess if there is a difference in land rental and/or land sales value between epidemic and endemic zones, and if there is any further difference between FISP project and non-project areas therein.

With respect to estimating benefits, because the way in which CLYD is transmitted from infected tree to healthy tree was -- and still is not -- known, the intervention that MCC supported was based on assumptions about transmission that are neither confirmed nor questioned in the scientific literature. MCC decided to support investments in cutting down visibly infected trees on the plausible, though unsupported, assumptions that a) the spread of the disease can be described by a logistic curve (and given that assumption) that the parameter of the curve, "r" [1]in the MCC ERR worksheets, is 0.375 and b) that these investments would prevent or mitigate the transmission of the disease, thereby delaying the death of healthy trees. The postponement of the decline in the number of healthy producing coconut palms, together with much smaller benefits from replanting and promotion of high-value crops, was expected to result in benefits great enough to justify the investments. During the execution of the project no new information about disease transmission was developed or about the effectiveness of cutting and burning to mitigate the spread of the disease. The impact evaluation will verify if the FISP interventions overall did lead to an improvement income potentially because of the delay in the disease. Our estimates of the benefits will come from this impact evaluation. The evaluation will provide an estimate of the impact FISP had on disease prevalence, coconut production, and farmer incomes at the endline, which will revise MCC's estimate of the benefits. There are several challenges in the evaluation that are important to highlight. First, the evaluation is being conducted at the end of the project without any usable baseline that limits the evaluation design options. Particularly, the project implementation did not consider options for counterfactual areas to establish program impact. Therefore, the evaluation is focused on geographic areas where the counterfactual area can be established – it excludes three out of the eight districts. Second, there are gaps in our knowledge about CLYD (see Section 4.1.4 for more details); therefore, while the evaluation can establish if the program had an impact on disease prevalence, it is difficult to assess if the project controlled the disease vectors (because the vector is not known), and therefore if FISP truly controlled the progression of the disease or just delayed the progression of the disease.

To estimate the benefits, other than the impact estimate at the project endline, we need to project the expected stream of benefits over time, which requires being able to estimate the difference in income with and without the project over time. The impact evaluation will provide an estimate of difference in income at the endline, which needs to be extrapolated to an estimate of expected benefits over time. This requires an estimate of the disease spread rate with and without the program. In the absence of any information on how specifically CLYD progresses, we use a commonly used functional form for the way disease progresses: we assume that the disease follows the logarithmic function: the disease spread rate is the change in disease prevalence over time, and is assumed to be proportional to an infection rate (τ) as follows:

$$\frac{dx_t}{dt} = \tau \frac{x_t}{1-x_t} \quad [1]$$

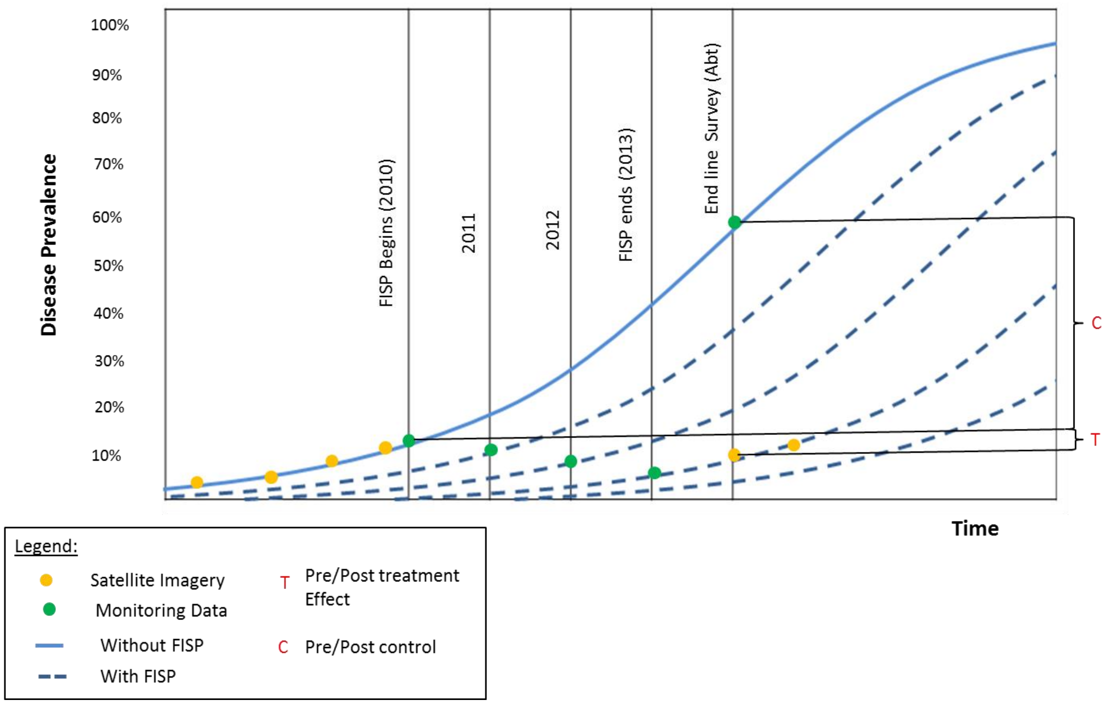
Where x_t is the disease prevalence at time t. Equation [1] can be rearranged to get the Van der Plank equation, which implies that the infection rate between two time periods can be estimated using disease prevalence at the time periods:

$$\tau = \frac{\log\left[\frac{(1-x_t)}{x_t}\right] - \log\left[\frac{(1-x_{t+1})}{x_{t+1}}\right]}{T_{t+1} - T_t} \qquad [2]$$

The underlying assumption is that the infection rate is proportional to disease prevalence (equation [1]). In the ideal, we wanted to test this assumption; however, this would require time series data on disease prevalence, and this information was available only for a small area (see Section 4.1.4 for more details. Therefore, in the absence of information to test this assumption we follow the literature and use equation [2] to estimate the projected stream of benefits (Van der Plank, 1963; Eden-Green, 2006).

The original MCC ERR estimated the "with-project" and "without-project" rates of return by comparing the baseline and endline outcomes. Our impact evaluation estimates will provide more robust estimates of the impact of FISP, taking into account the change in disease prevalence in non-project areas. Therefore, we will re-estimate both the with-project and the without-project disease spread rate, which can be derived directly from the disease prevalence rates as estimated by the impact evaluation. However, there is a challenge in interpreting the impact of the program on the disease spread rate. This is because when FISP cut trees it is possible that it implied that disease progression got delayed, so the disease curve simply shifted out. With each cutting, the reduction in the disease prevalence resulted from a shift in the curve. Consider Figure 2-2, in which the solid blue line depicts how CLYD progresses assuming equation [2] holds, and there is no program intervention. In this case (let's call it the comparison group), the change in disease prevalence between FISP initiation and the endline survey is given by "C," from which we can estimate a disease spread rate. However, as the dotted lines depict, in the treatment areas, as the trees are cut the curve shifts to the right. The change in disease prevalence is given by "T," but it is no longer accurate to estimate the disease spread rate using equation [2], which describes the relationship for movements *along* the curve, and not as the curve shifts. However, this does not present a problem in estimating the expected change in stream of benefits resulting from FISP, if we assume that FISP did not affect the underlying disease prevalence curve. As noted above, ideally we would like to estimate the future projection of disease prevalence from time series data, but we are able to do this only for a case study, which is described in Section 6.2.3.

Figure 2-2: Illustrative Depiction of the Change in Disease Prevalence over Time with and without FISP



Once we assume that the underlying functional form is as given by equation [2], and that it is unchanged by the project (that it only shifts), estimates of the rates of spread permit a fairly straightforward estimate of the number of trees saved by Activity 1. Updating and confirming estimates of productivity for the existing coconut variety and of the realized and inflation-adjusted price of coconuts multiplied by the proportion of coconuts marketed as whole coconuts will yield the revenue stream of coconuts. (Cultivation costs of maintaining an existing coconut tree are thought to be negligible.) Coconuts are also marketed as copra, the "meat" of the coconut. We will calculate the net revenue stream from copra by looking at the total number of coconut trees saved, the number of coconuts per tree, the proportion used for copra, the conversion rate of fresh coconuts into copra, and the price of copra minus any conversion costs. We do not have a reliable estimate of baseline incomes or shares of net income needed for a pre/post-evaluation, but we intend to use the COWI and Verde Azul studies to provide context to our results, as both of the studies look at the coconut-producing region as a whole (see Section 3 for a discussion of the studies).

To assess the overall impact on coconut prices as a result of CLYD, we will also track the real price of coconuts from five years before the Compact, during the FISP years, and onwards.

Many of the data gathered to estimate the values needed to calculate the ERR are useful in answering the research questions. In turn, the answers to many of the research questions are inputs for—or are based on inputs for—the ERR. These relationships are laid out in Table 2-2.

Table 2-2: Research Questions and Economic Rate of Return

Research Question	Relation to ERR Calculation
1. What is the impact of the technical assistance provided by the project on coconut production?	To answer this question, it will be necessary to distinguish (possibly by relying on the household survey) beneficiaries who received different types and levels of technical assistance, and why they received that assistance.
2. How did the evolving program logic affect the scope of implementation activities?	The ERR will test the development hypothesis that was actually implemented, how the program logic evolved over the project timeline, and how the pre-implementation and actual implementation hypothesis changed.
3. What is the impact of the technical assistance provided by the project on income diversification due to the introduction and adoption of high-value crops?	Technical assistance was part of Activity 3; the data requirements will be the same for the ERR. To answer this question, it will be necessary to rely completely on the household survey, no useful monitoring data were obtained from ACDI/VOCA-MCA.
4. What is the potential increase in coconut supply in the Zambézia and Nampula provinces over a 20-year investment period?	The same model that will be used to estimate the spread of CLYD for the ERR can be applied to the total coconut production in the two provinces. Because the model shows a continuous fall in coconut supply, we expect to measure a decrease in supply.
5. What is the present rate of CLYD prevalence in adult trees in the epidemic FISP intervention area?	This is one of the key inputs into the ERR calculation.
6. What is the present survival rate of adult trees in epidemic areas?	The ERR will use this to determine future returns from coconut production.
7a. What is the impact of FISP in reducing CLYD prevalence?	This is part of determining the with-project disease prevalence of CLYD, a key ERR parameter
7b. What is the efficiency of FISP in reducing the CLYD disease spread rate?	This is part of determining the with-project disease spread rate of CLYD, a key ERR parameter (τ)
8, To what degree must post-Compact (September 2013) felling activities be scaled up to keep the disease spread rate below 2 percent?	The data used for the ERR's projections of future benefits (such as investment to achieve a given rate of spread) can be used to estimate the level of Task 1.
9. What are the results of the ERR with variable CLYD infestation rates and other determinants of survival rates of coconut trees?	This is part of the sensitivity analysis that is part of the ERR.
10a. What is the impact of the project on the post-planting care of coconut seedlings?	This is one of the implicit determinants of the benefits of Task 2.
10b. What is the impact of FISP on the present survival rate of the seedlings?	This is one of the implicit determinants of the benefits of Task 2.
11. What is the impact of the project on the incomes of participating farmers in the endemic and epidemic zones? Are the changes in outcomes associated with the project different for male and female heads of households?	This is the sum of the benefits of Activities 1 and 3.
12. How has the promotion of high-value crops affected household incomes in communities that grew them before, compared to those that did not grow them prior to project intervention?	This is part of determining the benefits of Activity 2.
13. What was the impact of BDF activities on the aggregate income of the beneficiary population?	This will not be part of the ERR, although a similar cost/benefit analysis will be used.

Research Question	Relation to ERR Calculation
14. How have research and development activities aided in the development of CLYD-tolerant seedlings?	None.

3. Literature Review of the Evidence

Currently, there is no rigorous evidence of the impact of FISP that attributes the impact of the project separately from other changes that might have affected farmer incomes or coconut disease. This evaluation will fill this important gap by rigorously establishing the impact of FISP. Two studies were commissioned by MCA to characterize the "coconut belt" of Mozambique and contribute to the body of knowledge for this evaluation.[5] The first conducted a quantitative study of smallholders in the two main coconut-growing provinces of Mozambique—Zambézia and Nampula (Verde Azul Consult 2013). The study focused on farming systems, CLYD spread, *Oryctes* infestation levels, and food security, and provided some scenarios on future income given the CLYD infestation rates found. This survey found that coconut farming in the region generally uses one variety of palm (tall green giant) and most palms are relatively mature, with the average age being about 40 years. The survey also found that the average yield of these palms is 32 coconuts per palm per year. Assuming an average density of 107 coconut palms per hectare, this translates into 4,300 coconuts per hectare per year. Another relevant finding of the survey was that farmers know how to identify CLYD and acknowledge that cutting is the best way to manage the disease, but most coconut "fields" are also full of weeds that are believed to facilitate disease propagation. However, most farmers do not burn felled palms, which is important to control the spread of Rhinoceros beetle (*Oryctes)*. The study therefore concludes that the lack of burning felled palms contributes greatly to the spreading of *Oryctes*, which is found in 90 percent of coconut plantations and exaggerates CLYD infestation by making the palms more susceptible to disease. One main result related to disease management was that farm sanitation and maintenance (i.e., clearing the fields of weeds) can significantly reduce CLYD spread by eliminating the vector's primary hosts. Based on their data, Verde Azul estimates the infected area increases by 6 percent a year and that all areas will be infected by 2020. Our disease impact evaluation and the proposed case study will provide some evidence to test this assumption.

Regarding income, the study found that farmer households in the region depend greatly on coconut and its byproducts for income, but in areas with high disease prevalence, households seem to substitute away from coconut production and rely on livestock. Despite this alternative income stream, there seems to be a clear dependence in the region on coconuts for both income and food security. The study shows a significant negative relationship between CLYD prevalence and income, concluding that on average, a household moving from 10 percent or lower prevalence to 10–50 percent prevalence will experience a 646 metical (US$20.50) loss of annual income.

The second study commissioned by MCA (COWI, 2013) conducted an anthropological study of the coconut belt of Mozambique (Zambézia and Nampula Provinces) in order to characterize the demographics of the region and measure stakeholder perceptions of the project. The main results

5 Both firms, Verde Azul and COWI, are local consulting firms. Neither study claims to establish the impact of FISP; they are both general characterizations of the region as a whole.

show that 97 percent of the regions' households depend on agriculture as a principal source of income and do so without formal land entitlement. Among the sampled population, the majority of farmers (60 percent) rated the project as "good," while 30 percent rated it as "reasonable" and 6 percent rated it as "bad." The population generally agreed that felling diseased palms was the correct strategy to employ, but most stakeholders (including both farmers and government officials) commented that the scale of the project was far too small. Overall, the study concludes that there were no anthropological factors inhibiting beneficiaries from "appropriating"[6] the project, but the sustainability of the project post-Compact is highly questionable. The report concluded with a set of intervention recommendations for future projects, which mainly emphasized scaling up FISP activities. Some of the more important recommendations were: both the family and commercial coconut sectors must be included in the felling activities, more research should be put into identifying a tolerant coconut variety, additional focus should be put on irrigation systems in addition to alternative crops, and community awareness campaigns should also focus on land rights and documentation. The recommendations are meant to be taken as lessons learned from FISP to be applied to future projects in the region.

In addition to external studies commissioned by MCA, there were also several pieces of research conducted by consultants for FISP. Simon E. Green and Fabian Pilet both formally documented their observations on CLYD in the project area from several field visits. There was also a small seedling survival rate study conducted by the project to determine how many seedlings were estimated to become coconut-producing adults. The results of these internal pieces of research, as well as other relevant research conducted outside of Mozambique, will be documented in the Pest Risk Analysis (see Section 4.1.4).

4. Evaluation Design

4.1 Evaluation Type and Methodology

We will employ a mixed-method evaluation to answer the 14 evaluation questions: we will answer certain questions primarily using a qualitative approach and some questions using a quantitative approach supported by qualitative data for more in-depth understanding of the impacts. Figure 4-1 presents the Abt team's overall evaluation approach, detailing the use of quantitative and qualitative approaches and the related data sources to answer key evaluation questions.

In addition, Table 4-1 presents our evaluation approach by each of the evaluation questions, which takes into account MCC's Policy for Monitoring and Evaluation of Compacts and Threshold Programs (MCC 2012). We will answer the 14 research questions described in Section 2.3 using five broad evaluation approaches. We briefly list and describe them below and in Table 4-1; the balance of this section provides details of each of these approaches.

6 The Abt team interprets this to mean "project buy-in," signifying there were no anthropological factors inhibiting the project from being accepted by the local population.

Figure 4-1: Evaluation Approach for FISP: Quantitative and Qualitative Approaches

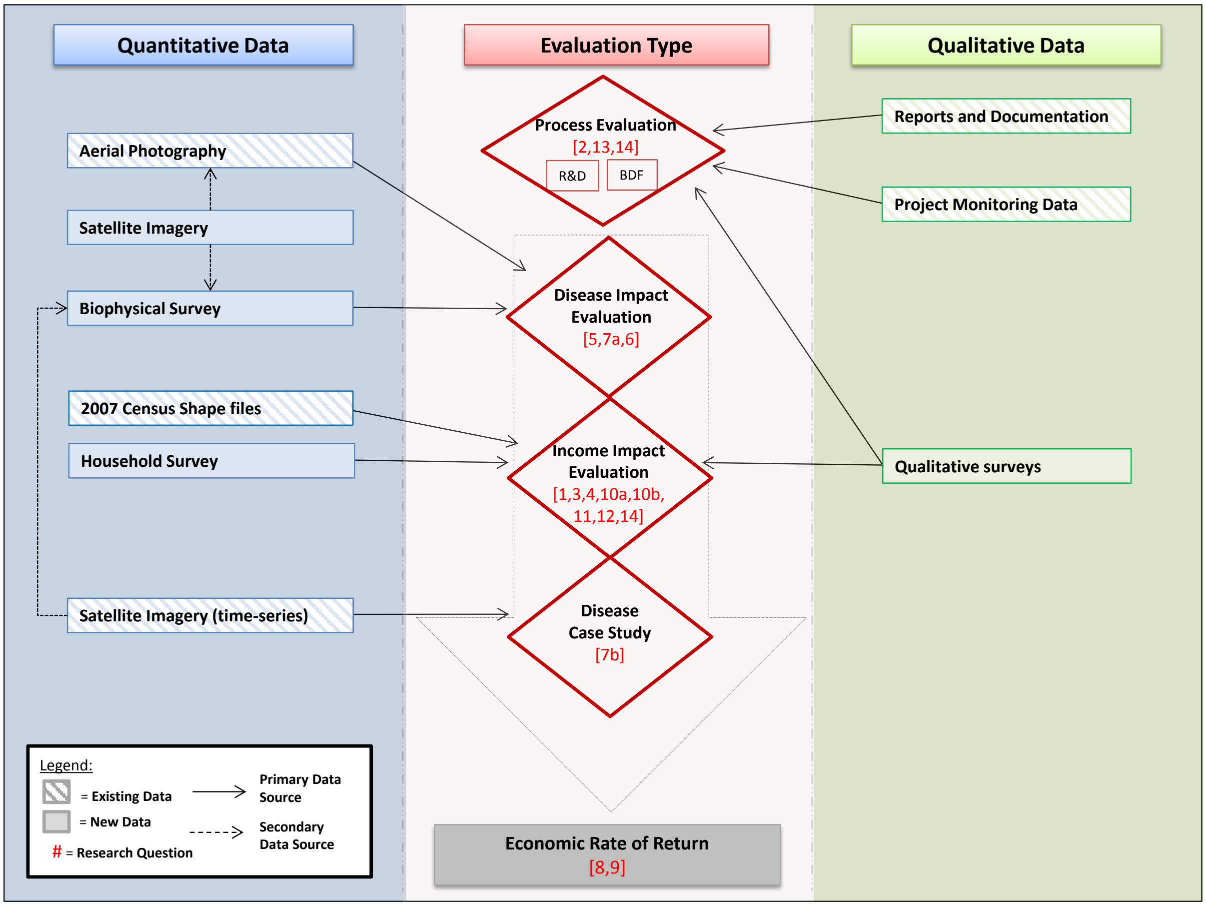


Table 4-1: Research Questions, Approach, and Data Sources

No.	Research Question	Evaluation Method	Data Collection Methods	Data Requirement
1.	What is the impact of the technical assistance provided by the project on coconut production?	Income impact evaluation focused on production in the FISP evaluation sample; not representative for the region	Household survey	Current production of coconut and cost of technical assistance (for ERR)
2.	How did the evolving program logic affect the scope of implementation activities?	Process evaluation	Key informant interviews	Interviews with MCC, MCA, and implementers
3.	What is the impact of technical assistance provided by the project on income diversification due to the introduction and adoption of high-value crops?	Income impact evaluation	Household survey	Income diversification index (project/non-project areas) and rate of adoption of high-value crops[1]

No.	Research Question	Evaluation Method	Data Collection Methods	Data Requirement
4.	What is the potential increase in coconut supply in the Zambézia and Nampula provinces over a 20-year investment period?	Analysis of results from income and disease impact evaluation	Household survey	CLYD prevalence, survival rate of seedlings, tree productivity
5.	What is the present rate of CLYD prevalence in adult trees in the epidemic FISP intervention area?	Disease impact evaluation	Biophysical survey of trees in endline.	Number of infected trees by total trees, per hectare, project and non-project areas in epidemic zones
6.	What is the present survival rate of adult trees in epidemic areas?	Derived metric	Derived from answer to question 7. Satellite imagery if biophysical data is not viable approach.	Disease prevalence.
7a.	What is the impact of FISP in reducing CLYD prevalence?	Disease impact evaluation	Aerial photographs for baseline, biophysical survey	Current CLYD prevalence and historic CLYD prevalence (in both project and non-project areas); cost of project
7b.	What is the impact of FISP in reducing the disease spread rate (or infection rate)?	Case study	Panel of satellite images	Disease prevalence before during and after FISP intervention in project and non-project areas.
8.	To what degree must post-Compact (September 2013) felling activities be scaled up to keep disease spread rate below 2 percent?	Combined assessment	Derived metric	Current CLYD prevalence and cost per percent reduction in rate of spread (from # 6)
9.	What are the results of the ERR with variable CLYD infestation rates and other determinants of survival rates of coconut trees?	Combined assessment to support ERR	Derived metric	ERR variables
10a.	What is the impact of the project on the post-planting care of the coconut seedlings?	Income impact evaluation	Household survey	Post-planting care training and planting of CLYD-resistant varieties of coconut seedlings in project and non-project areas
10b.	What is the impact of FISP on the survival rate of the seedlings?	Income impact evaluation	Household survey	Post-planting care and survival rate of seedlings
11.	What is the impact of the project on the incomes of participating farmers in the endemic and epidemic zones? Have the project impacts been different for men and women?	Income impact evaluation	Household survey	Net incomes of farmers in project and non-project areas, disaggregated by endemic and epidemic zones
12.	How has the promotion of high-value crops affected household incomes in communities that grew them before, compared to	Income impact analysis, with qualitative analysis to assess	Household survey and focus group discussions	Contribution of high-value crops to income and total net income in project vs. non-project households

No.	Research Question	Evaluation Method	Data Collection Methods	Data Requirement
	those that did not grow them prior to project intervention?	incremental impact of high-value crops		
13.	What was the impact of BDF activities on the aggregate income of the beneficiary population?	Case studies	Project documents and interviews	Profit and loss statements, job creation figures, estimated multiplier effects
14.	How have research and development activities aided in the development of CLYD-tolerant seedlings?	Case studies	Technical review	Research proposals and reported results

[1] **Income diversification index**: $S_k=(Y_k/Y)$ and $D=\sum_{k=1}^{n}[1/(S_k)]$ where Y_k is total income from source *n* (n=number of sources) and Y is total household income. Using this technique, D will be the diversification "score," and the higher the number, the more "diverse" the household income (Ersado 2003).

