Cacao Intensification in Sulawesi: A Green Prosperity Model Project

K. Moriarty, M. Elchinger, G. Hill, J. Katz, and J. Barnett

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Work for Others Report
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September 2014

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NATIONAL RENEWABLE ENERGY LABORATORY

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Abbreviations and Acronyms

AMDAL	full environmental assessment
CF	counterfactual
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
CSP	Cocoa Sustainability Partnership
DOE	U.S. Department of Energy
ERR	economic rate of return
ESMS	Environmental and Social Management System
FAS	Foreign Agriculture Services
GP	Green Prosperity
ha	hectare
ICCO	International Cocoa Organization
ICCRI	Indonesia Coffee and Cocoa Research institute
IDR	Indonesia rupiah
IFC	International Finance Corporation
IPB	Bogor Agricultural University
IPCC	Intergovernmental Panel on Climate Change
IRR	internal rate of return
kg	kilograms
km	kilometers
m	meters
MCA-I	Millennium Challenge Account – Indonesia
MCC	Millennium Challenge Corporation
NGO	non-governmental organization

NPV	net present value
NREL	National Renewable Energy Lab
RFP	request for proposal
SPPL	letter of commitment to manage the environment
t	ton
tCO2e	ton of carbon dioxide equivalent
UKL-UPL	environmental management and monitoring plan
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WCF	World Cocoa Foundation
WP	with-project
yr	year

Preface

This study supports the Millennium Challenge Corporation's (MCC) Compact with Indonesia.[1] The National Renewable Energy Laboratory (NREL) has contributed to the Compact in many areas including by formulating project evaluation guidance; participating in stakeholder forums; and developing studies of illustrative projects meeting Indonesian and MCC requirements and aspirations.

Green Prosperity, the largest project of the Compact, seeks to address critical constraints to economic growth while supporting the government of Indonesia's commitment to a more sustainable, less carbon-intensive future. An ambitious project, Green Prosperity seeks to contribute to some of Indonesia's most prominent development priorities including increased access to clean and reliable energy in rural areas, and improved stewardship of natural resources.

This report is one of a series evaluating eight model Green Prosperity projects on behalf of MCC and the Indonesian implementing organization, Millennium Challenge Account-Indonesia (MCA-I). Each report reviews the potential of a project centered on a defined geographic area or landscape. Ideal Green Prosperity projects will be designed to improve the economic conditions of the people living in the identified landscape, integrating some combination of renewable energy, natural resources management, and sustainable land-use activities. The eight studies are identified below in Table P-1.

Note that two studies— centered on Rantau Suli village and Berbak National Park—are examples of integrated projects strongly linking renewable energy production, natural resources management and sustainable land use. The other six studies are also defined in a landscape context, but focus more on particular project types identified in the Compact. All of the project types explored in the series of eight model studies can be considered by project developers and sponsors for any landscape, and in any combination that makes sense in a local context.

Each study includes a project description; technical analysis; economic assessment; environmental and land-use impacts; and social implications. Other potential energy or land-use activities are also often noted. The studies are intended to serve as examples for potential project sponsors, who may choose to propose something similar, or who may be inspired to propose some other innovative project. Further, the technical, economic, environmental/land use, and social discussions and analyses in these studies are intended to help guide the assessment of proposals submitted to MCA-I for Green Prosperity funding.

This report does not constitute an endorsement of the identified projects by anyone and does not give the identified projects preferential status for funding. Additional detailed analysis of formal proposals would be needed prior to any investment decision.

[1] Additional information about the Millennium Challenge Corporation's Indonesia Compact is available at http://www.mcc.gov/pages/countries/program/indonesia-compact.

Table P-1. The Eight Model Green Prosperity Projects

Model Project	Kabupaten/Province	Emphasis
Rantau Suli Integrated Project	Merangin, Jambi	Mini-hydropower, with protection of forested catchment area
Berbak National Park Integrated Project	Muaro Jambi, Jambi	Forest protection and restoration, with off-grid solar photovoltaic power production
Methane Capture for Power Generation	Muaro Jambi, Jambi	Power production from methane captured from palm oil mill effluent
Cacao Intensification	Mamuju and Mamasa, Sulawesi Barat	Training to improve cacao yields, as an example of agricultural intensification
Karampuang Island Solar Photovoltaic Electricity	Mamuju, Sulawesi Barat	Solar photovoltaic power for an island, with project options including connection to the mainland grid
Grid-Tied Mini-Hydropower	Mamasa, Sulawesi Barat	Assessment of a larger mini-hydropower project
Community Agroforestry	Mamuju, Sulawesi Barat	Forest boundary protection through community-based peripheral agroforestry
Aggregated Micro-Hydropower	Mamasa, Sulawesi Barat	Transaction/implementation cost reduction through aggregation of small projects

Executive Summary

Cacao is an important cash crop in Indonesia, cultivated by an estimated one million smallholders, and is an important economic driver in rural Sulawesi Island. Indonesia is the third largest cocoa bean producer in the world in a market where demand has exceeded supply in recent years. Changes in Indonesian policy and export taxes have led to a significant increase in downstream cocoa processing activities within Indonesia, supporting many jobs. Cacao smallholders are suffering from declines in production negatively impacting household income. The two most significant reasons for low production are aging trees and pest infestations. Indonesia's cacao boom started in the early 1990s and many trees have reached an age of 20 to 25 years, when they are no longer productive. The cacao industry estimates that pest infestations reduce yield by 40%. Cacao uses more land than other crops in Green Prosperity's starter districts of Mamuju and Mamasa in West Sulawesi province.

This model project, set in selected cacao-growing landscapes of Sulawesi Island, explores the impacts of two established types of training which the cacao industry has identified as the best methods for improving production and smallholder income: farmer field schools (FFS) and cocoa development centers (CDC). As is the case for all eight model studies developed for the Green Prosperity project, it is not expected that this illustrative project would necessarily be implemented in the form assessed in this report; rather, the methodologies of assessment and analysis described and employed here are intended as a guide to how well similar agriculture intensification projects can meet the various Green Prosperity program requirements.

This model project is based on the premise that education and training can substantively improve economic outcomes for the smallholders; it is not assumed that the smallholders lack knowledge of how to effectively manage their farms, but they may not know how and when to make changes that would positively impact their income. Moving smallholders from knowledge to action in implementing interventions is a function of a smallholder's belief in the benefits of the intervention, labor required, and availability of inputs. While some smallholders are already aware of the techniques taught in training, many lack understanding of the underlying causes of why their production is declining.

This study examines the effects of farmer field schools (FFS) in good agricultural practices (GAP) of interventions known to improve yield. FFS teach interventions including pruning, replacing aging trees with quality seedlings, grafting, sanitation, fertilizer and pesticides, all of which are evaluated in the economic model of this study. The FFS also teaches composting, certification, and fermentation which are not included in the economic model due to an unclear benefit to smallholders for composting and certification. Fermentation is described in the study but not considered in the economic model due to a reluctance of smallholders to adopt the technique due to a belief that any potential profit may be eliminated in the days it takes to complete the process, dry, and sell the cocoa beans. The cacao industry states that yields can be improved from current levels of around 500 kilograms (kg)/hectare (ha) to 1 ton (t)/ha through labor-intensive but inexpensive steps of pruning, tree replacement, grafting, and sanitation. The only way to reach yields of 2 t/ha and above is to use fertilizer and pesticide, which many smallholders lack the cash or credit to purchase at the time it is needed. There are several existing mechanisms for cacao smallholders to borrow money but they are not available to the entire community since loans typically require a bank account, land certificate, or membership in farmer's group. While this study does not evaluate access to credit, a project funded by U.S. Agency for International Development (USAID) is directly addressing this issue with a novel approach of credit schemes implemented through mobile phones.

In the model project assessed in this report, a subset of 600 motivated cacao smallholders would receive intensive training at CDC to serve as a rural network of entrepreneurs providing inputs and services to other cacao smallholders in their area. These individuals could be the leaders of farmer groups or other individuals identified by collectors, communities, or trainees who excelled in the initial FFS currently deployed in Sulawesi. These entrepreneurs are called cocoa doctors and the economic model includes costs to train and establish their businesses. The model does not include potential cocoa doctor income due to insufficient information to make estimates and also because it is anticipated that FFS-trained smallholders will be their customers. While data are limited, Mars and Armajaro (an international trade organization) track the progress and profits of cocoa doctors after their CDC training and establishment of their businesses; after 2 years, cocoa doctor profits range from Indonesia Rupiah (IDR) 81 million/year (yr) to IDR 464 million/yr.[2]

Both the FFS and CDC are deployed on a limited scale in Indonesia with funding from donors and the cacao industry. Initial results have been promising; this study was informed by a similar project in Aceh province resulting in high adoption rates and increased income. Other FFS in Africa have demonstrated promising results in increased production and income for cacao smallholders (Section 2.3.2).

The economic model evaluates the effects of training 60,000 smallholders with a medium-yield group achieving an increase in yield from about 500 kg/ha to 1 t/ha, and a much smaller group using fertilizer and pesticide reaching 2 t/ha. This project meets Green Prosperity's hurdle of a 10% economic rate of return (ERR) and directly meets the goal of reducing poverty through increasing income for cacao smallholders while providing a positive net present value (NPV).

Table ES-1. Economic Results

Economic Results	
ERR	19.00%
NPV (Million IDR)	991,000
NPV (US$)	$88,400,000

There have been several past government and donor projects working with cacao smallholders but none focused entirely on training. The majority of funding dedicated towards Indonesian cacao smallholders was spent on seedlings using novel technology, which resulted in a significant failure upon deployment (see Section 2.3.1).

Project Overview

This project evaluates the impacts of training 60,000 cacao smallholders at FFS and an additional 600 cocoa doctors at CDC to improve their productivity and incomes. The project would also

[2] Based on Mars, Inc. tracking cocoa doctor progress after training and converting $7,000 and $40,000 to IDR at a rate of 1 USD=11,602 on Nov. 20, 2013.

train a subset of motivated cacao smallholders at a more rigorous level, and assist them in establishing small businesses selling services and inputs to cacao smallholders in their area. The trainings are targeted in areas of concentrated cacao land in South Sulawesi (Luwu, East Luwu, North Luwu), South East Sulawesi (East Kolaka, West Kolaka), and West Sulawesi (Mamasa, Mamuju). Villagers in Mamasa and Mamuju derive the majority of their income from agriculture, and cacao land accounts for more land use than other crops. The decline in cacao production has negatively impacted household income and the majority of cacao smallholders earn income from other sources such as rice farming. Many cacao smallholders do not understand the reasons for their decline in yield and would benefit from understanding the impacts of aging trees and pests. Learning and implementing the interventions taught at FFS provide them with the skills to increase the productivity of their farms more leading to greater incomes.

It is assumed that this project would be funded equally by cocoa industry companies and Green Prosperity. Companies that derive more income from chocolate are expected to contribute at a greater rate than companies that trade and process cocoa beans since they derive income from numerous commodities. The formation of the Cocoa Sustainability Partnership in Indonesia has brought together many organizations involved in cacao to share data and ideas as they all rely on a continued supply of cocoa beans. Previously, many of these organizations were making independent attempts to fix the issue of declining production without sharing their various successes and failures or ideas and data.

A successful project team will require a coordinated effort by cocoa industry companies and local government—particularly agriculture extension offices and other organizations active in cacao in Sulawesi. FFS are expected to be taught by local trainers such as collectors or local extension office staff and will require 15-20 trainers for the duration of the project. Each CDC would be staffed by two agronomists provided by the cacao industry. Training would be available to cacao farmers of all ethnic and religious groups as well as women and disadvantaged groups.

Technical Assessment

Both the FFS and CDC train the same interventions at different levels, with the CDC being far more rigorous and inclusive of more business training. Interventions in this study were modeled based on the assumption that a medium-yield group would adopt pruning, phytosanitation, side-grafting, and replanting trees, while a smaller subset high-yield group would incorporate all those interventions with the addition of fertilizers and pesticides. A FFS is anticipated as an all-day training once a week for 9-10 weeks while CDC training is for 30 continuous days. These training regimes were developed by Swisscontact and Mars—recognized leaders in cacao smallholder education.

An important intervention taught at FFS is grafting, a technique used both to rehabilitate and increase production of older trees as well as to ensure genetics of seedlings. Cocoa doctors, CDCs and other organizations have budwood gardens which provide smallholders with known high-performing branches to graft onto their trees. Side-grafting is done by making a diagonal cut into a tree and affixing budwood (a small branch) then wrapping the tree with plastic or straw and covering the graft with a plastic bag for a month to protect it. The new branches start producing cocoa pods in 14 to 15 months. Grafting allows the smallholder to continue to earn an income by harvesting pods from existing branches as the grafted branches grow. Cocoa doctors and other quality nurseries top graft all seedlings to ensure the genetics are known. This is accomplished when a graft is performed by cutting off the top of a seedling and attaching a small section of the selected budwood branch to the top of a seedling, which is held in place with plastic rope and covered by a plastic bag. Of all the interventions taught, grafting is the most difficult skill to acquire. Side-grafting costs are estimated at IDR 2,000 per tree if a smallholder does the labor and IDR 5,000/tree if hiring a cocoa doctor to apply the grafts. Some trees are too old to graft and will need to be replaced. This study assumes that if a smallholder farms two hectares, one is replanted overtime and the other hectare is grafted. In reality, some smallholders will be able to graft all trees while others will have much older farms and will need to replace all trees over time as grafts are ineffective on trees past their productive years. A typical cost for a seedling is IDR 5,000.

Both pruning and phytosanitation help to reduce pest infestations on cacao trees and pods. While there is no effective way to remove all pests from cacao farms, it is possible to greatly reduce incidence of pests with these two steps. Pruning is accomplished using shearers to remove leaves, which increase the productivity of a tree by promoting pollination and allowing in the appropriate amount of sunlight for photosynthesis activity. This allows new leaves and pods to form quickly as well as decrease cocoa pod borer (CPB) as sunlight disrupts their reproductive cycle. An agronomist who teaches pruning to smallholders says initially there is resistance to pruning due to the belief that healthy trees are those with the most leaves.[3] Phytosanitation is the removal and burial of diseased cocoa pods, branches, leaves, and weeds. For some smallholders, this may be the most cost effective method for reducing pests.

In order to reach yields of 2 t/ha and beyond, it is necessary to use fertilizer and pesticides. Smallholders have access to these inputs from local cooperatives (KUD) and there is a fertilizer plant in Makassar and it is not subsidized for cacao. Recommended fertilizer at planting is double super phosphate (36%), while nitrogen-phosphorus-potassium (NPK) (15% each nutrient) is recommended for ongoing years. Fertilizer application is recommended after pruning and side-grafting. Pesticide is a combination of insecticide, fungicide, herbicide, and foliar applied with sprayer pack worn on the back. CPB can be reduced from a 40% infestation rate to 10% with the use of insecticide if properly applied at the right time. Rates of application depend on the age of the cacao tree and type of pesticide.

Fertilizer and pesticide application rates and costs are available in Table 6 and Table 7. Fertilizer and pesticides are available and smallholders know where to purchase them, however, they are infrequently used on cacao farms. The most common reason smallholders do not purchase agrichemicals is due to a lack of money at the time they are needed and/or a lack of access to credit.

Other interventions are discussed in this study, but they are not included in the economic model because the value to smallholders is not clear. Fermentation of cocoa beans is a process that releases the familiar chocolate flavor common throughout the world. It is a biological process that takes about 5 days to complete and reduces the weight of cocoa beans by 7% to 8%. The positive reasons to ferment beans include enhancing flavor as the process reduces tannin content

[3] Information provided by a Mars agronomist who trains cocoa doctors at the Cocoa Development Centre in Wotu.

responsible for the bitter taste of raw beans, with a potential premium price (up to IDR 2,000/kg), and consistency with the rest of the world market. From a market standpoint, Indonesia's unfermented bulk filler beans with high fat content are valued as filler in chocolate products and Indonesia does not have significant competition in this market. The reason smallholders find fermentation risky is a belief that the premium could disappear in the days it takes to ferment as well as the reduction in weight of cocoa beans. Fermentation was not included in the economic model because smallholders are aware of the technique but unlikely to adopt it due to time it takes and the potential for the premium (IDR 1,000 to 2,000/kg) to evaporate as cocoa bean prices are constantly changing and smallholders are aware of price changes because they receive them on their mobile phones from collectors and traders.

Certification was another alternative considered but not included in the economic model because it is not clear if there are financial benefits for Indonesia smallholders. Certification is a process whereby smallholders are evaluated and approved based on sustainable GAP, protection of the local ecosystem, and safe working conditions. Demand for certified cocoa comes from importing nations, not from producer countries. Certification requires smallholders to document and make changes to their farm management practices. It is common in Indonesia for traders to pay for fees and hold the certification credential. Coffee and oil palm have encountered the issue of certified product exceeding demand; and in this situation, the products are sold to conventional markets, and no premium is paid. The cacao industry estimates a premium of 5% to 15%, but it is not clear if Indonesian smallholders receive any of the premium.

Economic Assessment

The Cacao intensification project performs well economically primarily because the productivity of the existing crop is low and the opportunity for incremental improvements to yield are significant with relatively modest associated cost increases. While the assumptions made in the cocoa industry proposal about adoption are optimistic, even with very conservative inputs, the project performs favorably. Under reference case assumptions, the project's ERR is 21.0% with a NPV of IDR 1,070 billion. This analysis is conducted assuming a grant is offered to the Cocoa Development Program with equal cost sharing arrangement between MCA-I and cocoa industry partners. The total MCA-I contribution is IDR 184 billion which includes overhead.

The main economic risk for this project involves assumptions about the counterfactual behavior of smallholders. While conservative assumptions about land productivity were modeled, other outcomes are possible. The model considers a constant, low-level yield using the last five year average for the counterfactual. Sensitivity analyses were performed for prominent counterfactual variables to determine the impact of various assumptions on economic results. With very conservative inputs (i.e., relatively high counterfactual yields and prices), the project still performs positively. At counterfactual annual land productivity values (price by yield) below IDR 13,500,000, the project delivers an ERR above 10%. A full assessment of alternative crop prices and yields would reveal the impact of each alternative, but from an economic perspective, there is relative certainty that the project would perform well.

The with-project yields, made possible by new farming techniques, are known with more certainty, but could be impacted by weather and long-term changes to crop management. There is, however, some uncertainty over how many smallholders ultimately adopt the new techniques and when they adopt them. The cocoa industry proposal contains optimistic adoption estimates, but with more conservative estimates the project performs well economically.

There have been several past government and donor projects working with cacao smallholders but none focused entirely on training; a summary of these projects is available in this report (Section 2.3.1).

Environmental and Spatial Land Use Assessment

The cacao intensification project is a training program with little to no environmental impact beyond very minimal construction or roofing at CDCs and travel of smallholders to CDC locations and facilitators to cacao smallholder land for FFS. There is the potential for environmental impacts as FFS trainees begin implementing the interventions they learned. Pruning and grafting would result in healthier trees, greater photosynthesis activity, more branches, cocoa pods, and biomass positively impacting the land. The sanitation of removing dead pods, leaves, and branches and burying them would return nutrients to the soil. The increase in cocoa pods would further help the soil as empty pods are placed in rows between trees returning organic matter to the soil. Some cacao smallholders are returning to harvest rattan and other wood out of the forest as a source of income, which did not occur much during good cacao production years and could negatively impact forests [1]. It is estimated that 8,000 of the 60,000 smallholders trained at FFS would use pesticides and fertilizer at a future date, which could negatively impact the environment. If the program is very successful and yields grow rapidly, there is the risk that smallholders would encroach onto forest and other lands to grow more cacao. The decline in cacao production has caused some smallholders to abandon their farms, leading to weeds and unhealthy trees, which pose a fire threat. Training resulting in greater yield could encourage smallholders to return and manage their cacao land, which would reduce fire risk.

Using available data and the Intergovernmental Panel on Climate Change (IPCC) default methodologies to estimate greenhouse gas (GHG) emissions impacts of agricultural intensification, this analysis indicates that the model project will not significantly reduce GHG emissions even under optimistic, conservative assumptions. Due primarily to the emissions associated with the production and application of fertilizer on high-yield plots, intensification of cacao could increase GHG emissions by 327,500-1,856,000 tCO_2e over 25 years. To realize net GHG reduction, fertilizer application across the farms adopting high-yield practices would need to be approximately halved from the current with-project assumptions.

However, the potential GHG sequestration benefits of practices such as pruning and phytosanitation were not quantified in this analysis due to data and methodological limitations. Therefore, actual GHG emission impacts associated with cacao intensification may be marginal. It is possible that a better accounting—and different results—could be achieved using more analytically-intensive growth models and site-specific data that accounts for the positive impacts of improved management practices. Based on project assumptions and existing literature, the following conclusions can be drawn:

- The production and application of synthetic fertilizers on high-yield farms would result in significant GHG emissions [up to 58,000-66,000 t carbon dioxide equivalent (CO_2e)/year, or up to 1.5 million tCO_2e over 25 years , assuming all high-yield farms applied fertilizer at the recommended rates]

- The initial clearing of farmland to plant higher quality cacao species would result in high one-time emissions (708,000-1,417,000 tCO_2e). However, these emissions would be offset as the new cacao trees grow and store carbon in aboveground woody biomass. Assuming that the new and current cacao species store equal amounts of carbon at maturity, the greatest net carbon storage will occur on farms where the density of new cacao trees exceeds the density of the original trees. Conservatively, carbon sequestration associated with planting new trees would reach 141,000-425,000 tCO_2e over 25 years. On the other hand, if new trees are planted less densely, approximately 283,000 tCO_2e may be emitted.
- No quantitative data are available on carbon storage in grafted cacao trees, nor on the rate of biomass accumulation in grafted trees. As an illustrative example, if grafted trees accumulate 10% additional carbon over their lifetimes relative to the baseline Sulawesi cacao tree, net carbon sequestration could increase by 70,840-141,680 tCO_2e (depending on the original density of cacao trees) over all 48,000 plots that graft 1ha. However, a conservative analysis would assume that the trees grafted with the new species are no longer accumulating carbon over their lifetimes because they have reached a steady state in which growth rates have slowed and are offset by natural mortality, pruning, and other losses.
- The addition of shade trees to intensified cacao plantations has the potential to improve aboveground carbon stocks relative to the baseline system (by 192,000-480,000 tCO_2e over 25 years); however, training and awareness-building—and possibly incentives—may be needed to encourage farmers to maintain shade when higher cacao yields are associated with full-sun systems.
- Several impacts that have not been quantitatively estimated in this prefeasibility-level analysis may have positive effects on carbon stocks in cacao plantations. These impacts are associated with practices—such as pruning and sanitation—that will add biomass and return more nutrients to the soil. Additionally, the impact of fertilizer on soil carbon storage and aboveground biomass has not been estimated in this study, but may help to offset some of the losses associated with fertilizer use. On the other hand, increased emissions associated with the production of pesticides and herbicides have also not been estimated and could increase net emissions.
- Due to the lack of historical evidence that improved productivity alone can discourage deforestation and degradation of local forestlands, this prefeasibility study does not consider cacao intensification to be a direct mechanism for reducing emissions associated with deforestation in Sulawesi. Though intensification may play a role in influencing land conversion, policy and economic interventions beyond the scope of this model project would very likely be necessary to ensure sustained forest conservation and realize the (potentially significant) GHG benefits associated with avoided deforestation.
- A more conclusive study of GHG emissions from cacao intensification should be based on the development and use of land-use and growth models, as well as site-specific data that can account for the numerous factors and dynamics at play in cacao intensification scenarios.

There is little information on the environmental impacts of agricultural intensification on existing lands. A full feasibility study should further explore this topic, with the assistance of the cacao industry and perhaps the International Institute of Tropical Agriculture, which has studied environmental impacts of cacao in West Africa.

Social Assessment

The majority of Mamuju (88%) and Mamasa (71%) populations earn income from agricultural activities [1,2]. In both districts, cacao is the dominant use of agricultural lands with lesser amounts of corn, rice, and oil palm grown in Mamuju, while other major crops in Mamasa are rice and coffee in the highlands. These districts are inhabited by various ethnicities including those native to Sulawesi and migrants with a mix of Muslim and Christian communities. Farmers groups are formed among villagers of the same ethnic and religious groups. The decline in cacao yield has negatively impacted smallholders as this has long been a source of cash income. The majority of cacao smallholders earn income from other sources, typically other agricultural commodities such as rice. Daily labor rates in South Sulawesi and West Sulawesi range between IDR 35,000 and 50,000 per day for agriculture, construction, and other day labor jobs.[4] Improving cacao yield on existing land would increase smallholder incomes and discourage encroachment into forest and other lands. Increasing cacao production in Sulawesi would also benefit downstream users of cocoa beans including local collectors/traders, international traders, processors, and manufacturers, which support a significant number of jobs in Sulawesi and Java.

Both men and women labor on cacao lands, with men typically responsible for planting and pruning while women weed; both harvest. Women tend to be responsible for finances in cacao households. FFS exist on a small-scale in Mamuju, but not in Mamasa as the cocoa industry has invested funds in areas with the most cacao lands and production. FFS, administered by Swisscontact in Sulawesi and Sumatra, have been fairly successful in reaching their target of 20% participation by women.

Project Risks

As a training program, there are no substantial technical risks as both FFS and CDC are already deployed in Indonesia on a limited scale. Cost share of cash and in-kind services from cacao industry project sponsors would need to be established prior to the start of the project to ensure that the project is fully funded. The risk exists that smallholders would decide that the extra labor effort of interventions is not worth the effort and use of their time on other crops or income opportunities. It would be important for facilitators/trainers to encourage smallholders to practice techniques and visit demonstration plots too highlight how interventions lead to greater productivity and income. Past cacao FFS in Aceh, Sumatra, demonstrated high implementation of interventions and increases in income. Any agriculture project and crop production could be impacted negatively by climatic conditions such as flooding or drought. FFS need to be made available to smallholders from different ethnic and religious groups as well as women, cacao day laborers, and any other marginalized groups interested in training.

[4] Based on site visits by NREL in June 2013 in South Sulawesi and West Sulawesi.

Conclusions

Cacao smallholders are suffering economic hardship due to declines in their productivity over the past several years, and this project could help to sustain and grow an existing cash commodity that not only supports an estimated one million smallholders, but also many downstream marketing and manufacturing jobs. Opportunities for using their land for other crops are somewhat limited as rice requires irrigation, oil palm requires proximity to a palm mill, coffee grows optimally at higher elevations, and crops like corn or potatoes are unlikely to provide a higher income. The interventions to improve yield are well known, but even smallholders aware of these techniques may not have the knowledge of how and when to apply the interventions. FFSs explain the reasons for yields loss and teach the interventions through classroom lessons and practice. Additionally, training cocoa doctors at CDCs provides an opportunity for greater income, extends the donor program to reach more smallholders and provides for expert knowledge to exist after the project ends. The cocoa doctors would operate for-profit businesses providing knowledge, training, services, and inputs to smallholders in their area. Both of these activities serve Green Prosperity's primary goal of reducing poverty, however, impacts on GHG emissions could be marginal or potentially negative and therefore must be assessed carefully in a full feasibility study since net GHG emissions reduction is a Compact requirement for NRM/SLU projects. Green Prosperity could have a solid sponsor for this type of project with the participation of cacao industry stakeholders, supporting the project through funds and experienced staff. Certainly any agricultural project is subject to the risk of climatic conditions where smallholders could do all that is necessary to improve their yield only to have negative impacts of drought, floods, or other weather impacts.

This project evaluation is intended to provide helpful guidance to sponsors developing similar projects, and to evaluators of agriculture intensification proposals submitted to MCA-I in application for Green Prosperity funding.

Table of Contents

Preface ..... **vi**
Executive Summary ..... **viii**
Project Overview ix
Technical Assessment x
Economic Assessment xii
Environmental and Spatial Land Use Assessment xiii
Social Assessment xv
Project Risks xv
Conclusions xvi
List of Figures ..... **xviii**
List of Tables ..... **xix**
1 Project Overview **1**
1.1 Project Location and Natural Features 1
1.2 Current Population and Economic Activities 2
1.3 Project Description and Rationale 3
1.4 Project Logic 5
1.5 Project Team 8
1.6 Project Site 8
1.7 Project Implementation Plan 9
2 Technical Assessment **11**
2.1 Resource Assessment 11
2.2 Technical Approach 23
2.3 Donor History and FFS Literature Review 38
2.4 Current Baseline 44
2.5 Operational Feasibility 49
2.6 Technical Risk Assessment 49
3 Economic Assessment **51**
3.1 Overview of Results 51
3.2 Assumptions 52
3.3 Results 63
3.4 Economic Risk Assessment 77
4 Environmental and Spatial Land Use Assessment **79**
4.1 Environmental Impact Assessment 79
4.2 Compliance with Legal Requirements and Performance Standards 80
4.3 Greenhouse Gas Emissions Impact 83
4.4 Spatial Land Use Planning 95
5 Social Assessment **98**
5.1 Community Impacts 98
5.2 Community Engagement Plan 108
5.3 Impact on Local Labor, Goods, and Services 109
5.4 Mitigation Plan for Identified Social/Gender Risks 109
6 Conclusions **112**
Appendix A: Details of Economic Calculations and Modeling **113**
Appendix B: IPB Supporting Agriculture Data **114**
References **117**

List of Figures

Figure 1. Mamuju area land-use map ... 1
Figure 2. Mamasa area land use map ... 2
Figure 3. Cacao intensification project logic ... 7
Figure 4. Target areas for cacao FFS and CDC ... 9
Figure 5. Historical Indonesian cacao hectares, production, and yield ... 12
Figure 6. Top 5 cacao producers ... 12
Figure 7. Sulawesi Cacao land area maps ... 14
Figure 8. Cocoa grinding capacity by region ... 15
Figure 9. USAID chart of volume and cocoa bean characteristics by country ... 16
Figure 10. Cocoa pests (from left: CPB, Black Pod, VSD) ... 17
Figure 11. International cocoa price ... 18
Figure 12. Indonesia cocoa exports by product in 2009 and 2011 ... 19
Figure 13. Reasons cacao smallholders borrow money ... 20
Figure 14. Where cacao smallholders borrow money ... 20
Figure 15. Side-grafting ... 26
Figure 16. Top grafting ... 27
Figure 17. Equipment for pesticide application ... 29
Figure 18. Impact of FFS in Aceh Province ... 41
Figure 19. Mamuju oil palm land area and production ... 47
Figure 20. Adoption curves for total farmers and cultivation area ... 54
Figure 21. Adoption curves for medium-yield smallholders and cultivation area ... 56
Figure 22. Adoption curves for high-yield smallholders and cultivation area ... 57
Figure 23. Medium Yield Cash Flows by Hectare Type ... 58
Figure 24. High Yield Cash Flows by Hectare Type ... 59
Figure 25. Medium Yield Cash Flows (With Replanting After Grafting) by Hectare Type ... 59
Figure 26. High Yield Cash Flows (With Replanting After Grafting) by Hectare Type ... 60
Figure 27. NPV of Net Income for Each Hectare Type ... 60
Figure 28. Medium Yield Comparison of per-Hectare Costs ... 61
Figure 29. High Yield Comparison of per-Hectare Costs ... 62
Figure 30. Lifetime net project benefits ... 65
Figure 31. Sensitivity of NPV to time horizon ... 66
Figure 32. Beneficiary analysis (percent of project NPV) ... 67
Figure 33. Beneficiary net benefit streams ... 68
Figure 34. Sensitivity analysis results for NPV and ERR ... 70
Figure 35. Tornado chart of sensitivity parameters ... 71
Figure 36. CF crop sensitivities ... 73
Figure 37. Medium-yield crop sensitivities ... 74
Figure 38. High-yield crop sensitivities ... 75
Figure 39. Adoption rate sensitivities ... 76
Figure 40. Double variable sensitivity of project NPV to CF yield and CF price ... 78
Figure 41. Land use in Mamuju ... 96
Figure 42. Land use in Mamasa ... 96
Figure 43. Reasons cacao smallholders save ... 104
Figure 44. Other sources of income ... 104

List of Tables

Table P-1. The Eight Model Green Prosperity Projects vii
Table ES-1. Economic Results ix
Table 1. Population and Income Sources in Mamuju and Mamasa 3
Table 2. Project Schedule 10
Table 3. Cocoa Bean Characteristics 14
Table 4. FFS Impacts 24
Table 5. SCPP Partners 25
Table 6. Fertilizer and Pesticide Application Rates and Costs 30
Table 7. Fertilizer and Pesticide Costs per Year 30
Table 8. Certification Organization Fees and Requirements 36
Table 9. Composted Cocoa Pod Composition 38
Table 10. Impacts of SUCCESS Project 39
Table 11. Impacts on Yield and Income from FFS 43
Table 12. Indonesia Rice and Corn Statistics 45
Table 13. Sulawesi Rice and Corn Statistics 46
Table 14. Mamuju Cropland Use and Production 48
Table 15. Mamasa Cropland Use and Production 48
Table 16. Proposal Cost Breakdown 53
Table 17. Credit needs by hectare and farmer type 61
Table 18. Economic Results (with MCA-I Overhead Burden) 63
Table 19. Economic Results (without MCA-I Overhead Burden) 63
Table 20. Reference Case Assumptions 64
Table 21. Distribution of Net Benefits 66
Table 22. Sensitivity Analysis Parameters 69
Table 23. IFC Environmental Performance Standards 81
Table 24. Relevant Indonesian Environmental Laws 82
Table 25. Illustrative Relationship between Original Cacao Tree Density and Net GHG Emissions in Aboveground Biomass in Intensified Systems (1-ha area) 85
Table 26. Relationship between Shade Tree Coverage and Carbon Stocks on Cacao Plantations in Sulawesi 86
Table 27. Parameters for Estimating GHG Emissions Impacts of Fertilizer Use 90
Table 28. Upper- and Lower-Bound Estimates GHG Emissions from Fertilizer Application 91
Table 29. Parameters for Estimating GHG Emissions Impacts of Forest Protection Activities 93
Table 30. Summary of 25-year GHG Emissions and Sequestration Ranges Associated with Cacao Intensification Practices[a] 94
Table 31. Mamasa Land Use Area 97
Table 32. Villages in Study Area Statistics and Information 99
Table 33. Cocoa Farming Harvest Frequency 101
Table 34. Participatory Assessment Community Ranking of Welfare Indicators 102
Table 35. e-MITRA Survey Results 103
Table 36. Division of Labor 105
Table 37. Access to Resources 106
Table 38. Decision and Gender 106
Table 39. Mamasa Income Source by Gender 107
Table 40. IFC Social Performance Standards 107
Table B-1. Agricultural Activity Calendars in Three Village Study Site 114
Table B-2. Agriculture/Plantation Commodities in Three Village Study Site 115
Table B-3. Kalumpang Village 116
Table B-4. Lumika Village 116
Table B-5. Keang Village 116

1 Project Overview

1.1 Project Location and Natural Features

This project evaluates the impacts of training on cacao smallholders throughout Sulawesi, with training expected in West Sulawesi, South Sulawesi, and Southeast Sulawesi provinces. Mamuju and Mamasa are both are starter districts for Green Prosperity and would be the site of both farmer field schools (FFS) and cocoa development centers (CDC). These trainings would occur on smallholder lands throughout the targeted Sulawesi districts.

Mamuju is 7,943 square-kilometers (km^2) with 16 subdistricts and 155 villages. The landscape is 57% lowland areas and 43% in mountain/sloped areas [1]. The economy has experienced growth of about 10% per year between 2009 and 2011 going from IDR 1,244 billion to IDR 1,534 billion with agricultural contributing almost half of the total. However, per capita income has remained somewhat constant over the past several years as population has grown. The dominant agricultural commodities in Mamuju are cacao [68,344 hectares (ha)], rice (31,145 ha), corn (16,480 ha), oil palm (13,296 ha) and peanuts (1,394 ha). Figure 1 shows Mamuju land use and highlights villages visited by Bogor Agricultural University (IPB) for their social and natural resource management/sustainable land use studies.

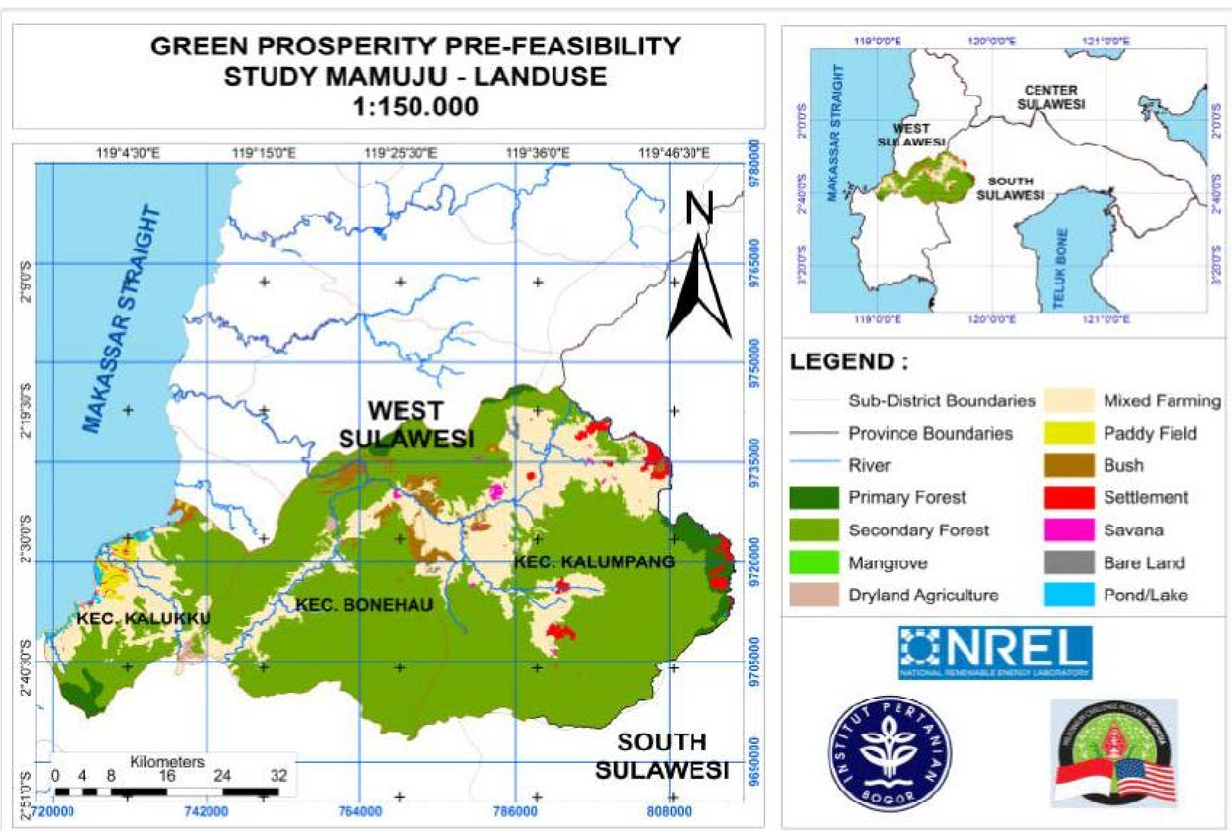


Figure 1. Mamuju area land-use map

Source: "Natural Resource Management and Sustainable Land Use: Mamuju District, West Sulawesi." Prepared for NREL by IPB. November 2013.

Mamasa covers 3,006 km^2, with 176 villages in 15 subdistricts. The district is mostly upland forested areas covering 261,000 ha, which includes 46,700 ha of critical land, 48,700 ha of production forests, and 150,173 ha of protected forests. The dominant agricultural commodities in Mamasa are cacao (21,746 ha), rice (20,491 ha), and coffee (18,038 ha). Minimal quantities of corn, peanuts, cassava, and sweet potato are grown. The economy expanded by 13% between 2008 and 2012 going from IDR 889 billion to IDR 1,527 billion with 2012 per capita income of IDR 4.8 million (growth of both population and economy has led to fairly constant income per capita). Agriculture's contribution to the economy has declined over time, but is still almost 50% of the total with increases in other sectors such as service (18.9%) and construction (5.8%). Figure 2 shows Mamasa land use in the villages visited by IPB for its social and natural resource management/sustainable land-use studies.

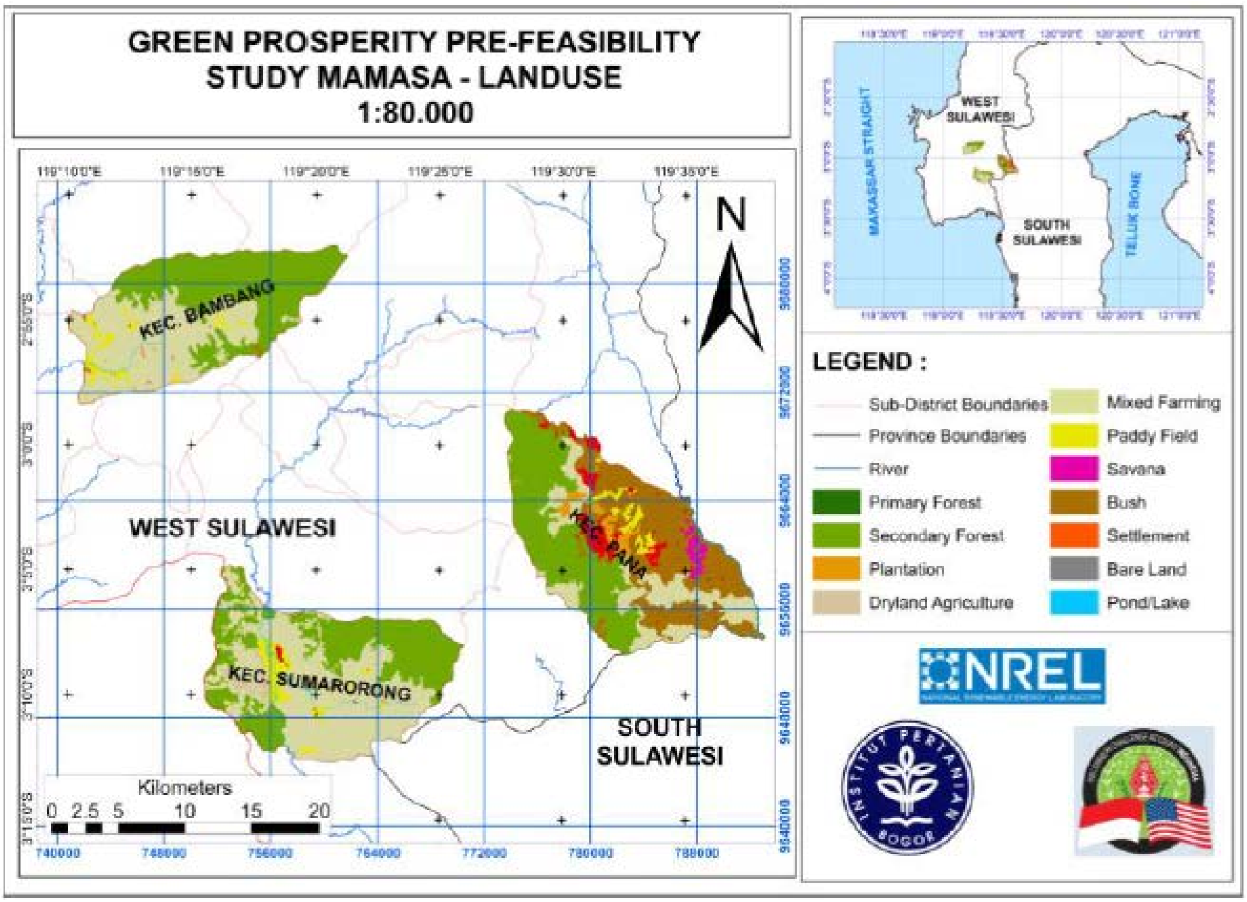


Figure 2. Mamasa area land use map

Source: "Natural Resource Management and Sustainable Land Use: Mamasa District, West Sulawesi." Prepared for NREL by IPB. November 2013.

1.2 Current Population and Economic Activities

The main economic activity in Mamuju and Mamasa is agriculture with rice, corn, potatoes, and fruits for subsistence and cacao for income (Table 1). Both Green Prosperity starter districts have more land dedicated to cacao production than any other crop. Additional sources of income include services, trade/hotel/restaurant, processing, and mining. Other economic activities include raising pigs and chickens, and a small portion of population own and/or operate stalls selling food or other goods. Other residents are civil servants and some are going outside their village to work as day laborers; reported rates during the National Renewable Energy Laboratory's (NREL's) site visits ranged between IDR 35,000 to IDR 50,000 per day for agriculture, construction, boat building, and other similar day labor jobs. During the cocoa boom, smallholders did not go into forests to remove timber for wages; however, the decline in cocoa bean production has resulted in some villagers returning to forests as a source of income [1].

Mamuju's population has seen sustained growth over the past several years from 315,053 in 2009 to 349,571 with 77,136 households in 2011 [1]. Mamasa's population has grown from 125,000 in 2008 to over 146,000 in 2012 [2].

Table 1. Population and Income Sources in Mamuju and Mamasa

Measure	Mamuju	Mamasa
Population	349,571	146,292
Households	77,136	32,268
Income Source		
Agriculture, forestry	88%	71%
Services	4%	15%
Trade, hotel, restaurant	1%	7%
Other	6%	6%
Processing industry	1%	1%

Source: "Natural Resource Management and Sustainable Land Use: Mamuju District, West Sulawesi" and "Natural Resource Management and Sustainable Land Use: Mamasa District, West Sulawesi." Prepared for NREL by IPB. November 2013.

West Sulawesi is politically divided between mountain and coastal peoples, reflecting two major historical kingdoms. Lohe was a traditional mountain kingdom dominated by the Mangki ethnic group while the historic coastal kingdom of Pitu 'Uluna Salu consisted of seven ethnicities (Rantai Bulahan, Bambang, Mambi, Aralle, Tabulahan, Mattanga, and Tabang). Leadership is dominated by those with good knowledge of past history, customs, religious practices, and familial linkages with past royals or the village founder. Villages are led by a custom leader called a "tobara" who has responsibility for maintaining social laws and mitigating disputes through custom laws. The tobara and local government mitigate disputes between villagers on land boundaries.

1.3 Project Description and Rationale

This model project is designed to address issues with declining production of cocoa beans negatively impacting income of Sulawesi smallholders, and more broadly explores how an agriculture intensification project may satisfy Green Prosperity program requirements. Cacao was planted in Indonesia in the late 1980s and 1990s with Indonesia quickly became one of the top three producing cocoa bean countries in the world. Smallholders experienced good production and income during the cocoa boom, but both aging trees and increased incidence of pests have reduced yield by half, negatively impacting their income. Sulawesi is the primary production area in Indonesia and is a natural focus of this study. This report evaluates the impacts and effects of training cacao smallholders in an effort to increase their income by doubling the cocoa bean yield, restoring production to previous levels.

The cacao industry has found that farmer field schools (FFS), which train smallholders on several low-cost interventions, has great potential to increase yield. This approach proceeds from the viewpoint that smallholders should understand the causes of declining yields such as the lifecycle of pests and how they infect trees and pods. Understanding the causes and issues could increase adoption rates because smallholders would better appreciate how the interventions would impact yield. Aging trees are addressed by replacing trees over time with known high-producing seedlings and side-grafting trees that are still productive allows smallholders to continue earning income as they improve their farms. Pests are reduced by phytosanitation—a method of removing and burying diseased cocoa pods and branches to slow the spread of pest and disease. Pruning is another important technique as letting in more light stimulates more cocoa pod growth and also reduces pests as the sunlight makes their reproductive activities more difficult. The aforementioned interventions have very small costs but do require more labor. It is expected that adopting these interventions would allow a smallholder to double their yield from a baseline of 500 kilograms (kg)/ha to 1 ton (t)/ha. Increasing yields to 2 t/ha and beyond requires fertilizer and pesticide, neither of which is commonly used on cacao farms. Greater details on interventions taught at FFS are described in Section 2.2.

It is anticipated that a small subset of the anticipated 60,000 smallholders trained in FFS would begin to apply fertilizer and pesticide leading to greater cocoa bean production and, therefore, greater income. A recent cacao FFS program conducted in Aceh, Sumatra, resulted in a significant increase in yield of 124% leading to an average increase in income of 101% [3]. A smaller subset of motivated cacao smallholders would be trained at a more rigorous level at CDCs that would enable them to both open small businesses to provide inputs and services to other cacao smallholders as well as train them to ensure the learning process reaches more smallholders and continues after the donor project ends. NREL site visits to cocoa doctors trained at CDCs highlighted the opportunity to earn higher incomes through servicing cacao smallholders in their communities.

The decline in cocoa bean production has resulted in increased poverty for Sulawesi cacao smallholders. A survey of cacao smallholders found that more than nearly 70% derive income from other sources, mostly from other agricultural production and sales [4]. Furthermore, some cacao smallholders are returning to the forest to remove rattan and other timber to supplement their income, which may negatively impact the environment [1]. Some smallholders have abandoned their cacao farms leaving lands more susceptible to fires, and it is not being used to grow crops for subsistence or income. Increasing yield and income for cacao smallholders in Sulawesi directly addresses Green Prosperity's (GP) primary goal of reducing poverty. The environmental impacts of agricultural intensification on existing land are not well known, however, this study has identified past work that indicates the potential positive impacts on the environment and possibly a net decrease in greenhouse gas (GHG) emissions, another important requirement of the Green Prosperity program.

This project would be funded as a grant with cost-sharing provided by cocoa industry participants. This study evaluated a project funded 50% with a grant and 50% by industry. A potential sponsor and funder for this project is the Cocoa Sustainability Partnership (CSP), an Indonesian membership organization of companies across the cocoa supply chain as well as nongovernmental organizations (NGO). Local government participation was established in 2006 due to concerns of continued cocoa supply. While all significant cocoa industry companies are a part of CSP, there are a few companies that are not members who could decide to participate and co-fund the project. The cacao industry is unlikely to pay for the entirety of this project due to its significant investment in West Africa because of higher quality and quantities of cacao production in that region. Additionally, it is expected that companies that derive a significant source of their profits from chocolate would contribute more than companies that process or trade cocoa beans since they are involved in numerous commodities.