- ***Process evaluation.*** This category of questions pertains to assessing FISP implementation, the project's response to changing needs, and efficiency of implementation. We will conduct a process evaluation using qualitative methods (described in more detail below) to answer this question [question 2].

- ***Income impact evaluation.*** Based on our assessment of the potential counterfactual areas and FISP program areas, the number of households therein, we are able to conduct separate impact evaluations for epidemic and endemic zones to assess the impact of FISP activities on farmer incomes and the interim outcomes that are expected to increase incomes. In the endemic zone, FISP is expected to increase farmer incomes by helping them diversify into new crops and to plant and care for new seedlings. In the epidemic zones, FISP is expected to increase incomes primarily by controlling CLYD, and its consequent impact on coconut production and plant and care for new seedlings. Therefore, in both zones we will assess if FISP had an impact on farmers' knowledge, attitudes, and practices (KAP) to control CLYD, whether it impacted farmers' practices in post-planting care of coconut seedlings [question 10a], whether it impacted survival rates of coconut seedlings [10b], and whether it led to higher farmer incomes [question 11]. In the epidemic zone, we will also assess FISP's impact on CLYD, which is discussed in more detail under the disease impact evaluation described below. In the endemic zone, the income impact evaluation will also assess if FISP led to greater income diversity and consequently greater income [questions 3 and 12]. The income impact evaluation is described in more detail in Section 0.

- ***Disease impact evaluation.*** As agreed with MCC, we will assess FISP's impact on CLYD only in the epidemic zones since all trees were cut in the endemic zones, making the question irrelevant. In the epidemic zone, FISP-control of CLYD and impact on coconut production is the main mechanism through which farmer incomes are expected to increase. Based on our review of the available baseline data on disease prevalence from 2008 aerial photographs, and the availability of counterfactual areas, we propose an impact evaluation to assess if FISP had an impact on disease prevalence [question 7a]. Following the literature and assuming a logarithmic disease prevalence curve with proportional infection rate, the impact of FISP on infection rate or the disease spread rate can be derived from the project's impact on prevalence rates (see Equations [1] and [2] above) for the comparison areas where the difference disease prevalence can be assumed to move along the underlying disease prevalence curve. However, as discussed in Section 2.3, it cannot be estimated for the treatment areas. To estimate the impact of FISP on the disease spread rate, we therefore propose a case study as data were not adequate to conduct an impact evaluation. The disease impact evaluation to estimate FISP impact on disease prevalence is presented in Section 4.1.1, and details on the case study are presented in Section 4.1.4.

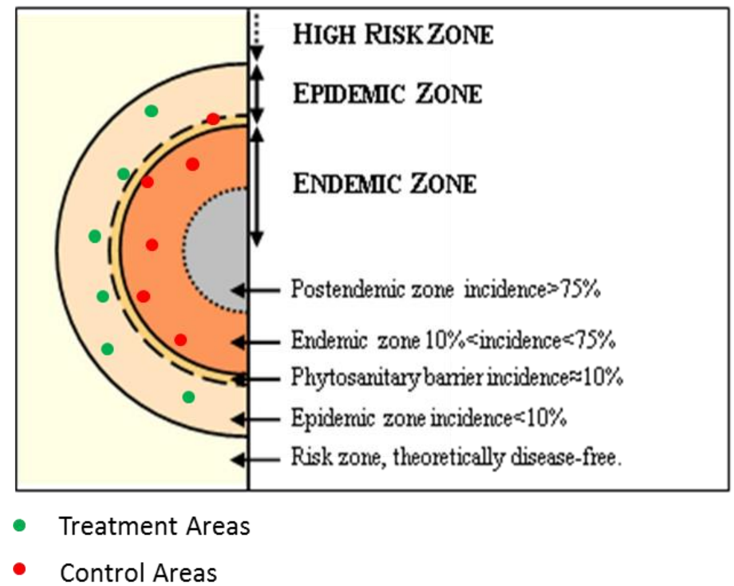
- ***Combined assessment for ERR.*** This category of questions [question 4, question 8, and question 9] will use the combined results of the assessment of disease progression and farmer impact, together with the project's impact on coconut production, to estimate FISP's overall ERR. These analyses rely on the results that are derived from the first two categories of assessment.
- ***Case study.*** The final category of questions pertains to specific assessments of the BDF Activity and the Research and Development Activity [question 13 and question 14] and the case study to assess the impact on the disease spread rate. We will complete this assessment qualitatively using case studies.

4.1.1 Impact Evaluations

As noted above, we propose to conduct three impact evaluations: one to estimate the impact of FISP on disease prevalence in the epidemic zones, a second to estimate the consequent impact (primarily through its control of the disease) on farmer incomes in the epidemic zone, and a third to estimate the impact of FISP through its efforts on diversification of crops on farmer incomes in the endemic zone.

Ideally, geographic areas would have been randomly assigned to receive the intervention, and others to not receive the intervention. As the intervention activities varied based on the baseline disease prevalence (endemic versus epidemic), the ideal evaluation would have stratified the randomization of geographic areas of these two zone types. Since FISP did not conduct a randomized experiment, the next best approach is to identify geographic areas that were very similar at baseline and were otherwise split into intervention and non-intervention (or comparison) areas by some external "quasi-random" factor. Our methodology for identifying the impacts of the intervention in the epidemic zones employs this quasi-random approach, based on the phytosanitary barrier. In the epidemic zone, FISP implementation areas were defined along a phytosanitary barrier—a north-to-south line that separated the epidemic zones into eastern and western halves—that was drawn roughly around 10 percent disease prevalence. FISP worked only on the western half, away from the coast, where the disease prevalence was expected to be less than 10 percent, given the assumption that disease prevalence is lower away from the coast. Defined this way (all areas east of the phytosanitary barrier), the project worked in the entire epidemic zone. However, in effect this barrier was imperfect because while it is true that the disease prevalence is greater near the coast, the disease prevalence has a mosaic pattern. This means that even in regions near the coast, or in the eastern half, there can be areas with disease prevalence lower than 10 percent. Furthermore, the barrier was imperfectly drawn even along the perceived divide of 10 percent prevalence, as it was drawn along natural barriers such as water bodies and roads. These characteristics of the barrier and how the FISP program implementation areas were defined, give a unique opportunity to identify the counterfactual areas. Accordingly, we used the 2008 TTI aerial photography data to identify areas with similar disease prevalence as proximate as possible to either side of the barrier, with the areas on the west side serving as treatment areas, and areas on the east side serving as the comparison areas (see Figure 4-2 and Annex 2, which describes our approach to estimating baseline disease prevalence). Overall, from among the entire FISP project areas on the east side of the barrier, and the non-project areas form the west side of the barrier, we identified areas where the disease prevalence was between 0 and 15 percent disease prevalence. These areas amounted to 93 project and 65 non-project census enumeration areas (EAs) very close [within 73 kilometers] to the phytosanitary barrier that shared similar disease prevalence, implying that our analysis is limited to areas close to this barrier. Unlike in the endemic zones, in the epidemic zones there is a large variation in EAs' distance to the coastline, which also impacts both disease prevalence and (most likely) disease spread. Keeping the study analysis areas close to the barrier will also ensure that there is not a large variation in the EAs' distance from the coastline.

Figure 4-2: Comparison Areas for the Epidemic Zone



Source: Colon (2013).

The FISP phytosanitary barrier was reevaluated a total of 5 times throughout the project. The reevaluation was based on the results of the disease inventories, as the barrier was meant to demarcate where the epidemic zone began (i.e. where disease prevalence was approximately 10% or lower.) The 2009 barrier (orange and black) was the first to be established, and according to project documentation, was not used for implementation, which started in 2010 (see Figure 2-1 above). As a result, the 2010 barrier is considered to be the first barrier which dictated where the epidemic interventions should take place. Over time the barrier shifted, with the majority and most dramatic shifts occurring in Nicoadala district. In this case there were both eastern and western shifts of the barrier, which effectively switched a region of about 10000ha from being "comparison" to being "treatment" and then back to "comparison." To ensure that all comparison areas did not receive treatment, we have chosen comparison located east of the 2012 barrier, which is the furthest east the barrier was shifted over the course of the project.

It is important to note that in three out of the eight FISP program districts there was no barrier drawn (normally because natural features like the coastline of geographical spacing of trees delineated the two zones.) For the districts of Pebane, Moma, and Angoche, the implementation of FISP activities was mixed to the extent that no counterfactual areas were able to be identified because there were no non-project areas. There was no barrier drawn in the district of Chinde, but epidemic and endemic areas (as well as project and non-project areas) were geographically separated in a way that allowed us to include the district in our sampling frame. As a result, our impact evaluation is focused on five out of the eight FISP districts (Nicoadala, Namacurra, Maganja da Costa, Chinde, and Inhassunge).

In sum, the phytosanitary barrier distinguished between epidemic project areas and epidemic non-project areas. We have identified 93 program and 65 non-project areas very close (within 73 kilometers) to this phytosanitary barrier and have verified that the baseline disease prevalence (using the aerial photography data from TTI Production, 2008) is very similar in the study areas to the west of the barrier (non-project), as compared to the study areas to the east of the barrier (project). Therefore, these study areas will serve as our intervention and comparison groups. Their baseline similarity, geographical similarity, and haphazard separation by the phytosanitary barrier create the ideal conditions for a quasi-experimental evaluation. This quasi-random approach identifies the impact because difference in outcomes can be attributed only to the intervention; other potentially confounding factors are similar across the phytosanitary barrier, due to geographic proximity. We will use this quasi-experimental framework to identify the impacts on income and disease prevalence in the epidemic zones. To investigate the homogeneity of farmer types and agricultural markets across the treatment and comparison area, we will report and compare covariates in addition to regression-adjusted outcome measures, for the treatment and control areas (this plan is also discussed later, under "Income Impact Evaluation").

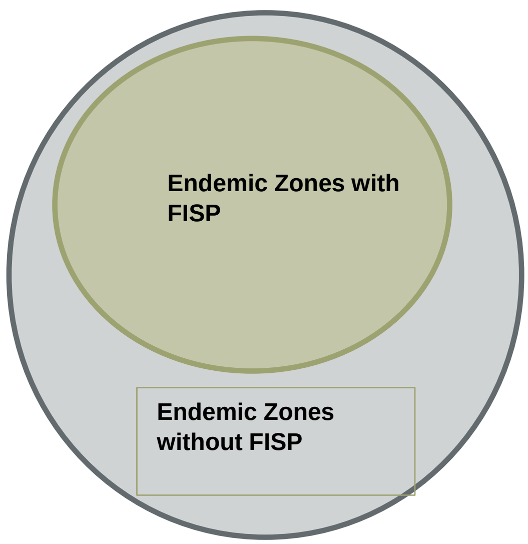
A threat in any border-discontinuity design is the possibility that treatment, and/or its effect, can "spill over" into the comparison area. The ideal way to prevent spill-over would be to begin with a model of disease progression that gives geographic distances on the outer limits of the effect of administering treatment in a certain area, and to randomly assign geographic areas to treatment or control groups such that no areas are have overlapping "outer-limit-of-spill-over" boundaries. However, assignment to the treatment and control group was not random and we contend that there are no models of disease progression that would inform our selection of the best geographic areas from which to draw the control group sample. For this evaluation, the selection of the control group rests on the trade-off between maximizing homogeneity of market characteristics, natural environment, and farming practices; and minimizing the likelihood of spill-over effects. To test whether treatment spill-over might have occurred, we will provide a comparison of disease prevalence within various areas of the comparison group, for example those that are between 0 km and X km from the barrier and those that are between X km and Y km, etc. If the FISP activity had an effect on disease progression on both sides of the barrier, then we might expect the outcomes in the control areas between 0 km and X km from the barrier might have different outcomes than the control areas between X km and Y km from the barrier. We will conduct this analysis, trying two different "X" and "Y" pairs, and present the findings as exploratory rather than definitive because the sample was not powered to detect subgroup effects.

A quasi-experimental approach is not available for the endemic zones because the endemic zones were east of the phytosanitary barrier, and there was no similar geographic cutoff in selecting project areas. Barring a randomized experiment or a quasi-experiment, the next best approach is a non-experimental method for selecting untreated geographic areas that, at baseline, were very similar to the treated areas. The untreated and treated areas will be inherently different because of the "selection" of certain endemic zones for the intervention. To identify untreated areas that best match the treated areas, we matched geographic areas on baseline disease prevalence and on agro-ecological zones within districts. We will use this non-experimental framework to identify the impacts on income in the endemic zones.

Other than selection of areas, another concern in this design is the potential for bias because farmers in comparison areas may be systematically different from farmers in the treatment areas. In epidemic areas this is not an important concern because FISP worked with communities the entire area consequently there was no selection of communities or farmers for the FISP intervention. In the endemic areas, the program had defined criteria to select communities based on first the disease prevalence, and on their willingness to participate. There can be a selection bias if in our comparison group we are not able to identify household that would have participated in the program. We have worked with FISP implementation staff to do our best to include communities in the endemic areas that were most like communities that were included in the program based on the specific agro-ecological zone and their willingness to participate – the two main criteria to select communities.

Other threats to evaluation design include contamination of the comparison group or interventions by other donors. To mitigate this threat our process for identifying the study sample and comparison areas (described in more detail in Section 4.2) was based on a very detailed initial qualitative assessment stage where we had in-depth interaction with FISP implementation staff and other stakeholder to carefully identify the FISP implementation areas, and to understand any other programs that could have affected our outcome variables.

Figure 4-3: Comparison Areas for the Endemic Zones



Next we describe in more detail the proposed income impact evaluation and the disease impact evaluation.

Income Impact Evaluation

Under the income impact evaluation, we will answer questions to assess FISP's impact on income and on interim outcomes that are expected to impact incomes – through an increase in coconut production in epidemic zones and through increased income diversification:

- What is the impact of the project on the incomes of participating farmers in the endemic and epidemic zones? Are the changes in outcomes associated with the project different for male and female heads of households? [question 11]

- What is the impact of the project on the post-planting care of coconut seedlings [question 10a]?
- What is the impact of FISP on the present survival rate of the seedlings [question 10b]?
- What is the impact of the technical assistance provided by the project on coconut production [question 1]?
- What is the impact of the technical assistance provided by the project on income diversification due to the introduction and adoption of high-value crops [question 3]?
- How has the promotion of high-value crops affected household incomes in communities that grew them before, compared to those that did not grow them prior to project intervention [question 12]?

We will analyze all of these research questions separately for each zone—endemic and epidemic—to estimate FISP's impact on household incomes and on interim outcomes that are expected to impact incomes: the change in knowledge, attitudes, and practices around CLYD; adoption of alternative crops (in the epidemic zones only); seedling care; and seedling survival rates (questions 1, 3, 10a, 10b, and 11in Table 4-1 above).

To estimate the impact of FISP on farmer incomes and on KAP, we will conduct the income impact assessment by interviewing farmers in the selected implementation areas and their "matched" counterfactual areas. The proposed units of analysis for the income impact evaluation are households within villages (*nomes*), which are larger than census enumeration areas (or clusters). During the household survey, we will collect additional household-level socio-economic data, supplementing it with data on distance from plantations and distance from the coastline. We will report average household characteristics such as house construction, employment, and level of past coconut farming, identifying any statistically significant differences between households in the implementation areas and households in the counterfactual areas. If the groups are imbalanced on baseline and demographic variables, we will consider assigning relative weights to each of the households in order achieve balance between the treatment and comparison areas. We will use regression analysis to study income, controlling for household characteristics that reflect demographic and historical or "sticky" information (household construction does not change every year), as well as baseline geographic and CLYD information.

The Abt team has developed the household survey, drawing from several previous surveys. These include the Government of Mozambique's Agricultural Labor Survey (*Trabalho do Inquérito Agrícola*, or TIA) (MINAG 2008) and Verde Azul's *Impact of Coconut Lethal Yellowing Disease and of the Beetle (Oryctes) on Farming Systems and Household Income in the Coastal Provinces of Zambezia and Nampula* (Verde Azul Consult 2013). The survey has different modules for epidemic and endemic zones to capture the different activities and the different mechanism through which farm incomes will be affected by the project. The draft survey instrument, along with a table that maps specific survey questions to the relevant research questions, can be found in Annex 1.

Qualitative Approach

The Abt team will use focus and discussion groups to supplement the information gathered by the household survey and to support the quantitative analysis. This will enable us to draw more robust conclusions on how successful the promotion of high-value crops was in increasing farmer incomes and how the impacts of FISP can be disaggregated across gender groups (research question 11). As outlined above, we developed the household survey to collect quantitative data from four specific zones: endemic (treatment and comparison) and epidemic (treatment and comparison).

To ensure the compatibility of the two types of data (qualitative and quantitative), we will design the qualitative collection so that it draws information from the same four zones. The principal methods of data collection will be to hold focus group discussions and key informant interviews. The content and demographics of these focus group discussions will be centered around the two research questions mentioned above (questions 11 and 14). Because the questions are complementary in nature, the same focus groups can be used to answer both questions.

Our team will work closely with the contracted survey firm to develop instruments that will guide the focus group discussions and collect the qualitative information.[7] The instruments will consist of a set of standardized questions that we will use in four types of focus groups for each of the project zones (epidemic and endemic):

- Female heads of household who live in treatment areas
- Male heads of household who live in treatment areas
- Female heads of household who do not live in treatment areas
- Male heads of household who do not live in treatment areas

It is important that the questions be standardized in order to produce comparable information among the four groups; ideally, we will be able to compare intervention and non-intervention responses for both male and female heads of household. The questions will capture information about each individual's perceptions of income impacts and gender equality (or inequality) in project implementation and outcomes. For the non-intervention areas, we will not ask intervention-related questions, but will focus on participants' perceptions of the generally perceived economic potential of high-value crops and what equalities or inequalities exist in household income, labor markets, etc. Ultimately, the focus groups will allow us to identify:

- Whether the project affected households differ depending on the gender of the head of household
- What perceptions exist about FISP's high-value crops and income generation activities
- What factors led to these differences or similarities in perception
- Whether these factors were a by-product of project design
- What differences exist in perceptions about inequality across genders
- What sort of inequality exists in labor market outcomes or household income across genders
- Whether there was a gender difference in the profitability of high-value crops

We will combine the results of the focus group discussions with the disaggregated household survey data, using the same four groups listed above. This will provide both qualitative and quantitative evidence on how the impacts of the project were distributed among heads of household of different genders in the intervention areas compared to those who did not receive any intervention.

Disease Impact Evaluation

Under the disease impact evaluation, we will answer the following question from Table 4-1:

- What is the impact of FISP in reducing CLYD prevalence [question 7a]?

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[7] This task was included in the Terms of Reference for the survey firm. We will rely on the firm's regional expertise and knowledge of qualitative data collection in the area to refine our qualitative protocol and survey instruments.

Since FISP cut all the trees in the endemic zone, there are no trees on which to measure the disease. This means that these questions are relevant only for the epidemic zone.

Our counterfactual identification strategy for the disease impact evaluation is the same as that for the income impact evaluation in the epidemic zones (described above). The estimates of current disease prevalence will be based on biophysical measurement (foot-survey that relies on visual assessment of CLYD as was done by FISP). We are able to assess the accuracy of the biophysical survey (see Box 1) and can assess the efficacy of the aerial with respect to satellite data (aerial was found to be more accurate by FISP). Based on the results of this analysis, we will keep the option open of using satellite data as an alternative approach to estimate the endline disease prevalence. It should be noted though that if we move to using satellite imagery data, we will be able to assess the project's impact on healthy tree cover and the inverse of the infection rate, but not the disease prevalence. Also, we will not have any basis for assessing the accuracy of the satellite so unless the results on the bio-physical are particularly alarming, we expect to use a bio-physical survey. The assessment of the efficacy of the bio-physical has its own merit in assessing the program's primary method for identifying CLYD affected palms.

In consultation with MCC and experts in CLYD, we will make a final determination on the approach for measuring disease in the endline after our pretests are completed. We will evaluate both of these approaches during the pretest, when we will measure the accuracy of the biophysical measurement by conducting laboratory tests to determine the presence of CLYD disease in both trees that are identified to have CLYD disease and those that are identified to have no disease (see Box 1). (Note that our evaluation will not attempt to distinguish coconut mortality caused by Rhinoceros beetle and CLYD.)

Since we have baseline estimates of disease prevalence from the aerial photography conducted in 2008 by TTI Production, we will use it as covariate in our regression analysis to improve the precision of our estimates (see Section 6.2 for more details on the analysis plan). We prefer this approach over estimating a difference-in-difference estimate as it also removes any concerns that the baseline prevalence data is based on aerial photography, while the endline data will come from a bio-physical foot survey that relies on visual confirmation of CLYD

Box 1:
Measuring Efficacy of the Biophysical Survey in Detecting CLYD

We will conduct this analysis in non-treatment areas since we are looking for natural situations, and we will conduct it in different disease prevalence bands: two areas – with low 0% and <33%) prevalence levels of CLYD. For both of these baseline prevalence levels, we will identify 60 visual-CLYD-positive and 140 visual-healthy (CLYD "negative") palms, or a total of 200 (<10%) and moderate (between 10 and 33 %) palms for laboratory testing of CLYD. The larger sample of visual-healthy palms is to reflect the expected lower rate of CLYD detection among these palms. Photographs and data sheets on each palm sampled will be completed, providing a traceable audit to the position of the palm and a full description of its condition. The method of palm sampling and testing will closely mirror that developed under FISP. In the studies undertaken by FISP a higher rate of detection was shown when testing the inflorescence, with the stem providing the next best site. Given palm height and that a palm is not always with an inflorescence, it was generally the case that a stem sample was taken. Accordingly, under this activity sampling will also be limited to the stem.

The physical sampling of palms will be coordinated by local personnel and if possible with individuals who are familiar with the practice having undertaken the activity under FISP. The molecular analysis will be undertaken at FERA in the UK based on a LAMP detection method that has previously been shown to work well with St Pauls Wilt of coconut in Ghana.

The proposed units of analysis for the disease impact evaluation are one-hectare grids within villages (or "Nomes") that are larger than census enumeration areas. These grids are reasonable units of analysis in the absence of any advancement in science to understand how CLYD spreads in coconuts. People within these villages are likely to care for the coconuts in similar ways and have the same agro-ecological characteristics—they are, therefore, likely to be similar to each other. Other analyses that study disease prevalence on crops often use farm fields as units of analysis. This choice is not necessarily informed by how the disease spreads but is based on the fact that farm fields have similar cropping practices.

4.1.2 Combined Assessment: Economic Rate of Return

This assessment will answer the following evaluation questions:

- To what degree must post-Compact felling activities be scaled up to keep the disease spread rate below 2 percent [question 8]?
- What are the results of the ERR with variable CLYD infestation rates and other determinants of survival rates of coconut trees [question 9]?
- What is the potential increase in coconut supply in the Zambézia and Nampula provinces over a 20-year investment period [question 4]?

During the first field visit, the Abt evaluation team met with project implementers to inventory the monitoring data collected throughout FISP. From our interviews with the FISP implementers, it became apparent that since the project mitigated the spread of disease instead of eliminating the disease completely, our estimates of the benefits stream of future coconut production will have to include the almost-certain resurgence of the disease in epidemic zones and infection of replanted trees upon maturity. Our current understanding of how the ERR will be calculated, given the information collected in the field, is illustrated below.