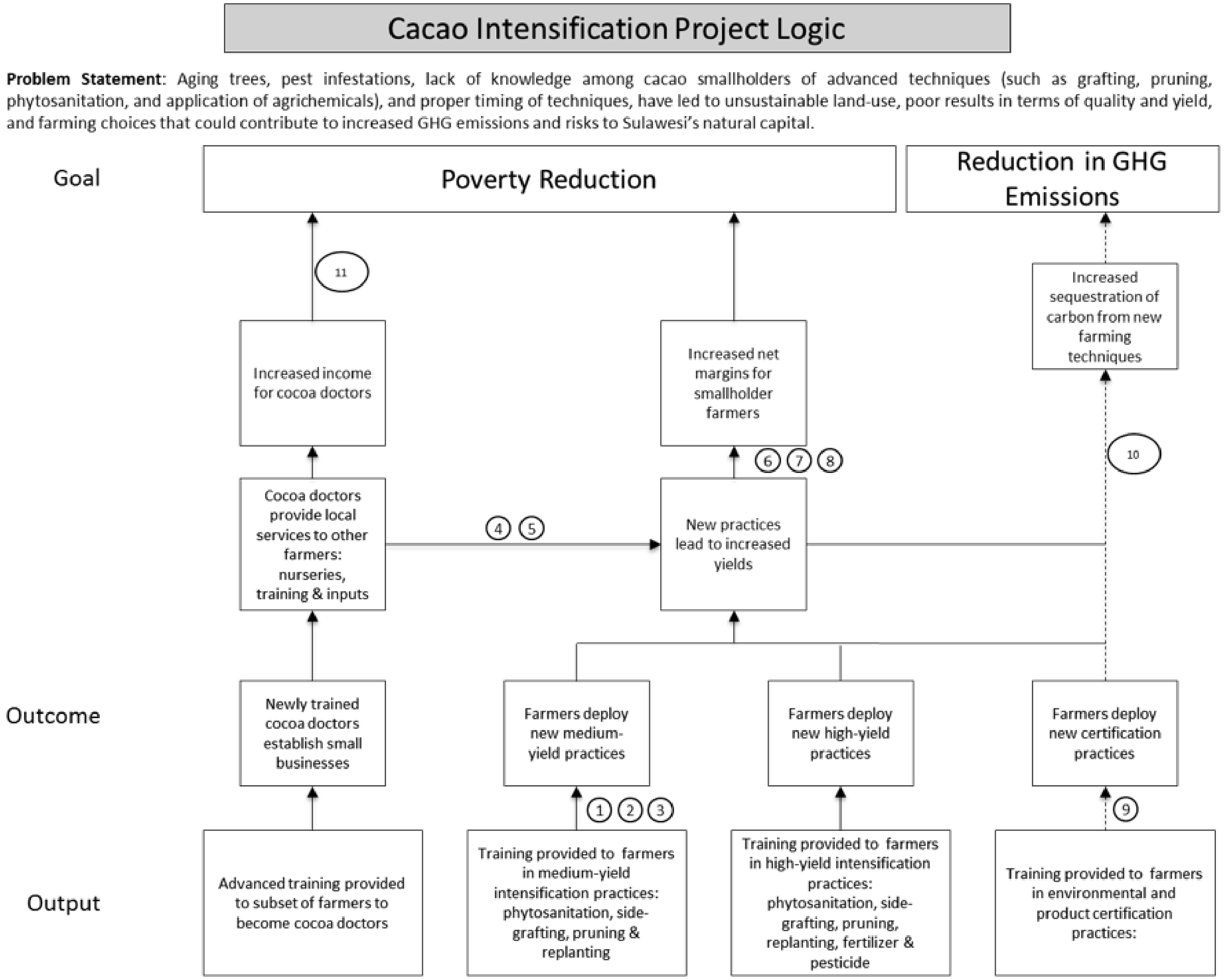
1.4 Project Logic

In an international development context, a project logic visually displays an impact analysis. It is designed to link project interventions with intermediate outputs, longer-term outcomes and overall project goals. In this project logic, we examine the impacts the project would have on Green Prosperity goals of poverty and GHG emission reduction through agricultural intensification of cacao on existing land through training smallholders in good agricultural practices (GAP) and further training a subset of smalholders as rural entrepreneurs who develop for-profit businesses serving cacao farms. At the prefeasibility stage of project assessment, the project logic is less detailed than in its fully-developed form. As the project is developed further and becomes more defined, additional information that characterizes individual relationships in quantitative and qualitative ways can be added, serving as a guide for monitoring and evaluation activities. Where assumptions and risks deserve mention or require explanation, notes have been added as clarification. The project logic for this project is shown in Figure 3. The following list corresponds to the numbers in Figure 3.

1. **Assumption:** Training reaches the targeted number of farmers (applies to all training activities).
2. **Assumption:** Farmers who are trained are motivated and have the means to adopt the new farming practice (applies to all training activities).
3. **Assumption:** New practices are suited to the agricultural context in Indonesia and, if employed properly, have been shown to increase yields in similar contexts.
4. **Assumption:** Rural entrepreneurs (cocoa doctors) that sell services and inputs to other cacao farmers are able to extend the reach of the overall program.
5. **Assumption:** There will be demand from farmers for the services that cocoa doctors provide.
6. **Assumption:** Increased net margins depend on reliable access to markets, and sustained market factors such as demand for cocoa products.
7. **Assumption:** Change in crop management costs do not outweigh the positive impact of yield improvements.
8. **Assumption: E**xisting supply chains have sufficient capacity to handle increased production (likely based on past cacao production levels).

9. **Assumption**: Environmental certification programs are not currently part of project design, though would be necessary to achieve desired environmental impact through improved land use.
10. **Assumption:** New farming techniques are effective at sequestering carbon through improved environmental management and increased biomass. More research and data collection are required to fully quantify this link, both in the context of certification and relative to standard management.
11. **Assumption**: Cocoa doctor incomes are included in farmer expenses.

Figure 3. Cacao intensification project logic



1.5 Project Team

A successful project team will require a coordinated effort by cocoa industry companies and local government—particularly agriculture extension offices and other organizations active in cacao in Sulawesi. The project sponsor should select a project implementer with known effectiveness in administering training programs to smallholders with a preference for experience in cacao because it is a specialty crop with concentrated growth in just a handful of countries. The project should hire and train FFS facilitators local to the targeted Sulawesi districts, particularly agriculture extension agents and local cocoa bean collectors and traders who have long relationships with cacao communities. The cocoa industry proposes supplying expertise, information, resources, and staffing CDCs with its own agronomists and expert trainers. Cocoa industry participants would oversee the project and establish a board to solicit, review, and select implementation partners and a controller. The project should engage the expertise of Indonesian institutions involved in cacao research such as the Indonesia Coffee and Cocoa Research institute (ICCRI) and universities, for example Hassanuddin University's Cocoa Research Group. The project should engage an independent organization to assess impacts of training and visit former FFS smallholders to continuously monitor progress in achieving goals of the project over its life.

1.6 Project Site

FFS would take place throughout the targeted areas of West Sulawesi, (Mamasa, Mamuju, and potentially Polman), South Sulawesi (Luwu, East Luwu, North Luwu, and potentially in Bone, Soppeng), and Southeast Sulawesi (East Kolaka, North Kolaka). Figure 4 highlights planned target areas with darker circles and potential areas with lighter circles—all these areas have concentrated areas of cacao farmland. There would be between 2,000 and 2,400 FFS conducted in these targeted areas assuming a class size of 25 to 30. For convenience, FFS are held in villages on a cacao smallholders land once per week, and a demonstration plot would be established in each FFS village to practice techniques such as pruning and side-grafting. The specific locations of FFS would be determined by the project sponsor working with local government and village leadership. FFS do not require energy and are conducted during daylight hours in the shade of cacao trees; trainer can use a dry-erase board for the lessons, and each trainee would receive a book highlighting the information taught.

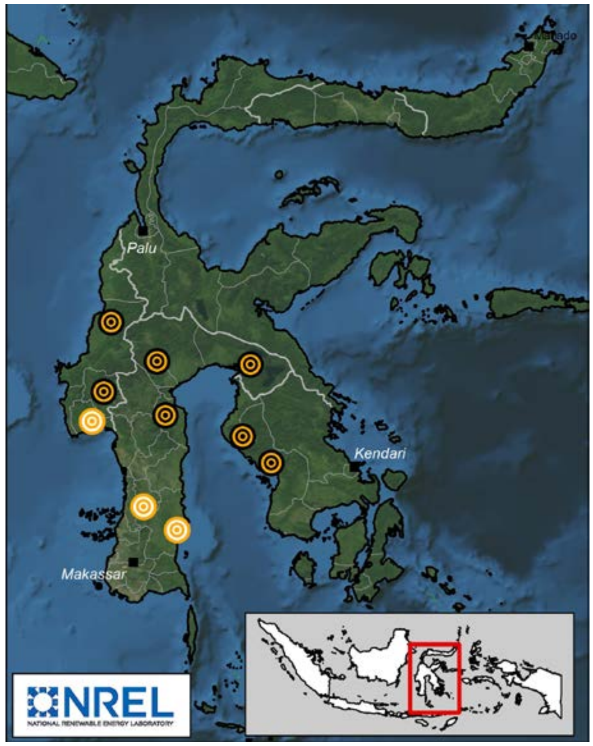


Figure 4. Target areas for cacao FFS and CDC

Dark circles represent target areas; light circles represent potential areas

The project sponsor would need to identify potential locations for the 20 CDCs and negotiate land leases for the duration of the project for each. About 2 ha are sufficient for each CDC, which includes a covered training area, a nursery, and a demonstration plot or plots. Mars established a 10-year lease on its CDC in Luwu. It is important to carefully select locations and landowners for CDC because Mars lost the land for a CDC in the past when the landowner sold his land, and the new owner was not interested in continuing the CDC project.

1.7 Project Implementation Plan

The project sponsor would need to conduct a multitude of tasks prior to training smallholders at FFS and CDCs. The project would need to issue a request for proposals and select an implementer; there are several organizations in Indonesia that have administered FFS programs in the past. FFS and CDC are currently deployed on a limited scale in Sulawesi and any larger project should consider building upon the existing project. Coordination is needed to determine when and where to conduct FFS in targeted areas, which should be achieved through coordination with local government, organizations, and village-level leadership. The project sponsor, presumably cocoa industry partners from across the supply chain, would need to determine which of its staff and training experts would be made available for CDCs. A program and timeline would need to be developed for training facilitators such as local collectors, traders, and agriculture extension office staff. The project should review existing training materials and handouts and make updates where necessary. This study evaluated training 60,000 smallholders at FFS over a 10-year period, which is a conservative estimate as it is possible the training could occur in less time perhaps in the 3-7 year time frame MCC has experienced in other nations on agriculture programs. It is assumed that cocoa doctors would be trained at CDCs over a 5-year period, and it would take 1 to 2 years to establish profitable businesses. The project sponsor needs to establish a tracking and monitoring program to evaluate adoption rates, yields, and incomes in order to make adjustments to FFS/CDC training for improving these criteria over the life of the project.

Table 2. Project Schedule

Activity	Estimated Timeline
Pre-Feasibility Study	6 months
Full Feasibility Study and Engineering Design	6 months to 1 year
FFS	10 years (train 60,0000 smallholders; potential to complete in less time)
CDCs	5 years (training/mentoring of 600 motivated smallholders to develop for-profit businesses supplying knowledge, inputs, and services to cocoa smallholders)

2 Technical Assessment

This section starts with a review of Indonesia cacao statistics and the current situation, issues, and finances for cacao smallholders. It is followed by the technical approach which describes the training programs and interventions researched by the cacao industry known to improve yield (replanting, grafting, pruning, phytosanitation, and agrichemicals) and farmer incomes, a primary goal of Green Prosperity. Other potential interventions and activities are described, however, they are not included in the financial model either due to farmer resistance or unknown value for smallholders—these include fermentation, certification, and compost. There are also literature reviews on past cacao projects in Indonesia as well as a review of previous FFS. This section also provides information on potential alternative crops for cacao smallholders.

2.1 Resource Assessment

Most cacao trees were planted in Indonesia, with a concentration in Sulawesi, in the 1980s and 1990s were typically a Criollo variety selected from Malaysia for high fat content rather than flavor. Many Indonesian had been working on cacao plantations in Malaysia when production dropped dramatically, and they returned to Sulawesi with growing skills and started cacao farms. Land area expanded quickly over two decades, and production grew for a sustained period until aging trees and pests caused production to decline (Figure 5). Pest infestations likely reduce Indonesian yield by 40% and become more problematic as trees age. Over 93% of cacao land is owned and farmed by smallholders with the remaining land split between government and private companies [5]. Cacao is a labor-intensive crop making it more suitable for smallholder farms than large-scale plantations.

As evidenced by the United Nations Food and Agriculture Organization (FAO) production statistics, overall land area has continued to grow as production has declined. The International Cocoa Organization (ICCO) projects Indonesia 2012-2013 production at 450,000 t. The cocoa industry has suggested that official government land area and production data may exceed actuals (ICCO and others report 2011 production of 500,000 tons or less). FAO reports that Indonesia was second in production in 2011; and the top five producer nations accounted for 79% of production, and the top 10 produced 94% [6]. The cocoa industry believes demand will exceed supply by 1 million t in upcoming years.[5]

[5] Cacao industry leaders have made this projection, and it was stated during numerous NREL meetings in Makassar in June 2013.

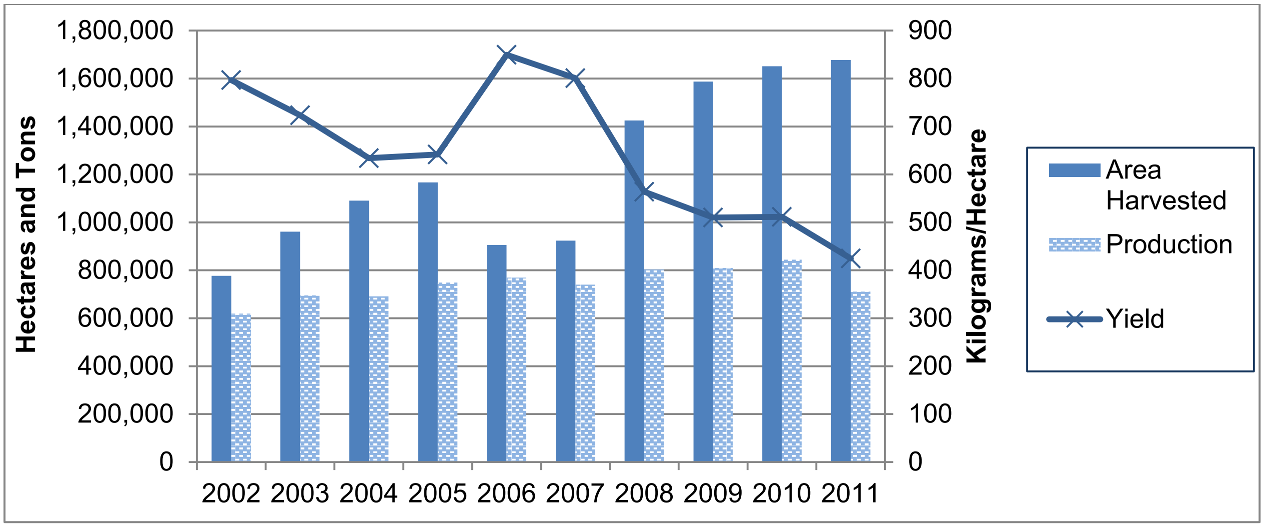


Figure 5. Historical Indonesian cacao hectares, production, and yield
Source: FAO Statistics Database

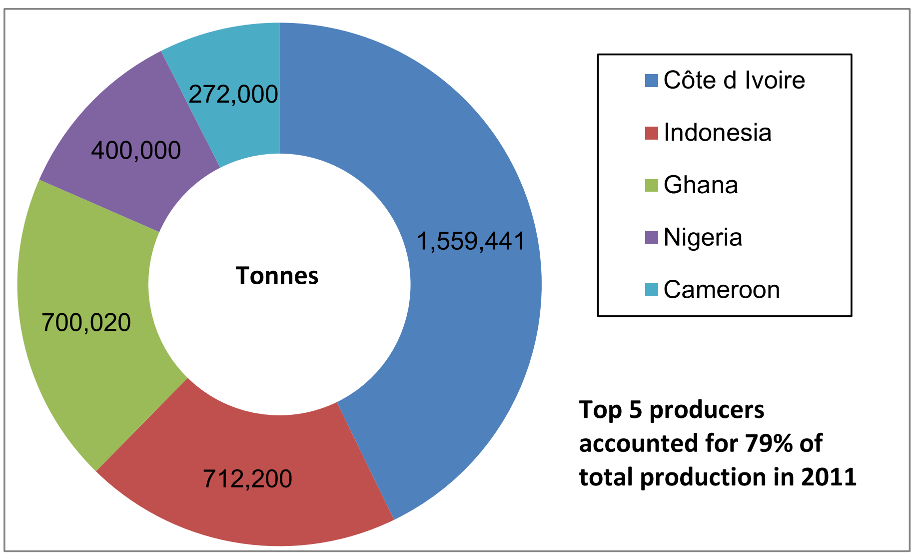


Figure 6. Top 5 cacao producers
Source: FAO Statistics Database

It is estimated that there are 1 million cacao smallholders in Indonesia and Sulawesi accounts for at least 60% of Indonesian production (Figure 7) [7]. The top three producing provinces are Central Sulawesi, South Sulawesi, and South Sulawesi with continued growth of land area in Sumatra, which accounts for around 30% of production with the remainder produced in Bali, Java, and Papua. West Sulawesi is probably the sixth most productive district with the cocoa industry estimating 47,000 ha and the government reporting 68,000 ha in Mamuju, and somewhere between 13,000 and 22,000 ha in Mamasa (Figure 7).[6] Cacao is the principal use of

[6] The range of land area dedicated to cacao varies with the cocoa industry reporting lower numbers than Government of Indonesia.

agricultural land in Mamuju and Mamasa. Both the cacao industry and local government stated that some Mamuju cacao land area has been converted to oil palm and rice. Palm oil production is limited in Sulawesi accounting for 3% of mills and 4% of capacity, however, it is possible more mills could be built creating more opportunities to convert land to oil palm [8]. Due to rapid degradation, oil palm fresh fruit bunches must be delivered the same day they are harvested, which may limit cacao smallholders from converting if they are too far from a mill.

Cacao trees grow best at 10° above or below the equator in the lowlands at an elevation of less than 300 meters (m) for optimal production.[7] It is possible to grow cacao at higher elevations up to 1,000 m in the tropics, but yields are much lower. It takes at least 2 years from planting for cacao trees to begin producing, and between 5 and 8 months for a flower bud to grow into a ripe cocoa pod. Most hectares have about 1,000 trees; however, 800 trees are considered optimal for maximizing yield based on spacing of 3.4-3.5 m, heights of 3-4 m, and 18 shade trees(gamal or coconut) to filter sunlight. Growing and harvesting cacao trees is labor intensive with many activities done by one person. Harvesting varies by area and climatic conditions and can occur many months during a year with the first harvest typically falling between April and June, and a second harvest around October. Smallholders harvest fruits by cutting the ripe fruit stalk and storing in a shady place until all pods are collected. Then a pod is cut open, and beans are separated from the fruit skin/pulp and dried for 4-5 days to reduce moisture content. Typical input costs are approximately IDR 2.8 million per ha, and most smallholders do not use fertilizer or pesticide.[8]

It is typical for men to do the bulk of the work on a cacao farm. If women in the household assist, they typically harvest, open pods, clean, weed, sanitize, fertilize, and assist in the drying of beans. Men prune, apply pesticide, grow seedlings, graft, plant, and purchase inputs. Men negotiate the sale of cocoa beans, and women collect the money.

[7] The data in this paragraph were provided during numerous meetings NREL held with cocoa industry companies in Makassar and Mamuju June 3-10, 2013.
[8] Input costs provided by a CDC agronomist during an NREL site visit to South Sulawesi in June 2013.

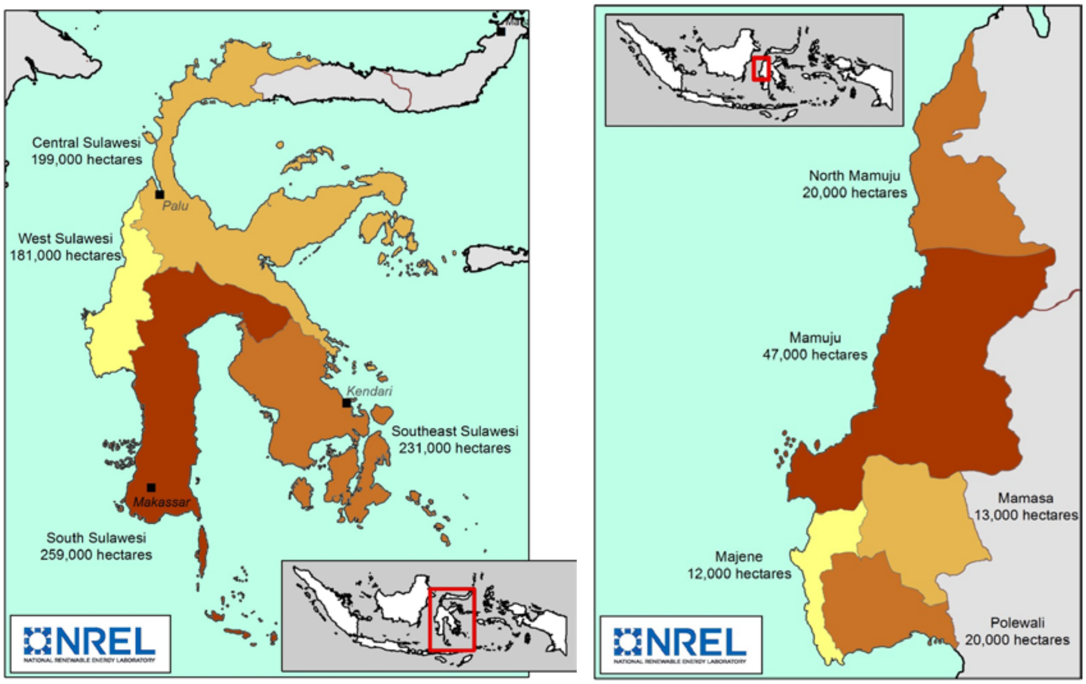


Figure 7. Sulawesi Cacao land area maps

Cocoa beans are comprised primarily of water and fat (Table 3). Quality is impacted by soil fertility; harvest technique; quantity of beans in a pod; moisture content; mold; shape of bean; and downstream processes including drying, fermenting, roasting, and processing. The characteristics of quality beans include fully ripe round beans uniform in size with undamaged shells. Poor quality cocoa beans may be moldy, infected with pests, broken, and have a high percentage of wastes. Mold is more likely in the rainy season as smallholders depend on sunlight to dry beans. Wastes are usually other pod materials introduced during harvesting. More beans per kg indicate aged trees or harvest from immature pods.

Table 3. Cocoa Bean Characteristics

Cocoa Bean	
Water	32-39%
Fat	30-32%
Protein	8-10%
Polyphenols	5-6%
Starch	4-6%
Pentosans	4-6%
Cellulose	2-3%
Sucrose	2-3%
Theobromine	1-2%
Acids	1%
Caffeine	1%

Source: Lambert, S. "Cocoa fermentation – general aspects." Mars, Inc. Accessed September 3, 2013: www.canacacao.org/uploads/smartsection/19_Cocoa_fermentation_General_aspects.pdf.

Nearly all cocoa beans in Sulawesi are delivered to Makassar where they are either processed or exported. It is expected that Sulawesi supply chains could handle an increase in cocoa beans due to both past higher volumes and due to increases in processing capacity. After removing debris, cocoa processors roast beans to bring out flavor and then de-shell them, resulting in an intermediary product—nibs. The nibs are alkalized to release flavor and milled to create cocoa liquor. The cocoa liquor is passed through a hydraulic press to extract cocoa butter leaving a by-product of cocoa powder. These products are either exported or further processed into chocolate products. An export tax established in 2010 on cocoa beans led to quick growth in domestic cocoa processing capacity because there is no export tax on cocoa products. In the past 2 years existing grinding capacity has doubled to 500,000 t per year as of June 2013, which is expected to increase to 600,000 t per year when Cargill's Java-based plant starts operations at the end of 2013.[9] Installed capacity exceeds current bean production in Indonesia increasing competition with current capacity utilization between 70% and 80%. World grinding capacity indicates that Europe and the Americas import the largest quantities of cocoa beans (Figure 8). The global retail market for chocolate was IDR 1.2 quadrillion as of 2013 with a projected increase to IDR 1.6 quadrillion by 2017 [9].[10] The United States is the largest importer of cocoa powder and the second largest exporter of chocolate candy [10].

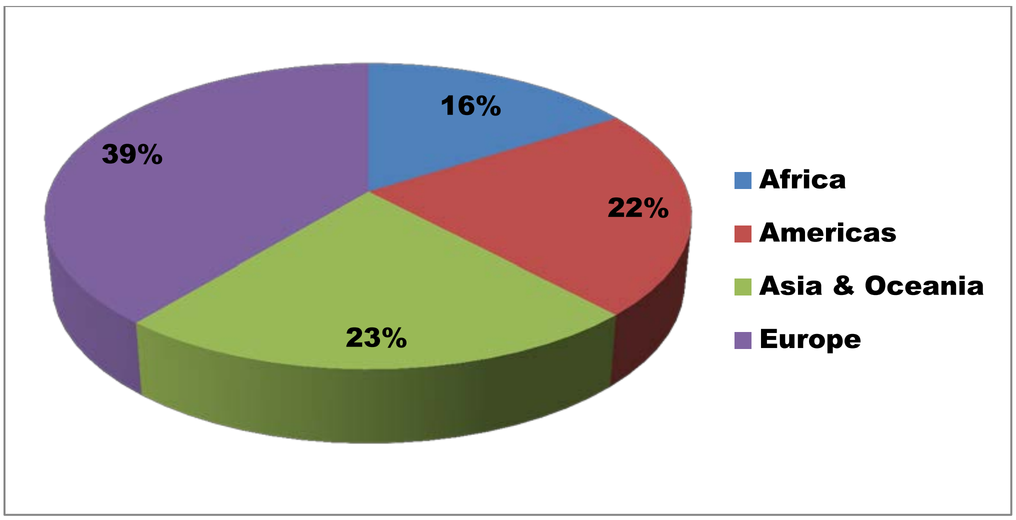


Figure 8. Cocoa grinding capacity by region

Source: "Cocoa Market Update." World Cocoa Foundation. March 2012.

Indonesian beans are valued for their fat content in cocoa butter, which is useful as filler in chocolate products. Indonesian beans lack the quality of taste common to West African fermented beans. Cocoa manufacturers have long blended Sulawesi bulk beans with more flavorful West African beans to meet product specifications for fat and flavor. Indonesia does not have any competitors as a large volume supplier of filler cocoa beans (Figure 9).

[9] Capacity and utilization based on NREL site visits to cocoa manufacturing plants and meetings with manufacturing plant owners.
[10] Based on converting $107 and $147 Billion to IDR at a rate of 1 USD=10,870 on Oct. 22, 2013.

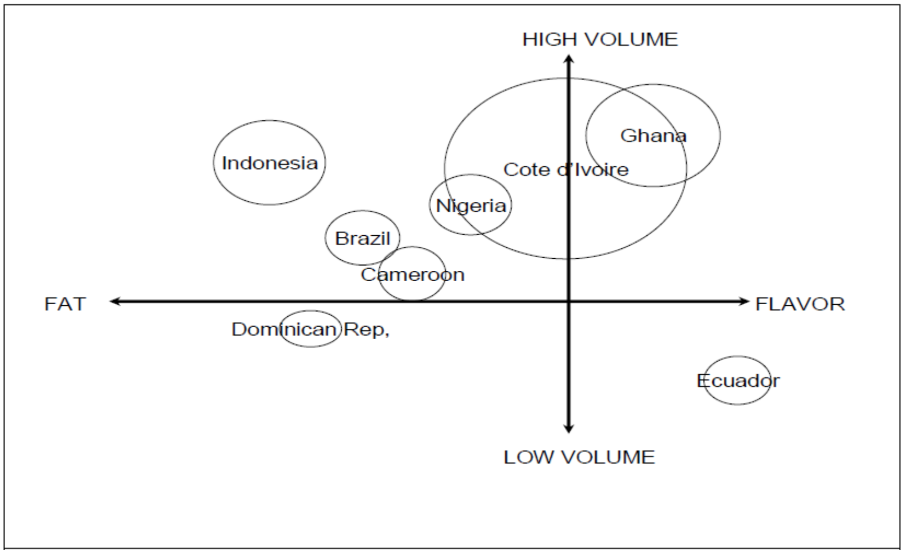


Figure 9. USAID chart of volume and cocoa bean characteristics by country

Source: Panlibuton, H., Meyer, M. "Value Chain Assessment: Indonesian Cocoa." USAID. June 2004.

CSP is an Indonesian membership organization of companies across the cocoa supply chain as well as nongovernment organizations, and local government participation was established in 2006 due to concerns of continued cocoa supply. CSP was formed to ensure the continuation of cocoa supply since interaction was limited among chocolate companies but many were independently making efforts in production, sustainability, and with other farmer outreach activities, but with limited interaction between companies. The supply of cacao beans is threatened in the top-producing countries including Cote d'Ivoire, Ghana, and Indonesia. Members of CSP recognized that they needed to share data and ideas to improve Indonesia's cacao crop. This is a positive development since previously different organizations were funding various projects with little interaction among groups to share data, ideas, and results. The focus has been on standardizing solutions and tools while gaining consensus. The organization does not believe providing free inputs, such as seedlings and fertilizer, is an effective approach. All of these companies work in West Africa where more R&D is invested due to quality, greater volumes, and it being the primary agricultural product in Cote d'Ivoire.

2.1.1 Pests

The cocoa pod borer (CPB) is the greatest pest threat to Indonesian production and responsible for an estimated 40% loss in yield. The CPB is a moth who lays larva on the surface of cocoa pods, which tunnel into pods and eat cocoa beans. It is sometimes possible to harvest some beans from an infected pod; but there are fewer beans, and they are of poor quality and should not be fermented (Figure 10). Black pod, also known as pod rot, is a fungal cocoa pod disease, which causes pods to shrivel and die. It is common throughout the world but particularly problematic in the highlands of Sulawesi. It can be spotted early by small dots appearing on the cocoa pod. The fungus causes cocoa pods to shrivel and die. Vascular-streak dieback (VSD), common in Southeast Asia, is a fungal disease impacting leaves by slowing or stopping the photosynthesis process. Other pests that are present, but have a lower impact on production, include helopeltis and stem borer. While pests cannot be eliminated, they can be reduced by pruning, phytosanitation, more frequent harvesting, and pesticides.

Figure 10. Cocoa pests (from left: CPB, Black Pod, VSD)

Source: photos by Kristi Moriarty, NREL

2.1.2 Selling and Pricing

Smallholders benefit from intense competition for cocoa beans with several potential channels for sales. The U.S. Agency for International Development's (USAID's) mobile money program (e-MITRA) conducted a survey of the financial habits of 700 Sulawesi cacao smallholders [4]. Approximately 80% of smallholders sell to local collectors and traders with whom they have long trusted relationships. About a third of sales transaction take place at the smallholder's home, and half of the sales take place a collection facility. The number of sales transactions per smallholder varies between 13 and 24 times per year with average sales value of IDR 500,000 [4]. About 20% sell directly to exporters or manufacturers, particularly smallholders who ferment or certify beans. Only a quarter of smallholders negotiate cocoa bean price with the purchaser, but this may be due to transparency in pricing as they receive daily pricing via text message from both local collectors and major trade companies. Margins are thin for both collectors (reported at IDR 50-150 per kg) and traders as they must deal with daily fluctuations in exchange rates.[11] Additionally, there are taxes along the supply chain including an IDR 40/kg fee in Makassar and additional IDR 10/kg when cocoa beans leave Makassar.[11]

There are two world exchanges for cocoa pricing: the London International Financial Futures and Options Exchange (LIFFE-£) and the IntercontinentalExchange [(ICE)-former New York Board of Trade (NYBOT)-$]. World cocoa prices are influenced by production, stock, delay in transport to ports, weather, political instability in larger producer countries, and hedge fund speculation (Figure 11). The price Sulawesi smallholders receive for cocoa beans is mostly influenced by international prices, world demand, and exchange rates. Smallholders receive daily pricing through text message on their mobile phones, which is highly correlated to the NYBOT price. Smallholders receive approximately 80% of the world price due to the competitive nature of local cocoa beans sales.[12] Prices fluctuate daily, and a conservative price of IDR 18,000/kg was selected for this study based on input from industry and the discount to the world price the smallholder receives.[13] Also, IPB reported prices in remote Mamuju villages between IDR 17,000-19,000/kg [1].

[11] Collector margins provided at NREL Makassar meetings with cocoa industry companies in June 2013.
[12] NREL meetings with cocoa industry companies are the source of 80% of the world price going to Indonesian smallholders.
[13] Smallholders reported prices between IDR 18,000 and 20,000 during NREL site visits in South Sulawesi and West Sulawesi in June 2013.

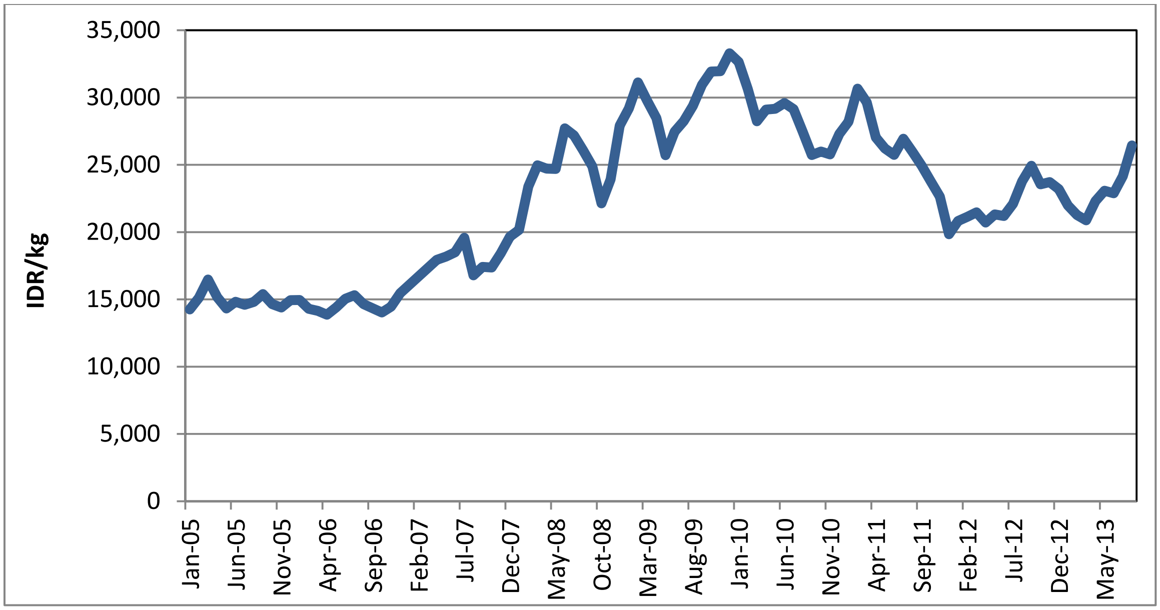


Figure 11. International cocoa price

Source: International Cocoa Organization[14]

An export tax of 10% was applied to cocoa beans beginning in April 2010 with a goal of increasing cocoa processing in Indonesia. This shifted competition and demand from exports markets to domestic processors (Figure 12). The cocoa export market is important in Indonesia accounting for ($1.6 billion) in 2010 and ($1.3 billion) in 2011 [11].The initial dip in export value is likely temporary as the cocoa industry is currently building new plants and increasing grinding capacity. As these plants start production, the value of exported processed cocoa is expected to rise. The introduction of an export tax reduced exports of cocoa beans and increased exports of processed cocoa representing economic export value proportions of 39% and 61% respectively for the first 10 months of 2012 [12].

[14] International prices reported in USD were converted to IDR based on historical monthly averages. The estimated Indonesian price is 80% of world price.

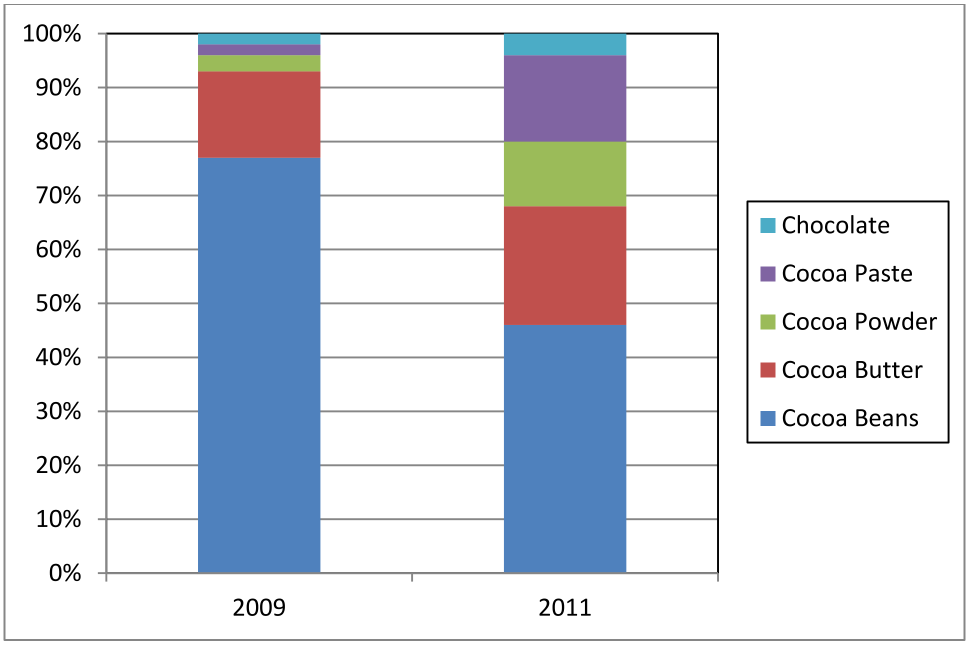


Figure 12. Indonesia cocoa exports by product in 2009 and 2011

Source: "Impact of Export Tax Policy on Cocoa Farmers and Supply Chain." SEADI Discussion Paper No. 1. DAI/Nathan Group. USAID. December 2012.

2.1.3 Access to Credit

Access of credit is a significant issue for cacao smallholders and it is being addressed by USAID's e-MITRA program. This section provides information on smallholder finances but does not analyze current or future access to credit schemes. Smallholders often cite a lack of money and access to credit as a barrier to purchasing inputs for their cacao farms. While there are several schemes available to smallholders, some require land certificates or bank accounts, or membership in a farmers group—many smallholders won't meet one or all of these criteria. As production declines, smallholders have even less money available. According to e-MITRA, only 46% of cacao smallholders have savings—and of those saving 25% have bank accounts and the rest keep cash savings at home [4]. Of the nearly 700 smallholders surveyed by e-MITRA, only 36% reported borrowing money. Half of those borrowing money used it for cocoa farm inputs; and the other primary reasons for a loan were to pay for school fees or food and other recurring bills (Figure 13). Smallholders have several sources for loans including banks, collectors, farmers group, and land mortgages (Figure 14). E-MITRA is working on developing mobile-based financial services for smallholders to improve savings and access to credit across Sulawesi.

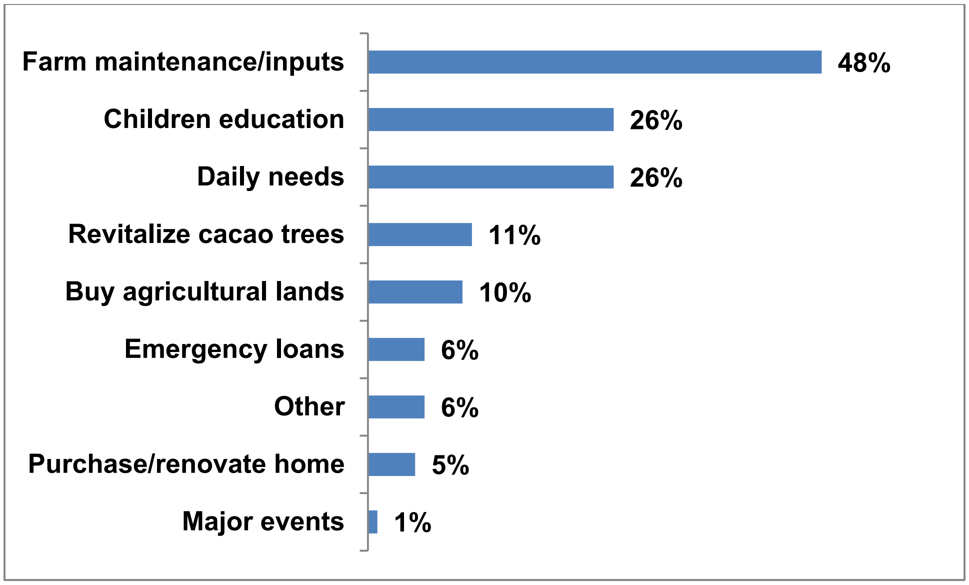


Figure 13. Reasons cacao smallholders borrow money

Source: "Market Insights into the Financial Behaviors and Design of Mobile Financial Services Products for Cacao Farmers in Indonesia." e-MITRA. USAID. May 2013.

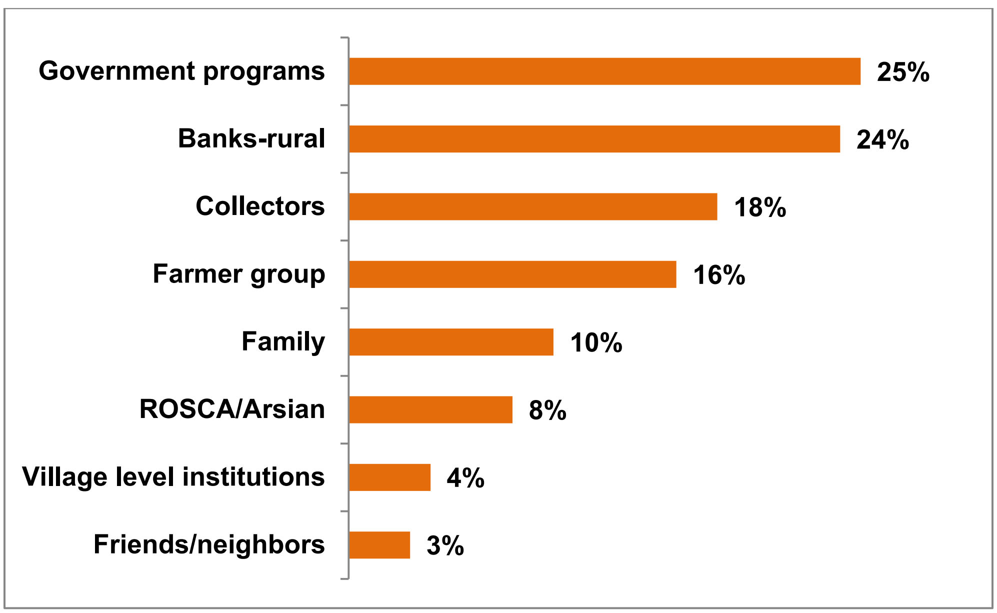


Figure 14. Where cacao smallholders borrow money

Source: "Market Insights into the Financial Behaviors and Design of Mobile Financial Services Products for Cacao Farmers in Indonesia." e-MITRA. USAID. May 2013.

2.1.3.1 Loans

Subsidized Government Programs

There are several government subsidized loan programs available through government-owned banks for cacao smallholders including Peoples Entrepreneurs Credit (KUR), the Government's National Program for Community Empowerment (PNPM), and Credit for Development of

Renewable Energy and Revitalization of Estate Crops. Government loan programs account for about 25% of cacao farmer loans [4]. The KUR program provides loans up to IDR 20 million with interest rates of 13% and 22% for retail and micro-businesses respectively.

The PNPM offers government-backed community development project program loans available to women farmers groups. The loan amount and term is IDR 10 million and 1year repaid in monthly installments by the farmer group leader who receives individual monthly cash payments from each smallholder. Renewable Energy and Revitalization of Estate Crops is a government-subsidized credit program that allows approved banks to lend with an interest rate of 7% (government covers the other 6%). These loans are only available to farmers groups, and the amount is based on land area with a maximum loan of IDR 500 million. Government loan programs administered by government-owned banks (PT Bank Rakyat Indonesia in Sulawesi) suffer from a high default rate possibly due to insufficient evaluation of credit worthiness of farmer group borrowers.

Farmer groups have greater access to subsidized loans than individual smallholders, but the default rate may be higher as groups may view it as a grant rather than a loan. Smallholders without land certificates (approximately 40%) are unlikely to obtain government loans because these programs require collateral. Past donor programs have assisted smallholders in obtaining land certificates, but the process is lengthy, and while the official price is IDR 900,000/ha, the cost typically paid is IDR 3 million/ha.[15]

Unsubsidized Bank Loans

BRI, a government-owned bank, is the most commonly used bank among cacao smallholders and collectors. It offers unsecured loans of IDR 1 million at a commercial loan interest rate of 13% and a term of 3 years.[15] The default rate on these loans is very low at 1.4%, and BRI plans to expand loans to its cacao customers. Smallholders borrowing money obtain 24% of loans through BRI. Cacao smallholders reported only borrowing from BRI due to favorable interest rates and loan terms as well as the availability of unsecured loans compared to other banks.

USAID's Agribusiness Market and Support Activity (ARMATA II) developed a commercial microfinance loan program to assist cacao smallholders with purchase of inputs.[16] This program was developed with Bank Tabunan Pension Nasional, an Indonesian commercial bank who collaborated with the International Finance Corporation (IFC). The interest rates are considered high due to costs to establish microfinance schemes and range between 24%-30% annual rates (26%-27% effective interest rates). This program made loans to 450 smallholders in three cycles. The loan amount was IDR 6.5 million with smallholders receiving IDR 3.2 million between January and April, and the other half between July and December. ARMATA II's focus was to provide input-based loans to cacao smallholders, and loans are paid out as one-third cash and two-thirds fertilizer. During the three cycles, 40 participants defaulted in cycle 1, and 99 defaulted in cycle 2. Weather was an issue and now 82 of the 99 loans are paid back. The default issue could have been mitigated by better screening of smallholders' creditworthiness.

[15] Data provided by BRI in Makassar.
[16] ARMATA II data provided during a meeting with its Chief of Party in Jakarta in June 2013.

Loans from Collectors
Smallholders develop long-term relationships with area cocoa bean traders, and a level of trust exists between both the collectors and the smallholders. Collectors are able to provide loans of between IDR 1 and 2 million. This type of loan does not require collateral, and the collector has good knowledge of a smallholder's ability to repay the loan. While there is no interest or fees for these loans, there is the implicit understanding that the smallholder will sell output to the collector who provided the loan. The collector is repaid by deducting the loan costs from the sales transaction of cocoa beans. Additionally, a collector typically recaptures fees of providing loans by offering a slightly lower than market rate for the smallholder's cocoa beans. When smallholders do not have outstanding loans with a collector, they sell to whichever collector or trader is offering the best price in their area. Of the 36% of cacao smallholders taking out loans, 18% of them are from collectors in their communities [4].

Gapoktan Loans and Gadai Land Mortgages
Another method for borrowing is through Gapoktan, a large farmer group made of many smaller Poktans farmers' groups. The loan process is informal, but requires collateral of either land or vehicle documentation. The interest rates are favorable at 1.5% per month, which is taken out of the loan prior to disbursement. These loans are unpopular due to a repayment term of 6 months.

An alternative form of lending is a "Gadai," where smallholders lease their land for cash to other smallholders. This method of borrowing money is common among cacao landowners who do not wish to farm their land. This scheme tends to last 1 to 2 years; and the lender is repaid at the end of the term, and collects fees by harvesting and selling cocoa beans during the length of the loan. The value of this loan type is a function of land size ranging between IDR 2 and 20 million.

In limited instances, smallholders may borrow from pawnshops (pegadaian) due to quick access to cash and minimal requirements. However, the smallholder must have gold, a vehicle, or something else of value to obtain this loan type. Smallholders view this loan method as expensive.

2.1.3.2 Financial Habits

Nearly all transactions including selling cocoa beans, earning income, and paying bills are conducted in cash. Only 25% of cacao smallholders use banks due to both bank fees and an average distance of 15 to 20 km to a bank, resulting in lost productivity time and transportation costs [4]. Smallholders with bank accounts tend to deposit between 2 and 4 times a year and make withdrawals 6 to 12 times each year. While bank account holders have ATM cards, they rarely use them except for some withdrawals. The most popular bank among cacao smallholders is BRI, which has many locations in Sulawesi.

The e-MITRA program is seeking potential mobile financial solutions because 69% of cacao smallholders and 79% of cacao households have mobile phones. Many smallholders receive cocoa bean prices daily via text message, and they purchase airtime at kiosks in their community, which may be a better model for financial services than more distant banks.

Bank Muamalat provides an interesting alternative method for transactions by using post offices, which are generally closer to smallholders than banks.

2.2 Technical Approach

This study evaluates the potential for production increases through the key types of training: FFS and CDCs. The former is a primary school level of training focused on teaching interventions capable of doubling smallholder yields from 500 kg/ha to 1 t/ha. The study assumes a smaller subset of smallholders trained at FFS would use additional agrichemicals, such as fertilizer and pesticides, to reach a higher 2 t/ha. CDCs would provide a university-type of education for cacao smallholders demonstrating the most potential and motivation. After completion of CDC education, these cocoa doctors would open businesses providing inputs and services to cocoa smallholders. Cocoa doctors could extend the reach of the program by servicing cacao smallholders who did not attend FFS. Cacao industry-funded FFS and CDCs are demonstrating effective results on an initial small-scale deployment in Indonesia. This study evaluates expansion of FFS, some of which are currently ongoing, to 60,000 Sulawesi smallholders with a focus on West Sulawesi, South Sulawesi, and Southeast Sulawesi as well as deploying 20 CDCs. The project would also include more stakeholders with ties to the Indonesian chocolate industry from across the supply chain.

2.2.1 Farmer Field Schools

FFS are a form of capacity-building long used to educate smallholders on interventions to improve their livelihoods and better manage their farms. FFS have a long history in Indonesia and were the first instances of this type of training in the world when they began in 1989 to reduce insecticide use in rice, and have expanded to 78 nations and 4 million trainees [13]. FFS are anticipated to have immediate and development impacts on technical and social issues for smallholders (Table 4). Improved knowledge and awareness are important first steps towards implementing agriculture interventions to increase yield. However, moving smallholders from knowledge to implementation of interventions is a function of a farmer's belief in the benefits of the intervention, labor required, and availability of inputs. While some smallholders are already aware of the techniques taught at FFS, many lack the understanding of the underlying causes of why their production is declining. Learning how the various diseases spread, and when a tree is too old to produce, may positively impact adoption rates.

FFS are held in villages of cacao smallholders, usually for one farmer group per facilitator; and the course includes an explanation on the causes of declining production, teaching of good GAP and interventions, and repeated experimentation of interventions taught to develop understanding and expertise. The course takes place one day per week for 9 to 10 weeks depending on curriculum and is typically taught by local agriculture extension office staff (dishutbun). Smallholders practice the techniques they learn, and one of their farms would be used as a demonstration plot for the community to highlight the positive impacts of interventions.

Table 4. FFS Impacts

Domain	Initial Impact	Development Impact
Technical	Ecological knowledge	Increased sustainable production
	Improved crop management	Improved livelihoods
	Pest reduction	Cost-effective production
	Yield increase	Improved biodiversity
	Income increase	Poverty reduction
	Risk reduction	
Social	Formation of farmers groups	Collaboration between smallholders
	Communication skills	Smallholder-to-smallholder extension
	Decision and problem-solving skills	Greater access to markets
	Negotiation skills	Improved leverage
	Education skills	Policy changes

Source: David, S. Asamoah, C. "Farmer knowledge as an early indicator of IPM adoption: A case study from cocoa farmer field schools in Ghana." Sustainable Tree Crops Program, International Institute of Tropical Agriculture. Journal of Sustainable Development in Africa (Volume 13, No.4, 2011).