Expected measurable project benefits (those that can be incorporated into an ERR)[8] come from three activity streams: (1) prevention of existing palms from becoming infected with CLYD by culling and removing diseased trees, (2) generation of income from palms replanted on cleared land, and (3) generation of income from high-value crops that can grow among coconut seedlings while they attain maturity. Based on the MCC model, the bulk of the benefits (91 percent) would come from prevention, with less coming from replanting (7 percent), and still less from the high-value crops (2 percent).

The logic of the original MCC model and a subsequent 2013 model are sound, and the team's analysis will replicate it, but with independent estimates of the parameters of the economic models. The two most important pieces of information for the ERR are the rate at which the disease spreads, given any initial rate of disease prevalence, and the rate of prevalence achieved by the project at the end of its prevention activities in December 2012. Disaggregated data (from 53 localities) from the service provider show this rate to be 0.9 percent. Consequently, we will focus on estimating the τ parameter of a Van der Plank equation (see Equation [2]).

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8 There is too little information available about the income generated by BDF grants to incorporate this activity into the ERR. Likewise, the benefits of research are too difficult to quantify in ways commensurable with income-generating activities to make them a part of the ERR.

This estimation can be made in three ways, which will serve as cross-checks on each other: (1) inferring τ from the observations of changes in prevalence rates using a case study of satellite imagery; (2) comparing the prevalence rates of CLYD in 2014 in areas not benefitting from FISP culling and removal activities (obtained from the biophysical survey) to rates estimated from satellite imagery of those same areas in 2008; and (3) comparing the prevalence rates of CLYD in 2010 in areas not yet benefitting from FISP culling and removal activities (obtained from the service provider's first disease survey of those areas) to rates estimated from aerial photographs of those same areas in 2008.[9] Data for these estimations are either available or will be obtained by the biophysical and household surveys.

Knowledge of how rapidly prevalence rates change (τ) enables us to estimate the "with-project" and "without-project" effects of the culling and removal activity on preventing infection and death among palms existing in 2009, the expected (post-maturity) survival of replanted palms, and the level of culling and removal that would be required from 2012 onward to prevent the prevalence rate from again climbing above 2 percent.[10]

The prevention activities were carried out only in low-prevalence areas (the epidemic zone), whereas replanting and promotion of high-value crops were carried out mainly in the high-prevalence areas (the endemic zone). In addition, the costs of culling and removal are substantially different from the costs of removing dead palms, replanting, and promoting high-value crops. For these reasons, we propose—in addition to the overall ERR—to conduct separate analyses of activities in each zone. As the MCA did not systematically collect costs by activity, these separate estimates will be subject to greater uncertainty than the overall ERR.

We will also confirm or re-estimate a large number of other inputs into the ERR, based on the results of the household survey. Data on the productivity of coconut trees are reliable and indeed conservative by international standards, and in any case depend on observation of actual practices. Estimates of incomes generated by high-value crops depend on yields likely to be obtained by farmers who have little experience to date with these crops. In this regard, the household survey will be an invaluable source of the most recent observation of these data and of the multi-year survival of palm seedlings (the service provider collected data on one-year survival rates only).[11]

The net benefit of the total FISP would combine the net benefits of three out of the five FISP activities.

Benefit stream from Activity 1 is as follows:

$$\mathbf{B_1 = R_{f1} + R_{c1} - I_1}$$

Where:

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[9] The latter is apparently the basis for MCC's estimate of τ at 0.0375. It may also be possible to infer τ from the observations of changes in prevalence rates combined with removal activities during project execution.

[10] The ERRs elaborated by MCC in 2008 and 2013 assume that replanted palms are resistant to CLYD, but there does not appear to be any evidence of this resistance.

[11] From January to March 2011, the FISP service provider conducted surveys in 15 localities to better understand the survival rate of coconut seedlings. The methodology used was "sending teams of ten people in each of the communities to manually count the seedlings and report the totals to FISP M&E assistants in the field" (Colon 2012).

B_1 = Net benefits of Activity 1
R_{f1} = Revenue from fresh coconuts
R_{c1} = Revenue from copra
I_1 = Investment in Activity 1

$$\mathbf{R_f = (T_{t1m} + T_{t1p}) * C * v * P_f}$$

Where:

T_{t1m} = Number of coconut trees that are in production in year t in the endemic zone
T_{t1p} = Number of coconut trees that are in production in year t in the epidemic zone
C = Number of coconuts produced on a typical tree in a year
v = Proportion of coconuts marked fresh
P_f = Farm gate price of a coconut

And

$$\mathbf{R_{c1} = (T_{t1m} + T_{t1p}) * C * (1\text{-}v) * k * P_c - B}$$

Where:

T_{t1m} = Number of coconut trees that are in production in year t in the endemic zone
T_{t1p} = Number of coconut trees that are in production in year t in the epidemic zone
C = Number of coconuts produced on a typical tree in a year
1-v = Proportion of coconuts marked as copra
k = Conversion rate of coconuts into copra
P_c = Farm gate price of copra
B = Cost of converting coconuts to copra

Benefits from Activity 2, replanted trees, are similar to the revenues from Activity 1:

$$\mathbf{B_2 = R_{f2} + R_{c2} – I_2}$$

Where:

B_2 = Net benefits of Activity 2
R_{f2} = Fresh coconut revenue from replanted trees
R_{c2} = Copra revenue from replanted trees
I_2 = Investment cost in Activity 2 (seedlings, their care until maturity, and technical assistance)

Benefits from Activity 3, promotion of high-value crops, were estimated with simple agronomic models by MCC at project initiation:

$$\mathbf{B_3 = \sum (H_n * y_n * P_n - D_n) - I_3}$$

Where:

B_3 = Net benefits of Activity 3
H_n = Hectares devoted to crop n
y_n = Yield (kilogram/hectare)
P_n = Farm gate price per kilogram
D_n = Inputs (sum of costs of production)
I_3 = Investments in Activity 3 (provision of inputs, seeds, and technical assistance)

These estimates for each crop will be confirmed or adjusted as necessary by the evaluation. We will conduct separate analyses of investments in endemic zones and epidemic zones, as shown in Table 4-2.

Table 4-2: Benefits by Activity and Epidemic and Endemic Zones

Activities	Epidemic	Endemic	Total Activity
Fell and burn	B_{1n}	B_{1p}	$B_1=B_{1n} + B_{1p}$
Replant		B_2	B_2
High-value crops		B_3	B_3
Total area	B_{1n}	$B_{1p} + B_2 + B_3$	$B_1+ B_2 + B_3$

We will also conduct beneficiary analysis to *disaggregate* the total increase in income (if any) as estimated in the impact evaluation, to determine specifically *which segments* of society will benefit from the interventions. In particular, we will consider the comparison between the two provinces (Zambézia and Nampula), between endemic and epidemic zones, and between male-headed and female-headed households. Such beneficiary analysis can shed light on the merits of promoting proposed investments.

Once we have the benefits and the costs by epidemic and endemic zones, we will estimate the benefit-cost ratio by epidemic and endemic zone. Cost data are not available to estimate this ratio by other project implementation categories.

4.1.3 Process Evaluation

The Abt team will conduct a process evaluation in order to answer research question 2: How did the evolving program logic affect the scope of implementation activities?

The main methodology used to evaluate this question will involve collecting information from key stakeholders through interviews. The interviews' objective will be to trace the evolution of the program logic throughout the five-year duration of the Compact, in order to determine how changes in the logic affected the implementation of activities. This is a particularly important exercise for this evaluation because of the programmatic changes that have occurred throughout the project. These changes have the potential to affect outcomes. For this reason, accounting for them will be crucial to both the ex-post evaluation of the project's effect on households' livelihoods and to the calculation of the project's ERR. Based on the results of this assessment, we will develop the lessons learned and provide recommendations for MCC's restructuring and rescoping process.

The information collected during the interviews will provide a qualitative mapping of how the program logic changed over time, which will help us understand how the corresponding changes in implementation might have affected household outcomes, the disease rate, or other outcomes of interest. The interviews will also provide an opportunity to vet various details about program logic and implementation. We will conduct interviews at three institutional levels:

- ***MCC.*** Interviews with key MCC personnel will help us understand the justification for any changes to the program logic from a top-down perspective. During our first field trip, we were able to speak with relevant MCC personnel in Mozambique and collect the information needed to compare with the other two groups. As of now, there are some inconsistencies regarding the areas of implementation; these inconsistencies will be resolved by gathering further information from the implementers during our data collection in June 2014.
- ***MCA-Mozambique (MCA-M).*** Interviews with MCA-M also commenced during our first field trip, which allowed us to document the project-wide changes as they related to the development

of the evaluation design. We will now follow up with the key stakeholders to identify any regional (within-project) differences in project changes and clarify any inconsistencies discovered during our desk review.

- ***Implementers.*** Interviews with project implementers will provide us with an understanding of how institutional changes translated into changes in implementation. This information will be important to inform the actual effects of project changes on the program logic throughout the project. We expect most information to come from these stakeholders, as they played a vital role in the day-to-day management and implementation of the project. They will be the stakeholders who know what changes actually occurred on the ground.

The Abt team will use the information gathered from the interviews to answer research question 2. Answering this question will fit into the larger evaluation by confirming our understanding of the timeline of activities and by providing qualitative information to support our quantitative data analysis.

4.1.4 Case Studies: Assessing the Rate of Change of Disease, Analyzing the Business Development Fund, and Evaluating the Research and Development Activities

We propose three case studies: one that is focused on understanding the impact of FISP on disease spread rate, a second that analyzes the business development fund activities, and a third case study that evaluates the research and development activities. These case studies will answer the following evaluation questions:

- What is the impact of FISP in reducing the disease spread rate [question 7b]?
- What was the impact of BDF activities on the aggregate income of the beneficiary population [question 13]?
- How have the research and development activities aided in the development of CLYD-tolerant seedlings [question 14]?

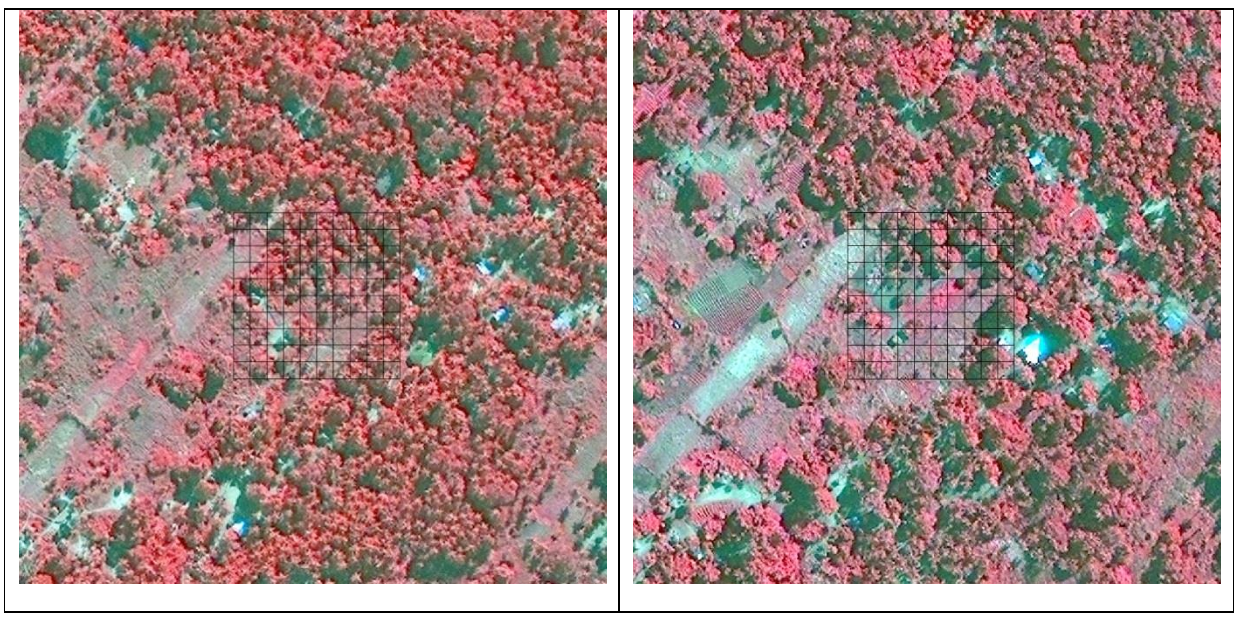
Case Study Analysis on Disease Spread Rate

To estimate the impact of FISP on disease spread rate, satellite images are the best source of data; they can provide a time series of images before, during, and after FISP in both treatment and comparison areas. To assess the impact of FISP on the disease progression, we need data on disease prevalence with and without FISP for several points in time (a minimum of three data points are required to identify two separate measures of change in disease prevalence). Satellite data—which can give a reasonable estimate of disease prevalence—could have provided such a time series, and would have been adequate to answer the question on disease prevalence. However, these data are not available for a sufficient number of observations in the FISP area. Therefore, we propose a case study that examines the impact of FISP on disease spread using a time series analysis for two locations for which satellite data are available from 2008 to 2014.

To assess if satellite images are a reasonable tool for estimating CLYD prevalence, we collected several samples of these images (see Figure 4-4). It is evident from these images that there was a reduction in the number of palms and in the canopy from 2008 to 2013. Regrowth of under-vegetation is also evident, and can detract from visibility of the palms. Looking at these images, we judged it impossible to see yellowing or dead palms, which may be indicative of CLYD and beetle damage. In an attempt to pull out spectral differences that may indicate yellowing or plant stress, we produced a Normalized Difference Vegetation Index (NDVI) for both images. However, the NDVIs did not adequately differentiate between stressed and healthy palms. Moreover, this approach to comparing time points or areas was seen as open to ascribing differences to environmental factor (e.g., drought or nutrition) more than CLYD. Although the images do not allow trees, healthy or diseased, to be counted, it is possible to develop an "index of palm canopy or coverage" (i.e., a quantified measure of healthy palms over a unit area). Moreover, a measure of palm health can provide an inverse proxy for CLYD and beetle damage (undifferentiated). We also believe it is reasonable for an assessment of the consequences of palm-felling to address maintaining palm health rather than be limited to controlling CLYD. Farmers are more concerned with what is productive than what is lost.

Based on these observations, the following Palm Canopy Index (PCI) score is suggested as appropriate for measuring the palm coverage and health. This index will provide an inverse proxy for CLYD and beetle damage (undifferentiated). This is a reasonable measure since the consequence of FISP activities is maintenance of palm health. Evidence for the viability of this approach is drawn from plant pathology and ecology, where the use of indexing to score necrotic lesions on leaves and satellite images as mega-quadrats for vegetative quantification has precedents. Horsfall and Barratt (1945) initially proposed the concept of indexing for lesions on plants, and this approach has held as relevant under subsequent investigations to the current day (Cook 2006). Notably, studies have looked at the levels of uncertainty associated with increasing index value and more recently started to compare visual and automated data. These studies have theorized greatest uncertainty at the 50:50 area; however, some studies suggest more uncertainty associated with higher index scores (Parker et al. 1995).

Figure 4-4: Satellite Images over Time



Source: FERA analysis of satellite images.

Palm Canopy Index: Palm cover will be assessed against the following scoring index[12]:

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[12] The determination of granularity will be an outcome of the assessment itself, and will therefore be refined as much as possible in order to decrease the size of the scoring ranges.

1) Healthy palms trees largely excluding other vegetation and exceeding 75 percent by land cover
2) Healthy palm trees dominate, gaps evident along with other vegetation: >50 and ≤75 percent by land cover
3) Healthy palm trees >10 percent and ≤50 percent by land cover
4) Healthy palm trees ≤10 percent of land cover

Next, we assessed the availability of satellite images for the epidemic zones study area as defined by our counterfactual identification strategy: FISP treatment areas and non-FISP comparison areas with similar baseline prevalence, based on 2008 aerial photography. Satellite data are available from a number of providers with large swaths of coverage, typically 25km x 25km and costing about $400 each. Image availability is subject to the frequency of satellite pass-over and whether an image was taken. The quality of images in terms of resolution and spectral coverage is generally similar. However, cloud coverage obviously impacts what is seen, so the images must be assessed on a case-by-case basis.

A review of the availability of satellite images shows that time-coursed images for a period before 2008 and to the end of the project (June 2013) is not available in all localities at a given time. Unfortunately, out of hundreds of EAs in our study area, only a few EAs had a time series of images from 2008 to 2014. This held true even though we did not exclude EAs where images were skipped for a year or two. We found three matched sites: one in Nicoadala, one in Inhassunge, and one in Chinde (see Figure 4-5) close to the phytosanitary barrier. We excluded the site in Chinde since the treatment and comparison areas are very far from each other, with the comparison area very close to the coast where disease prevalence tends to be the highest) Even though the selected EA had matching prevalence with the treatment area, it will be surrounded by areas of higher prevalence.) We also excluded the EAs in Inhassunge that were too close to the coast, leaving two matched areas—one in Inhassunge and one in Nicoadala—that are suitable for case studies (see Figure 4-6). For each of the matched areas, we will obtain a 25km x 25km satellite image for years 2008, 2009, 2010, 2011, 2012, 2013 and 2014. Given that we have two case study areas, this equates to four 25km by 25km areas per year and 28 satellite images in total. For each 25km x 25km image, we will randomly pick 20 mega-quadrats of 100m x 100m (560 quadrats) for estimating the palm canopy index. To the extent possible, these quadrats will then be spatially fixed over time so as to potentially allow for an analysis of data over years by fixed positions. The 100m x 100m mega-quadrats will form the units for analysis (Horsfall and Barratt 1945; Cook 2006; Parker et al. 1995).

In our view this case study will provide important insight into how the disease progresses, and whether FISP impacted the underlying relationship. However, we recognize that the analysis will not apply more generally and therefore are open to key stakeholders (IIAM, CIPAGRI and Provincial Ministries of Agriculture) and MCC's views on conducting this analysis.

Figure 4-5: Enumeration Areas with Time Series of Satellite Images

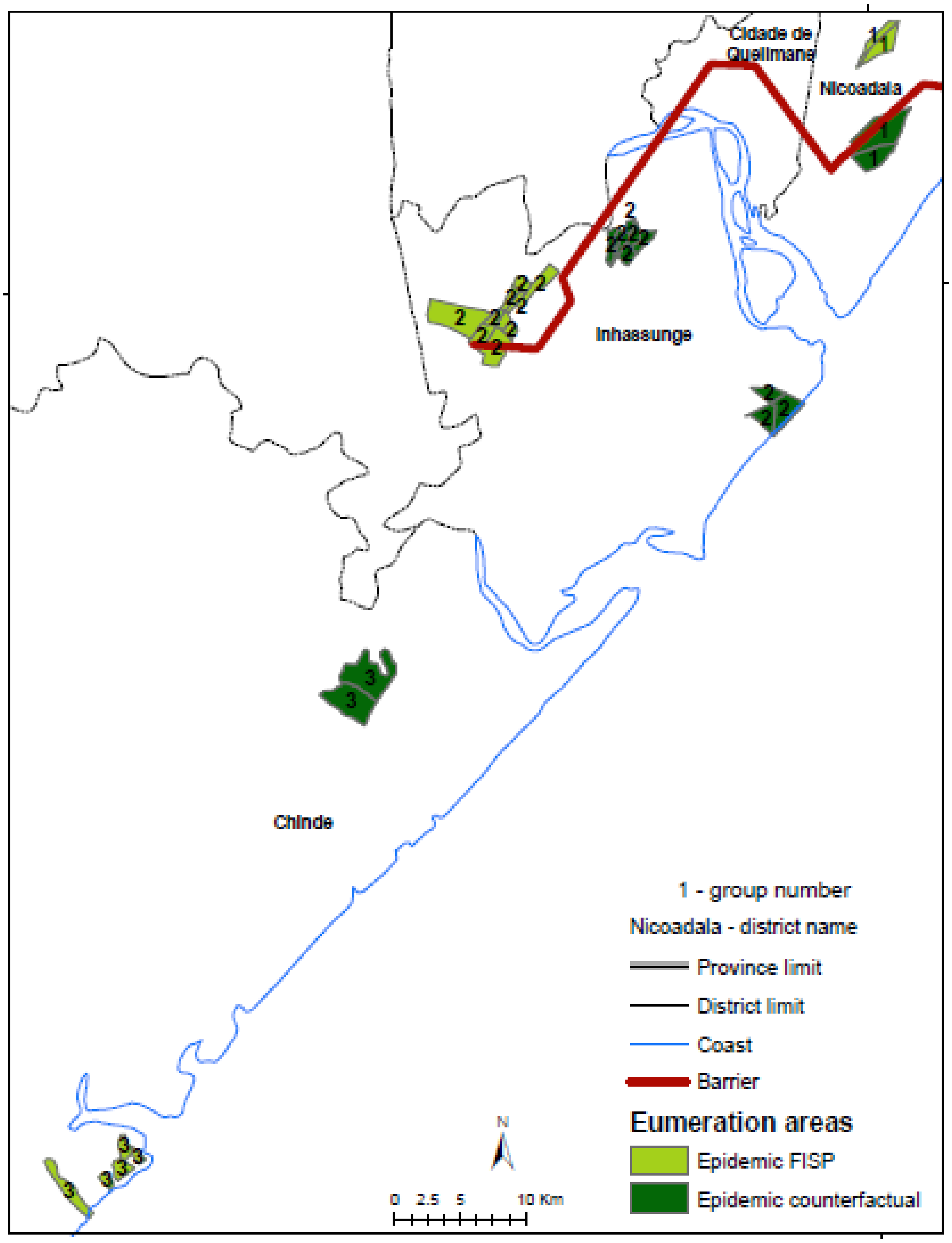
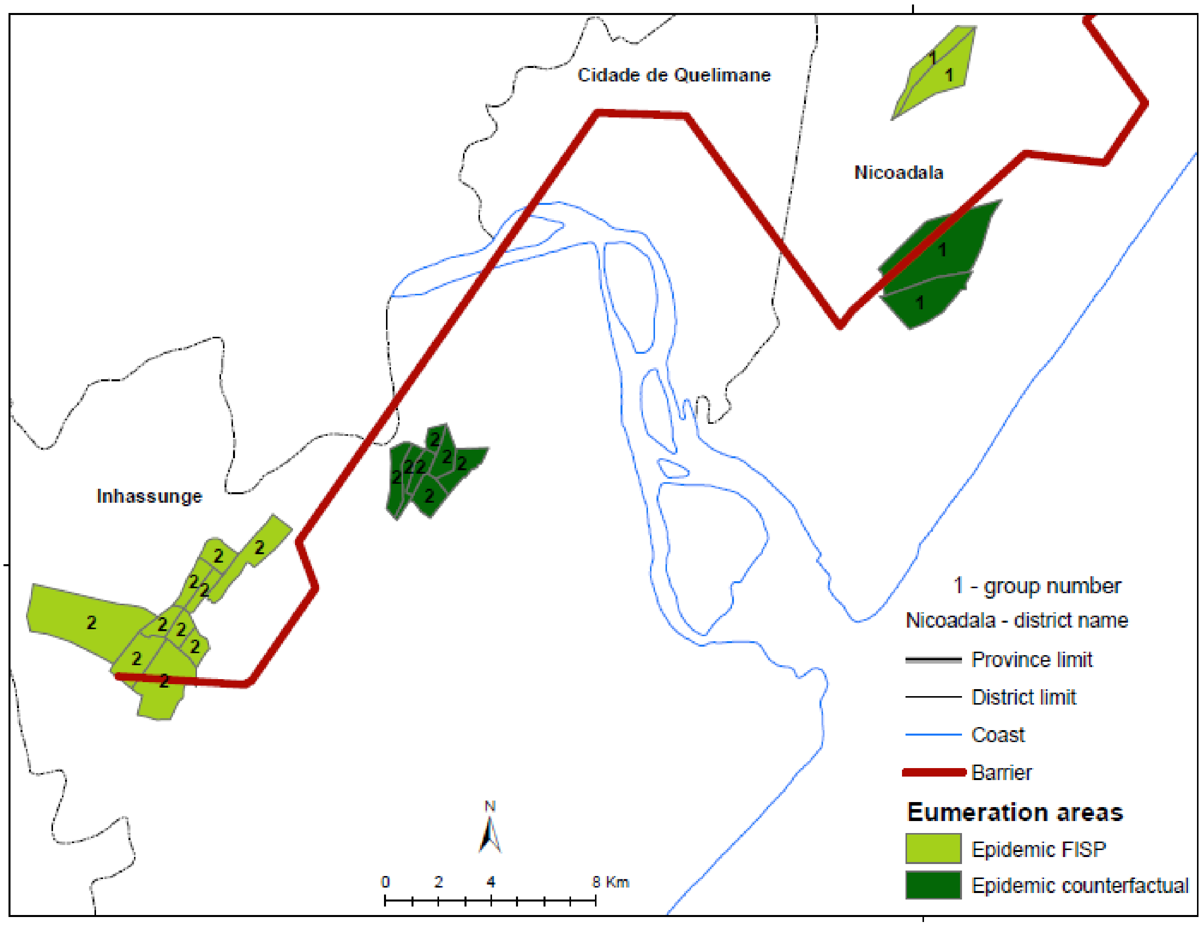


Figure 4-6: Case Study Areas for Studying FISP Impact on Disease Spread



Brief Review of CLYD and Underlying Assumptions of FISP Design – Production of a Pest Risk Analysis

As an important component of the evaluation of FISP, we will undertake a broader assessment of our understanding of CLYD. This will take the form of a Pest Risk Analysis (PRA), which is accepted by the International Plant Protection Convention[13] as a tool for estimating and communicating on pest risk. Specifically, a PRA sets out to document what is known and not known for a particular pest (i.e., the causal agent of CLYD) and how this knowledge applies to the risk of future spread, efficacy of control, and level of uncertainty in positions reached. In the context of the FISP evaluation, the PRA will provide the evidence base and justification for the “working assumptions” made in designing the evaluation. The below is therefore a very brief account of what will be a more rigorous exercise. The

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[13] A PRA can be a short or very elaborate document, depending on the level of information available, rigor, consultation, and resources (International Plant Protection Convention 2013). There is a limited amount of published and peer-reviewed literature that is applicable to CLYD in Mozambique. The PRA will mainly draw from experiences of lethal yellowing palm disorders that occur in other parts of the world. The PRA is intended to be jointly authored by Drs. Marcos Freire (IIAM) and Maria Mercedes Roca (independent consultant contracted to Abt Associates).