The teaching materials cover the impacts of aging trees and pest infestation, and how to manage a farm as a business. Cacao farms can increase production by pruning, phytosanitation, grafting, and replacing unproductive trees with seedlings known to perform well in Sulawesi. Smallholders are also taught the proper timing, application rates, and types of fertilizer and pesticides, which can maximize their yields. These techniques are described in detail later in this section. These activities require more labor by smallholders and small increases in costs for inputs (grafting budwood and seedlings). The proposed expansion of this program may consider training local collectors to administer FFS as they have strong relationships with cacao communities. The current FFS curriculum also provides for an additional three days of training —targeted for women in cacao households—on nutrition and the importance of maintaining a subsistence garden of fruit and vegetables.

The Sustainable Cocoa Production Program (SCPP) operated by Swisscontact, a Switzerland-based nongovernment organization (NGO), is currently conducting cacao FFS. SCPP started in Jan. 1, 2012, and is scheduled to end Dec. 31, 2015. The program is implemented in Aceh, West Sumatra, West Sulawesi, South Sulawesi, Central Sulawesi, and Southeast Sulawesi. The funders are the Swiss State Secretariat for Economic Affairs (40%), the Sustainable Trade Initiative (IDH) (22%), private sector (27%), and the Netherlands (12%).[17] Private sector funders include Cargill, Mars, and Nestle; and each tends to sponsor FFS in different districts and subdistricts (Table 5).

[17] Swisscontact provided data at its Makassar office during a June 3, 2013 meeting.

Table 5. SCPP Partners

Funding Partners		Non-Funding	
Public	**Private**	**Implementers**	**Government Relationships**
Swiss State Secretariat for Economic Affairs (SECO) IDH Netherlands	ADM Armajaro Cargill Mars Nestle	Bank of Indonesia BT Cocoa Cocoa Sustainability Partnership Delfi Rabobank Rainforest Alliance Syngenta UTZ World Cocoa Foundation	Department of Estate Crops and Forestry (Dishutbun) Department of Agricultural Extension and Human Resources Development (BPPSDMP)Department of Industry and Commerce (Disperindag) Agency for Local Development Planning (BAPPEDA)

Source: Swisscontact

The program trains local government extension office staff to serve as FFS facilitators. The project field facilitator is responsible for a region and oversees the local training staff. The program has 312 full-time staff, which includes 184 government extension staff. [17] The target for women participation is 20% in cacao training and 80% in nutritional training. SCPP has developed four high-quality training manuals:

- Best Cocoa Cultivation Practices
- Post-Harvest, Cocoa Beans Quality and Fermentation
- Cocoa Producer Group Empowerment and Certification
- Household Nutrition and Food Preparation.

In 2012, the SCPP program conducted 217 FFS in Sulawesi training about 5,800 smallholders.18 It is too soon to measure adoption rates and impacts on yield from implementation. In West Sulawesi, SCPP has established 69 demonstration plots, one per farmer group trained in a FFS. Swisscontact intends to train 2,000 smallholders in 2013 in West Sulawesi.

NREL visited the final day of FFS training in the Kalukka area of West Sulawesi. While unusual, this farmers' group was 75% women including a woman as the key farmer (leader). These smallholders communicated that they witnessed their yields declining and were aware of pests, but without understanding of how they were infecting and impacting their trees. They stated that the FFS training provided them with a clear understanding of why production was declining. Some of this group had fertilized in the past, but without knowledge of appropriate formulas, application rates, and timing. This group was not previously aware of the techniques taught in the FFS. Some in this group derive all of their income from cacao while others harvest rice, corn, and vegetables; and a few owned kiosks.

2.2.1.1 Grafting

Grafting is a technique used to both rehabilitate and increase production of older trees as well as a method to ensure known clones of seedlings. Smallholders do not plant all new trees at once as

[18] Data provided by Swisscontact during a meeting at their Makassar office in June 2013.

they must continue to harvest productive trees to earn an income. They replace aged trees over time and graft those trees, which are still somewhat productive. Cocoa doctors, ICCRI, and other organizations grow budwood gardens to supply grafting materials. These budwood gardens are growing cacao tree clone types known for high productivity, quality beans, and pest resistance in Sulawesi. It takes about 14 to 15 months before grafted branches start producing cocoa pods. NREL visited several farms where all trees had been side-grafted; all smallholders reported a significant increase in yield. Costs for quality budwood are approximately IDR 1,000 per stem, and most side-grafts are two per tree.[19] Cacao doctors charge IDR 5,000 per tree for grafting services.

Steps for side grafting on an unproductive tree include (Figure 15) [14]:

1. Prepare budwood by making a diagonal cut
2. Make a deep horizontal cut by shaving bark downward on the main trunk of the tree (must see white inside tree to know cut is deep enough)
3. Peel bark downward to expose the sapwood and apply budwood
4. Tie bark and budwood with straw or string and cover graft with a plastic bag for one month
5. Repeat on the opposite side of the tree; grafts must be at least 30 centimeters apart.

Figure 15. Side-grafting

Photos by Kristi Moriarty, NREL

Top grafting ensures quality seedlings are planted. Both the cacao industry and ICCRI provide seed clones known to perform well in Sulawesi. A graft is performed by cutting off the top of a seedling and attaching a small section of the selected budwood branch to the top of a seedling, which is held in place with plastic rope and covered by a plastic bag (Figure 16). After 10-15 days, the plastic bag is removed; and after 1month, the plastic connector can be removed. All seedlings at cocoa doctor nurseries are top grafted. A seedling grows at least three to four months

[19] Pricing for budwood and cacao doctor grafting service provided by Mars during a site visits in June 2013.

before it is sold; then it typically takes two years or more before pods start to grow. Nurseries offer seedlings at various stages of growth. The government of Indonesia's GERNAS program tried an alternative technique—somatic embryogenesis—for mass producing seedlings of known clones, which had demonstrated small-scale success in Ecuador. It appears something happened in the handling and distribution of these seedlings resulting in trees with weak root systems, which grew taller than expected and did not result in quality beans. These seedlings were planted on approximately 200,000 ha; and 20% have died, and another 70% are not expected to live long.[20] While many in the cacao industry support this type of technology, it will be a long time before smallholders will be open to planting somatic-embryogenesis seedlings.

Figure 16. Top grafting

Photos by Kristi Moriarty, NREL

2.2.1.2 Pruning and Phytosantitation

Both pruning and phytosantiation help to reduce pest infestations on cacao trees and pods. While there is no effective way to remove all pests from cacao farms, it is possible to greatly reduce incidence of pests with these two steps.

Pruning is accomplished by using shearers to remove leaves, which increase the productivity of a tree by promoting pollination and allowing in the appropriate amount of sunlight for photosynthesis activity. Trees should be pruned in the center to increase sunlight and reduce

[20] Data provided to NREL during a June 2013 meeting with Hassanuddin University's Cocoa Research Group.

humidity. This allows new leaves and pods to form quickly as well as decrease CPB as sunlight disrupts their reproductive cycle. A healthy ratio of leaves to pods is 100:1. It is recommended to prune twice per year—once after the main harvest and again 5months later. Trees should be pruned as they grow to control both the height (3 to 4 m is ideal) and shape of the tree, which makes maintenance and harvesting easier. Branches that grow down towards the ground or are dead should be removed. Also, suckers—branches that grow but do not produce flowers—should be removed as they take nutrients away from productive branches. VSD can be reduced by removing infected branches 30 centimeters (cm) from where the infestation starts. The ideal time to apply fertilizer is after pruning.

An agronomist, who teaches pruning to smallholders, says initially there is resistance to pruning due to the belief that more leaves means a healthy tree.[21] This is especially true of smallholders who only derive income from cacao. However, despite this fear, past projects indicate that most smallholders implement pruning after they learn how to do it properly. Pruning shears are provided to smallholders attending Farmer Field School and costs donor programs IDR 70,000 per shearer.

Phytosanitation is an essential crop management tool in reducing pest infestation and keeping pests from moving to new areas. It refers to the removal and burial of diseased cocoa pods, branches, leaves, and weeds. FFS teach smallholders how disease spread, which positively impacts how they handle diseased pods. Field trials in Peru found that weekly removal of pods infected with Black Pod reduced incidence of the disease by 35%-66% and improved yield by 26%-36% [15]. The labor time required to remove diseased matter from the tree is compensated by increased production. However, some smallholders report sanitation as too much work especially because pods infected with Black Pod cannot be sold. For some smallholders, this may be the most cost-effective method for reducing pests. Weeds should be removed four to five times per year, so that they do not draw nutrients away from cacao trees.

2.2.1.3 Fertilizer and Pesticide

In order to reach yields of 2 t/ha and beyond, it is necessary to use fertilizer and pesticides. According to chocolate company research, fertilizer alone may be sufficient to increase yield by 1 t/ha. Smallholders have access to these inputs from local cooperatives (KUD), and there is a fertilizer plant in Makassar (and an additional six in Indonesia;-most are government owned). Few smallholders use agrichemicals because they lack the funds to purchase them at the time they need to be applied. Fertilizer is subsidized for rice, and some smallholders apply the subsidized fertilizer to cacao; but this is not a sustainable practice, and the quantities are inadequate to meet cacao needs to replace nutrients in soils. Fertilizer is also believed to extend the productive life of trees; however, fertilizer should not be applied to trees that are no longer producing pods.

Recommended application rates provided by a Mars CDC in South Sulawesi for fertilizer are double super phosphate (36%) at planting and a nitrogen phosphorus potassium blend with 15% of each nutrient (NPK) in subsequent years. For existing trees, 700 grams (g) are recommended per year (350 g applied twice a year depending on weather). When side grafting, 250 g are recommended when the plastic bag is removed an additional 250 g 3 months later. It is

[21] Information provided by an agronomist who trains cocoa doctors at the Cocoa Development Centre in Wotu.

recommended to apply fertilizer by making a small indentation in the dirt around the tree at the outer branch line. Mars is conducting research on optimizing fertilizer for cocoa in Indonesia, hoping to identify one fertilizer that can meet the needs of most soil types. It was able to develop a fertilizer for West Africa that meets the needs for 80% of the cacao land there. Recommended fertilizer application rates and costs are available in Table 6 and Table 7.

To determine the impacts of fertilizer on cacao yield, a French agriculture research organization, French Agricultural Research Centre for International Development, tested 160 farm test plots in West Africa with fertilizer and controls [16]. The fertilizers used included a mix of phosphorus (23%), potassium (19%), and magnesium (5%) at a rate of 440 kg/ha. Calcium nitrate was also used at a rate of 220 kg/ha. After 2years, production had increased in most areas by 127% compared to control plots. The increases in yield varied depending on other activities of smallholders such as pruning and use of pesticides. As of 2011, 70% of Ghana (fertilizer is heavily subsidized) and 15% of Cote d'Ivoire smallholders fertilized their cacao farms.

Pesticide is combination of insecticide, fungicide, herbicide, and folior applied with a sprayer pack worn on the back. It is recommended to use a sprayer nozzle from Malaysia as they are more efficient than domestic nozzles. CPBs can be reduced from a 40% infestation rate to 10% with the use of insecticide while folior is used to reduce incidence of VSD. Fungicides are effective against Black Pod, and herbicide is used to reduce other pests. Mars is researching low-toxicity levels and is attempting to find out what is attracting female CPB to lay eggs on pods. Sometimes ants are helpful in protecting against minor diseases such as stem borer or helopeltis. Hassanuddin University is testing bioinsecticides and integrated pest management at its test plot in South Sulawesi. These trials include trigadoma for VSD and endophite for Black Pod. For CPB, it is trying mulching and ants, including nests for ants. Recommended pesticide application rates and costs are available in Table 6 and Table 7.

Figure 17. Equipment for pesticide application

Photo by Kristi Moriarty, NREL

Table 6. Fertilizer and Pesticide Application Rates and Costs

Type	Timing	Application Rate	Cost
Fertilizer			
SP36[a]	At planting	100 g per tree	IDR 2,100/kg
NPK 15:15:15[b]	Annually	Year 1: 220 g/tree Year 2: 320 g/tree Year 3: 600 g/tree Year 4+: 700 g/tree	IDR 2,500/kg
Pesticide			
Insecticide	Annually staring in year 2	Year 1: 0 Year 2: 1 ml/tree Year 3+:2 ml/tree	IDR 165,000/l
Fungicide	Annually staring in year 2	Year 1: 0 Year 2: 200 g/tree Year 3: 300 g/tree Year 4+: 400 g/tree	IDR 85,000/kg
Herbicide	Annually	Year 1 and 2: 12 ml/tree Year 2: 9 ml/tree Year 3+: 1.5 ml/tree	IDR 50,000/l
Folior	Annually staring in year 3	Year 1: 0 Year 2: 0 Year 3: 5.3 g/tree Year 4+: 6.4 /tree	IDR 55,000/kg
[a]SP36 is 36% double super phosphate			
[b]NPK 15:15:15 is equal parts of nitrogen, phosphorus, and potassium			

Source: Data provided from an Indonesia specific pricing tool. Supplied by MarsCocoa Development Centre in Wotu

Table 7. Fertilizer and Pesticide Costs per Year

Fertilizer	Year 1	Year 2	Year 3	Year 4+
	IDR per Hectare (assuming 800 trees)			
Fertilizer - SP-36	168,000	0	0	0
Fertilizer NPK (15+15+15)	440,000	640,000	1,200,000	1,400,000
Folior	10,560	79,200	234,667	281,600
Insecticide	23,760	118,800	264,000	316,800
Fungicide	20,400	102,000	226,667	272,000
Herbicide	480,000	480,000	360,000	60,000
TOTAL	**1,242,720**	**1,420,000**	**2,285,333**	**2,330,400**

Source: Data provided from an Indonesia specific pricing tool. Supplied by MarsCocoa Development Centre in Wotu

The economic model assumes that few smallholders implement fertilizer and pesticide due to cost. The assumption is at the end of the training 8,000 smallholders regularly apply these inputs growing their yield to 2 t/ha/yr.

2.2.2 Cocoa Development Centers

The objective is for CDCs to train a subset of cacao smallholders to develop commercial enterprises for distributing knowledge, inputs, and services to cacao smallholders. This would perpetuate the reach of the program beyond the 60,000 smallholders trained in FFS. The project would select 600 cacao smallholders who would receive rigorous university-level training at 20 CDCs spread across targeted districts in Sulawesi to become cocoa doctors. Cocoa doctors would establish for-profit businesses providing services and inputs to cacao smallholder peers in their village and local area. Examples of cacao small business include nurseries; budwood gardens (for top- and side-grafting); on-farm side-grafting; sales of fertilizer; and pesticide, training, and facilitation of access to credit.[22] The cacao industry estimates costs to establish a CDC at IDR 2,536 million per facility or IDR 50.7 billion for all 20.[23] Other costs would include start-up costs of IDR 63 million for each cocoa doctor to provide a polyethylene roof to protect seedlings from spores in nurseries as they grow and other initial inputs.[24] The cocoa doctors will live in their communities and continue to provide training, services, and inputs to cacao smallholders long after the donor program has ended.

The CDC is an existing model developed by Mars that has shown success at the initial small-scale in Indonesia. CDC training covers topics taught in FFS, but in greater detail and with more practice of techniques, in addition to business training for providing services and inputs to cacao smallholders. This would include how to establish a nursery and/or a budwood garden (for top- and side-grafting), track profits and losses, start side-grafting as a business, procure and handle fertilizer and pesticides, and develop 10-year business plans. The training is challenging and is best attended by cacao smallholders with significant motivation. The first week of training is a period of time where the agroeconomists could determine the level of commitment of trainees, and only keep those who are determined and motivated to complete the entire course.

The project would need to lease land for each CDC, which has been done in the past by finding willing farmers with enough land to devote to the project for a specified period of time. CDCs require approximately 2 ha to establish a covered training area, a nursery, and a demonstration plot. Demonstration plots are important as smallholders must see what is working to convince them that the effort of interventions and inputs would improve production.

Each CDC would be staffed and funded with two agronomists from participating cocoa industry companies. Mars's CDC in Luwu, South Sulawesi, secured 52 ha on a 10-year lease with 2 ha used for training, lodging, and nurseries while the rest of the land area is used to research the impacts of various seedlings and techniques. Mars also has another CDC, which it transferred to Amanjaro in effort to get other cocoa industry partners to support CDC development. The cacao industry identifies and interbreeds seedlings from trees that are both high yielding and minimally impacted by pests. These seedlings would be supplied for demonstration plots at CDCs and to cocoa doctors to help them establish quality nurseries and budwood gardens. Cocoa doctors must supply quality materials and services to generate business and keep smallholders returning.

[22] The cacao industry refers to cocoa doctor's for-profit business as Cocoa Village Centers (CVCs).
[23] Based on converting $220,000/CDC and $4.4 million for 20 CDC to IDR at a rate of 1 USD=10,870 on Oct. 22, 2013.
[24] Mars stated that polyethylene roofs are difficult to obtain in Indonesia, and are durable in the climate and ideal for cacao nurseries.

Cocoa doctors typically sell seedlings for IDR 5,000, and the smallholder either picks up the seedlings at the nursery or pays for delivery.[25] Grafting is a skill that even with training is difficult for some cacao smallholders to develop. Cacao doctors offer grafting services to area smallholders and typically charge IDR 5,000 per tree. Mars tracks the progress and profits of cocoa doctors after their CDC training and establishment of their businesses; and after two years, cocoa doctor profits range from IDR 81 million/yr to IDR 464 million/yr.[26] Potential earnings of cocoa doctor were not included in the economic model of this study because there is not sufficient data to project earnings.

2.2.2.1 NREL Cacao Doctor and Key Farmer Site Visits

In June 2013, NREL visited several cocoa doctors who attended CDC training in Luwu. Andi Asri is located in Awo, South Sulawesi. He had previously abandoned his cacao land but heard about CDC training and attended it in 2010. He was motivated by the differences he saw of rehabilitated trees at the demonstration plot. Mars provided Pak Andi with a polyethylene roof and seedlings while he spent IDR 11.6 million of his own money to develop his nursery and budwood garden.[26] He also provides training and has reached approximately 700 other cacao smallholders in his area. In his second year of business, he earned a profit of IDR 104.4 million from providing training and selling seedlings, budwood, pesticide and fertilizer.[26] His own cacao farm has increased in yield from 200-300 kg/ha to 1.4 t/ha in two years and believes he can reach 2.5 t/ha in the next few years. NREL observed the sale of 300 seedlings to Pak Mura who has 3 ha of old cacao trees in the highlands, and his current production has fallen to a yield of 250 kg/ha/yr; he wants to see the outcome of the first 300 trees before replanting all of his land. Pak Mura also plans to engage Pak Andi's services for pruning his trees.

Pak Laudi is a cocoa doctor located in Jala Ja Boso Batu, a remote and sloped area where smallholders have trouble accessing inputs. Some of these smallholders also grow coffee but at higher elevations than their cacao. He started his cacao business in 2009 with both a nursery and side-grafting services. He employs a staff of 12 and pays them IDR 1,000 per side-grafted tree, and the typical laborer can graft 170 trees per day. Meaning his staff earn more than the average IDR 40,000/day wage rate in the area. Pak Laudi receives advance orders of up to 1,000 seedlings from area cacao smallholders. He does not sell fertilizer or pesticide, but would if he had access to credit to buy and store them. He stated his profits are good, and labor only represents 20% of profits.

NREL visited another cocoa doctor who had just finished CDC training and recently established a budwood garden with plans to set up a nursery through an agreement by Amanjaro to provide the roof. This cacao doctor has four farms with a total of 2 ha; and with previous certification training in 2011, he was given quality seedlings, which increased his yield from 500 kg/ha to 2 t/ha in 2 years.

NREL also visited key farmers trained at FFS in West Sulawesi. Key farmers are excellent candidates for CDC training as they already have some training and are typically farmer group leaders. Pak Rahmat in Kalukku, Mamuju, has been farming cacao for 26 years and has long practiced the techniques taught at FFS. He grafted all his trees and regularly prunes, reaching a

[25] Based on NREL site visits to nurseries in West Sulawesi and South Sulawesi in June 2013.
[26] Based on converting $1,000, $7,000, and $40,000 to IDR at a rate of 1 USD=11,602 on 11/20/2013.

yield of 2 ton/ha, and estimates he spends IDR 3,500/tree/yr on input costs. He ferments beans and receives a premium of IDR 2,000/kg from BT Cocoa, but said it was a premium of IDR 3,000 3 years ago. He believes fermenting is worth the extra days and effort, but other smallholders in his group do not ferment. Pak Rahmat uses fertilizer sparingly at a rate of 200 g/tree when he thinks it is needed. He stated that he rarely has money to purchase fertilizer and pesticide at the time it is needed, which would cost him IDR 2.25 and IDR 1.25 million per year respectively. He composts on-site and applies one-third of a bucket per tree, but thinks it is too labor intensive; and while it improves soil quality, it does not improve his yield. Pak Rahmat uses income from cocoa bean sales to pay for labor and fertilizer at his rice farm and uses rice income to pay for school costs.

Key Farmer Desa Sisango is also a local cocoa bean collector and derives most of his income from collecting beans. He grafts, but does not prune, and fertilizes 4 times a year at a rate of 200 kg/tree. He said his village was established 20 years ago through forest clearing, and the 75 households grew cacao. Corn and coconut are grown in small quantities. As of June 2013, 15 families no longer grow cacao and have left the village to work as day laborers elsewhere. Of the 60 families still growing cacao, only 10 actively manage their land, but 25 recently attended FFS; and they plan to establish a nursery with seedlings for their village and eventually for sale to other area cacao smallholders.

2.2.3 Other Interventions

2.2.3.1 Fermentation

Fermentation is a potential intervention that was not considered in the economics due to smallholders resistance to the practice which is explained in this section. Fermentation of cocoa beans is a process that releases the familiar chocolate flavor. The fermentation process begins immediately after raw cocoa beans are placed in wooden boxes with holes to allow air circulation and drainage. Naturally occurring yeast ferment the pulp surrounding the cocoa bean, converting sugars into alcohol while releasing carbon dioxide and liquids. The alcohol is converted to acetic acid by bacteria, which degrades the protein in the inner cocoa bean, releasing amino acids responsible for the chocolate flavor and color. The temperature climbs as high as 48°C, and beans are either turned or moved to a different box one or more days in the five-day process to ensure all beans are fermented completely. Properly fermented beans are brown or dark red while partially fermented beans are purple, and over-fermented beans are very dark in color. The fermentation process reduces the weight of beans by 7% to 8%. Following fermentation, the beans must be dried for four or more days to reduce moisture content as is done with unfermented beans. Drying typically takes place on bamboo or shade tables, which is more efficient than drying on the ground.

Many cocoa processors, manufacturers, and traders reported receiving partially fermented beans due to how smallholders store and transport beans after harvest. Some manufacturers buy wet beans, so that they can ferment beans in a controlled environment for specific product lines. It is estimated that approximately 90% to 95% of Indonesian beans are unfermented. An international trader explained that demand is growing for fermented beans, but the supply is neither large nor consistent.

The positive reasons to ferment beans include enhancing flavor as the process reduces tannin content responsible for the bitter taste of raw beans, potential premium price, and consistency with the rest of the world market. Additionally, Indonesia imports high-quality fermented cocoa beans from West Africa with a 5% import tax; therefore, there is a market for fermented beans in Indonesian if they can be properly produced. Several factors impact the quality of fermented beans including pod ripeness; how pods are stored; quantity of beans and pulp; type of cocoa; and length of fermentation, season, climate, and infestation. This is to say that fermentation of Indonesian beans will increase flavor, but perhaps not to the level of flavor typical of West Africa.

There are reasons why fermentation may not be attractive. The vast majority of smallholders prefer cash as soon as beans are harvested and dried. They think the additional five days they wait for fermentation to occur may wipe out any potential premium payment due to daily fluctuations in market prices for beans. Smalholders are also concerned about the reduction in weight of fermented beans and the additional labor required.

From a market standpoint, Indonesia's primary competitive advantage in global cocoa trade is the ability to supply a large volume of beans with high fat content. The cocoa industry values lower-cost Sulawesi unfermented beans for its fat content, which is useful as filler (cocoa butter) in their products. The quality and taste of cocoa butter are not impacted by fermentation, which provides the smooth quality of chocolate. Cocoa processors and manufacturers have long blended unfermented beans with fermented beans to reach the fat content and flavor specifications of their products. A processor stated that Indonesian unfermented cocoa powder is difficult to sell to European markets. While less important, two recent studies found that polyphenols in chocolate, known for benefits to human health, are reduced by fermenting beans [17,18].

There is demand for fermented beans, and Amanjaro and Olam (international trader) and BT Cocoa (Indonesian manufacturer) are working in a limited capacity directly with smallholders to obtain fermented beans. Companies offer an IDR 1,200 to 2,000 per kg premium over the market price for unfermented beans. An additional fermentation program was developed by ARMATA II as requested by Kraft and funded by Olam. A women's farmer group in South Sulawesi has established capacity to ferment 250 tons of beans per year with the potential to scale up to 1,500 tons per year with additional farmer group participation. The goal is for a 10% margin, and the focus is on women's groups because their labor costs are lower. Mars also sites 10% as a realistic profit margin on fermentation.

Indonesia's Ministry of Agriculture is drafting regulation that would require smallholders to ferment all beans and industry to only purchase fermented beans. This regulation has long been under development but is not law at the time of this report. Neither the cocoa industry nor smallholders view this potential legislation favorably. However, the cocoa industry is interested in sourcing more fermented beans domestically but not through the government of Indonesia's legislation. Fermenting should be considered only if it would result in the desired flavor/quality for all products and if the premium price would remain available with the disappearance of unfermented beans.