PRA will also form the baseline for evaluating the research and development activities as described later in this section under “Research and Development Activities.”

Ability to identify the causal organism. Despite CLYD-like diseases being reported on coconut trees in many parts of the world and associated with a specific bacterium, very little is known about the epidemiology of CLYD. A major constraint in undertaking research on the bacterium is that it is a fastidious organism, meaning that cannot be cultured outside of its host.

A key area of uncertainty relates to the reliability of CLYD diagnosis by visual means, levels of asymptomatic infection, incubation periods between infection and disease onset, and period of infectiousness. The consequences of this are discussed further in the preceding section and in the section on “Outcomes of PRA on evaluation design and conclusions reached.”

An initial review of the R&D funded by FISP indicates that a high number of CLYD-positive palms were tested by molecular methods (polymerase chain reaction, PCR) at the Quelimane laboratory and at CIRAD *(Centre International de Recherches Agronomiques pour le Développement)*; however, these reports suggest that these analyses did not address well a research question on CLYD symptom and PCR identification. For example, samples received at the Quelimane laboratory from the cutting teams were biased toward those palms that were judged by visual means as the borderline for CLYD. This bias will tend toward an under-estimate of a correlation. Moreover, the reliability of the lab testing was not rigorously demonstrated. Overall, these factors can lead to a misleadingly low level of confidence in the reliability of visual identification. The FISP R&D activities did not address asymptomatic infection, inasmuch as no systematic testing was undertaken on palms that were seen as healthy.

Given the scale of the uncertainty in estimating the impact of felling and projecting outcomes, Box 1 identifies a limited research activity that aims to systematically assess CLYD infection in healthy and unhealthy palms in environments of low, medium, and high CLYD prevalence.

Mode of spread and infectiousness of palms. The mode of spread is assumed to be by a phloem-sucking insect, but the identity and therefore the dynamics of this insect are not known. It is also not known what a typical latent period of infection is for CLYD, leading up to a symptom stage and death. Farmers report that the time between first symptom and death is between three and six months; however, this gives very little information about the infectiousness of palms prior to first symptoms. Because there is a latent period of CLYD, we cannot say what the level of infection is with visually healthy palms. What can be assumed is that as visual CLYD increases, the proportion of healthy palms with latent CLYD is also increased. It is also not known whether environmental factors trigger CLYD symptom expression. Thus, a felling strategy predicated on removal at first symptom expression tells us very little about whether or not an overall reduction in the inoculum load may exist within the system, notwithstanding the probability of alternative hosts for the CLYD causal organism that may exist in the system.

Palm “cultivar” tolerance to CLYD. The concept of cultivar is not as prevalent with coconut as it is with other crops; however, coconut types are widely accepted. Knowledge of palm cultivar tolerance is not well studied, and while there appears to be no resistance to CLYD, there are reports of observations of individual palms that appear to be more resilient to CLYD. The primary breeding strategy is based on positive selection from such palms. The success of this approach will not be known for five or more years, much longer if the field observation that young palms are less susceptible to CLYD than old palms is true (CLYD is often said to be a disease of mature palms). However, the truth of this observation appears to be open to question: it may be a spurious association, since most palm populations are mature. There has not been testing of the assumption that newly planted palms will not acquire CLYD early on and will therefore have a measure of productivity, even though this assumption is pivotal to the replanting strategy of both the epidemic and endemic zones.

Environmental factors' impact on CLYD spread and expression. The geographic distribution of CLYD, and its high prevalence toward the coast, is probably the most notable feature of CLYD. The geographic split feature of CLYD is at the heart of the FISP design of recognizing a phytosanitary barrier. Many factors may contribute to the split, including the distribution of the insect vector and alternate hosts of CLYD, and differences in temperature and humidity. These factors are not mutually exclusive—the coastal location will impact climate, vegetation, and insect populations. Despite the lack of knowledge about which of these, or other determinants, are driving CLYD, it is evident that the symptomatic phase of CLYD is much greater near the coast. It is assumed that rates of CLYD spread are also greater in coastal regions. For these reasons, there is no scientific basis for applying a control measure for CLYD (when proven in areas away from the coast) in coastal areas; i.e., the success of palm-felling, if shown effective in epidemic zones, should not be extrapolated to the endemic zones without a strong caveat.

Pests and other compounding factors. The increase in CLYD in the region is not questioned. There are, however, compounding factors that have exacerbated the decline in palm health. First is the age of the palms. Although not quantified, it is apparent that the majority of palms are past an optimal age for health, which may lead to a predisposition to CLYD. A lack of succession planning in plantations is common to most plantation crops of palm (oil and coconut), coffee, and cocoa globally in areas where planting predominated in the early to mid-20th century and during the colonial era. Second is the presence of the Rhinoceros beetle and the impact this pest has had on the palm leaf canopy and in causing palm death. This pest is a compounding factor for CLYD because the dead palm trunks that result from CLYD provide ideal habitat for the beetle larvae. Observations show that over the period of CLYD increase, Rhinoceros beetle populations have likewise increased. This suggests that the increase in CLYD-dead palms has led to an increase in the Rhinoceros beetle populations, which in turn has led to canopy degeneration and palm deaths. Under FISP, the burning of felled palms seems to have been weakly implemented; in the majority of cases, felled palms were simply cut into a few shorter lengths and stacked. Differentiating between and attributing CLYD death and Rhinoceros beetle damage is not straightforward. It calls into question the feasibility of controlling CLYD by felling when the disease has been identified only through visual means, which may mean that trees without CLYD are also felled.

Outcomes of PRA on evaluation design and conclusions reached. While the PRA is not complete, the process of scientific review has already markedly shaped the evaluation design and uncovered caveats for uncertainty in outcomes reached. Most notable is the realization that CLYD prevalence is geographically biased, as evidenced by higher prevalence toward the coast and the recognition of a phytosanitary barrier. The concept of differences in pressure or predisposition to CLYD that maps to epidemic and non-epidemic areas makes direct comparison problematic. The evaluation design has taken this into account by focusing on treatment and non-treatment areas as proximate to the phytosanitary barrier as possible to ensure near-equivalence in CLYD pressure. How the outcomes of these analyses are extrapolated to areas with increasing distance from the phytosanitary barrier (i.e., assumed non-equivalence in CYLD pressure) will be likely to either over- or under-estimate CLYD effects.

The PRA will also inform the future vision for CLYD and felling and for coconut production, and thereof the economic and environmental outcomes. While FISP talks of planting back resistant coconut types, there is limited evidence to support the claim, and the probable outcome will be that the replanted palms will be exposed to the causal agent of CLYD at a young age and succumb to CLYD well before an age that was typical before CLYD was endemic. The PRA is thus likely to conclude that the historical life expectancy of coconut palm stands of 50 to more than 80 years years are unlikely in the future without an intervention.

Assessing the extent to which the intervention of felling checks the spread of CLYD and prolongs the life expectancy is a primary aim of the evaluation. In this regard an improved understanding of the dynamics of asymptomatic infection, disease onset, and the concept of an infectious period are critical. It is for this reason the activity to gain a better knowledge on CLYD infection and disease has been set out in Box 1. The specifics of such a modeled outcome would require critical knowledge of environment and CLYD spread, and its disease vectors; however, some highly theorized modeled outcomes could be considered under a separate initiative. Not least models serve to focus prioritization on address of knowledge gaps and the opportunities to influence outcomes.

Qualitative Approach

Qualitative analysis to support the impact evaluation of disease prevalence and spread will employ the same methodology as described above for income and gender impacts. In this case, the qualitative analysis will primarily support research questions 4 and 6, and to lesser degree questions 5, 7, and 9, by collecting information on farmers' perceptions of the impact FISP had on disease prevalence and disease spread rate. Our visits to the field have confirmed that farmers have an intimate knowledge of how the disease has affected their trees over the last several years. Given that coconuts have been the main livelihood for most farmers in this region, it is reasonable for them to have such detailed accounts of tree deaths. Therefore, we can expect the information collected through focus group discussions to be accurate and to span the lifetime of FISP.

For the qualitative analysis on income and gender, we have developed survey instruments for focus group discussion (see Appendix), which will be conducted in the same four groups as above (in both endemic and epidemic zones):

- Female heads of households who live in treatment areas
- Male heads of households who live in treatment areas
- Female heads of households who do not live in treatment areas
- Male heads of households who do not live in treatment areas

We will continue to separate groups by gender in order to detect any differential impacts of the disease mitigation activities realized across gender and assess impacts on intra-household allocation of labor, which will add to and strengthen our analysis of research question 11. In addition, we expect the focus groups to generate responses to the following questions:

- What are farmers' perceptions of the culling and burning activities?
- How closely did farmers follow the culling methodologies promoted by FISP?
- How do farmers perceive the change (or lack thereof) in the spread of CLYD before, during, and after FISP?

- What changes in the market for coconuts have occurred before, during, and after FISP (e.g., in coconut supply, demand for coconut and its byproducts, demand for coconut wood)?
- How have KAPs related to CLYD evolved over the lifespan of FISP?
- How sustainable is the cutting and burning technique now that FISP has ended?

We will combine the results of the focus group discussions with the data collected by the biophysical survey and the results of the case study using satellite imagery. This will provide both qualitative and quantitative evidence on how the impacts of the project's disease mitigation effects were realized and perceived by farmers. The results will also allow us to comment on the sustainability of FISP and its potential for being scaled up in the future.

Business Development Fund Activities

The BDF provided 119 grants (a total of $1 million) to SMEs. The purpose of these grants was to improve the coconut and intercropping value chains in northern Mozambique and to add value to primary products. The activity used innovative approaches based on market analysis. BDF activities took place in eight project districts: Angoche, Chinde, Inhassunge, Maganja da Costa, Moma, Namacurra, Nicoadala, and Pebane in Zambézia and Nampula provinces (MCA-M 2013).

To facilitate the assessment of BDF activities, ACDI/VOCA provided monitoring and evaluation (M&E) data for activities funded by the BDF. The Abt team will first review these data and assess the impacts of the 119 grants at the project level. We will consider who received the grants, whether women or men participated, and whether the funded activities were successful in providing financial returns.

While we will rely as much as possible on information from ACDI/VOCA (e.g., using any available sales and financial statements to assess enterprises' success) and other existing sources, we will also conduct independent case studies of a subset of the enterprises supported by the BDF. The evaluation will conduct case studies of approximately 15 beneficiary firms and will seek data on increase in entrepreneurial incomes but will look for other outcome indicators such as knowledge about business development, employment, sales, and expectations.

In order to select the grants for in-depth case studies, we will do the following:

- ***Determine categories of enterprises.*** After collaborating with the project implementers, we have determined the most appropriate set of categories for the different types of enterprises funded by the BDF (see Table 4-3):
    1) Agriculture and Fisheries
    2) Wood Products
    3) Other Value Chains

Table 4-3: Categories of Enterprises Supported by the Business Development Fund

Category 1: Agriculture and Fisheries	
1.1	Agricultural inputs shops
1.2	Agriculture
1.3	Artisanal fisheries
1.4	Fishing kits
1.5	Oxen driven carts + two oxen

1.6	Sea transport
1.7	Coconut seeds
Category 2: Wood Products	
2.1	Carpentry and sawmills
2.2	Charcoal
2.3	Manual sawmill equipment
2.4	Naval carpentry
Category 3: Promote utilization of coconut timber or high-value timber	
3.1	Agricultural machinery
3.2	Input shops
3.3	Milling
3.4	Groundnut processing
3.5	Warehousing/storage

- ***Select enterprises.*** We will sample of 15-20 projects weighted by the amount invested, ensuring that projects are chosen from each category (1, 2, and 3) and between localities within epidemic and endemic zones.
- ***Conduct assessments of the selected enterprises.*** The goal of the assessments will be to determine the success of the enterprises and to examine the impacts of other parameters (e.g., job creation and enterprises). We will consult with the survey firm to finalize the data collection method (e.g., interviews supplemented by as much financial information as the interviewees can make available) and determine the key data elements to target during the conversations. Subsequently, the Abt evaluation team will develop any survey instruments with inputs from the survey firm. Ultimately, the case studies will inform the overall impacts of BDF activities on the aggregate income of beneficiaries. A draft of the questions to be addressed to BDF interviewees is attached in Annex 1.

Research and Development Activities

Activity 5 of FISP addressed research and development. It aimed to develop the understanding of CLYD in order to improve control. This area was contracted to the *Instituto de Investigação Agrária de Moçambique* and led by Dr. Marcos Freire. The outline for the R&D activity was set out under the IIAM Research Action Plan (IIAM 2009.)

The research initiative had two mechanisms of implementation: (1) a Research and Development Fund (RDF: $880,000) focused on coconut palms and the control of CLYD and (2) a Competitive Grants Fund (CGF: $220,000) that was intended to be more flexible and that targeted extension and information to farmers on coconut and companion crops within coconut-based systems. While funding from the RDF was restricted to IIAM and other named partners, the CGF was open to all (maximum funds available per project were $40,000).

A Research Action Plan was established to lay the foundation for a **National Coconut Research Program**. The intention of this plan was to promote the sustainability of FISP by guaranteeing that support to coconut research would carry on after the project's completion in late 2013. This is especially important for the Variety Screening Plots and the Seed Production Plots (IIAM 2009).

The RDF had three sub-components:

- Sub-component A: Maintain and augment screening for resistance to CLYD
- Sub-component B: Develop, test, and utilize practical techniques for early detection and diagnosis

- Sub-component C: Epidemiological analyses of large-scale control operations

The Research Action Plan identifies a loose prioritization for the CRF, and provides information on the process of project selection. Overall, the Research Action Plan was written with clear intentions and high expectations.

Methodology and Data Sources

The Abt team had initial face-to-face discussions have been held with Dr. Marcos Freire (IIAM; lead for the R&D activity) on two occasions. This helped substantiate the differences between the Research Action Plan's actual activities and its anticipated activities. In summary:

RDF: Sub-component A was implemented by IIAM, and B and C were subcontracted, with CIRAD as the lead. We have obtained yearly reports and a final report (all in English) for sub-components B and C, and a near-complete final draft for sub-component A. It is not clear whether annual reports may be available for sub-component A. Dr. Freire said that no conference abstracts or grey or peer-reviewed scientific publications have arisen from any of these sub-components.

We will review all reports obtained to date and critique them based on the principle of scientific peer review. When required, we will contact the primary authors to verify any ambiguities, question whether any additional reports should be considered, and ascertain the level of capacity building and legacy the research enabled. We will also seek confirmation that no peer-reviewed or conference proceedings have arisen from the work. We will conduct a database review of publications to further substantiate the absence of peer-reviewed publications directly emanating from or associated with this funded research.

CRF: From the budget, it is apparent that five $40,000 proposals were funded. To date, no specific information has been obtained as to what was funded or reported on under the CRF. However, discussions with IIAM identified various farmer dissemination materials that were supported by FISP under the research budget and appear to be separate from the RDF activities. We will follow up with MCA-M and IIAM to determine whether these are the outputs of the CRF and whether other activities were funded under the CRF. Assuming, as seems likely, that these are the outputs of the CRF, it is evident that these materials are not "research," but rather extension materials. We will, therefore, give them only a light assessment.

Our analysis of all R&D activities conducted under FISP will rely on a combination of scientific peer review and a qualitative assessment of the research undertaken. We will consider the following criteria:

- Scope of research included and not included within the research plan
- Realism of expectations given timeframe; resources and complexity of the research addressed
- Review of the scientific rigor of the approach, evidence of learning, and adaptation of research aims
- Assessment of outputs and outcomes
- Appropriateness of partnership, including international consultants, and engagement with national partners
- Sense of legacy/sustainability

The results of this analysis will show the quality of research actually undertaken, the research's effectiveness in contributing to FISP field operations, and how sustainable the research can be in post-FISP Mozambique. Dr. Julian Smith will engage his colleagues at the Food & Environment Research Agency (FERA) to conduct the peer review element of the evaluation of FISP research. He will rely on project documentation provided by MCA-M and Dr. Marcos Freire to assess the remaining points. The review will not provide a cost-benefit analysis or a value for money assessment.

4.2 Study Sample—Impact of FISP on Farmer Incomes

4.2.1 Study Sample and Sample Selection

The study area for the income impact estimates is described in Section 0 above. To draw the sample, we will first select households within villages *(nomes)* from enumeration areas that were subject to the FISP intervention. To ensure that the study is representative of all five districts, we will randomly select EAs in the treatment area of all five districts *in proportion to the total fraction of EAs that are from each district*. For each selected EA that was a part of FISP, we will select a "matched" EA from our larger, pre-selected counterfactual areas that "matches" its paired treatment area in the following respects:

- Same district
- Roughly the same baseline CLYD prevalence in 2008
- Roughly the same density of coconut trees
- Coconuts mostly cultivated by small-scale farmers

No counterfactual EA will be "matched" with more than one treatment EA. Within each of the selected EAs, we will select farmers using either a roster or field-based sampling. The sample will be stratified by district, but we will not be oversampling in any of the districts, so stratification weights are not necessary for the data analysis.

The Abt team has released an RFP for the household and qualitative surveys. The terms of reference request the firm to have a procedure for dealing with survey non-response. We expect the firm to field the survey with approximately a 90 percent response rate and will require that their data collection procedures ensure a minimum of 90 percent. During the bidder's conference, this topic was discussed, and all firms agreed a 90 percent response rate is achievable. Moreover, within each of the selected EAs, we will randomly list the names of farmers we expect to obtain from the National Institute of Statistics *(Instituto Nacional de Estatística,* INE), and instruct the survey firm to interview farmers in the order listed, continuing down the list until the desired number of completed surveys from each enumeration area is achieved. If the roster is not available, we will use field-based sampling, and instruct survey firms to continue the field sampling until the desired sample is achieved.[14] This process will be managed and overseen by Servicos ELIM and the Abt team. Both will participate in the enumerator trainings and the instrument pre-test, in order to ensure data will be collected as intended. ELIM will be responsible for monitoring the data collection, conducting back checks on the surveys and reporting any quality issues to the Abt team.

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14 Field-based sampling design will be finalized in coordination with the survey firm. It essentially involves starting from a central point in the village and selecting the *n*th household.

4.2.2 Power Analysis

We will survey households within *nomes* in the enumeration areas to gather data on demographics, income, farming activities, level of participation in FISP and extension services, and knowledge of CLYD. Based on the power analysis presented in this section, we expect to hold interviews in approximately 108 EAs for the evaluation of activities in the endemic zones and 130 EAs for the evaluation of activities in the epidemic zones. The final estimates may be slightly different, based on the survey firm's relative costs for interviewing in more EAs, versus interviewing more households within the same EA. In each EA, we will attempt to interview six or seven households, expecting a response rate of 90 percent based on our prior experience in similar areas.

We have conducted a power analysis to show how these sample sizes for attempted interviews—and the resulting anticipated 1,382 *completed* interviews (in expectation of a 90-percent response rate)—will affect our ability to detect impacts of the intervention on the treatment group as compared to the comparison group. We adopt the typical rules of thumb for impact analysis hypothesis testing: design a sample with an 80-percent chance of detecting a statistically significant impact if there is a true non-zero impact, and a 10-percent chance of accidentally obtaining a statistically significant result where there is no true impact. Although it is more typical to admit only a 5-percent chance of falsely claiming a statistically significant result, we have increased this threshold to 10 percent because no baseline data are available, income has a high variance, and resources to survey farmers are limited. In addition, FISP is a pilot intervention rather than a full-scale implementation, and thus a less conservative approach has a lower risk of rejecting true impacts that may be difficult to detect with the available design and sample size. The power analysis accounts for the fact that we will be using cluster-robust standard errors (discussed later). The cluster-robust standard errors take into account the fact that survey responses may not be truly independent measures (geographically close farmers share the same markets, social networks, soil types, random adverse events, and other localized factors).

Several kinds of impacts are of interest: total income, income from off-farm activities, and income from on-farm activities. Table 4-4 shows the minimum detectable impacts, or MDIs, associated with the planned number and allocation of survey interview attempts, as described above. The approach to calculating MDIs for the epidemic and endemic studies is identical, because although the comparison group was identified differently in each study, the analysis method in both cases is ordinary least squares regression with random EA effects. The suggested number of survey attempts and the associated MDIs differ for the epidemic and endemic studies because these studies involved different numbers of EAs (161 endemic with 107 of those in "treatment"; 158 epidemic with 93 of those in "treatment").