2.2.3.2 Certification

Certification was another alternative considered but not included in the economic model because it is not clear if there are benefits to Indonesia smallholders. Certification is a process where smallholders are evaluated and approved based on GAP that are sustainable and protect the local ecosystem as well as safe working conditions. Demand for certified cocoa comes from importing nations, not from producer countries. There are three organizations offering cocoa certification in Indonesia: Rainforest Alliance, UTZ, and Fairtrade International. The schemes of each organization are similar; however, UTZ and Rainforest Alliance focus more on production while Fairtrade International emphasizes trade relations. Many chocolate companies have goals for some or all chocolate certified in 2020 or in later years. The World Cocoa Foundation stated that the market for certified chocolate is less than 5%, and much of this total is from Latin America. For comparison, certified coffee was 8% of the global market in 2010 [19].

The certification process for cocoa is similar to those for other commodities such as sustainable timber and fair trade coffee. Requirements for certification include GAP, farmer group internal control system, human rights, banning child labor, addressing environmental issues, smallholder income, and training. Environmental issues may include addressing pest management and limits on which pesticides are allowable; maintaining soil fertility; and protecting biodiversity, water management and buffer zones by bodies of water, and practices to reduce GHG emissions and increase carbon sequestration. Fees for certification are applied across the supply chain to smallholders, traders, exporters, processors, and manufacturers. Compliance is determined by independent audits at the outset of certification and on regular time intervals.

The steps and documentation required to obtain certification include: documentation of production practices; pest management inclusive of integrated pest management to reduce the number of pests prior to using pesticide; only using the least toxic approved pesticides available economically; soil management to maintain fertility; adding shade trees; and protecting and enhancing biodiversity and water management (cacao is not irrigated) [20]. Buffers must be maintained around watershed areas and bodies of water. Certification requires reporting on practices used to reduce GHG emissions and increase carbon sequestration. There are also requirements to end child labor, which is an issue in West Africa. Smallholders receive training to meet the certification standards. The purchaser of certified cocoa beans must be able to trace the product back to the producer by keeping records (name, date, volume, and price) showing the flow of cocoa beans from the smallholder to a processing mill. Auditors would evaluate if an organization sells more certified product than its purchase records indicate.

The ICCO funded a study to analyze the benefits of cocoa certification with a focus on Côte d'Ivoire and Ghana [21]. A basic conclusion is that not enough analysis or information exists to determine if certification benefits smallholders or not. While it may add transparency and sustainability to the supply chain, it burdens smallholders with additional costs. Smallholders least likely to benefit from certification include those with a plot of less than one ha, not members of a farmers group, and with low potential to increase production. The ICCO study acknowledges that little analysis exists in understanding distribution of premiums as well as costs at the farm level. In Indonesia, it is typical for international traders to pay for and hold the certificate; and then those smallholders sell the trader their certified beans. The Indonesian cocoa industry stated the price premium is 5% to 15%; however, it appears costs to certify may exceed the price premium. There is the potential for no premium if certified beans are sold in conventional markets. This issue is well documented in other studies showing that only a portion of certified coffee and cocoa were sold to buyers willing to pay a premium [21]. Another example of a scheme where a premium advantage was never realized was sustainable palm oil, which takes years and significant funds to achieve and resulted in a near zero premium when supply exceeded demand [22].

The costs for certification vary between organizations with fees on a per unit or group size basis. Some organization certify on a per hectare basis while others certify on a per ton basis. There are fees for smallholders and organizations throughout the entire supply chain. Rainforest Alliance and UTZ state that they do not charge smallholders fees; however, requirements guarantee that smallholders and farmers groups would incur costs. NREL met with organizations holding certification documents in Makassar and found that one organization paid IDR 2.3 to 2.8 million/t to certify production of 10,000 t of cocoa beans from 1,600 smallholders. Another organization reported paying IDR 700,000 per ha for 8,000 ha (4,000 t of cocoa beans). There are additional fees for end users including chain of custody per ton and a flat operator fee ranging between IDR 57,000 and 670,000/t and IDR 3.7 to 59.0 million/yr based on certification organization, volume, and location [21]. These organizations suggested payback periods of three years. It is not clear if the smallholder is paid any premium as the organizations holding the certificate paid all certification costs.

Table 8. Certification Organization Fees and Requirements

Organization	Fees[a]	Premium	Requirements for Label	Market Share (2010)
Fairtrade International	IDR 21 million for smallholder groups <50 initial and IDR 17 million for ongoing years	$200/t	100% certified content for use of their label; at least 20% weight for composite products	39%
Rainforest Alliance	IDR 170,200/ t paid by smallholders; IDR 2.3-2.8 million/t for traders	No fixed premium rate; pays 150-200 USD premium in West Africa	30% content by dry weight	20%
UTZ	$325/t for supply chain operations < 100 t; $5,200 > 50,000 t	No fixed premium; based on market rates $140-$152 in West Africa per ton)	60% minimum content in 2013 increasing to 95% minimum content in 2014	25%

[a]costs are difficult to compare as they are structured differently although all companies have some costs across the entire supply chain

Source: "Cocoa Certification." KPMG. The International Cocoa Organization. October 2012.

The AMARTA II project, funded by USAID, believes certification forces transparency by a closer relationship between smallholders, local traders, and large traders/exporters. It is a safeguard for quality and easier to qualify certified smallholders for financing because data and documentation on their farms is collected during the certification process. A cacao agronomist expressed concern for certification as it only approves certain pesticides and may prevent smallholders from using those most effective against Indonesian pests.

2.2.3.3 Compost

Compost is another alternative considered but not included in the economic model because while it improves soil, it requires significant time and has not resulted in higher cocoa bean production. Compost is viewed as an effective soil amendment in many agricultural applications because it adds nutrients and improves density and water retention of soil. Composting and data on its use in cacao farms are limited, and there is no evidence to suggest an increase in yield from applying it to trees. Site visits found that harvested cocoa pods are generally arranged in piles or in long rows between trees. Mars has several cacao demonstration plots testing compost, but results are not yet available; they estimate 6 to 10 times as much compost would be needed than fertilizer to replenish soil nutrients. Mars has motorbikes with shredders; and cocoa wastes may be mixed with manure, banana leaves, and rice husks. Composting, and applying it to trees, is labor intensive and is not as effective as other interventions, which also require the farmer's time. There is limited evidence to suggest compost is useful in growing seedlings at nurseries.

NREL visited a cacao compost site in Wotu, South Sulawesi. There are three cacao farmers groups in this location with approximately 30 smallholders in each group. They began composting in April 2013 using cocoa pods and leaves, banana stems, and gamal leaves. They are producing compost in two to four weeks, but this resulted in incomplete, poor quality compost. They have a nice covered facility but would benefit from a thermometer, which would indicate when the pile should be turned. They do not have enough material to meet the recommended application rate of 5 t/ha (500 g per tree) and wonder at the costs to bring in additional organic materials to their compost site. These farmer groups are also applying an organic fertilizer provided by the government with organic carbon of 12.3%, C/N ratio of 15.19, pH 8.0, and moisture content of 8.16%. Mars is currently evaluating this fertilizer type at a laboratory. At Tasiu Village in Mamuju, NREL met with a farmer group leader who occasionally composts pods and applies one third of a bucket to trees for overall health, but he has not seen an increase in production and views it as labor intensive. ICCRI measured the components of composted cocoa pods (Table 9).

Table 9. Composted Cocoa Pod Composition

Composted Cocoa Pod		
Component	**Measure**	**Units**
Carbon	42.35	%
Nitrogen	2.82	%
C/N	15	ratio
Organic Matter	73.02	%
Phosphorus	0.31	%
Potassium	4.2	%
Calcium	1.33	%
Magnesium	0.57	%
Sulfate	3.34	%
Manganese	247	ppm
Iron	6,723	ppm
Copper	27	ppm
Zinc	97	ppm

Source: ICCRI. Last Accessed September 9, 2013: http://iccri.net/post-harvest-and-engineering-division/

2.3 Donor History and FFS Literature Review

2.3.1 Indonesia Cocoa Projects

There have been several donor-funded multiyear projects to assist Indonesia cacao smallholders. Most of these projects involved both public and private companies and attempted to reach 10,000 or more smallholders with a focus on Sulawesi farmers [7]. The total estimated funding for the projects described in this section is IDR 1.1 to 1.6 trillion with the vast majority of the funding provided by the government of Indonesia, not donors.[27]

This study focuses on a training program, and cocoa doctors who would continue to educate and provide both inputs and services for smallholders after the conclusion of the project. The previous projects described in this section covered training but also formation of farmers groups, supply chain management, and development of relationships across the industry and among private and public entities. It is not clear what portion of funding was spent solely on training for each project, and not all projects budgeted for follow-up monitoring of training and/or project impacts.

2.3.1.1 Sustainable Cocoa Enterprise Solutions for Smallholders (SUCCESS)[28]

Two successive project followed a similar approach: SUCCESS (2000-2003) and SUCCESS Alliance (2005-2005). The initial project was funded by the U.S. Department of Agriculture, and the follow-on project was funded by the USAID for a total of IDR 58.7 billion.[29] Both projects were implemented by ACDI-VOCA, an NGO, focused on international agriculture development. The initial SUCCESS project focused on educating smallholders on interventions to prevent or

[27] Based on converting $100 and $150 million to IDR at a rate of 1 USD=10,870 on Oct. 22, 2013.
[28] All data in this section are from a 2013 World Bank study [7].
[29] Based on converting $5.4 million to IDR at a rate of 1 USD=10,870 on Oct. 22, 2013.

reduce the incidence of CPBs with non-pesticide controls such as ants.[30] Smallholders were trained on interventions including biological control agents, fertilizer, sanitation, and increasing frequency of harvesting. The project conducted 715 FFS trainings for a total of 35,135 smallholders.

The follow-on project, SUCCESS Alliance, established partnerships with the World Cocoa Foundation and chocolate industry companies. This project also focused on integrated pest management to reduce CPBs and sought to further develop relationships between cocoa industry companies and public entities. The project conducted 25 trainings for 29,700 smallholders on CPB interventions. The training was conducted for a total of 9-10 days over 3-5 months. This project also trained a limited number of smallholders and farmer group leaders on the importance of record keeping to determine profits and losses for a farm. Analysis after training found that of the smallholders trained, side-grafting incidence increased from 9% to 41% with a survival rate of grafts around 50% as it is a real skill, and timing of applying grafts to rehabilitate trees is important. Only 5%-10% of trained smallholders were interviewed about project impacts, but those interviewed showed progress in implementing techniques learned at FFS. Training appears to have led to an increase in production for some smallholders, and maintaining or reduction in production for others, though less than for untrained smallholders (Table 10). The average increase in income or savings is estimated at $435/ha/yr. Beyond the initial interviews of 600 trained smallholders, there was no follow up with trainees after the projects ended.

Table 10. Impacts of SUCCESS Project

Measure	Baseline	After Training
Harvest Increase to two times/month	43%	74%
Harvest infected pods	19%	62%
Pruning	90%	99%
Heavy Pruning	43%	80%
Sanitation	15%	73%

Source: de Wolf, C. "Lessons Learned and Opportunities for Scaling-up of Successful Models of Value Chain Development for Smallholder Coffee, Cocoa and Tea." World Bank. May 30, 2013.

It has been suggested that the focus of these project was too narrow in scope and did not provide technical support after training. These projects did not address the primary issue of aging trees, but there were experiments on determining the best seedlings for Sulawesi, which was important for later projects.

Wasiat, one of the service providers in this project, continued to receive funding at a rate of IDR 120 million for farmer group activities and supply chain management through Vredeseilanden, a Belgium based NGO. Wasiat is affiliated with Armajaro, an international trade company, which is why some smallholders choose not to participate as they prefer to sell to other traders.

2.3.1.2 GERNAS Kakao

The GERNAS Kakao is an ongoing government program administered by the Ministry of Agriculture starting in 2009 with a focus on replacing old and unproductive trees. The GOI

[30] Black ants and pheromone traps are rarely recommended for CPB control in recent years. A fear with pheromone traps is that they will attract insects responsible for pollinating cacao flowers.

investment was significant with 2 years of funding totaling IDR 1.18 trillion.[31] The project focused on somatic embryogenesis, a process of quickly reproducing known seedling clones. The seedlings were based on five types of straight monoclonal from both Ecuador and Indonesia. These seedlings did well in field trials, and the technology is supported by research, but it had never been implemented on a large scale. The project generated 70 million seedlings; and it is believed that deployment of the seedlings led to an issue with the root structure, which did not allow the roots to establish properly, and trees grew a meter taller than expected. Hassanuddin University conducted a survey of farmers who implemented GERNAS program somatic embryogenesis plants. The project did not perform well as 200,000 ha were planted; and 20% of the trees from these seedlings died, and 70% are dying.[32] The program also sought to rehabilitate over 200,000 ha of trees with side-grafting and train 450,000 smallholders on pest control management, provide additional hours for extension agents to provide assistance with an intended ratio of 1 extension agent for each 500 smallholders; however, the actual ratio was 1:5,000, and the training may not have been adequate for extension staff.

2.3.1.3 AMARTA I and II

The AMARTA I project funded by USAID was focused on supply chain management and linking smallholders with more stakeholders to increase access to markets. The AMARTA I project ran between 2006 and 2010 and built upon the work done in the SUCCESS ALLIANCE project. Initially, the project focused on nine crops but was reduced to three crops (coffee, cocoa, and horticulture) midway through the project with total funding of IDR 62.7 billion [7]. It is reported that 46,000 smallholders received GAP training covering increased harvesting, grafting, and nursery management. The project did not evaluate results or implementation rates making it difficult to determine the effectiveness of training. It is also unclear what portion of funding was spent on training versus the supply chain and other aspects of the project.

AMARTA II ran between 2012 and 2013, and the cacao work was focused on microfinance through the use of cell phones and text message (SMS) (Section 2.1.2 of this report), and post-production processes such as fermentation (Section 2.2.3.1 of this report).

It was suggested that the AMARTA I project identified a need for broader industry engagement to achieve scale in future projects and a need for buy-in from national government prior to the implementation phase by development organizations. A lesson learned from AMARTA II was the need to obtain national government support during development of the project.

2.3.1.4 PEKA

Swisscontact administered the World Bank funded Peningkatan Ekonomi Kakao Aceh (PEKA) program in Aceh, which was one of several programs designed to assist in post-tsunami recovery. The PEKA project funding of IDR 58.5 billion covered more than FFS including workshops for supply chain staff, testing seedling clones, organization of farmers group, training trainers, market access evaluation, and quality testing; 12,616 cacao smallholders attended FFS between 2010 and 2012 [3]. The FFS were conducted one day per week for 16 weeks in five Aceh districts inclusive of 51 subdistricts and 321 villages (representing 33% of villages in the

[31] Based on converting $109 million to IDR at a rate of 1 USD=10,870 on Oct. 22, 2013.
[32] Data provided to NREL during a June 2013 meeting with Hassanuddin University's Cocoa Research Group.

five target districts). Gender participation was 78% men and 22% women. PEKA targeted 1.6 million trees for grafting, and facilitators monitoring progress found that 1.2 million trees (76%) had been grafted in the 2 years following training. Facilitators followed up with more than 1,000 trained smallholders to track adoption rates. Aceh experienced an average yield increase of 124% from 350 to 753 kg/ha when comparing baseline with production 2 years after FFS training [3]. The improvements varied across Aceh with some areas experiencing greater improvements than others. Considered even more important was a 101% increase in income. Both the production and income improvements exceeded PEKA's targets.

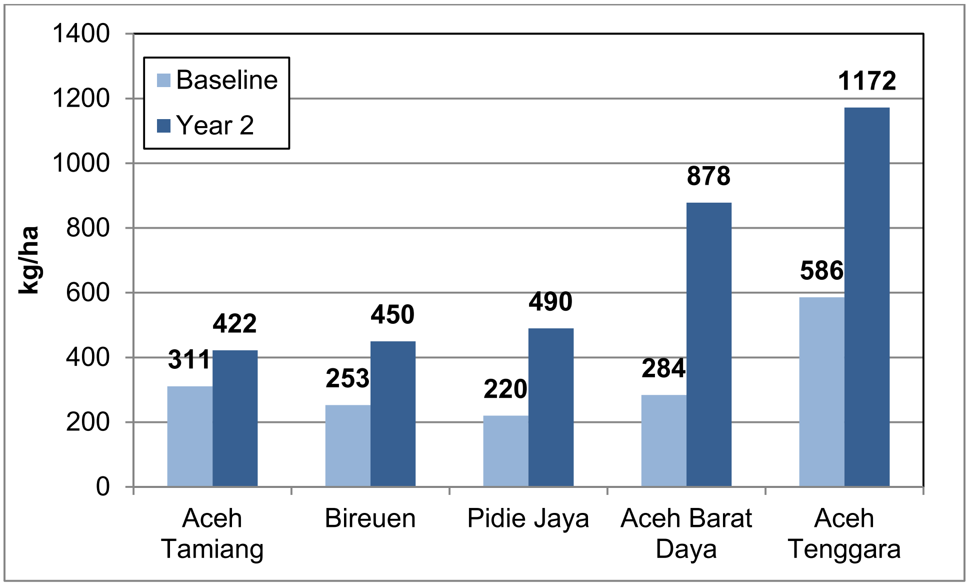


Figure 18. Impact of FFS in Aceh Province
Source: Swisscontact

Swisscontact is administering the Sustainable Cocoa Production Program (SCPP) follow-on project, which began work in 2012. This is a multi-donor project that implements many of the PEKA project activities in six Indonesia provinces concentrated in Sulawesi.

2.3.2 FFS Impacts Literature Review

Very few of the FFS training programs provide sufficient funding to measure adoption rates or determine success of these projects after training has occurred. There are no clear methods on how to best track the impacts of FFS programs. . Additionally, different programs may vary in their FFS follow-up approach such as how they measure impacts, which could make it difficult to compare the impacts of FFS between projects. There is also the consideration of the complexity of how farmers make decisions that may affect if they implement interventions from FFS training. When programs do assess impacts, they find that smallholders trained at an FFS are more aware of GAP than those who did not receive training.

2.3.2.1 IITA Study

The Sustainable Tree Crops Program (STCP) of International Institute of Tropical Agriculture (IITA) funded a study focused on the importance of following up after FFS to determine the rates of adoption of integrated crop and pest management with a case study on impacts of FFS in a primary cacao region of Ghana. Studies on the impact of FFS most often use yield to determine if a program was successful or not. These types of analysis typically do not account for climatic conditions such as flooding, drought, or adverse weather conditions that may negatively impact yield despite smallholders implementing interventions learned in FFS.

The STCP study did not find any significant differences in social indicators between smallholders receiving FFS training and those who did not. The proportion of women in a community, age, education level, cacao farm size, and prior cacao training was similar. The FFS were conducted between 2003 and 2007 with 3,590 smallholders trained for 4 hours every 2 weeks for 10 months [23]. The FFS taught GAP including pruning, sanitation, grafting, shading, and post-harvest practices to improve quality. The first assessment of impact was conducted in 2005, a year after the first FFS were conducted. A 14% increase in production was observed and attributed to implementation of pruning and the addition of shade trees; however, the study stated there were concerns about accuracy in quantifying yields. A more formal impact study was conducted in 2007 analyzing results of 70 randomly selected smallholders who attended FFS in seven different villages between 2004 and 2005. This impact analysis also included interviews in seven villages that did not have FFS as well as interviews with 18 smallholders who did not attend FFS, but gained knowledge from other smallholders in their community who did attend FFS. STCP trainers tested these smallholders on their knowledge of technical aspects taught in FFS with an average test score of 54% for FFS trainees and 39% for smallholders without FFS training. Both groups of smallholders demonstrated good knowledge of pruning and sanitation, and both demonstrated little knowledge of shade management. Further analysis and observation found that smallholders who attended FFS were more likely to prune adequately at the right time; remove and dispose of diseased pods by the recommended method; and weed more frequently than untrained smallholders.

The STCP study suggests that smallholders were already aware of techniques taught in FFS, but that the training provided context on why these techniques work and on the importance of timing the interventions;70% of FFS interviewees stating that the FFS provided them with new information on techniques of which they were already aware. The STCP study found the results of the FFS trainee test disappointing and believes it highlights a need for improvement for both facilitator and smallholder training methods. The study expressed a concern with not providing any written materials to trainees to help them retain the skills taught in FFS.

An earlier STCP study assessed the impacts of FFS on perennial crops in Cameroon. Smalholders surveyed after FFS training experienced an increase in production and income of 32% and 45% respectively when compared with farmers who did not receive training [24].

2.3.2.2 IFPRI Study

The International Food Policy Research Institute (IFPRI) conducted a study on impacts of FFS on agriculture productivity and poverty in Kenya, Tanzania, and Uganda. The study particularly focused on the impacts of FFS on the poor, women, and marginalized groups as well as the effect on poverty, gender, and productivity. To determine the impacts of FFS, IFPRI conducted 1,126 household surveys in villages that had FFS and in similar villages that did not have training [25]. The study found that FFS were mostly attended by low- and middle-income farmers. In some instances, the very poor attended FFS; however, some did not meet the criteria because they do not own land or could not afford the training fee. The majority of the population surveyed in all countries did not have education beyond a primary level.

This study found the greatest FFS impact on crop productivity and income for women-led households. Participation in FFS in these countries was evenly split between men and women; and those belonging to either farmers groups or credit and savings groups were more likely to attend than independent farmers. Table 11 shows improvements in crop yield and agriculture income (both crops and livestock) when comparing farmers attending FFS with those that did not. The greatest impacts on yield and income were experienced by women; this may be due to poor availability of extension services for women. Another interesting outcome was that FFS attendees with no formal education greatly improved their livelihoods from attending FFS. Additionally farmers with medium-sized land parcels experienced greater yields and income than farmers with small- or large-sized land parcels. As evidenced in Table 11, Uganda experienced a decline in crop yield, which may be explained by another agricultural development program occurring in the same districts at the same time as FFS.

Table 11. Impacts on Yield and Income from FFS

Nation	Crop Yield[a]		Agriculture Income[a]	
	Overall	Woman-led Households[b]	Overall	Woman-led Households[b]
Kenya	80%	83%	21%	332%
Tanzania	23%	55%	104%	155%
Uganda	-10%	102%	18%	36%
Overall	32%	139%	61%	187%

a-Yield and income increases are compared with farmers who did not attend FFS

b-increases are over woman-led households which did not attend FFS

Source: Davis, K. Nkonya, E., Kato, E., Mekonnen, D. Odendo, M., Miiro, R., Nkuba, J. " Impact of Farmer Field Schools on Agricultural Productivity and Poverty in East Africa". IFPRI Discussion Paper 00992. June 2010.

Wageningen University in the Netherlands published a journal article, which reviewed four FFS integrated pest management impact studies [26]. Three of these four studies found the impacts of FFS met the goals of the various programs with farmers implementing better pest management practices as well as increases in crop yield. The fourth study evaluated was a World Bank assessment of FFS impacts on Indonesian pesticide use in rice. The World Bank study assessed the impacts of FFS in 1991 and 1999 and found no difference in pesticide use between villages with FFS when compared with control villages that did not have FFS. The Wageningen study said it was concerned with the World Bank's selection of control villages as three out of four were within 1 km of villages with FFS, and in more than 8 years it is possible that the farmers shared knowledge as they sell into the same markets.

Indonesia assessed the impacts of 182 FFS in rice farming, and the FAO published six case studies. The FAO study found that rice FFS resulted in positive changes for farmers in their production, social interaction, and their efforts to affect policy. Further, many farmers organized and invested their own time and money in additional activities after the donor project ended.

2.4 Current Baseline

The baseline case assumes that cacao farming would continue on existing land in Indonesia, and yield would be impacted by aging trees and pests, but the decline would be mitigated by modest efforts funded by the cocoa industry. While GOI statistics indicate land use to cultivate cacao is growing, other private cocoa industry data sets indicate that land expansion is stagnate. Cacao land use is not expected to expand with current conditions of yield and price. It is anticipated that the cocoa industry would continue to fund FFS and CDCs at current levels, which may be enough to keep yields from declining more; however, it may not be sufficient for smallholders to continue growing cacao. The cocoa industry makes a significant investment in interventions in West Africa due to the higher levels of production and the importance of cacao in those nations. The cocoa industry expects a higher return on its investment in West Africa when compared with Indonesia. Thus, FFS would continue but would only train and impact a percentage of the smallholder population, which may not be significant enough to induce major changes across Sulawesi and Indonesia. If FFS and other cacao interventions decline in Indonesia, then smallholders might abandon their land, work as day laborers, or potentially expand into forested land to grow cacao or other crops. Indonesian cocoa manufacturing plants would need to continue importing cocoa beans from West Africa and other nations to meet capacity and quality requirements.

2.4.1 Alternative Crops and Intercropping

Historically, Indonesian cacao smallholders have been more likely to abandon unproductive cacao land than repurpose it. However, as land becomes more scare, there is more potential to repurpose cacao land to another crop and it makes financial sense if cacao smallholders are able to return to yields of 1 t/ha or greater, they are less likely to change to a different crop. Other crops considered as potential competition for cacao land area include oil palm, rice, corn, coffee, and rubber. Cacao, coffee, and rubber are considered cash crops because they are sold to processors or traders for export while rice and corn are food crops, which Indonesia both grows and imports. Rubber production is concentrated in Sumatra and Kalimantan with minimal production in Sulawesi making it an improbable candidate to replace cacao.