Table 4-4: Minimum Detectable Impacts for the Chosen Design, by Population Segment and Outcome Measure

Population Segment	Outcome Measure			
	MDI for Total Household Income	MDI for Off-Farm Household Income	MDI for On-Farm Household Income	Total Interviewed
Endemic Study				
108 enumeration areas; 7 households in each enumeration area	2,423	1,452	2,234	756
Epidemic Study				
130 enumeration areas; 6 households in each enumeration area	3,857	1,997	2,803	780
Total Study				**1,536**

Table 4-5 and Table 4-6 show minimum detectable impacts on income for the endemic and epidemic studies, respectively, by displaying possible survey plans in terms of the three key choices:

- The number of EAs in the treatment area in which surveys are attempted
- The number of EAs in the comparison area in which surveys are attempted
- The average number of household interview attempts in each EA.

Table 4-5: Minimum Detectable Impacts for Income under Alternative Designs, Endemic Areas

	# EAs, Treatment	# EAs, Comparison	# Households per EA	# EAs, Total	Total Interviews Attempted	MDI: Total Income (MZN)	MDI: Off-Farm Income (MZN)	MDI: On-Farm Income (MZN)
(A)	30	30	10	60	600	2,964	1,777	2,658
(B)	30	30	12	60	720	2,845	1,706	2,513
(C)	40	40	8	80	640	2,714	1,627	2,478
(D)	40	40	9	80	720	2,634	1,579	2,381
(E)	45	45	7	90	630	2,654	1,591	2,448
(F)	45	45	8	90	720	2,559	1,534	2,336
(G)	54	54	7	108	756	2,423	1,452	2,234
(H)	54	54	8	108	864	2,336	1,401	2,132
(I)	75	54	5	129	645	2,486	1,490	2,349
(J)	75	54	6	129	774	2,349	1,408	2,192
(K)	107	54	4	161	644	2,504	1,501	2,401
(L)	107	54	5	161	805	2,325	1,394	2,197

Table 4-6: Minimum Detectable Impacts for Income under Alternative Designs, Epidemic Areas

	# EAs, Treatment	# EAs, Comparison	# Households per EA	# EAs, Total	Total Interviews Attempted	MDI: Total Income (MZN)	MDI: Off-Farm Income (MZN)	MDI: On-Farm Income (MZN)
(A)	40	40	8	80	640	4,535	2,348	3,224
(B)	40	40	10	80	800	4,289	2,221	2,995
(C)	50	50	7	100	700	4,206	2,178	3,021
(D)	50	50	8	100	800	4,056	2,100	2,884
(E)	55	55	6	110	660	4,193	2,171	3,047
(F)	55	55	7	110	770	4,010	2,077	2,881
(G)	65	65	5	130	650	4,081	2,114	3,004
(H)	65	65	6	130	780	3,857	1,997	2,803
(I)	93	65	4	158	632	4,467	2,313	3,336
(J)	93	65	5	158	790	3,762	1,948	2,769

Total sample size ranges from 1,240 to 1,664 total interview attempts across the two scenarios in Table 4-5 and Table 4-6. As can be seen by comparing rows (E) and (H) in Table 4-6, for example, the number of enumeration areas makes more difference to MDI magnitudes than the number of farmers. However, we have budgeted for a total of roughly 1,500 interviews, so the number of households we can attempt to interview per EA decreases as the number of EAs increases. (Note however that based on the assessment of equivalent baseline disease prevalence, and valid comparison areas, we are limited by the total number of EAs available to sample from in both zones). The final survey plan will thus be based on the cost estimates we obtain from the survey firms. We anticipate an MDI for total income of roughly 2,234 MZN ($73) in the endemic study and 2,803 MZN ($92) in the epidemic study.

The factors that have the greatest impact on the MDIs are the variation in income and the fact that income measures of households in the same EA are correlated; thus a correction factor must be included to account for the lack of independence across correlated outcome measures. As noted above, we are limited by the number of available EAs to sample from and cannot increase the sample size to lower the MDIs. Given this limitation, the key question is whether the available sample size implies reasonable MDIs. There are two perspectives on this assessment. One is how much impact the project expects to have, and whether we are powered to detect those impacts, and second is what magnitude of impact is worth detecting from a development impact perspective. If we consider the impacts expected from MCC’s project closeout ERR, in the epidemic regions the expected impact is $102, and in endemic it is as low as $8. From the development impact perspective, Table 4-7 reports the median incomes as measured in the Verde Azul Report (Verde Azul Consult 2013) and reports the MDI as a percentage of this median. Table 4-7 also reports the median income and the MDI as a fraction of the international poverty line, which is currently $1.25/day (USD) or 64,900 MZN. Overall, the MDIs for the two zones are a very small fraction of the international poverty line meaning that if we find that the program had impact at this level, it will imply an improvement that is only a small fraction of the international poverty line.

From both perspectives, given that we are limited by our sample size and that the ERRs estimates are based on several assumptions, our effects sizes within reasonable range of the expected impacts for the epidemic region (MDI of $92 compared to expected impact of $102). In the endemic region, the expected income impact is very small and we believe it is not worth powering the evaluation to detect impacts as small as $8 per household in annual incomes. Instead we argue that measuring impacts that can detect an impact which is only 4.6% of the international poverty line or 17% of their current incomes is appropriate (which is similar in percentage terms to the impact expected in the epidemic regions).

Table 4-7: Minimum Detectable Impacts in Perspective

	Endemic Regions	Epidemic Regions
Average household income[1]	10,487 MZN	17,521 MZN
Average household income as percentage of estimated household international poverty line[2]	16.1%	27%
Expected impact based on MCC's ERR	57 MZN	3298 MZN
MDI	~2234 MZN	~2803MZN
MDI as percentage of estimated household international poverty line	3.4%	4.3%
MDI as fraction of average household income	22.9%	17.1%

[1] The estimates of average household income are derived from Verde Azul Consult (2013). For the endemic study, the estimates we use are a weighted average of the farmers with 10-50 percent and 50-100 percent CLYD prevalence, as the latter group only contains 34 observations. For the epidemic study, we use a weighted average of farmers with 0-100 percent CLYD prevalence.

[2] If we assume an average of 5 people per household, then the annual income for a family living at the international poverty line is $2,031.25 a year. Translated into Mozambican meticales, this is approximately 2031.25*(32)=65,000 a year. Mozambique's gross national income per capita is $510 or roughly 16,320 meticales.

The results of the power analysis rely on multiple assumptions. The first set of assumptions required for the power analysis is the expected standard deviation in the outcome variables examined. We use the reported income standard deviations in Verde Azul Consult (2013), which aims to report on the effect of CLYD on small-scale farmers' income and other outcomes. We also compared the Verde Azul estimates with estimates calculated using the TIA data. We calculated the total, off-farm, and on-farm income of all TIA samples from Zambezi in the year 2008. These measures are composite measures of various income variables, including agricultural/horticultural production, off-farm income, and remittances. These measures closely mimic the survey we are drafting, in which we will ask about the same basic indicators, with a particular emphasis on coconut and high-value crop (pigeon pea, groundnut, sesame, and cowpea) production and sales. The TIA standard deviation of off-farm income is 9,341 MZN; this estimate matches the Verde Azul estimated standard deviation. We use the Verde Azul estimates because the TIA data include only 19 observations of on-farm income.

The power calculation uses residual variance, i.e. it accounts for the reduction in variance due to the inclusion of covariates. Many data elements in the survey will not be suitable covariates, as they are likely determined simultaneously with the outcome variable so as to avoid bias in estimating the impact of the intervention. For example, if the impact of CLYD or the intervention on CLYD causes a farmer to plant certain crops or seek certain types of livelihoods, then including non-coconut farming activities and other livelihood-descriptive covariates in the regression will cause a downward bias on the impact estimate of the intervention. R-squared estimates are much higher for predictive models because there is no concern about admitting covariates that are determined simultaneously with income (for example, Benin and Randriamamonjy 2008). For the regression analysis, we intend to include covariates that describe past (but not current) farming activity, land type, demographic and education variables. In U.S. domestic economic research, an R-squared of 0.1 for income is a conservative rule-of-thumb, and a reduction to .07 is appropriate given the lack of panel (longitudinal) data (for example, Duggan and Kearney 2007). If our estimates are conservative and the r-squared turns out to be 0.2, then the MDIs decrease by roughly 7.3 percent; if the R-squared turns out to be 0.3, then the MDIs decrease by roughly 13.2 percent.

Because no baseline data are available, we will estimate a regression for income with covariates that include only demographic characteristics that are likely not affected by the intervention. These include age, religion, household composition, lot size, distance from market/major road, and material/construction of the farmer's house. In our experience, these covariates are marginally helpful; we expect an r-squared of about 0.07; i.e., that the covariates alone (before the introduction of the treatment indicator) will explain 7 percent of the variation in the outcome variable.

The next set of assumptions for the power analysis concerns the structure of the "clustered" outcomes. We assume that 11 percent of the overall variability in outcomes across households occurs between enumeration areas—that this is the result of differences in *average outcomes between EAs*. (The use of cluster-robust standard errors will not impose a clustering structure, but the EA intra-cluster correlation coefficient helps to estimate the "size" of the clustering effect we might expect.) We estimated this parameter using the TIA data. To conclude this section, we estimate that we will be able to detect the anticipated impacts by attempting survey interviews with 756 total farmers for the endemic study and 780 total farmers for the epidemic study.

4.3 Study Sample—Impact of FISP on Disease Prevalence and Disease Spread Rate

4.3.1 Study Sample and Sample Selection

As noted above, we will focus our disease impact analysis only in the epidemic zones. We will conduct a full impact analysis to assess the impact of FISP on disease prevalence. Our study sample for the impact analysis on disease prevalence draws from the same treatment and comparison areas as that for the income analysis in the epidemic zones—the areas on either side of the phytosanitary barrier. The unit of analysis for the income impact is the people living within EAs, based on the population of people who live in those areas. This unit of analysis is reasonable for assessing income impacts, since it is based on a sample designed to be representative among people, and since it accounts for how people interact and share characteristics.

However, this unit of analysis may not be ideal for measuring impact on trees, because trees relate to each other biologically, and to some extent are affected by how they are handled by humans. The latter factor can affect their health. To the degree that people within a community treat trees in similar ways, it is reasonable to use the same unit of analysis as for income to study trees. However, trees are also affected by their biological relationship to other trees, climate, and other factors.

To study FISP's impact on CLYD, and to determine the ideal unit of analysis, an understanding of *how* the disease spreads across trees (the disease vectors) is needed. Unfortunately, little is known about the progression of CLYD among trees and about the possible disease vector; hence, it is difficult to know what the ideal unit of analysis should be. It is conceivable that "tree clusters"—trees separated by physical barriers such as land without trees or water bodies—might be a reasonable way to delineate units of analysis. Even if this approach had sufficient scientific basis, it would require a full listing of all clusters that exist in the FISP area— a task that is infeasible given the labor effort required.

Without a good scientific basis for using tree cluster as the unit of analysis, and knowing that trees within villages will be related at least in how they are cared for, we consider it more reasonable to use the same unit of analysis that we use for the income impact. Instead of using EAs, however, we use a level higher assuming that trees are connected to each other over larger areas.[15] Therefore, we use villages *(nomes)* as our units of analysis, and propose to sample one-hectare square grids from the villages. We will conduct this analysis in a sub-sample that is selected for the income analysis and the strategy therein to select matching treatment and comparison groups. Within each selected village, we will enumerate one-hectare square grids that have a specified minimum density of coconut trees (using baseline aerial photography), and we will randomly select the required number of grids from this list of sample-eligible grids.

Since our samples are grids of land that we will biophysically measure for disease prevalence, we do not anticipate significant concerns about "absence." However, it is feasible that landowners will not give permission to survey their land, or that there will be difficulty in reaching the land grid. In this case, we will select another replacement sample from the grid.

4.3.2 Power Analysis

The average baseline disease prevalence in the surveyed treatment and comparison epidemic areas is 5.9 percent. Table 4-8 depicts the deciles of the prevalence rate (percentage of coconut trees with observed CLYD) in the treatment and comparison EAs in 2008, illustrating that there is close overlap in terms of CLYD between the treatment and comparison group.

Table 4-8: CLYD Disease Prevalence in Treatment and Comparison Areas (2008), Epidemic

	Disease Prevalence in Comparison Area	Disease Prevalence in Treatment Area
Minimum	0.00 %	0.00 %
10th percentile	0.00 %	0.00 %
30th percentile	0.15 %	0.44 %
50th percentile	1.20 %	0.93 %
70th percentile	3.03 %	2.45 %
90th percentile	6.32 %	15.02 %
Maximum	16.64 %	28.26 %
Mean	2.42 %	3.55 %

[15] We used the 2008 TIA data to estimate the intra-cluster correlation (ICC) coefficients for CLYD prevalence at various levels, and found that the ICC was higher for *nomes* than for enumeration areas.

	Disease Prevalence in Comparison Area	Disease Prevalence in Treatment Area
Standard Deviation	3.26 %	6.25 %

Source: TTI Production (2009)

These percentages are small, implying that it could be challenging to obtain sufficient measurements to detect a significant change in disease prevalence with an 80 percent chance of detecting a statistically significant impact if there is a true non-zero impact, and a 10-percent chance of accidentally obtaining a statistically significant result if there is no true impact. However, it is important to note that FISP began two years after these data were collected, so the disease prevalence is likely to have increased. We analyzed the FISP monitoring data on disease prevalence in epidemic zones beginning in 2010 and collected at six-month intervals using biophysical measurement. To assess the extent of the impact we might see, we calculated the disease rate with and without the diseased trees that were cut by FISP. This estimates the disease prevalence reduction that is guaranteed by the fact that the trees are cut; in other words, the minimum impact expected if we know the number of trees that were cut. The monitoring data suggest that at the end of the year, the *difference* in disease prevalence with and without FISP (if the trees were not cut) ranged from 10.5 percent in Nicoadala district to 25.9 percent in Namcurra district, with an average reduction of 19.2 percent (see Figure 4-7). This gives us more confidence that the impact on disease prevalence may not be that small.

Figure 4-7: Disease Prevalence—with FISP and without FISP, Assuming no Cutting of Trees

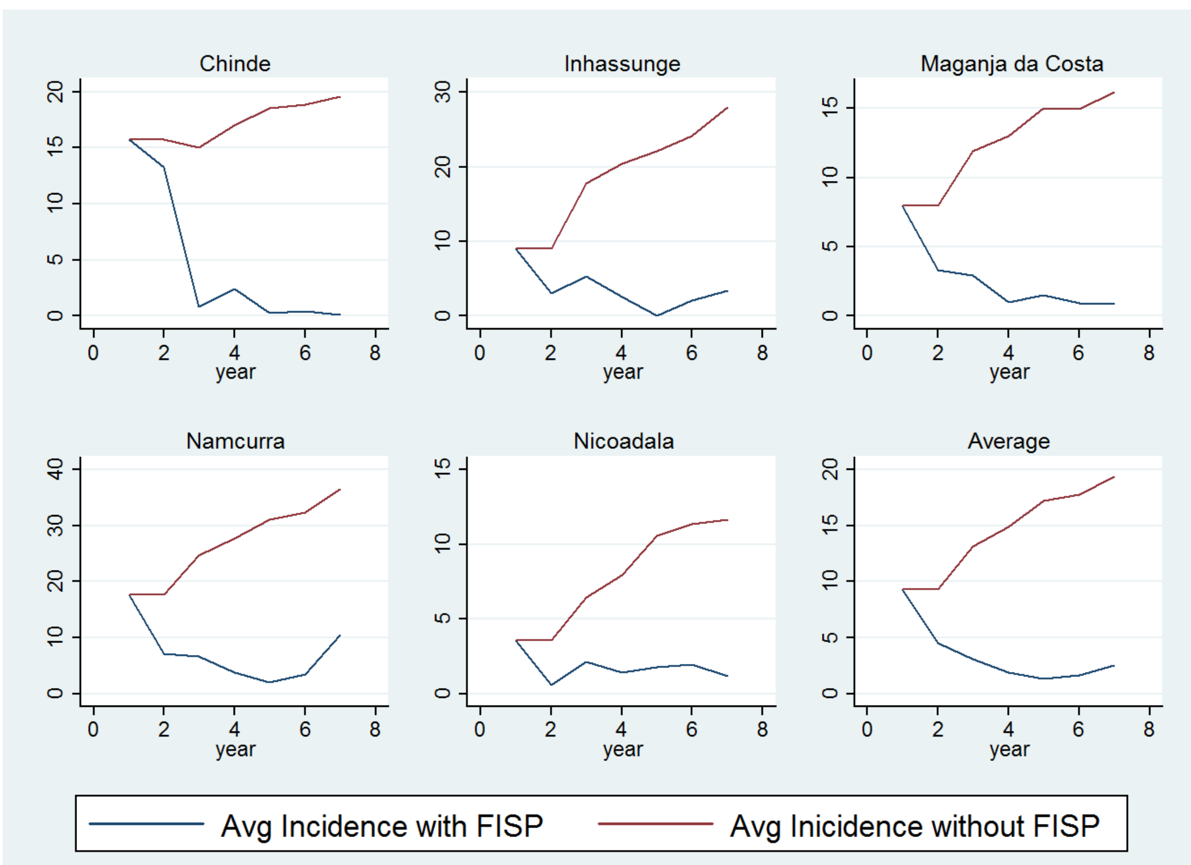


Table 4-9 displays the MDIs for a analysis across treatment and counterfactual areas. We propose to conduct biophysical measurement of the disease in 800 to 1,600 units, equally divided across treatment and comparison areas. For efficiency, we will conduct this analysis in a sub-sample of the study sample for the income analysis. The final decision on the total number of observations will depend on the cost of survey and the amount we need to have available for the case study to assess the impact of FISP on disease spread rate. The intervention would have to have an average impact between 15.1 and 15.3 percent in the epidemic region in order to have an 80-percent chance of being detected in our analysis. The monitoring data suggest that the lack of any tree-cutting activity can result in an impact of more than 19 percent; thus, the MDI seems appropriate. If we see an impact well above 19 percent, it will be evidence of FISP's impact in curtailing the disease spread rate.

The results of the power analysis rely on assumptions about the expected standard deviation in disease prevalence, and the correlation between clusters. We used the 2008 TTI data to estimate the standard deviation in disease prevalence within a *nome.* The estimates are based on the assumption that no regression analysis will be done (R-square is zero). For intra-cluster correlation, we assume that 25 percent of the overall variability in disease prevalence can be explained by clustering. We estimated this parameter using the baseline prevalence from the 2008 TTI data. In summary, we will be able to detect the anticipated impacts by conducting biophysical surveys in 800 to 1,600 grids, covering between 80 and 160 EAs within the income impact sample.

Table 4-9: Minimum Detectable Impacts for Disease Prevalence, Epidemic Study

	# Nomes, Total	# EA per Nome EA	# Analysis Units per Nome	Total Analysis Units	MDI: Disease Prevalence
(A)	12	1	20	240	18.3%
(B)	12	5	10	600	17.6%
(C)	12	7	20	1,680	17.3%
(D)	12	10	10	1,200	17.4%
(E)	16	1	20	320	15.9%
(F)	16	5	10	800	15.3%
(G)	16	7	20	2,240	15.0%
(H)	16	10	10	1,600	15.1%

4.4 Timeframe

The evaluation is being conducted after project implementation is completed and therefore relies on data to be collected ex-post. At this point in the evaluation timeframe, we anticipate finalizing our evaluation design, then quickly moving into the implementation of the data collection. The data collection will begin with a pre-test of our survey instruments and methodologies before going into the field. Below we give a brief explanation of the three main next steps of this evaluation.

4.4.1 Finalizing Evaluation Design

The Abt team anticipates MCC approval of our evaluation design during the month of June, after which the Abt team will proceed with subcontracting a survey firm(s) to implement the qualitative and quantitative data collection. We have issued an RFP, have received and reviewed proposals, and are now finalizing our selection in order to be prepared to issue a subcontract upon MCC approval of our design.

4.4.2 Pretest

Before implementing the qualitative and quantitative surveys, we will work closely with the hired survey firm(s) to pretest our instruments and methodologies. For the quantitative survey, we will pretest the instrument on approximately 20 rural households and incorporate the testing into enumerator training. This way, enumerators are able to practice interviews before going to the field and the Abt team will receive feedback from the enumerators (and their supervisors) regarding which questions were hard for households to understand, and if any other changes are needed in order to ensure high-quality (and consistent) data collection. The qualitative survey instruments will undergo a similar testing process, and the contracted survey firm will facilitate both the testing and the feedback/changes needed for each instrument.

The pretesting phase for the biophysical survey will be crucial in validating the accuracy of our approach. We will strategically select areas to send counting teams to conduct "pretest counts" that coincide with pre-selected satellite data in order for our team to understand how much variation exists between manually counting and visual identification from satellite images. The variation between the two approaches will both inform the accuracy of our biophysical survey and also provide an understanding of how the relative accuracies of manual counting, satellite imagery, and aerial photography compare. As discussed in Box 1, we will also conduct a test to assess the efficacy of visual identification methods used in a biophysical survey by comparing 60 visual-CLYD trees, and 140 visually healthy trees with results from laboratory tests. This assessment will provide evidence on the efficacy of the project's primary method of identifying CLYD-affected palms for cutting. In addition, it will also inform our approach of using the biophysical survey as a means to assess CLYD prevalence, and our adjustment of findings from the biophysical survey based on the measurement error we find from this analysis.

4.4.3 Survey Implementation

We expect the survey work to be conducted throughout July 2014. The initial survey dates were originally anticipated to be much earlier, but we determined through fieldwork that June was the earliest and most appropriate time to survey, due to harvest seasons and the rainy season (many study areas are completely inaccessible during the rainy season). The evaluation is ex-post and is requested by MCC at this time. There would have been some advantages of conducting an evaluation later, to assess whether FISP had any long-term impact on disease prevalence or simply delayed the onset of disease. However, there is an advantage of conducting the evaluation at the heels of FISP completion so we can assess the impact of FISP on interim outcomes, and understand the pathways through which FISP worked or did not work.

5. Data Sources and Outcome Definitions

The evaluation will use data from several different sources, each requiring a different data collection methodology. The proposed methodologies for obtaining the data to answer each of the research questions are noted in Table 4-1 in Section 4.1. These methodologies include a household survey, biophysical survey, case studies, and technical reviews. The research questions fall broadly into two categories: (1) those on the impact of the project on farmer welfare (i.e., incomes), for which we will primarily use a quasi-experimental approach requiring a household survey; and (2) those addressing the impact of the project on disease spread, which will be primarily addressed using satellite imagery. Several research questions are answered by combining data from these different sources, and are referred to as derived metrics.

We reviewed several existing data sources before deciding on the specific data sources to use for the evaluation, and determining the new data that we need to collect. Table 5-1 presents all the existing data we reviewed: what they contain, what limitations or opportunities they have, and how we intend to use (or not use) the data. It also describes the new data that we intend to collect. In the subsequent sub-sections below, we present our data sources and data collection methods in more detail.

Table 5-1: Data Sources for Evaluation

Source	Description	Advantages	Limitations	Use for evaluation
Existing Data				
Satellite Imagery	Historical satellite data	Is the only feasible way to obtain data on disease prevalence over time to establish the disease spread rate, which is an important metric for the ERR and forecasting of future coconut production.	A time series is only available for 2 treatment and 2 comparison enumeration areas due to lack of image availability across whole study area over the desired time period. Cannot accurately distinguish between diseased and healthy palms; it can only give a relative measure of canopy cover (i.e., a proxy of healthy trees). However, the accuracy of other methods to identify diseased or healthy palms is also not fully established.	Will be the primary data source for a case study on estimating the disease spread rate. Will also be used to measure the relative accuracy of the aerial photography and establish a sensitivity measure between aerial photography and satellite imagery, and the biophysical survey and satellite imagery.
Aerial Photography	Collected in 2008 by French company, TTI Production	Provides pre-FISP disease prevalence and was the basis on which FISP decided where to implement different activities. For this reason, it is used to identify treatment and comparison areas on either side of the phytosanitary barrier with similar baseline prevalence.	Was taken 2 years before FISP began implementation and therefore cannot be compared to the first biophysical-based disease inventory conducted by FISP. Cannot be replicated at endline due to cost.	Will function as our baseline of disease prevalence for the disease impact evaluation and to identify matching treatment and comparison areas.
Project Monitoring Data	Also known as "disease inventories"; collected every 6 months beginning in March 2010 and ending in January 2013	Provides biannual indicators on number of trees cut and arithmetical disease prevalence based on initial tree inventory minus the number of trees cut. Also frames the expectation of the impact on disease prevalence by providing the mathematical disease prevalence after all cutting.	Seems to have some data entry/collection inconsistencies across years. Assumes disease identification was accurate and does not track non-FISP areas (which is needed to establish impact.)	Will be used to compare the results from impact evaluation on disease prevalence.
Reports and Documenta-	Reports were developed on a quarterly basis	Allows the Abt team to establish a timeline of events	Will not contribute to our ability to measure impact and has various	Will provide the timeline of events and lay the foundation for the process evaluation

Source	Description	Advantages	Limitations	Use for evaluation
tion	throughout the project. The main documents are quarterly and annual reports, but also include documentation on BDFs, R&D, and timeline of project.	during FISP and gives insight into program logic, how it changed over time, and citations for our assumptions.	missing reports. The project documents collected were very disorganized and difficult to inventory.	of FISP.
TIA data	Last collected in 2012, but only 2008 data are available for use	Is the only source of data in Mozambique that surveys coconut farmers and specifically asks about coconut production.	Is only representative at the province level and therefore has very few observations in the FISP project area. The questions on coconut production are limited to quantity and are not very detailed. 2012 data are still being processed and are not available for public use yet.	These data were analyzed and compared to the Verde Azul data (Verde Azul Consult 2013) as a robustness check for our power calculations.
Census Data	Last collected in 2007	Is representative at a smaller level than TIA and therefore would have more useful observations. Established EAs that represent the geographical area where 100 people reside.	Household level data are not made available by INE, and the instrument used does not ask detailed questions on coconut production. Locality level data is not useful for our analysis due to its lack of granularity.	The census enumeration areas were obtained from INE and used as the sampling unit for our evaluation.
COWI Study	Qualitative study on entire coconut production zone in Mozambique	Provides important context to our qualitative protocol and has contributed to the development of our survey instruments.	The scope of the study was larger than our sample frame and the questions asked were purely qualitative. No information on household income or assets.	The data will help frame the results of our qualitative analysis.
Verde Azul Study	Quantitative study on entire coconut production zone in Mozambique	Provides important context for our evaluation questions and has also provided important information in the development of our survey instruments.	The scope of the study extends beyond the FISP treatment areas, and the sampled EAs do not match up with our selected EAs.	The data were used to help refine our power calculations and will provide some context for our results.
Michigan State Coconut Farmer Survey/dataset	Intended to be the baseline for FISP but the surveyed area did not ultimately match up with FISP treatment areas	We did not use these data in our design due to their limitations.	Baseline areas did not match up with treatment areas, and therefore these data were not usable.	We will not use these data for the evaluation.

Source	Description	Advantages	Limitations	Use for evaluation
New Data				
Household Survey	Primary data collection: information on household agricultural production, incomes, and knowledge of CLYD by a survey firm (TBD) using Abt's survey instrument.	The Abt team was able to design the survey in order to obtain household-level information that feeds into the income impact evaluation and the ERR.	We do not have a valid baseline to compare survey results; therefore, we are relying on the phytosanitary barrier to provide a discontinuity in FISP implementation, which allows for a valid counterfactual.	The primary data source for the impact evaluation on incomes and the ERR
Biophysical Survey	Primary data collection: collected using the same approach as used for the biannual disease inventories	Is the only viable methodology that can provide endline prevalence rates (satellite images can provide healthy canopy tree cover), which are necessary for conducting an impact evaluation on the disease prevalence.	Will be compared to baseline prevalence data (2008 TTI aerial photography) and therefore will require analysis of the error associated with comparing data from different sources.	Will function as our endline data source and will be used in conjunction with the (baseline) TTI photography in order to establish what (if any) impact FISP had on disease prevalence in the epidemic zones.
Qualitative Survey	Primary data collection: collected using the qualitative protocol and using survey instruments developed by Abt team	Allows the Abt team to assess FISP as a whole and provides lessons learned from key stakeholders that can inform future program designs.	Is not representative and will be conducted on much smaller sample size than the quantitative survey. Will not give impact of FISP or its activities.	Will be the primary source of data for the process evaluation of FISP. Will also be primary source for assessing the BDFs, R&D fund as well as provide support to findings of the quantitative components.
Satellite Imagery	Satellite images will be requested from European Space Imaging (EUSI) by FERA in order to verify biophysical survey during pretest	We are able to order (in advance) the images to be taken in a pre-specified area. This area will purposefully coincide with our pretest area in order to verify the accuracy of the biophysical survey.	Cannot accurately distinguish between diseased and healthy palms. Can only give a relative measure of canopy cover (i.e., a proxy of healthy trees).	Comparisons of these data sets, matched by time and location, will allow a qualitative assessment on the overall reliability of the approaches employed and allow some guidance as to those data that may be providing the most reliable information or, importantly, where more uncertainty may reside.

Source	Description	Advantages	Limitations	Use for evaluation
Physical Samples from Coconut Palms	Primary data collection: we will collect physical samples from coconut palms in areas with less than and greater than 10% disease prevalence for visual-CLYD trees and visually healthy trees and then test in a laboratory to determine if the palm has CLYD.	The information will help determine the efficacy of the visual identification technique used for each biannual disease inventory throughout the project.	We will not be physically sampling every tree we count, due to the magnitude of the project area. The quality of the data depends on correct storage and transportation of the samples, which will be managed by Dr. Smith and his colleagues at FERA.	The results of these tests will also inform our own biophysical survey and its subsequent analysis by giving the evaluation team a quantitative idea of how much variation visual spotting has in terms of identifying (or not identifying) CLYD-affected palms.

5.1 Existing

Several quantitative and qualitative sources of data exist that the Abt team has reviewed and considered for the evaluation. These are listed below.

5.1.1 Quantitative

- Michigan State University (MSU) Coconut Farmer Survey/dataset (Donovan et al. 2010)
- Verde Azul CLYD Study/dataset (Verde Azul Consult 2013)
- COWI Anthropological Study/dataset
- GIS datasets and tables that document the spread and prevalence of CLYD in the endemic and epidemic zones
- 2007 Census Enumeration Area shapefiles
- 2007 Census data (at the locality level)

5.1.2 Qualitative

- ACDI/VOCA quarterly reports, annual reports, and final report
- Research studies and findings related to the selection of coconut varieties resistant to CLYD
- Business Development Fund profiles
- The National Plan for Coconut (forthcoming)

5.2 New

New data collected by the Abt team will be the key data on which the evaluation will be based. These are described in the sections below.

5.2.1 Quantitative

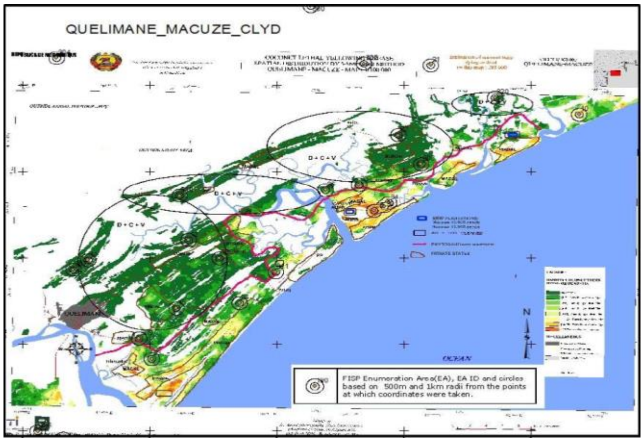
Household Survey

The household survey will be used to assess the impact of Activity 1 (Rehabilitation of Endemic Zones), Activity 3 (Improvement of Productivity), and to some extent Activity 2 (Control of Epidemic Disease). The household survey will provide data on income and the different component parts of household income. The survey will also provide specific information on different income streams, crop diversification, knowledge of and adoption of the different agricultural practices imparted by FISP, post-planting care of seedlings, and seedling survival rates. For a draft version of the survey questionnaire, see Annex 1.

Satellite Imagery/Aerial Photographs

Satellite imagery data can provide a good estimate of how the project has affected the disease spread rate. The Abt team will use these data to conduct the case study to study FISP’s impact on disease spread in Niacodala and Inhassunge districts. We are using the TTI satellite imagery study that has disease prevalence from 2008 (TTI Production 2009) to assess baseline disease prevalence to select counterfactual areas, and also to include as baseline covariates in our income impact regressions.

Figure 5-1: TTI Interpreted Image



5.2.2 Qualitative

Case Studies to Assess the Business Development Fund

The Abt evaluation team, led by the Agricultural Economist, will conduct case studies to assess the impact of Activity 4 (Business Development Fund). The team will review existing ACDI/VOCA M&E data on the enterprises (such as sales data and financial statements) to determine the success of the enterprises. Using these M&E data and other existing sources, the team will also examine other parameters, such as job creation and the enterprises' estimated multiplier effects within their value chains, to determine the firms' overall impact on the economy within the project area. We will rely heavily on information about these enterprises from the project implementers, but will also independently conduct case studies of enterprises supported by the BDF.

Technical Assessment of Research and Development Activities

FISP has funded research initiatives administered by IIAM. The Abt team will conduct a technical assessment of each funded research initiative and assess its relevance to FISP's overall objectives based on a review of the efficacy trials established by the research team. Abt will not conduct any scientific trials of the varieties, instead reviewing the research protocol of trials established by the FISP-funded research, assessing its soundness, and providing an overall assessment of its efficacy. We will assess the robustness of the initiative's design and the impact that the research has had (and will continue to have) on the mitigation of CLYD. The Abt team will evaluate the overall program by examining (1) the quality of research resulting from FISP funding, and (2) the activity's success in funding research that comprehensively addresses priority issues in mitigating the impact of CLYD on people in Zambézia and Nampula provinces.

Beneficiary Analysis and Gender

The MCC's gender policy (MCC 2011) requires Compact countries to integrate gender considerations into the development, design, implementation, and monitoring and evaluation of Compact programs. Initially, the Abt team will assess gender within FISP by tracing the development of a gender approach from the stage of Compact development to the design of the project and through its implementation. We will assess whether FISP's implementers maintained the tenets of the gender approach throughout the project and whether gender-appropriate indicators were integrated into their M&E plan.

The Abt team will then examine data from FISP to assess the project's success in integrating gender issues, while also assessing, through the household surveys, how women and men may have been differently affected by FISP. We have integrated questions into the household survey to elucidate these factors. In addition, however, we will rely on separate focus group interviews with women and men—conducted concurrently with the household surveys—to qualitatively assess the project's impact on gender equality.

We will disaggregate data for household-level parameters by gender, by age of the head of household, by farm size, and by poverty level. We do not intend to stratify our samples across all these categories because we do not believe it is feasible to do so. We plan to stratify by district in order to maintain consistency with our quantitative approach and because our two field trips have not revealed a need for any further stratification. Our household survey and qualitative surveys will also collect the data needed to disaggregate income and other benefits by source and gender.

6. Analysis Plan

The Abt team will collect data on farmers in the groups shown in Table 4-1. To estimate impact, we will use the comparisons listed in Table 4-2. We propose to estimate income impacts for two disease prevalence zones– one for the endemic zone and another for the epidemic zone. The survey sample has not been built at a scale to provide for confident analysis of effect by more disease prevalence zones within endemic and epidemic zone and/or to estimate other heterogeneities in impact. That said, it will be feasible to detect impacts on subgroups, if the magnitude of impact is large. Female-headed households may experience different intervention impacts and in order to test this we intend to (1) estimate the impact models specified in the sub-sections below separately for female-headed households and the rest of the sample (i.e., estimating one model using only the households in the subgroup of interest and another model for the rest of the sample) and (2) compare the resulting subgroup-specific impact estimate to that for the rest of the sample.

6.1 Impact of FISP on Household Incomes

6.1.1 Epidemic

To evaluate whether FISP improved farmer incomes in the epidemic zones, we will estimate a simple linear regression model of farmer income using survey response data from comparison and various treatment arms. The regression model will control for baseline CLYD prevalence from 2008 TTI data, village characteristics (e.g., distance from coast, agro-ecological zones, distance from road), household demographic data, and other household characteristics that are unlikely to change over time (such as education, housing structure type/construction, and coconut production activities in earlier years). Note that we will not have information on baseline income.

We will report the mean and standard deviation of the covariates separately for the farmers in the intervention areas and the farmers in the counterfactual areas. If we find imbalance (defined as a difference in means that exceeds 25 percent of a standard deviation) between the groups on important characteristics, we will re-weight the data in the sample of farmers in the counterfactual area. In particular, we will reassign sample weights to achieve balance on the following characteristics: pre-intervention coconut production, pre-intervention coconut production as a function of pre-intervention total farm production, and education or housing construction type/materials, whichever of the latter two is more strongly correlated with income.

To conduct valid inference on the estimated impact, we will need to take into account the fact that geographically proximate groups of farmers might have correlated outcomes. In particular, clustered farmers (for example, in the same village) are likely to have correlated outcomes because they share a knowledge network, common soil quality, pest risks, and possibly other common unobservable factors. We will account for this correlation by using *cluster-robust standard errors* in the regression impact estimation model.

The regression model will have the form suggested in Equation [3], where the estimate of δ measures the average impact of the intervention on outcome Y. Each farmer i obtains outcome Y_i, has baseline characteristics captured in vector X_i, and a random, cluster-robust, farmer-specific factor ε_i. There is a treatment indicator T_i which is equal to one if the farmer is in the intervention area, and zero otherwise. There are five districts in the epidemic income regression, and D_q is the district dummy.

$$Y_i = \sum_{q=1}^{5} D_q + \delta T_i + \beta X_i + \varepsilon_i \quad [3]$$

For a continuous variable (income), we will estimate a linear model, and when the dependent variable is binary (knowledge or adoption), we will estimate it using a linear probability model.

6.1.2 Endemic

The estimation strategy for the endemic zones is the same as that for the epidemic zones.

6.2 Impact of FISP on Disease Prevalence

6.2.1 Endemic

MCC and the Abt team decided that an impact evaluation of FISP on disease spread or prevalence in the endemic zones would not be appropriate since all trees were cleared.

6.2.2 Epidemic

The outcome, or dependent, variable for the impact analysis of FISP on disease prevalence in the epidemic zones is disease prevalence at the time of follow-up: a cross-sectional measure. We have some data on disease prevalence at baseline, if not for the identical measurement areas, then at least for the follow-up measurement area's corresponding enumeration area. We will use these baseline estimates in our study of the follow-up disease prevalence measures. More specifically, we will use these baseline disease prevalence measures as covariates in the regression model. The regression coefficient of interest will be the effect of the FISP intervention on disease prevalence at the time of follow-up, *while controlling for baseline disease prevalence*. The variance of the outcome measure is still a cross-sectional variance; controlling for baseline disease prevalence does not affect the variance of the outcome measure, but it could affect the precision of our estimates by reducing the variance in the outcome measure that can be explained by the treatment variable (i.e., the baseline measure may increase the R-squared value).

With disease prevalence data for two time periods (baseline and follow-up), one option is to analyze the *difference* between the disease prevalence at the time of follow-up and the estimate of baseline disease prevalence. We will conduct this analysis, as it is standard practice in the development literature. However, this analysis is akin to conducting a restricted test of the regression described above (in the linear case, it simply restricts the regression coefficient of the baseline measure to be equal to negative one). With little knowledge of the time trend behavior of CLYD, we prefer the unrestricted model, and thus we will supplement the analysis with estimates obtained from the unrestricted model. Any additional reason that we lean towards the unrestricted model is that the baseline measure (assessed using GIS software) and follow-up measurements (assessed in the field, on foot) were assessed using different methods and correspond to different areas; thus the measure resulting from their difference has units that are slightly clumsy to interpret: the average difference in endline prevalence among tree clusters and baseline prevalence in the surrounding area.

The regression model will have the form in Equation [4], where ϑ measures the average impact of the intervention on disease prevalence. Disease prevalence in each grid *j* is a dependent on baseline characteristics Z_j *(including baseline prevalence)* and a random, cluster-robust, grid-specific factor e_i. There is a treatment indicator T_j that is equal to one if the grid is in the treatment group, and zero otherwise. There are five districts in the epidemic region, and D_q is the district dummy.

$$Y_j = \sum_{q=1}^{5} D_q + \vartheta T_j + \beta Z_j + e_i \quad [4]$$

With fewer samples, the regression approach is often preferred because it is more efficient (it maximizes the "information" on the right hand side and avoids potentially adding variance on the left hand side) and less restrictive (the coefficient on the baseline measure is not restricted to -1). The baseline prevalence is included in the *Z* characteristics. For the difference method, the baseline prevalence is removed from the set of Z characteristics and the outcome variable becomes Y_j minus the baseline prevance for observation *j*. As mentioned earlier, in this application, the measures and unit of observation for the baseline and endline outcome data – disease prevalence is measured using aerial data in the baseline, and bio-physical foot survey in the endline – are not equivalent, further motivating the use of regression instead of difference-in-differences because the time-constant observation-specific characteristic is less likely to be time-constant over different baseline and endline measures; in addition, it is not clear what the unit of the new outcome variable would be when combining the two measures.

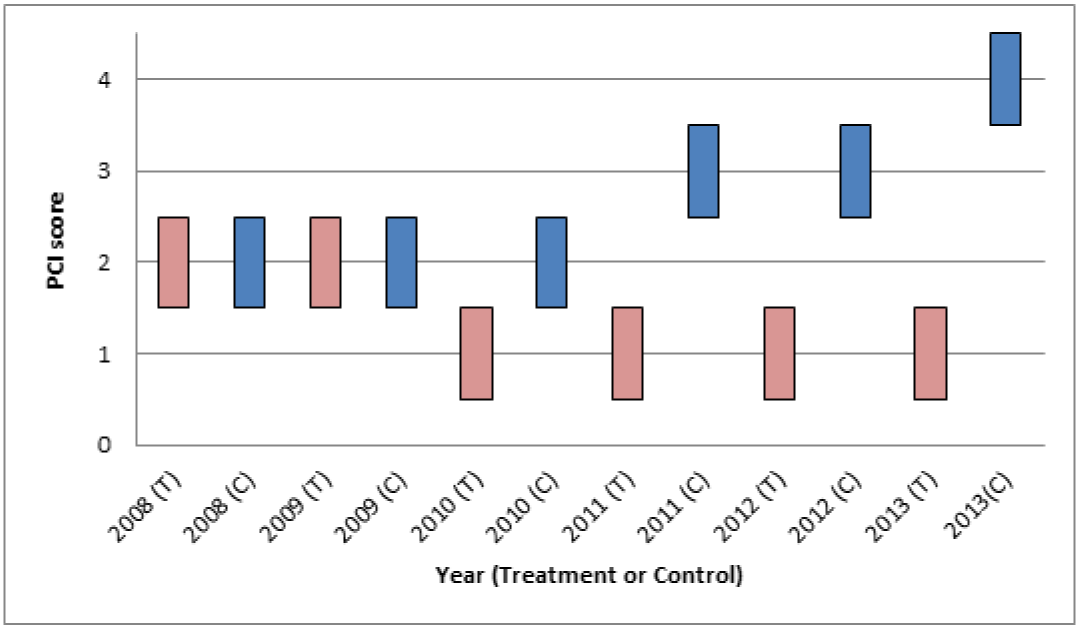
6.2.3 Case Study on Disease Spread

The case study on disease spread will assess the change in PCI scores described in Section 4.1.4 to proxy for change in disease spread in comparison and treatment areas of two districts: Nicoadala and Inhassunge. We will assign PCI scores to each sampled unit (four each in treatment and comparison EAs) between the dates of 2008 and 2010. To estimate uncertainty, sampled satellite images will be provided in a random order to an assessor within a finite time period (approximately 5 seconds) to assign the PCI scoring system to each image. This time period will be deliberately short to prevent over-analysis and to record perception. Three separate assessors will be asked to score a subset of images to ascertain an estimate of subjectivity. On a subset of units scored for a range of coverage, a more detailed quantitative palm count will be undertaken. These approaches will be combined to give an overall uncertainty (and possible bias) estimate in the PCI scores. To show differences in disease spread between FISP intervention areas and counterfactual areas (see Figure 6-1), we will calculate weighted averages of PCI scores for each of the four study areas for every year for which we have data, rounding the weighted averages to the nearest PCI score. These averages will then be graphed over time to show relative changes between treatment and comparison areas before and during FISP.

$$\overline{PCI_\iota} = \frac{\sum_{i=1}^{4} s_i p_i}{\sum_{i=1}^{4} s_i} \quad [5]$$

In this equation, *s* is the number of samples within a site that received a PCI score, *p*. We will then graph both the weighted averages and the individual scores from each year. This will provide a visual depiction of how tree coverage (proxied by PCI score) changed over time for both treatment and comparison areas in each study site (see Figure 6-1).

Figure 6-1: Time Series Analysis for Disease Rate



In order to determine any statistical differences in the change of PCI scores over time, we will conduct the following two-step process:

1. Calculate the change in PCI index score between years (where $\Delta PCI = PCI_2 - PCI_1$) for treatment and comparison areas. For each sampled image, we will sample at random among the multiple assessors to introduce variability due to assessors (note that calculating differences in scores will be interpreted as a proxy for assessing disease spread, since the satellite imagery is unable to provide us with accurate disease-prevalence levels.)
2. Compare the frequency distribution of changes in PCI between the treatment and comparison areas, testing for a difference in those frequency distributions using a straightforward non-parametric test (e.g., Kolmogorov-Smirnoff).[16]

The results of our comparison of the frequency distribution of change in PCI scores over time will complement the time series graph. This will enable us to statistically test differences observed in treatment and comparison areas.

[16] The two-sample Kolmogorov-Smirnov test is a nonparametric method of a two-sample t-test. It is used to test whether two samples come from the same distribution. In this case, it will use the maximal distance between cumulative frequency distributions of the treatment and control samples as the test statistic in order to determine whether the two frequency distributions are different.

6.3 Monitoring Plan

Since the evaluation is ex-post, we do not expect to have a monitoring plan. Instead we propose to review the available monitoring data, interview MCA-M staff, and interview individuals who served as staff for the implementing partners. For the same reason there is no need for a plan to assess the adherence to treatment and comparison areas.

7. Administrative

7.1 Summary of Institutional Review Board Requirements and Clearances

The Abt team expects to complete all paperwork for conducting the household survey with our internal Institutional Review Board (IRB). Abt is committed to conducting research in conformity with basic ethical principles and federal and other regulatory requirements that govern research involving human subjects. Abt holds a current Federal-Wide Assurance of Compliance from the U.S. Department of Health and Human Services' Office for Human Research Protections. Before issuing approval, the Abt IRB ensures that any research protocol includes adequate provisions to protect the privacy of subjects and the confidentiality of their information. The IRB currently has about 150 studies in its purview.