Coffee and cacao are unlikely to grow in the same land area, and when they do overlap, one of the crops performs poorly. Robusta is an upland coffee, and the main type cultivated in Indonesia performing best at altitudes between 500 and 1,500 m. Arabic, grown in small quantities, is a highland coffee cultivated between 1,000 and 2,000 m. Cacao grows best below 500 m and optimally below 300 m, so there is little overlap of land in Indonesia between coffee and cacao. There is minimal production of lowland Liberica coffee grown in Indonesia, and it is sometimes grown in peat lands where cacao is not.[33]

Indonesian 2013 coffee production is suffering from drought conditions during flowering and heavy rains impacting cherry development as well as long-term issues of aged trees and low-quality inputs. Sumatra accounts for nearly 75% of Indonesia's production concentrated in Bengkulu, Lampung, and South Sumatra areas while Sulawesi accounts for 9% of production [27]. There are over 1.9 million coffee smallholders with an average land size of 0.6 ha and yields between 500 and 800 kg/ha (Mamasa yields are reported at 300-500 kg/ha [2]). Coffee

[33] Coffee altitude information was provided by Chris Bennett, an independent subcontractor to NREL.

grown on 1.2 million ha produced 582,000 t of coffee in 2012 (82% Robusta, 18% Arabica) [28]. IPB reported Mamuju coffee prices of IDR 15,000 to 20,000 per litre (l) and Mamasa prices were IDR 8,000/kg for Arabica and IDR 14,500/kg for Robusta in August 2013 [1,2].

Many cacao smallholders also have rice farms, which are typically located nearby; whereas their cacao land is adjacent to their home. Rice usually requires irrigation, which is costly and takes considerable time to obtain. Irrigation is not possible in all land areas, and there is also the risk of relying on a public entity to supply water. Rice is Indonesia's most important food crop, and Table 12 shows statistics for 2012. Sulawesi data are available in Table 13.

Rice costs per ha are estimated at IDR 3.7 million, which includes IDR 2.6 million for labor and IDR 1.1 million for fertilizer, and a farmer can expect a price of IDR 9-10.5 million/ha based on current yields and prices [19,29].Rice land is being negatively impacted by conversion to non-agricultural uses near cities. Land expansion is unlikely due to lack of irrigation infrastructure and soil fertility.

Corn is considered a lower value use of cacao land and suffers from pests and yield issues. Indonesian corn farmers receive between IDR 7.8 million and IDR 10.5 million per ha based on current pricing and yields [19]. Indonesian and Sulawesi corn land area, yield, and production for 2012 are available in Table 12 and Table 13. Corn demand as livestock feed exceeds demand in food markets and is the significant source of protein in livestock feed.

Table 12. Indonesia Rice and Corn Statistics

Measure	Rice	Corn
Area Harvested (million ha)	12.15	3.12
Production (million t)	37.5	9.0
Yield (t/ha)	3.09	3.0
Imports (million t)	1.0	1.7
Consumption (million t)	40	6.6 feed 4.4 food
Price received by farmers (IDR/kg)	3,300-4,500	2,600-3,500

Source: Slette, J. Meylinah, S. "Indonesia Grain and Feed Annual Report 2013". USDA FAS. Gain Report ID1318. April, 11, 2013. Last Accessed October 27, 2013: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Jakarta_Indonesia_4-11-2013.pdf

Table 13. Sulawesi Rice and Corn Statistics

Region	Area Harvested (million ha)	Production (million t)	Yield (t/ha)
Rice			
Central Sulawesi	228,223	1,047,055	4.59
South Sulawesi	967,354	4,872,384	5.04
Total Sulawesi	1,581,783	7,705,527	4.87
Corn			
North Sulawesi	120,167	439,836	3.66
South Sulawesi	320,178	1,457,879	4.55
Gorontalo	137,739	661,250	4.8
Total Sulawesi	672,831	2,904,691	4.32

Source: Slette, J. Meylinah, S. "Indonesia Grain and Feed Annual Report 2013". USDA FAS. Gain Report ID1318. April, 11, 2013. Last Accessed October 27, 2013: http://gain.fas.usda.gov/Recent%20GAIN%20Publications/Grain%20and%20Feed%20Annual_Jakarta_Indonesia_4-11-2013.pdf

In some instances, oil palm is replacing cacao. This only takes place in communities near to palm mills of which there are only 18 in all of Sulawesi, however, more mills could be built resulting in conversion of an unknown area of cacao land to oil palm. The investment to plant oil palm is significant at IDR 30 to 40 million/ha typically paid for with a loan; however, ongoing costs and labor are lower than other crops. Income per hectare varies over the 25-year life cycle of the tree, and it takes 5-7 years from planting before they start generating income. A study found that Indonesian oil palm smallholder yields were 35% and 40% lower than private and state-owned plantations respectively [30]. Another study found independent Indonesian growers make returns on land-use of IDR 11.0 million/ha for low-yielding lands to IDR 26.8 million/ha for high-yielding land [31].[34] If productivity of cacao remains low, there is a greater likelihood of conversion to oil palm in villages close to palm mills because oil palm fresh fruit bunches degrade quickly. Mamuju oil palm production is concentrated in Budong Budong, Karossa, Topoyo, and Tobadak (Figure 19). Budong Budong is the only subdistrict in Mamuju with more oil palm land area than cacao.

[34] Based on converting $960 and $2,340 to IDR at a rate of 1 USD=11,461 on 11/14/2013.

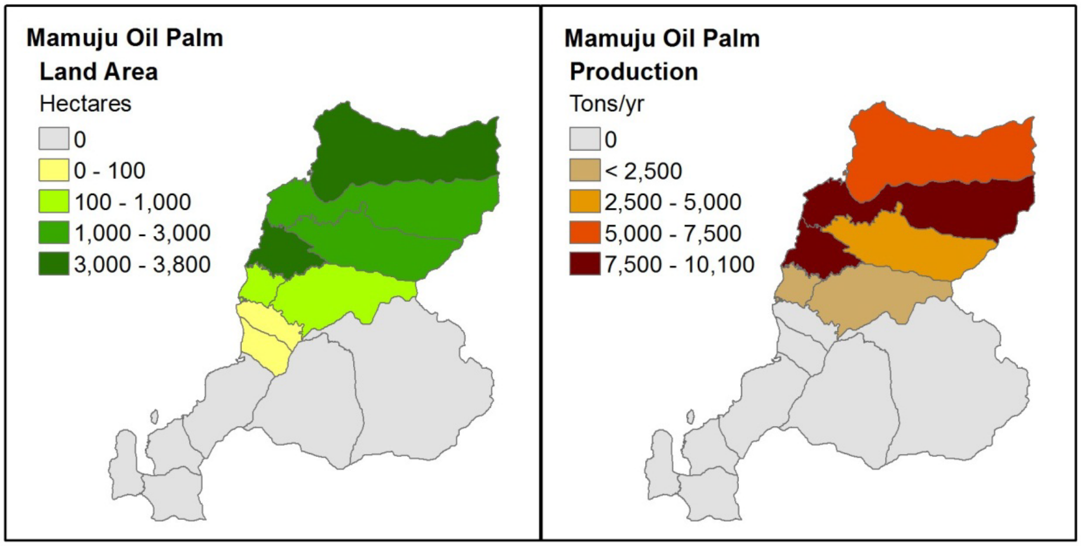


Figure 19. Mamuju oil palm land area and production

Source: Map created by NREL with data from "Natural Resource Management and Sustainable Land Use: Mamuju District, West Sulawesi." Prepared for NREL by Bogor Agricultural University (IPB). November 2013.

In Mamuju, cacao remains the dominant use of agricultural lands with far more hectares than rice, corn, oil palm, and coffee. Table 14 summarizes Mamuju subdistrict land use and production in 2011 for primary crops. Cacao is grown in every subdistrict except for Balabalakang, which is an island area. Rice is also grown in most areas as is corn. Coffee production is a limited use of land, and oil palm is only grown in a few subdistricts.

Mamasa has around 20,000 ha each dedicated to cultivating cacao, rice, and coffee (Table 15). In Mamasa there are 18,800 smallholders growing cacao and 25,460 growing coffee [2]. Land area includes immature, producing, and old plants, which impacts production by subdistrict. Other crops are grown on minimal land including cassava (443 ha), sweet potato (306 ha), corn (203 ha), and peanuts (112 ha). There are no data to suggest oil palm is produced in Mamasa.

Table 14. Mamuju Cropland Use and Production

Sub District	Cacao		Oil Palm		Coffee		Wet Rice		Corn	
	Land area (hectares)	Production (tons)	Land area (hectares)	Production (tons)	Land area (hectares)	Production (tons)	Land area (hectares)	Production (tons)	Land area (hectares)	Production (tons)
Tapalang	5,201	1,398	-	-	48	12.8	1,455	7,247	250	1,220
Tapalang Barat	2,072	1,234	-	-	22	7.5	45	224	124	610
Mamuju	2,357	1,230	-	-	7	2.5			75	366
Simboro	5,857	1,330	-	-	28	6.5	40	199	100	488
Balabalakang	-	-	-	-	-	-	0	0	-	0
Kalukku	7,491	1,600	-	-	1,165	25.8	4,509	22,775	1,507	7,369
Papalang	6,798	1,712	75	-	9	2.5	3,025	15,276	805	3,929
Sampaga	8,092	4,575	80	-	1	0.5	1,575	7,845	925	4,515
Tommo	4,704	1,986	500	1,347	60	38.8	4,070	20,391	1,530	7,469
Kalumpang	3,605	1,576	-	-	359	65.3	770	3,769	750	3,655
Bonehau	1,822	964	-	-	6	3.0	453	2,217	625	3,047
Budong Budong	3,082	1,499	3,753	10,008	7	3.5	1,768	8,806	3,960	19,384
Pangale	1,891	1,342	320	1,259	12	3.8	4,064	20,787	971	4,743
Topoyo	3,838	1,767	2,580	9,851	23	8.8	521	2,595	1,447	7,076
Karossa	4,493	2,593	3,352	6,727	157	45.0	2,953	14,694	1,635	7,979
Tobadak	7,044	3,058	2,536	4,035	82	25.8	3,128	15,565	1,775	8,662
Total	**68,347**	**27,864**	**13,196**	**33,227**	**1,986**	**252**	**28,376**	**142,390**	**16,479**	**80,512**

Source: "Natural Resource Management and Sustainable Land Use: Mamuju District, West Sulawesi." Prepared for NREL by IPB. November 2013.

Table 15. Mamasa Cropland Use and Production

Sub District	Cacao		Coffee		Rice	
	Land area (hectares)	Production (tons)	Land area (hectares)	Production (tons)	Land area (hectares)	Production (tons)
Sumarorong	98	9	995	110	522	1,670
Messaw a	1,805	11,875	712	145	804	3,296
Pana	900	202	1,100	169	812	2,355
Nosu			5,206	875	324	972
Tabang	400	72	1,150	281	832	2,496
Mamasa	80	3	495	54	2,010	5,829
Tanduk Kalua	480	8	1,534	149	1,404	5,897
Balla	82	7	715	95	1,521	4,563
Sesenapadang	365	13	845	116	528	1,584
Taw alian	205	7	610	118	742	2,226
Mambi	1,903	1,100	853	159	3,021	12,114
Bambang	6,650	1,750	973	332	1,400	5,460
Ran Tim	745	200	621	151	1,452	5,518
Mehalaan	548	177	822	167	1,016	3,048
Aralle	4,600	1,500	605	12	1,418	5,388
BuMal	800	10	682	123	1,472	4,710
Tabulahan	2,085	250	130	52	1,213	4,973
Total	**21,746**	**17,182**	**18,048**	**3,105**	**20,491**	**72,100**

Source: "Natural Resource Management and Sustainable Land Use: Mamasa District, West Sulawesi." Prepared for NREL by IPB. November 2013.

Opportunities for intercropping are limited. Other crops, such as corn, may grow in the first year or two as a cacao tree grows, but the canopy cover makes this ineffective for later years of tree development. In some instances, coconut trees are used as shade trees, and output is used for subsistence.

2.5 Operational Feasibility

The project would require training facilitators, training materials, agroeconomists, land for CDCs, an organization to oversee the program, and the availability of cocoa industry experts to provide guidance over the length of the project. FFS would be held on farms using a large tarp under cacao trees, and the facilitator would have a whiteboard to write and illustrate training. Additionally, each FFS trainee would receive a book covering all topics taught during training. These materials were created in a previous Swisscontact FFS program. The project would require an organization to implement a schedule and identify locations for each of the FFS. There are several organizations in Indonesia with experience implementing FFS.

It is anticipated that some of the facilitators of FFS would be agricultural extension agents as they currently facilitate Swisscontact FFS in Sulawesi. Ideally, some of the facilitators would be local cocoa bean collectors/traders due to their long-term relationship with cacao smallholders. Both extension agents and local traders/collectors will remain in these communities long after the donor project has ended and can continue to provide knowledge on cacao issues and interventions. Training 6,000 smallholders per year would require 200 to 240 FFS (depending on class size), which would be taught by a minimum of 15-20 well trained facilitators.

CDCs would require land available for the duration of the program and preferably after to continue demonstration plots, and to provide a meeting place for smallholders to gather and continue training activities. It is expected that the cocoa industry would supply 40 agronomists to staff 20 CDCs. The agronomists' responsibilities would include teaching the course and managing the demonstration plot. The project should seek to hire agroeconomists from Sulawesi or elsewhere in Indonesia, but it may be necessary to hire from Malaysia or other cocoa experts from nearby countries. CDCs currently operating are staffed by agroeconomists paid by Mars and Armajaro.

2.6 Technical Risk Assessment

2.6.1 Mitigation Plan for Identified Risks

This project is a training program, and therefore, is not anticipated to encounter technical risks. However, there are other types of risks that could impact the project. The most significant risk for this project is failure of smallholders to participate in training and failure of trained smallholders to adopt recommended practices. The project must demonstrate the effectiveness of training to potential trainees which could be accomplished by site visits to cacao doctor farms or demonstration plots at past FFS or CDC. Monitoring of FFS participants will indicate if smallholders are adopting recommended practices and techniques where adoption rates are low may indicate a need to alter training materials or methods during the project.

A potential risk is securing co-funding from the cacao industry. This activity should happen before any GP funding of the project to ensure all obligations would be met by both parties. Another risk is selecting facilitators and agroeconomists that are effective trainers. This risk is mitigated by selecting trainers who have documented previous past positive experiences as well as ensuring that facilitators and agroeconomists are well trained to teach their respective courses to participants, and that they have resources and are monitored for duration of the project. All crops are subject to climatic conditions and may be negatively impacted by drought, floods, and fire. The incidence of climate events may affect the ability to accurately measure impacts from FFS on crop yield and income. Smallholders could implement recommended practices only to have their crop fail or experience low production as a result of a climate event.

2.6.2 Monitoring and Evaluation Plan

Monitoring impacts of FFS in the months after smallholders' complete training is important to determine rates of adoption. Interviews and household surveys with the first groups of FFS trainees could highlight areas where training techniques and materials need to be improved to achieve greater adoption rates. It would assist the wider agriculture development community if the project could conduct ongoing assessments of impacts in the months and years after the project has taken place to determine the outcomes and identify areas for improvement. Ideally, impact analysis is carried out by an independent third party in villages with and without FFS training. There is no clear methodology for determining impacts of FFS, but there are some potential methods available from past projects (see Section 2.3.2). The goals of this project are to double yield as a result of smallholders attending FFS and implementing the techniques taught. The clearest initial indicators of FFS success are crop yield and increased income; however, long-term goals are improved quality and long-term income security.

3 Economic Assessment

An economic assessment evaluating the outcome of this project was performed and presents both the project's NPV and ERR as well as detailed economic results that highlight relevant elements of the analysis. The method for evaluating the impact of this project proposal involves comparing the cash flows of a counterfactual scenario (also referred to as the "base case" or "business-as-usual") to the cash flows if the project proceeds (the "with-project" or "WP" case).[35] Evaluating the project in this way enables a determination of whether the project delivers the incremental returns to meet the required 10% ERR hurdle rate.

The ultimate scope of MCC economic analyses is national, though regional in practice. Further, the economic assessment considers the project's impact on the regional economy instead of considering its impact only on the sponsor. Expanding the project boundary allows a better understanding of how the value created by the project is distributed among stakeholders. This has a dual purpose: to demonstrate that the Green Prosperity goal of poverty alleviation is met and to ensure that funding is provided to projects that would not attract a private investor otherwise.

Cash and value flows for both the counterfactual (CF) and WP cases are based wherever possible on data collected in site visits or on comparable projects in Indonesia if site-specific data were not available. Natural resource management (NRM) and sustainable land use (SLU) projects take a land-based approach where input costs and land values are all presented on a per-hectare basis. This allows the model to account for all changes to these inputs that result from a project intervention, and accommodates the greatest number of project design possibilities.

A full explanation of methods for calculating CF and WP benefit streams is forthcoming in a separate comprehensive document detailing the NRM/SLU land use-based economic model, which would describe methods, model structure, and procedures for its use in evaluating similar projects.

3.1 Overview of Results

The Cacao intensification project performs well economically primarily because the productivity of the existing crop is low, and the opportunity for incremental improvements to yield is significant with relatively modest associated cost increases. While the assumptions made in the cocoa industry proposal about adoption are optimistic, even with conservative inputs, the project performs favorably. Under reference case assumptions, the project ERR is 21.0% with an NPV of IDR 1,070 billion. This analysis is conducted assuming a grant is offered to the Cocoa Development Program with a 50/50 cost-sharing arrangement from MCA-I and the cocoa industry partners, however, MCA-I costs will be higher due to overhead. The total MCA-I contribution is IDR 184 billion.

The main economic risk for this project involves assumptions about the CF behavior of smallholders. While conservative assumptions about land productivity were modeled, other outcomes are certainly possible. The model considers a constant, low-level yield using the last 5-year average for the CF. Sensitivity analyses were performed for prominent CF variables to

[35] The counterfactual is what would happen in the project area if the project was not built.

determine the impact of various assumptions on economic results. With very conservative inputs (i.e., relatively high CF yields and prices), the project still performs positively. At CF annual land productivity values (price by yield) below IDR 13,500,000, the project delivers an ERR above 10%. A full assessment of alternative crop prices and yields would reveal the impact of each alternative, but from an economic perspective, there is relative certainty that the project would perform well.

The WP yields made possible by new farming techniques are known with more certainty, but can be impacted by weather and long-term changes to crop management. There is, however, some uncertainty over how many smallholders ultimately adopt the new techniques and when they adopt them. The cocoa industry suggests optimistic adoption estimates, but with more conservative estimates, the project performs well economically.

Project benefits are shared between the two farmer groups: the medium-yield and high-yield groups. The relative benefit for each group depends on the number of hectares devoted to each type of practice, as well as the associated costs and yield of that land. Because smallholders capture 80% of world market price, they benefit directly and significantly from yield improvements. The ERRs of the medium-yield group and the high-yield group are 18% and 39%, respectively.

3.2 Assumptions

3.2.1 Baseline Case

Due to aging trees and pest infestations, the past 5 years have experienced a decline in yield from 801 kg/ha in 2007 to 424 kg/ha in 2011— a compound annual rate of -12% (Figure 5). Recent past cacao smallholder training in Indonesia resulted in a measurable impact on local yields [3]. It is anticipated that the cacao industry would continue its modest investment in Indonesia for the project period, though not sufficiently enough to affect *positive* changes in aggregate yield. It is anticipated that this work would continue at least through 2015, and would cause yields to level off and stop their long-term decline. Therefore, the team assumes that the CF yield would remain at its low level with no change over the project life. This assumption has a conservative effect on the project's economic results by limiting CF losses, and therefore, moderating the incremental benefit caused by the project's interventions. The CF yield used in the model is the average of the last 5 years provided by cacao industry contacts (562 kg/ha).

The PFS team also considered whether the decline in cacao yields would cause increased encroachment by smallholders. While this is a possibility, more information is needed about land-use patterns, crop alternatives, smallholder behavior, and ecosystem service value of the encroached-upon land in order to perform a complete economic analysis on this issue. Bounding the problem to the area of cacao currently cultivated enables reasonably reliable and conservative economic results. From an economic perspective, encroachment would reduce the project ERR assuming the abandoned land subsequently produced nothing and that the difference between forgone ecosystem service value of the encroached-upon land and new cacao productivity were greater than lost cacao productivity of the abandoned land. While government data report increased land area under cacao cultivation overtime (Figure 5), the cacao industry suggests that it is more likely that land devoted to cacao has declined slightly in recent years due to lower productivity. If cacao production continues to decline, there may be more abandoned farms or crop-switching (see Section 2.4.1 of this report).

The price per kg for cacao used in the model was IDR 18,000 for both the CF and WP cases (see Figure 11, which explains why this price is realistic and conservative).[36] CF upfront and ongoing costs for smallholders are both IDR 2.8 million ha/yr.[37] At annual yields of 562 kg/ha and IDR 18,000 per kg, each hectare earns IDR 10.1 million per year, for annual farmer net income of IDR 7.3 million. A longer discussion of alternatives is available in Section 2.4.1and in the following Economic Risk Assessment (Section 3.3).

3.2.2 Proposed Project

The fundamental driver of value in this project is improved productivity of underperforming cacao trees. There are costs associated with training and capacity building of smallholders, and upfront and ongoing costs incurred by those who implement new techniques. The economic results depend on the magnitude of changes to costs and yield improvements.

The proposed interventions for this project include training and capacity-building exercises tailored to Sulawesi cacao smallholders. In order to track impacts and benefits among beneficiaries, the economic model focuses on changes to an individual hectare between the CF and WP case. So, if a single farmer who owns 2 ha makes no changes to his or her cacao crops in the CF, but decides to adopt new techniques proposed in the project, the impact to that single farmer is a function of the changes to upfront and ongoing costs and resulting changes in yield.

The PFS team considered the programmatic costs and impacts of a cacao industry proposal. The proposal calls for the training of 60,000 farmers in Sulawesi over 4 years through FFS, the establishment of CDCs, support and training of cocoa doctors, and program management costs. Table 16 shows the breakdown of these proposed costs. The model spreads costs out over time according to when they occur in order to account for timing and discounting impacts. For example, the FFS incur costs of $200 per farmer to train, but train farmers over 4 years. The costs to train farmers in later years would be discounted more heavily and would not have as large an impact on project costs. Similarly, program management costs are spread over the program life. The model accounts for the timing of these costs in the sensitivity analysis as well. All program elements are cost shared between MCA-I and the cocoa industry with aone-to-one match. MCA-I would provide its share of funding as a grant to the cacao industry partners.

Table 16. Proposal Cost Breakdown

Component	Cost (million IDR) [38]	Cost (USD)
FFS: 60,000 smallholders @ $200 each	136,977	$12,000,000
CDC Component Cost (Est.): Setup of 20 @ $220,000 each	50,308	$4,400,000
Cocoa Doctor Support Cost (Est.): 600 units at $5,500 each	37,730	$3,300,000
Program Management Cost (Est. 20%)	47,725	$4,140,000
Total	**272,740**	**$24,840,000**

[36] Smallholders reported prices between IDR 18,000 and 20,000 during NREL site visits in South Sulawesi and West Sulawesi in June 2013. IPB also reported prices in this area during its site visits in August 2013. Also, world prices are trending higher due to demand exceeding supply (Figure 11).
[37] Input costs provided by a CDC agronomist during NREL site visit to South Sulawesi in June 2013.
[38] Based on converting USD to IDR at a rate of 1 USD=11,528 on Nov. 19, 2013.

The total area under consideration is 120,000 ha, based on 2 ha per smallholder and 60,000 farmers trained. Some assumptions about adoption rates of specific techniques are required to observe the impact of proposed interventions, and because there are two levels of management proposed by the project (the first resulting in 1 t/ha yield with simple, low-cost techniques; the second resulting in 2 t/ha with fertilizer and pesticide), the adopters of each technique are tracked separately in the model because the marginal impacts and costs are different between the two techniques. Furthermore, within each group, there would likely be a sizeable portion that does not adopt either practice. So, there are three smallholder groups whose net impacts can be observed in the model: 1) those who never adopt, 2) those who adopt medium-yield practices, and 3) those who adopt high-yield practices. The farmers who never adopt would see no change in costs or output, so their net benefit would be zero. The other two groups' impacts are described below. The model divides the total cultivation area into two groups based on the two techniques, and treats each group as its own crop with its own input and adoption assumptions. The charts presented below in Figure 20, Figure 21 and Figure 22 show total and cumulative uptake for cultivation area and farmers, respectively.