We will initiate the application as soon as the survey instrument and phase two of the evaluation are approved by MCC. We expect our application to be exempt from detailed IRB review because we will not be collecting sensitive, personally identifiable information.[17]

7.2 Data Access, Privacy, and Documentation Plan

In keeping with MCC's commitment to transparency and public sharing of data, and to ensure replication of the evaluation, we will keep all the documentation required to replicate the evaluation. Documentation will include:

- Survey summary
- Descriptive statistics
- "Readme" file
- Brief survey description and basic documentation
- Enumerator and trainer manuals
- Questionnaires
- Codebook
- Analysis programs, where used
- Final documentation
- Anonymized and raw datasets in STATA
- Metadata file (in Nesstar format)
- Informed consent

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17 We will however be collecting GPS location, names, and village. Although these data are typically not deemed to be "sensitive" by Abt's IRB, they will be excluded from any public datasets.

All text documents, including the "Readme" file, survey description, manuals, questionnaires, and codebook will be made available in portable document format (PDF). All data will be provided in STATA format. The anonymized data will be free of identifiers that would permit linkages to individual respondents or their household members; it will exclude variables that could lead to deductive disclosure of the identity of individual subjects.

To do this in adherence with MCC's Checklist on Disclosure Potential for Proposed Data Release, we will form a disclosure risk team to analyze the variables collected and determine the best technique to anonymize the data. The disclosure risk team will include Abt's Institutional Risk Management representatives; our Project Quality Advisor, Kenneth Hoadley; and our Program Manager, Tulika Narayan. The disclosure risk team has provisionally approved using data reduction because the survey questionnaire (see Annex 1) will produce data in which reduction is the most efficient and time-effective way of recoding. Data reduction involves extracting data from the original source, and compiling, querying, and categorizing these data in subset databases by characteristics.

The disclosure risk team will finalize the appropriate categorical variables to collapse, recode, combine, and/or remove in order to create a new identification (ID) code for each observation in the dataset. The unique IDs will be reviewed by the disclosure risk team in order to ensure anonymity and rigor of data recoding.

7.3 Dissemination Plan

The Abt team expects to present the results of the evaluation at a stakeholder workshop in Mozambique one month after data collection efforts are complete, and keeping in mind the feasibility of the workshop given planned elections. Once the report is approved by MCC, we will distribute the report to all stakeholders. If the result of the analysis lends itself to an academic publication, and if MCC agrees to wider dissemination, we will compete for one of Abt Associates' internal development and dissemination grants to support the submission of results to a suitable journal. The MCC-approved final report, anonymized datasets, and supporting technical documentation will be posted to the MCC external website following MCC Disclosure Review Board clearance.

7.4 Evaluation Team Roles and Responsibilities

The core Abt team is comprised of six individuals: a Program Manager, an Agricultural Economist, an Epidemiologist, a GIS Specialist, a Research Assistant, and a CLYD Specialist. The Program Manager and Research Assistant are full-time Abt employees. The core team is supported by a Home Office Coordinator and other technical personnel with more specialized responsibilities, such as a Remote-Sensing Specialist, a Survey Manager, and a Statistician.

Table 7-1: Evaluation Team Roles—Phase 1

Core Team	Name	Academic Qualifications
Program Manager	Tulika Narayan	PhD, agricultural economics
Agricultural Economist	Thomas Hutcheson	PhD, economics
Epidemiologist	Julian Smith	PhD, rhizobial ecology
Statistician	Judy Geyer	PhD, economics
GIS Specialist	Jadwiga Massinga	MS, environment and development

Core Team	Name	Academic Qualifications
Research Assistant/Quantitative Specialist	Mikal Davis	MS, economics
CLYD Specialist	Maria Mercedes Roca	PhD, plant virology
Other Technical Personnel		
Technical Editor	Deborah Dangay	MS, foreign service
Project Quality Advisor	Kenneth Hoadley	DBA, business administration
Home Office Backstopping		
Coordinator	Patricia Costa	MPP, public policy
Finance and Contracts Analyst	Alex Rivera	BS, international government, politics, economics, Spanish

8. Quality Control Plan

Abt Associates has put in place a quality control plan (QCP) that will cover all aspects of the evaluation. The QCP will ensure that the evaluation uses an evaluation design with the highest rigor; obtains the best quality data; conducts robust data analysis and qualitative assessments; prepares appropriate documentation of data; ensures transparency and sharing of data; and prepares high-quality reports, documents, and documentation. We have designated Kenneth Hoadley, an Agricultural Expert by training, to be in charge of the overall QCP on the project. He will be assisted by various in-house and external experts, and will be supported by the Abt Associates Center for Evaluation Methods, which provides in-house peer reviews of proposed designs for evaluation projects undertaken by Abt. We will report any issues, together with our plan to address them, to MCC as soon as they are discovered.

8.1 Evaluation Design

The quality assurance process will ensure that we have identified and properly addressed all evaluation challenges, that we have developed a theory of change that suits the pilot and allows us to proceed with an evaluation design, that we have carefully carried out a power analysis before undertaking survey work, and that the plan for data analysis is sufficiently detailed to enhance our confidence in the evaluation design. Dr. Judy Geyer, an evaluation design expert at Abt Associates, will be in charge of reviewing the evaluation design and quantitative data analysis.

Abt's Evaluation Method Center Design Workshop has provided peer review of the proposed evaluation design. This peer review process allowed the FISP external evaluation team to present the proposed design to a group of evaluation experts who will review and provide comments. The Abt evaluation experts who participated in the design workshop had, on average, more than 15 years of experience conducting evaluations. The design workshop is headed by Jacob Klerman, who attends all the sessions. Dr. Klerman is a widely respected economist with more than 25 years of experience in social policy research. An expert in both experimental (i.e., random assignment) and quasi-experimental evaluation of social programs, Dr. Klerman is Co-Director of the Abt Associates Center for Evaluation Methods, the founder and Co-Director of Abt's internal seminar (the Journal Author Support Group), and one of Abt's eight Senior Fellows. A member of this peer review team also reviewed our power analysis calculations to ensure that our proposed data collection will provide the necessary power to test the impact of the project. This workshop provided critical review and inputs to finalize our evaluation design.

8.2 Data Quality

Abt has issued an RFP to survey firms. We will use a competitive process to select the most appropriate firm and ensure value for money. Once the survey designs are finalized and approved by MCC, we will conduct rigorous training of enumerators. This training will include topic area experts, to ensure that the enumerators completely understand the survey objectives and the reasons we are asking each question. In addition, we will review common errors that can occur in gathering the data and the specific questions that should be asked to make sure there are no biases introduced. Finally, an important part of the quality control on the questionnaire is to ensure that the English version and the translated versions (Portuguese and other local languages) are the same. To do this, we will perform a reverse translation from these languages to English. Once the questionnaire is complete, we will conduct a pilot test to test the field protocol, enumerator performance, and any difficulties faced in the field. We will also review the data collected in the pilot and make final adjustments to the questionnaire based on the review.

To ensure that there are no errors in data collection, we will use double entry or select the best approach suggested by the survey firms. In our request for proposals from survey firms we have asked them to present in detail their own quality assurance plans. We will review these carefully and work with a survey firm that has a strong quality assurance plan.

After data collection and entry is complete, we will conduct data cleaning to review the data. We expect this to be an intensive process where we will engage with the survey firm to fix any errors that we find from outlier and missing data analysis. In all instances, we will take special care to ensure that the data are simply compared to the paper questionnaire and no attempt is made to enter what is expected or to falsify data.

An important part of data quality is good documentation of the data. We will ensure that all variables in the data are clearly noted and that information on non-response, missing information, and any other detail necessary for analyzing the data are carefully recorded in the codebook and a “Readme” file.

8.3 Data Analysis

A technical expert on the team who is not directly involved in the work will review all data analysis. For example, since Thomas Hutcheson will lead the ERR calculation, Tulika Narayan will review the analysis for ERR. This review will be detailed and will include review of the calculations and a review of the report.

8.4 Quality of Reports and Documents

All reports and documents will be edited and formatted by a designated editor, ensuring that reports follow MCC templates where relevant, and will be subjected to a final review by our technical team and Dr. Hoadley prior to submission to MCC.

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FISP Quantitative Survey Instrument

HH ID |__|__|__|__|__|__|__|__|__|__|

Knock on the door.

Hello, my name is [Enumerator Name]. Can I speak with the head of the household?

Are you 18?

- ☐ Yes (continue with the script)
- ☐ No (thank them for their time, indicate result in spreadsheet)

I am working on a study evaluating the changes in coconut production during the last 5 years in Zambezia conducted by a research team from Abt Associates in cooperation with the MCC. We are interviewing people in this village and your house has been randomly selected to be surveyed.

As part of this study we would like to ask you questions about your farming practices, consumption and the members of your household. We would very much appreciate your participation in this survey. The interview will take about [**Insert time**] minutes to complete.

Your participation in this survey is voluntary; there is no direct benefit to you for participating. Refusing to participate in the study will not affect your future participation in any MCC or other projects.

The information you provide will be kept confidential to the best of our ability and will be shared only with the survey team. Your neighbors and/or any organizations will not have access to your responses. If you wish to skip certain questions or sections, just tell me, and I will go on to the next question. Also, if you wish to stop the interview at any time just let me know.

If you have any questions or concerns pertaining to your participation in this study, you may contact [**contact name**]. I will give you her phone number to write down at the end of the interview.

At this time, do you want to ask me anything about the survey?

- ☐ Yes
- ☐ No

Do you agree to participate?

- ☐ Yes (proceed to the survey questions)
- ☐ No (thank them for their time, indicate result in spreadsheet)

___________________________________ ___________

Interviewer signature Date

HH ID |__|__|__|__|__|__|__|__|__|__|

Screening Questions		
1	Has your household produced and/or owned coconut trees in the last 5 years? (1-Yes, 2-No ►**(go to next household)**)	
2	Are you the person who manages the coconut planting/production in this household? (1-Yes►A1, 2-No►**Q3**)	
3	Is the person who manages the coconut planting/production available to speak? (1-Yes►A1, 2-No►**(go to next household)**)	

Section A1: Household Identification								
Enumerator Instructions: Enter Household ID# in right hand corner of document.								
1	District (see codes)		5	Household Number/Address				
2	Administrative Post		6	GPS location of Household (include leading zeros)	Lat.		Lon.	
3	Community		7	Name of interviewee				
4	EA Number		8	Mobile number of interviewee				

Section A2: Survey Details					
Enumerator Instructions:					
1	Interview conducted in what language? (see codes)		6	Reason for 2nd interview (see code)	
2	Enumerator ID#		7	Time of 2nd interview (HH:MM)	From: To:
3	Date of 1st interview (MM/DD)		8	Supervisor ID#	
4	Time of 1st interview (HH:MM)	From: To:	9	Checked by (ID#)	
5	Date of 2nd interview (MM/DD)		10	Date of checking (MM/DD)	

HH ID |__|__|__|__|__|__|__|__|__|__|

CODES:

District Codes:		**Language Codes:**						**2nd interview reason:**	
1	Chinde	1	Portuguese	8	Ndau	15	Shona	1	Had to leave mid interview
2	Namcurra	2	Chuabo	9	Ngone	16	Swahili	2	Requested a two part interview
3	Nicoadala	3	Kimwani	10	Nyauna	17	Xitsonga	3	Could not answer all questions during 1st
4	Inhassunge	4	Lolo/Malolo	11	Nyanja	18	Xitswa	4	Other (specify)
5	Maganja da Costa	5	Makonde	12	Nyungwe	19	Yao		
		6	Makua	13	Ronga	20	Zulu		
		7	Marende	14	Sena	21	Other dialects (write in)		

DEFINITIONS:

HOUSEHOLD: For this survey, a household is defined as a group of people who live and eat together, share resources and form a common decision-making unit.

HOUSEHOLD MEMBERS: For this survey, a household member is an individual who belongs to the household as defined above who has lived with the household for at least six of the last twelve months. The individual should spend the majority of their time living/sleeping with the household. Also, new entrants into the household who are likely permanent new members but who entered less than 6 months ago are also included as household members, including newborn children, adopted children, and newly married spouses of members.

DWELLING: A structure or group of structures in which some or all of the household member reside.

GENERAL INSTRUCTIONS:

Read all enumerator instruction carefully before each section. Read each question as it is written. Be sure to write in responses that do not have corresponding codes.

NOTES:

*=Experimental Question to be tested during survey pre-test. We denote these as experimental either because we will use the pre-test to determine whether to include the question, or to refine the language of the question so it is not confusing to the respondent.

HH ID |__|__|__|__|__|__|__|__|__|__|

Section B: Household Demographics								
Enumerator Instructions:								
1	2*	3*	4*	5*	6	7	8	9
How old are you? (in years)	**Is this a female headed household?** 1-Yes 2-No	**Gender of respondent?** 1-Male 2-Female	**What is your relationship to the head of household?** 1…head 2…spouse 3…son/daughter 4…parent 5…brother/sister 6…niece/nephew 7…relative 8…Other (specify)	**What is your marital status?** 1…Married(monogamous) 2…Married (polygamous) 3…Informal union/cohabitation 4…Divorced 5…Separated 6…Widowed 7…Never married	**What is the highest level of education you have completed?** 1-elementary (1-7) 2-basic (8-10) 3-medio (11-12) 4-superioir (>12)	**Can you read and write?** 1-Yes 2-No	**What is your ethnicity?** *Will get list from survey firm	**How many household members reside in this dwelling?**

HH ID |__|__|__|__|__|__|__|__|__|__|

Section C: Household Characteristics										
Enumerator Instructions: *Ask each question referring to the present and 5 years ago, then move on to the next question.*										
1	2	3	4	5	6	7	8	9	10	11
What is the main economic activity of this household? 1-Agriculture 2-Mining 3-Manufacturing 4-Professional, Scientific or technical activities 6-Electricity 7-Construction 8-Transportation 9-Buying and selling 10-Financial services 11-Personal services 12-Education 13-Health 14-Public admin 15-Other, specify	**What is the main construction material used for the walls of your house?** 1...thatch 2...mud and poles 3...raw bricks 3...burnt bricks 4...cement blocks 5...stone 6...wood 7...other	**What is the main material used for the roof of your house?** 1...thatch 2...corrugated steel 3...tiles 4...aluminum 5...cement 6...mud 7...other	**What is the household's toilet facility?** 1...flush 2...pit latrine 3...other (write in)	**What is the floor in the household made of?** 1…Earth/mud 2…Straw 3…Cement 4…Tile 5…Wood 6…other (write in)	**What is the main source of water for the household?** 1…piped 2…public tap 3…bored hole 4…wellspring 5…rain 6…tanker/truck 7…river/lake/stream 8…other (specify)	**What is the primary cooking fuel used in the household?** 1...gas 2...electricity 3...charcoal 4...firewood 5...kerosene 6...other (specify)	**What type of lighting does the household use?** 1...electricity 2...paraffin or kerosene lantern 3...candle 4...firewood 5...solar 6...gas 7... other (specify)	**What is the most important source of nutrition for the household?** 1-maize 2-rice 3-mapira 4-mexoeria 5-cassav 6-sweet potato 7-beans 8-coconuts (or its derivatives) 9-other (write in)	**If you were to sell your farmland today, how much would you get for it?**	**Would you say you and your household are living in better worse or the same economic conditions as 5 years ago?** 1-better 2-worse 3-same
5 years ago?*	**5 years ago?***	**5 years ago?***	**5 years ago?***	**5 years ago?***	**5 years ago?***	**5 years ago?***	**5 years ago?***	**5 years ago?***	**5 years ago?***	

HH ID |__|__|__|__|__|__|__|__|__|__|

Section D: Household Assets			
Enumerator Instructions:			
Item code	Item	1-Yes 2-No	# of items
01	**Latrine**		
02	**Radio**		
03	**Mobile Phone**		
04	**Vehicle**		
05	**tractor**		
06	**pulverizer**		
07	**bicycle**		
08	**motorcycle**		
09	**refrigerator**		
10	**Storage Silo**		
11	**Other good (write in)**		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section E: Plot Roster													
Enumerator Instructions: *First ask the respondent to list the plots. Then, for each plot, ask questions 3-8, completing the row. When a row is complete, repeat questions 3-8 for the next plot, until all plots have been covered.*													
1	2	3	4	5	6				7		8		0
Plot ID Number	**Plot location** 1-high zone 2-low zone 3-other	**Plot Area**	**Unit**	**Do you inter-crop on this plot?**	**Which Crops are the top 4 crops planted on this plot in the last 12 months?** See crop codes				**How much time does it take to get to this plot from your main house?**		**How much time does it take to get from this plot to the nearest market?**		**What is the main variety of coconut tree planted on this plot?** 1-dwarf 2-giant 3-hybrid 4-green 5-yellow 6-red 7-No coconut 8-other (write in)
					C1	C2	C3	C4	A.amt	U.unit	A.amt	U.unit	
1													
2													
3													
4													
5													

Crop Codes														**Unit Codes**					
111	abobora	118	ervilha	125	tomate	228	F. manteiga	235	F. oloko	336	papaia	445	girassol	00	100kg sack	10	liter	30	months
112	alface	119	melancia	222	Milho	229	F. Nhemba	330	banana	337	tangerina	446	gergelim	01	90kg sack	11	25L	31	weeks
113	alho	120	pepino	223	Arroz	230	F. Jugo	331	limao	440	algodao	447	soja	02	70kg sack	12	20L	32	hours
114	beringela	121	Pimenta	224	Mapeira	331	F. Boer	332	laranja	441	tabaco	448	paprica	03	60kg sack	13	10L	33	minutes
115	cebola	122	piripiri	225	Mexoeira	232	Batata reno	333	goiaba	442	sisal	449	genibre	04	50kg sack	20	km		
116	cenoura	123	quiabo	226	Amendoim Gr	233	mandioca	334	manga	443	Cha folha	450	cajuiero	05	25kg sack	21	Sq. km.		
117	couve	124	repolho	226	Amendoim peq	234	F. verde	335	abacate	444	Cana doce	451		06	12.5kg sack	23	ha		

HH ID |__|__|__|__|__|__|__|__|__|__|

	Section F: Coconut Planting and seedling care										
	Enumerator Instructions: *For each plot that has coconuts, ask the household member the following questions*										
	1	2	3	4	5	6	7	8	9	10	11
	How many of your coconut trees have died from CLYD in the last 5 years? Enter Total Amount	**In the past 5 years, have you planted any new seedlings on this plot?** 1-Yes 2-No►Q5	**How many seedlings did you plant on this plot in the last 5 years?**	**Of those seedlings, how many are still alive today on this plot?**	**In the past 12 months, have you planted any new seedlings on this plot?** 1-Yes 2-No►Q8	**How many seedlings did you plant on this plot in the past 12 months?**	**Of those seedlings, how many are still alive today on this plot?**	**What is the main technique you use (currently) to care for coconut seedlings on this plot?** 1-irrigation 2-pest control 3-Intercropping 4-manual 5-other	**What type of pest control do you use (currently) on your coconut trees/seedlings on this plot?** 1-insectcide 2-herbicide 3-fungacide	**What is the most common reason for a seedling to die on this plot?** 1-oryctes beetle 2-CLYD 3-lack of water 4-other (write in)	**What is the main technique you use (currently) to combat the [answer in Q10] on this plot?** 1-irrigation 2-pest control 3-Intercropping 4-Other (write in)

HH ID |__|__|__|__|__|__|__|__|__|__|

Section G1: Coconut byproduct production and sales—Last 12 months [1]

Enumerator Instructions: *Make sure respondent is aware of the time period for each set of questions. For price inputs, enter the price for the quantity and unit listed. Be sure to put price in Meticals. Questions 7,8 and 9 are not by product, but general question regarding the household's trees.*

Time Period►		**FROM THE LAST 12 MONTHS**						
1	2	3	4		5	6		
Product	**Code**	**Did you produce [read ROW LABEL] in the last 12 months?** 1-Yes 2-No ►(go to next product)	**How much [read ROW LABEL] did you produce?**		**Have you sold [read ROW LABEL] in the last 12 months?** 1-Yes 2-No► (go to next product)	**What was the total amount of [read ROW LABEL] that you sold in the last 12 months?**		
			1.qty	2.unit		Q.qty	U.unit	P.price
Coco	100							
Copra	101							
Lanho	102							
Sura	103							
Wood	104							

7	**During the last 12 months, how many coconut palms do you have in production?**	
8	**How many coconut palms ["in production"?] have been affected by CLYD in the last 12 months?**	
9	**How many coconut palms have died from CLYD in the last 12 months?**	

Unit Codes

00	100kg sack	03	60kg sack	06	12.5kg sack	12	20L	21	Sq. km.	32	weeks
01	90kg sack	04	50kg sack	10	liter	13	10L	23	ha	33	minutes
02	70kg sack	05	25kg sack	11	25L	20	km	31	months		

[1] Coco, Copra, Lanho Sura and Wood are the coconut byproducts used in both the COWI, Verde Azul and TIA survey instruments. The version of the COWI study Abt has is seemingly incomplete, as it does not have the comprehensive list of coconut by-products. We will follow up with COWI in order to obtain this list and integrate it into each survey as necessary. Additional coconut uses will be covered by the qualitative survey.

HH ID |__|__|__|__|__|__|__|__|__|__|

Section G2: Coconut byproduct production and sales—During FISP

Enumerator Instructions: *Make sure respondent is aware of the time period for each set of questions. For price inputs, enter the price for the quantity and unit listed. Be sure to put price in Meticals. Questions 7,8 and 9 are not by product, but general question regarding the household's trees.*

Time Period►	**2009 (BEFORE FISP): ASK FARMER TO RECALL AVERAGES OF THIS TIME PERIOD**							
1	2	3	4		5	6		
Coconut byproduct	**Code**	**Did you produce [read ROW LABEL] in 2009 (before FISP)?** 1-Yes 2-No► (next product; if you have completed the list, go to question 7)	**How much [read ROW LABEL] did you produce that year?**		**Did you sell [read ROW LABEL] in 2009 (before FISP)?** 1-Yes 2-No► (next product)	**How much [read ROW LABEL] did you sell in that year?** *Enter price per unit*		
			Q.qty	U.unit		Q.qty	U.unit	P.price
Coco	100							
Copra	101							
Lanho	102							
Sura	103							
Wood	104							

7	**In 2009 (or the year before FISP), how many coconut palms did you have in production?**	
8	**In 2009 (or the year before FISP), how many coconut palms were affected by CLYD?**	
I	**In 2009 (or the year before FISP), how many trees would die from CLYD in an average year?**	

Unit Codes

00	100kg sack	03	60kg sack	06	12.5kg sack	12	20L	21	Sq. km.	32	weeks
01	90kg sack	04	50kg sack	10	liter	13	10L	23	ha	33	minutes
02	70kg sack	05	25kg sack	11	25L	20	km	31	months		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section G3: Coconut byproduct production and sales—Before CLYD

Enumerator Instructions: *Make sure respondent is aware of the time period for each set of questions. For price inputs, enter the price for the quantity and unit listed. Be sure to put price in Meticals. Questions 1, 9,10 and 11 are not by product, but general question regarding the household's trees.*

Time Period►	**BEFORE CLYD WAS INFECTING THE FARMER'S TREES**	
1►	**What date did you first begin seeing CLYD in your coconut trees?** MM/YY Or YYYY if month is not remembered	

2	3	4	5	6	7		8	9		
Coconut byproduct	**Code**	**What year did you first see your trees infected by CLYD?** **[If 2009 or later, skip this section. If before 2009, be sure farmer understands all these questions relate to that time period, not FISP]**	**Do you recall the amount of [read ROW LABEL] you harvested before CLYD appeared in your coconuts?** 1-Yes 2-No► (next product, if you have completed the list, go to section H)	**Did you produce [read ROW LABEL] before you saw CLYD in your coconuts?** 1-Yes 2-No 3-Always had CLYD	**How much [read ROW LABEL] did you produce?**		**Did you sell [read ROW LABEL] before you saw CLYD in your coconuts?** 1-Yes 2-No►(next product) 3-Always had CLYD	**How much [read ROW LABEL] would you sell in an average year before you saw CLYD in your coconuts?** *Enter price per unit. Enter 0 if always had CLYD*		
					Q.qty	U.unit		Q.qty	U.unit	P.price
Coco	100									
Copra	101									
Lanho	102									
Sura	103									
Wood	104									

9	**How many coconut palms did you have production in an average year, before you saw CLYD in your trees?**	
10	**How many would be affected by CLYD in an average year before you saw CLYD in your trees?**	
11	**How many trees would die from CLYD in an average year before you saw CLYD in your trees?**	

Unit Codes

00		100kg sack	03	60kg sack	06	12.5kg sack	12	20L	21	Sq. km.	32	weeks
01		90kg sack	04	50kg sack	10	liter	13	10L	23	ha	33	minutes
02		70kg sack	05	25kg sack	11	25L	20	km	31	months		

Section H: FISP extension services: coconuts and its derivatives														
Enumerator Instructions: *The following questions relate to coconut planting, production as well as copra, lanho, sura and coconut wood production.*														
1*	2	3	4	5	6	7		8	9	10	11			12
In the last 5 years, have you received any extension services (including saplings) regarding coconut (or its derivatives) production? 1-Yes 2-No►Q7	**From whom did you receive these services?** Enter code	**Did you receive saplings from [response from Q2]?** 1-Yes 2-No►Q5	**Over the last 5 years, how many saplings do you estimate you received (in total)?**	**Of those, how many are alive today?**	**Did you receive training on how to cut and burn diseased trees from source in Q2?** 1-Yes 2-No►Q8	**Do you cut and burn any of your diseased trees now, as a result of the services?** 1-Yes►(Enter number) 2-No		**Did an organized group of men come and cut any of your trees?** 1-Yes 2-No►Q10	**How many of your trees in total did these teams cut?**	**Did you receive training on how to best prevent CLYD from affecting your trees?** 1-Yes 2-No►Q12	**What are the top three preventive measures you can take to prevent CLYD?** 1-removing weeds/debris from field 2-using a resilient variety 3-insecticide 4-herbicide 5-irrigation 6-frequent watering 7-felling and burning 8-Other			**Have you noticed an increase in coconut health as a result of these services?** 1-Yes 2-No
						1.y/n	2.qty				1st	2nd	3rd	

Extension Service Provider Codes			Unit Codes					
99	Madal		00	100kg sack	10	liter	30	months
98	ACDI-VOCA		01	90kg sack	11	25L	31	weeks
97	Local government (DPA)		02	70kg sack	12	20L	32	hours
96	MCA		03	60kg sack	13	10L	33	minutes
95	FISP		04	50kg sack	20	km		
94	NGO (give name)		05	25kg sack	21	Sq. km.		
			06	12.5kg sack	23	ha		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section I: Alternative Crops-- Production and Sales

Enumerator Instructions: *Complete one row at a time before asking questions about the next product/row.*

1	2	3	4		5				6	7		8	10			11*		12	13		
Product	**Code**	**Have you produced [read ROW LABEL] in the last 5 years?** 1-Yes 2-No► (next product)	**When did you first begin planting [read ROW LABEL]?** (MM/YY)		**When were your most recent planting and harvest?** (MM/YY)				**Did you produce this product before you first saw CLYD (or before 2010)?** 1-Yes 2-No►K	**How much did you produce?**		**Did you sell this product before you first saw CLYD (or before 2010)?** 1-Yes 2-No►(next product)	**What was the total amount sold in an average year?**			*From now on, refer to only most recent harvest.* **How much [read ROW LABEL] did you produce?**		**Do you sell this product?** 1-Yes 2-No►(next product)	**What was the total amount sold from the last harvest?**		
					P.Planting		H.Harvest														
			M.	Y.	Q.qty	U.unit	Q.qty	U.unit		Q.	U.		P.price	Q.qty	U.unit	Q.qty	U.unit		Q.qty	U.unit	P.price
Ground nut	226																				
Pigeon Pea	332																				
Cowpea	550																				
Sesame	446																				

Unit Codes

00	100kg sack	10	liter	30	months
01	90kg sack	11	25L	31	weeks
02	70kg sack	12	20L	32	hours
03	60kg sack	13	10L	33	minutes
04	50kg sack	20	km		
05	25kg sack	21	Sq. km.		
06	12.5kg sack	23	ha		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section J: Alternative Crops--Inputs																			
Enumerator Instructions: *<u>All questions refer to the most recent harvest.</u> Complete one row at a time before asking questions about the next product/row.*																			
1	2	4		5	6			7	8			9	10			11	12
Product	**Code**	**What is the total estimated farm area used for production of [read ROW LABEL]?**[2]		**Did you use any hired labor to produce [read ROW LABEL]?** 1-yes 2-no►Q7	**How much labor was used for [read ROW LABEL] production? What was the total cost?** *Note: this should include planting weeding, pest control, harvesting and any other labor related cost associated with production.*			**Did you use any fertilizers to produce [read ROW LABEL]?** 1-yes 2-no►Q9	**How much did you use and what was the associated cost?**			**Did you use any herbicide or insecticide to produce [read ROW LABEL]?** 1-yes 2-no►Q11	**How much did you use and what was the associated cost?**			**What type of seed was used for the [read ROW LABEL]?** code	**From whom did you acquire the seeds?** code
		Q.qty	U.unit		Q.qty	T.time	C.cost		Q.qty	U.unit	C.cost		Q.qty	U.unit	C.cost		
Groundnut	226																
Pigeon Pea	332																
Cowpea	550																
Sesame	446																

Seed Type Codes (Q11)		**Seed Source Codes (Q12)**		**Unit Codes**					
1	Improved variety	1	NGO (write name)	00	100kg sack	10	liter	30	months
2	Hybrid	2	DPA/local government	01	90kg sack	11	25L	31	weeks
3	Other (write in)	3	Madal	02	70kg sack	12	20L	32	hours
		4	Boror	03	60kg sack	13	10L	33	minutes
		5	FISP	04	50kg sack	20	km		
		6	MCA	05	25kg sack	21	Sq. km.		
		7	ACDI-VOCA	06	12.5kg sack	23	ha		

[2] Standardized codes for farms areas will be added, after consulting with our survey firm.

HH ID |__|__|__|__|__|__|__|__|__|__|

Section K: FISP extension services: Alternative crops										
Enumerator Instructions: *Complete one row at a time before asking questions about the next product/row.*										
1	2	3	4	5	6		7	8	9	10
crop	**code**	**In the last 5 years, have you received any extension services regarding [read ROW LABEL]?** 1-Yes 2-No►Q5	**From whom did you receive these services?** (code)	**Did you receive seeds from the source in Q2?** 1-Yes 2-No►Q7	**Over the last 5 years, how much seed do you estimate you received?**		**Did you receive training on to properly plant and harvest [read ROW LABEL] from the source in Q2?** 1-Yes 2-No	**Did you cultivate [read ROW LABEL] before FISP?** 1-Yes 2-No	**Do you have access to seeds for [read ROW LABEL] for future planting?** 1-Yes 2-No	**From whom do you receive seeds now?** (code)
					Q.qty	U.unit				
Groundnut	226									
Pigeon Pea	332									
Cowpea	550									
Sesame	446									

Extension Service Codes:		**Seed Receipts codes (Q10):**		**Unit Codes:**					
99	Madal	1	NGO (write name)	00	100kg sack	10	liter	30	months
98	ACDI-VOCA	2	DPA/local government	01	90kg sack	11	25L	31	weeks
97	Local government (DPA)	3	Madal	02	70kg sack	12	20L	32	hours
96	MCA	4	Boror	03	60kg sack	13	10L	33	minutes
95	FISP	5	FISP	04	50kg sack	20	km		
94	NGO (give name)	6	MCA	05	25kg sack	21	Sq. km.		
		7	ACDI-VOCA	06	12.5kg sack	23	ha		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section L: Other on-farm Income/Production													
Enumerator Instructions: *DO NOT include crops from section L. Complete one row at a time before asking questions about the next product/row.*													
1►	**Would you say your off-farm activities are the principal or secondary source of income?** (1-principal, 2-secondary, 3-does not have this type of income)												
2►	**Apart from coconuts and its byproducts, did you cultivate any other crops in the last 12 months?** (1-yes►Q2 2-No►M)												
	2	3	4		5	6	7		8		9	10	
Crop Code	**Did you harvest this crop in the last season?** 1-Yes 2-No►next crop	**How many times did you harvest in the last 12 months?**	**How much did you harvest?**		**Did you have any losses after harvest that prevented the crop from being sold or consumed?** 1-Yes 2-No►Q7	**How much was lost in the last 12 months?**	**How much of this crop have you sold in the last 12 months?**		**What is the total estimated value of your sales for this crop over the last 12 months?**		**Did you cultivate this crop 5 years ago?** 1-Yes 2-No	**Would you say you rely more or less on this crop for income than you did 5 years ago?** 1-more 2-less 3-same	
			Q.qty	U.unit			Q.qty	U.unit	Q.qty	U.unit			

Crop Codes														Unit Codes					
111	abobora	118	ervilha	125	tomate	228	F. manteiga	235	F. oloko	336	papaia	445	girassol	00	100kg sack	10	liter	30	months
112	alface	119	melancia	222	Milho	229	F. Nhemba	330	banana	337	tangerina	23		01	90kg sack	11	25L	31	weeks
113	alho	120	pepino	223	Arroz	230	F. Jugo	331	limao	440	algodao	447	soja	02	70kg sack	12	20L	32	hours
114	beringela	121	Pimenta	224	Mapeira	331	F. Boer	332	laranja	441	tabaco	448	paprica	03	60kg sack	13	10L	33	minutes
115	cebola	122	piripiri	225	Mexoeira	232	Batata reno	333	goiaba	442	sisal	449	genibre	04	50kg sack	20	km		
116	cenoura	123	quiabo	226		233	mandioca	334	manga	443	Cha folha	450	cajuiero	05	25kg sack	21	Sq. km.		
117	couve	124	repolho	226		234	F. verde	335	abacate	444	Cana doce			06	12.5kg sack	23	ha		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section M: Off farm income

Enumerator Instructions: *Complete questions 1 and 2. Write the gender of each household member that generated income from off-farm activities in the last 12 months. For each member, complete questions 3-11 one row at a time.*

1 ▶	**Would you say your off-farm activities are the principal or secondary source of income?** (1-principal, 2-secondary, 3-does not have this type of income)	

2		3	4	5	6	7	8	9		10	11*
How many household members generated income form off-farm activities in the last 12 months? *Enter number, then list the gender (M/F) of the household member below (rows 2A-2D)*		**What type of work was it?** (codes)	**Type of employer?** (codes)	**Where was this work done?** 1-within aldeia 2-within district 3-within province 4-maputo 5-other province 6–other country (specify)	**In the last 12 months, did [LIST] work every month?** 1-Yes 2-No▶Q9	**Did [LIST] make a monthly salary?** 1-Yes 2-No▶Q9	**How much per month?**	**How much was [LIST] compensated for the work?**		**Did [LIST] work this job before CLYD infestation?** 1-Yes 2-No	**What is [LIST]'s average monthly income from off farm sources (estimate for entire household)?**
Number▼								A.amt	U.unit		
List▼ 2A											
2B											
2C											
2D											

Unit Codes						**Type of work codes (Q3):**				**Employer codes (Q4):**			
00	100kg sack	10	liter	30	months	900	agriculture	907	mechanic/construction	800	Family farm	807	government
01	90kg sack	11	25L	31	weeks	901	Fishing	908	driver	801	Medium/large farm	808	Other (specify)
02	70kg sack	12	20L	32	hours	902	Hunting	909	Domestic worker	802	Ranch		
03	60kg sack	13	10L	33	minutes	903	Agro-pecuario technicain	910	Other specialized labor	803	Factory		
04	50kg sack	20	km			904	Public nfunstionary	911	non-specialized labor	804	Estate		
05	25kg sack	21	Sq. km.			905	Professor/			805	Commericial		
06	12.5kg sack	23	ha			906	manager, accountant			806	NGO		

HH ID |__|__|__|__|__|__|__|__|__|__|

Section N: CLYD Knowledge and Practice (KAP) *(whole section is experimental)													
1	2	3	4	5				6	7	8	9	10
What is the first sign that a coconut tree has CLYD? 1-yellow leaves 2-broken leaves 3-dropping leaves 4-reeduced coconut production 5-smell 6-taste of coconut 7-don't know 8-other (write in)	**How is the disease spread from tree to tree?** 1-insect 2-wind 3-bird 4-humans 5-don't know 6-other (write in)	**What is the best way to manage the disease once a tree is infected?** 1-cutting trees 2-cutting trees and burning trunk 3-cutting trees, burning trunks and stumps 4-Leave tree to die in field 5-Pesticide 6-herbicide 7-Other (write in)	**After cutting it, should you also remove the stump?** 1-yes 2-no 3-doesn't matter 4-don't know	**On average, how is production affected by CLYD?** *Enter amount pre and post CLYD infection.*				**Which coconut varieties are most affected by CLYD?** 1-dwarf 2-giant 3-hybrid 4-green 5-yellow 6-red 7-other (write in)	**Does age of the tree affect its resiliency to CLYD?** 1-yes 2-no 3-don't know	**Since 2008, have you seen more or less of your trees affected by CLYD?** 1-more 2-less 3-same	**At what age do coconuts trees become vulnerable to CLYD?** 1-from the moment you plant 2-after 1 year 3-after 2 years 3-after 5 years 4-Only when plant is in adulthood 5-other (write in)	**In your opinion, which do you think has a greater effect on coconut production?** 1-oryctes 2-CLYD 3-don't know
				PRE		POST						
				A.amt	U.unit	A.amt	U.unit					

Unit Codes					
00	100kg sack	10	liter	30	months
01	90kg sack	11	25L	31	weeks
02	70kg sack	12	20L	32	hours
03	60kg sack	13	10L	33	minutes
04	50kg sack	20	km	34	Write in
05	25kg sack	21	Sq. km.		
06	12.5kg sack	23	ha		

HH ID |___|___|___|___|___|___|___|___|___|___|

HH ID |__|__|__|__|__|__|__|__|__|__|

Number	Research Question	Evaluation Method	Data Collection Methods	Data Requirement	Corresponding Qs in Survey
1	What is the impact of the technical assistance provided by the project on coconut production?	Income impact evaluation, focused on production in the FISP evaluation sample; not representative for the region	Household survey	Current production of coconut and cost of technical assistance (for ERR)	Sections G1,G1,G3, and H
2	How did the evolving program logic affect the scope of implementation activities?	Process evaluation	Key informant interviews	Interviews with MCC, MCA, and implementers	NA
3	What is the impact of technical assistance provided by the project on income diversification due to the introduction/adoption of high-value crops?	Income impact evaluation.	Household survey	Income diversification index (project/non-project zones) and rate of adoption of high-value crops[1]	Section L and N
4	What is the potential increase in coconut supply in the Zambézia and Nampula provinces?	Analysis of results from income and disease impact evaluation.	Household survey	CLYD incidence, survival rate of seedlings, tree productivity	Sections G1, G2, and G3: Q4
5	What is the present rate of CLYD incidence on adult trees in the FISP intervention zone?	Measurement of CLYD incidence.	Biophysical survey of trees in endline.	Number of infected trees by total trees, per hectare project and non-project zones in epidemic areas	NA
6	What is the efficiency of the FISP in reducing CLYD incidence?	Disease impact evaluation	Aerial photographs for baseline, biophysical survey	Current CLYD incidence and historic CLYD incidence (in both project and non-project zones); cost of project	NA
	What is the efficiency of the FISP in reducing disease spread rate?	Case study with time series analysis.	Panel of satellite images.	Disease incidence from 2006-2014 in treatment and control sites.	NA
7	To what degree must post-Compact (September 2013) felling activities be scaled up to keep disease spread rate at less than 2 percent?	Combined assessment.	Derived metric	Current CLYD incidence and cost per percent reduction in rate of spread (from # 6)	NA
8	What are the results of the ERR with sensitivity analysis around variable CLYD infestation rates?	Combined assessment to support ERR.	Derived metric	ERR variables	NA
9a	What is the impact of the project on the post-planting care of the coconut seedlings?	Income impact evaluation.	Household survey	Post-planting care training and planting of CYLD resistant varieties of coconut seedlings in project and	Section H: Q6-Q11

Number	Research Question	Evaluation Method	Data Collection Methods	Data Requirement	Corresponding Qs in Survey
				non-project zones	
9b	What is the impact of post-planting care on the survival rate of the seedlings?	Regression analysis.	Household survey	Post-planting care and survival rate of seedlings	Section H: Q3-Q5
10	What was the impact of the project on the incomes of participating farmers in the endemic and epidemic areas?	Income impact evaluation	Household survey	Net incomes of farmers in project and non-project zones, disaggregated by endemic and epidemic areas	<u>Summation of:</u> Section D: All Q Section G1: Q6 Section I: Q8, Q12 Section L: Q7, Q8 Section M: Q8, Q9, Q11
11	How has the promotion of high-value crops affected household incomes in communities that grew them before, compared to those that did not grow them prior to project intervention?	Income impact analysis, with qualitative analysis to assess incremental impact of high value crops.	Household survey and focus group discussions	Contribution of high-value crops to income and total net income in project vs. non-project households	Section I: Q8-Q12
12	What was the impact of the BDF (Activity 4) on the aggregate income in the beneficiary population?	Case studies	Project documents, and interviews.	Profit and loss statements, job creation figures, estimated multiplier effects	NA
13	How have research and development activities aided in the development of CLYD-tolerant seedlings?	Case studies	Technical review	Research proposals and reported results	NA
14	Have the project impacts been different for men and women?	Income impact evaluation with qualitative methods.	Household survey and focus groups	Disaggregated household data and qualitative assessments	Section B: Q2-Q5
Income diversification index: $S_k=(Y_k/Y)$ and $D=\sum_{k=1}^{n}[1/(S_k)]$ where Y_k is total income from source *n* (n=number of sources) and Y is total household income. Using this technique, D will be the diversification "score" and the higher the number, the more "diverse" the household income (Ersado, 2003).					

HH ID |___|___|___|___|___|___|___|___|___|___|

FGD Instrument

Qualitative FGD Instrument

1 What has changed to make your household better (worse) off in the last 5 years
2 Why did your HH change its:
  - main economic activity
  - main construction material used for the walls of the house?
  - main material used for the roof of the house?
  - toilet facility
  - floor in the household
  - main source of water
  - primary cooking fuel
  - lighting
  - most important source of nutrition

3 Why did you decide to acquire/How do you use:
  - bicycle
  - Latrine
  - Mobile Phone
  - motorcycle
  - pulveriser
  - Radio
  - refrigerator
  - Storage Silo
  - tractor
  - Vehicle

4 How do you decide which crops to grow on each plot?
5 How do you decide which coconut variety to cultivate?

6 Is CLYD getting better or worse?
7 Why do choose the technique for
  - care for coconut seedlings
  - pest control
  - combating the cause of seedling loss

8 How did you learn about these techniques?
9 How effective have these techniques been in preventing infection by CLYD?
10 How effective has cutting and burning infected trees been in preventing infection by CLYD?
11 Have you cut down any infected trees since the last time an organized group of men came to cut down infected trees?

12 What has changed to increase (decrease) production of:
  - Coco

- Copra
- Lanho
- Sura

13 Is it becoming easier or harder to sell these products?

14 What kind of extension service was the most (least) useful for coconut cultivation?
15 Who provided the best (worst) service? What is the primary factor that made it best/worst?
16 Which techniques recommended by an extension service are you still using?
17 What made you decide (or not) to use a technique recommended by an extension service?

18 Why did you decide to start growing:
- Groundnut
- Pigeon Pea
- Cowpea
- Sesame

19 What is the most important advantage (disadvantage) to growing [GPCS]?
20 Will you continue to grow the same amounts of [GPCS] and if not, why? How have the prices for each changed over time? Is there a general trend?

21 How did you learn about fertilizer and pesticide use?
22 At what time of year and for what tasks do you use hired labor?
23 How do you decide whether to use fertilizer and pesticides or herbicides?

24 What kind of extension service was the most (least) useful for [GPCS] cultivation?
25 Who provided the best (worst) service? What is the primary factor that made it best/worst?

26 Which crops do you intend to cultivate more (less) of and why?
27 Will you change any post harvest practices to diminish losses?
28 For any new crops that you have started cultivating recently, why did you decide to start growing the crop?

29 Will your HH be engaging in more or less off-farm work and if so why? What are the differences in intra-household farm labor allocation before and after the project?

30 Has your knowledge about CLYD and its effects changed and if so how did you obtain the new information?
31 How much would all you farmland be worth if you sold it today? How does that compare to the cost of renting the same amount of land in this area?
32 If you plant 100 seedlings, how many would survive, on average?

33 What are the main causes for seedling to die in this region?

BDF Instrument

Broad Quantitative-Qualitative questions for BDF firms

Qualitative

1 Do you have records of the firm's income and expenses since you started using the FISP-supplied asset?
2 How did you decide to participate in the BDF program?
3 Why was your firm selected?
4 Timeline - How long did it take from the time of selection to your starting to use the asset?
5 How was the asset selected?
6 Is the asset for a new activity? Or ongoing/already experienced with?
7 What was the process for obtaining the asset? Did you experience any challenges or problems in obtaining the asset?
8 How has the asset affected your business? In terms of sales, employment, processing, outputs, etc.
9 Do you have any employees? Has the asset had an impact on the number of people employed?
10 Have sales improved/declined/stayed the same since you started using the asset? Why do you think this happened?
11 Describe problems at any point (in using the asset, etc.)
12 What future do you see for the firm?

Quantitative

1 When was the firm selected to receive an asset?
2 When did the asset enter service?
3 What was the cost of the asset?
4 Did you invest additional amounts to put the asset into service?
5 What were the sales of the firm in the full year before receiving the asset?
- First full year?
- Most recent full year?
- Each intervening full year since receiving the asset?

6 What was the net income of the firm in the full year before receiving the asset?
- First full year?
- Most recent full year?
- Each intervening full year since receiving the asset?

7 How many employees including the owner did the firm have in the full year before receiving the asset?
- First full year?
- Most recent full year?

- Each intervening full year since receiving the asset?

8 Of these how many were female in the full year before receiving the asset?
- First full year?
- Most recent full year?
- Each intervening full year since receiving the asset?

9 Of these how many were seasonal in the full year before receiving the asset?
- First full year?
- Most recent full year?
- Each intervening full year since receiving the asset?

10 How much did the firm pay in wages in the full year before receiving the asset?
- First full year?
- Most recent full year?
- Each intervening full year since receiving the asset?