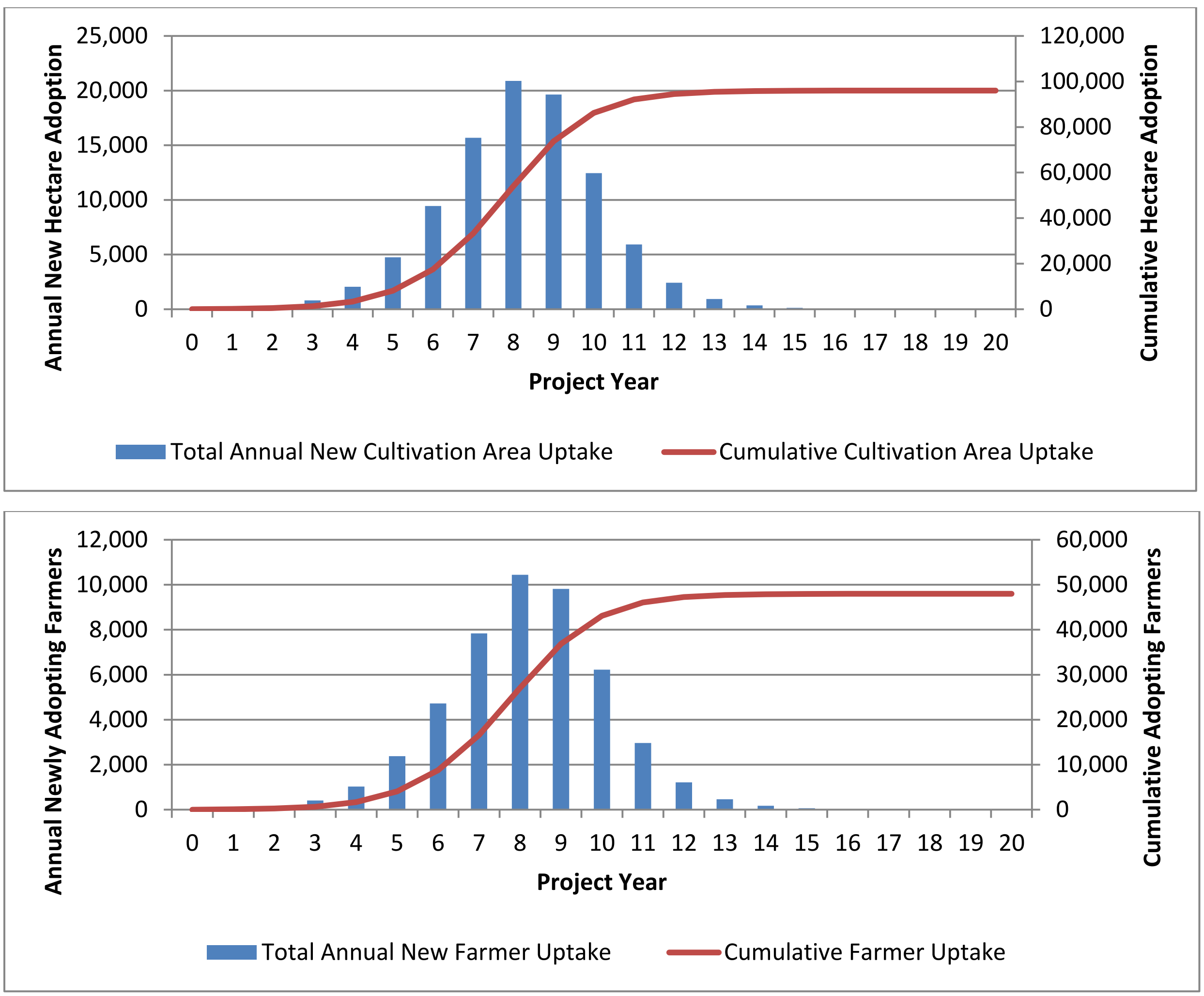


Figure 20. Adoption curves for total farmers and cultivation area

The high-yield farmer group would bear higher upfront and ongoing costs (IDR 5.3 million and IDR 7.2 million, respectively), so this group is likely to be a smaller portion of the 60,000 farmers. [39] Medium-yield techniques require upfront and ongoing costs of IDR 3.5 million and 3.2 million, respectively. The model begins with the assumption that 50,000 of the farmers trained are likely to employ the lower-level management practices to reach 1 t/ha yield, which means that 10,000 smallholders are likely to employ the higher-level management practices. Within each group, the model assumes that only 80% ultimately adopt the new techniques, which implies that 40,000 farmers adopt low-level techniques, and 8,000 adopt the high-level techniques, reaching a total of 96,000 ha.

In addition to assumptions on ultimate adoption levels, the model also accommodates time-phasing of adoption of new techniques by farmers. The industry proposal calls for training of 60,000 farmers over 4years in the FFS. This is an ambitious assumption, and there is the added complexity over whether farmers who are trained ultimately adopt. Instead, the model uses a logistic growth function to characterize the time phasing of adoption by farmers. A logistic function corresponds to adoption of new technologies generally, and its shape can easily be manipulated by the user. The three inputs that influence the shape of the logistic curve are the ultimate share of the targeted population that adopt, the timing of adoption (mathematically, the year in which 50% of ultimate adopters have adopted), and curve flatness (which theoretically represents the spread of ideas and therefore the pace of adoption). Ultimately, one cannot predict exactly how many farmers adopt new techniques and when, but the model assumptions can be subjected to sensitivity analysis and conservatively skew probability distribution ranges. The assumptions made by the industry proposal are at the optimistic end of the probability distribution assigned to the adoption variables. Figure 21 and Figure 22 show adoption curves for the medium-yield group (C1) and the high-yield group (C2).

[39] Input costs provided by a CDC agronomist during NREL site visit to South Sulawesi in June 2013.

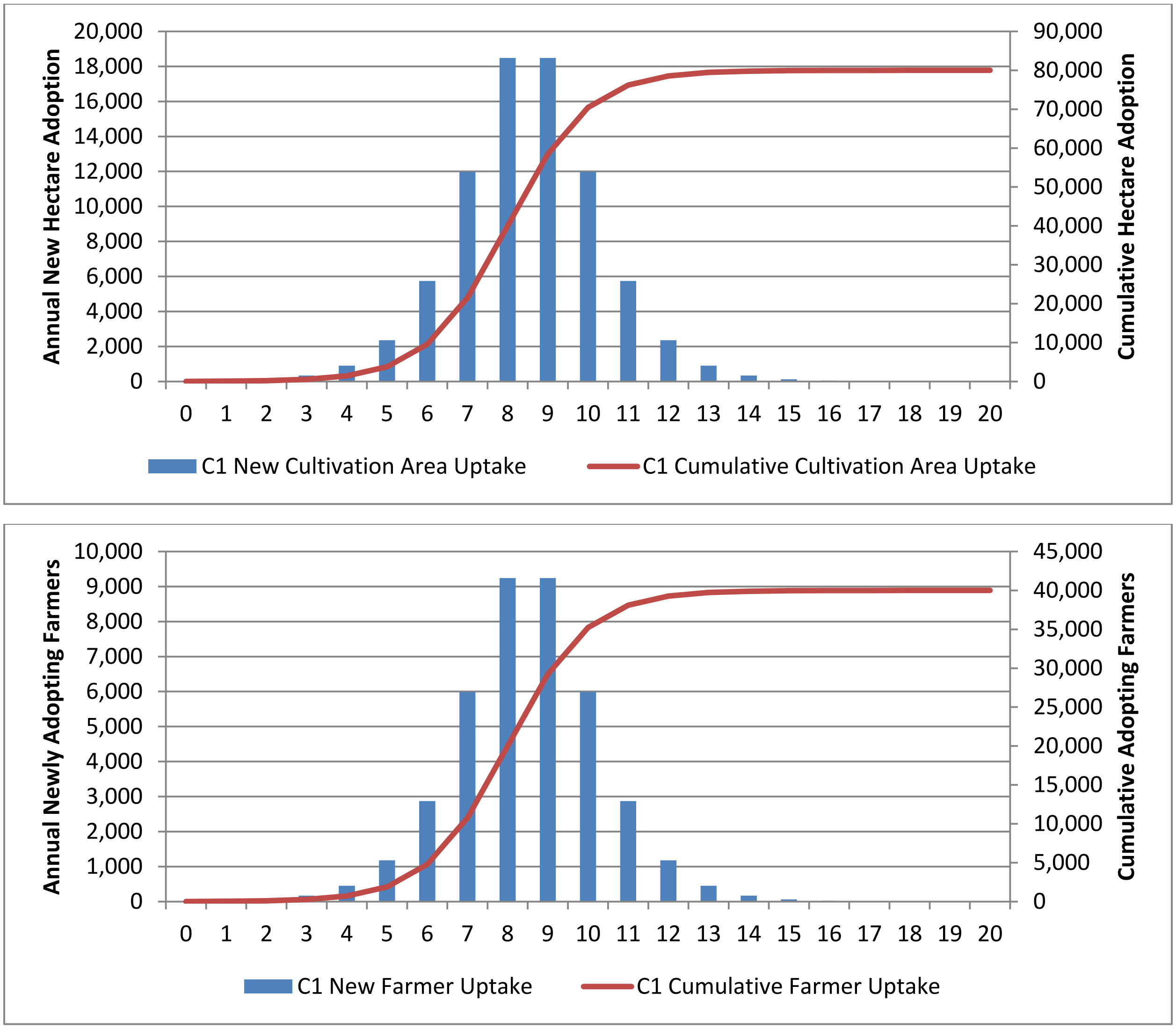


Figure 21. Adoption curves for medium-yield smallholders and cultivation area

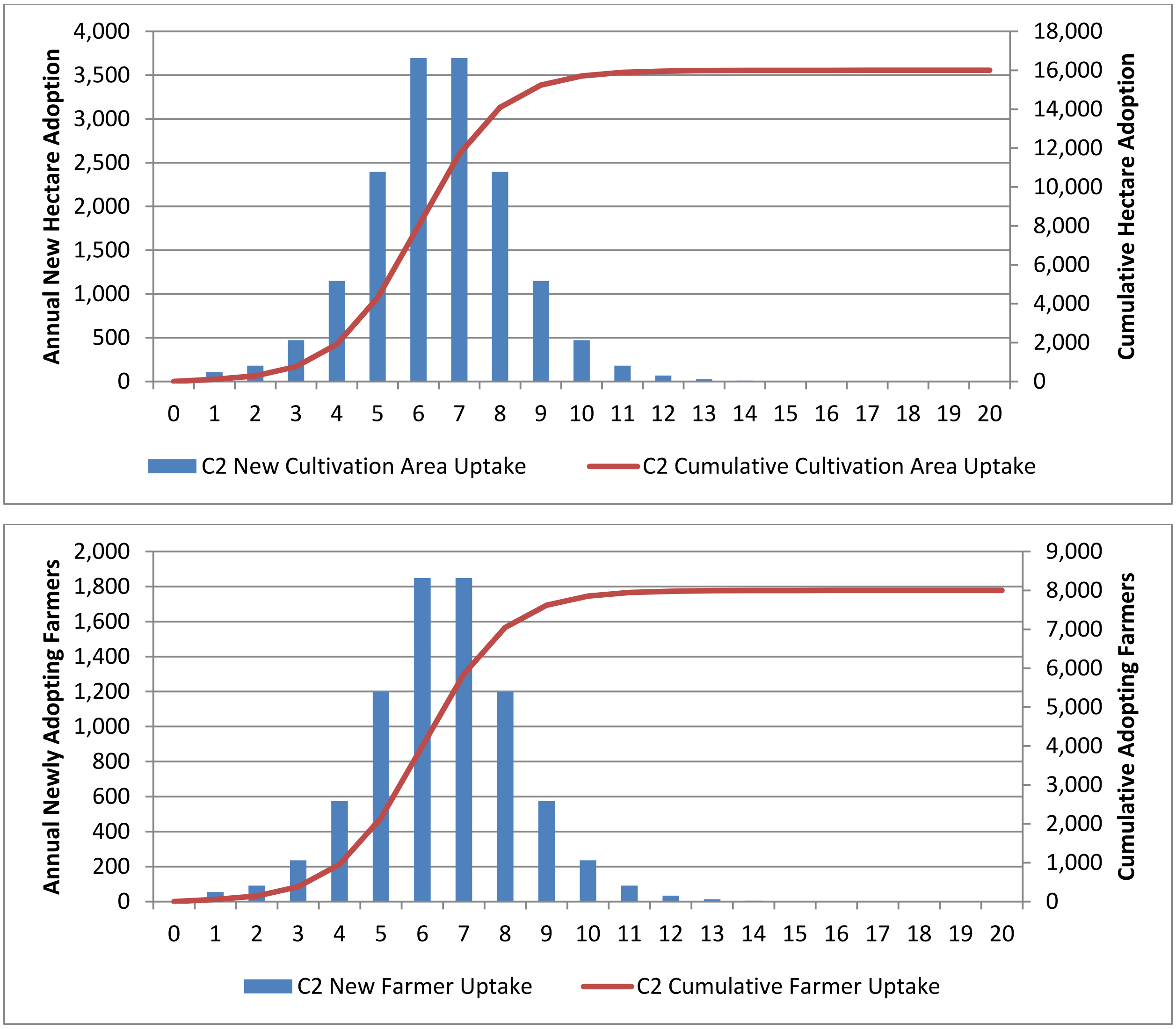


Figure 22. Adoption curves for high-yield smallholders and cultivation area

The model calculates the aggregate impact of project interventions across 120,000 ha in Sulawesi. This is a significantly different perspective from that of a single farmer. When designing the training and techniques for adoption, care was taken to ensure the smallholders had continued income through their transition to new practices. Though it would vary farm to farm, the model assumes that each farm that adopts the techniques would replant half of its land and would graft the other half. Grafting allows the host tree to continue to produce during the 15 months required for the graft to grow into a pod-producing branch. The other hectare that is replanted would begin to produce in 2 to 3 years depending on the variety of seedlings planted.

Additional analysis was performed to examine the impact of the proposed interventions on a single farmer for both the medium-yield and high-yield farmers, and for both the grafted hectare and the replanted hectare. Rather than compare the counterfactual to the with-project cases, it makes more sense to study the with-project effects from the perspective of an individual farmer.

In concert with assumptions in the rest of the model, this individual farmer analysis uses a two-hectare plot per farmer, and assumes that tree density is 800 trees per hectare. The individual farmers incur upfront and ongoing costs in the first year of planting that correspond with the particular type of management practice. These costs are shown in Figure 28 and Figure 29. In addition to these costs, the individual farmer analysis includes labor costs valued at the full opportunity cost of labor (a very conservative assumption because most farmers will perform the majority of the work themselves). The daily labor rate used in the model is 35,000 IDR, and the annual hours required per hectare vary from year to year based on the actual management practices employed. For all charts below, H1 corresponds to the replanted hectare, and H2 corresponds to the grafted hectare.

The trees on the replanted hectare begin yielding in year four. The grafted trees continue to yield their original amount, and increase to full potential after year two. To be conservative and enable a meaningful comparison, yields and prices are kept constant over the project life. There is a possibility that the grafted trees will need to be replanted at some point, but the effect of grafting on the lifespan of the host tree is inconclusive at this point. Furthermore, to the extent that the effect of grafting on a younger tree differs from that on an older tree, the precise distribution of ages among all trees is unknown. The following charts consider both cases: subsequently replanting in year ten after grafting in Figure 25 for medium-yield hectares and Figure 26 for high-yield hectares; and individual farmer cash flows without subsequent replanting in Figure 23 and Figure 24. In the case that the grafted hectares are replanted, the same stream of costs and revenues for the replanted hectare begins in the year of replanting. The green lines represent total income to the farmer, while the blue line represents net income from the replanted hectare and the red line represents net income from the grafted hectare.

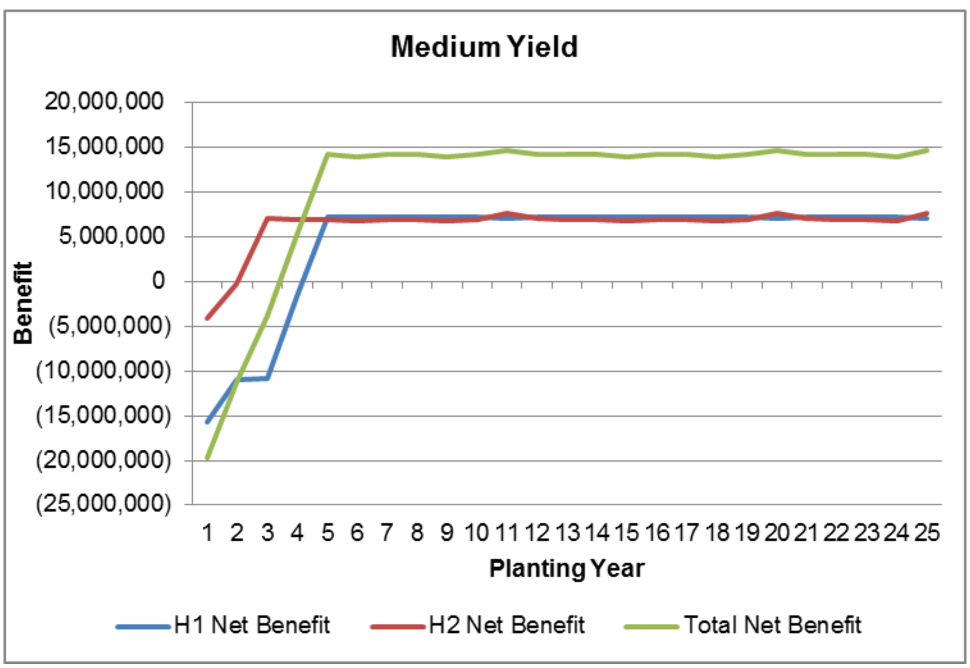


Figure 23. Medium Yield Cash Flows by Hectare Type

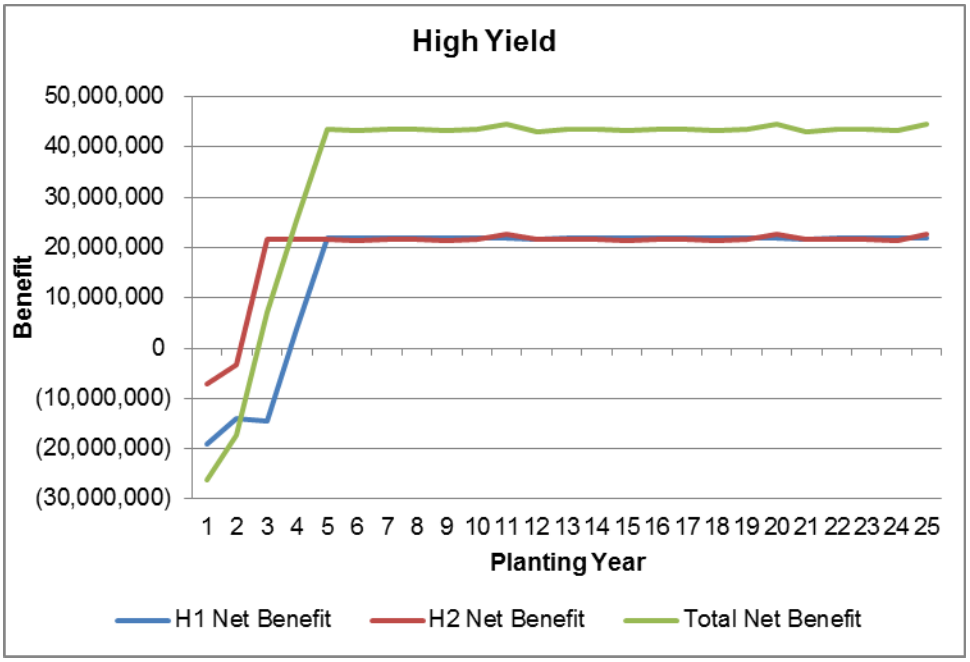


Figure 24. High Yield Cash Flows by Hectare Type

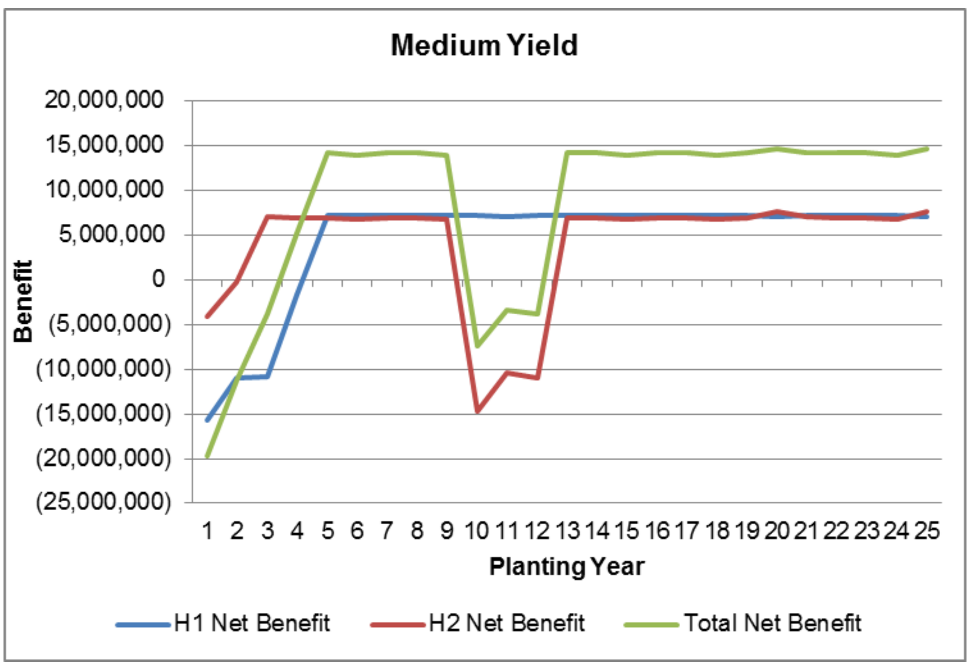


Figure 25. Medium Yield Cash Flows (With Replanting After Grafting) by Hectare Type

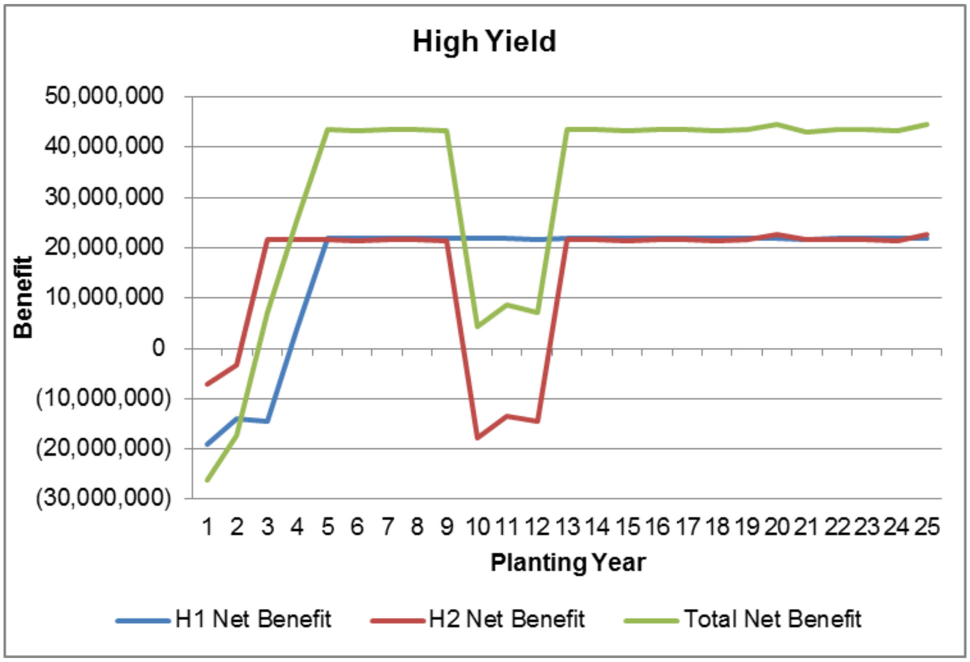


Figure 26. High Yield Cash Flows (With Replanting After Grafting) by Hectare Type

The benefits associated with each type of hectare vary predictably based on the level and type of management, the resulting costs and yields. Figure 27 shows the relative net present benefit for each type of hectare. As expected, the supposed foregone income from subsequently replanting a grafted hectare negatively impacts the farmer's benefits. While Figure 27 shows the net present value, the other aspect to consider here is cash flow in a given year, which would affect the need for financing. By combining the two types of management practices (replanting and grafting), farmers can buffer themselves against negative cash flows in years when replanting occurs.

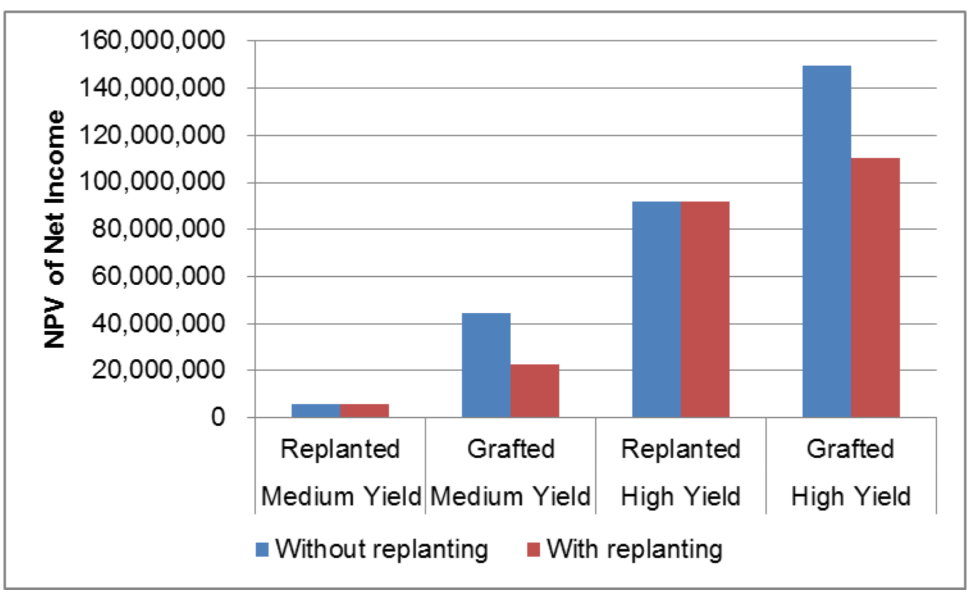


Figure 27. NPV of Net Income for Each Hectare Type

The negative cash flow in early years seen in Figure 23 through Figure 26 is an indication that farmers might need access to credit to fund their transition to new practices. The combination of grafting and replanting was suggested as a way to buffer the need for financing by providing continuous income through the transition. So, while replanting all of one's land may provide a more certain stream of cash flow for the long run (based on tree age), it would result in a more pronounced need for additional credit.

Table 17. Credit needs by hectare and farmer type

		Years	Total (IDR)
Medium Yield	Replanted	4	(39,238,350)
Medium Yield	Grafted	2	(4,341,175)
High Yield	Replanted	3	(47,681,474)
High Yield	Grafted	2	(10,349,649)

Figure 28 and Figure 29 show how the program costs per-hectare compare to the adoption costs per-hectare incurred by farmers. The fact that the program costs are comparable in magnitude to the implementation costs borne by farmers provides an indication that the project benefits may be more readily scalable. This is because the farmer bears the majority of the costs of adopting, rather than the project. This means that for each additional hectare targeted and adopted, the project benefits scale more quickly than the costs incurred.

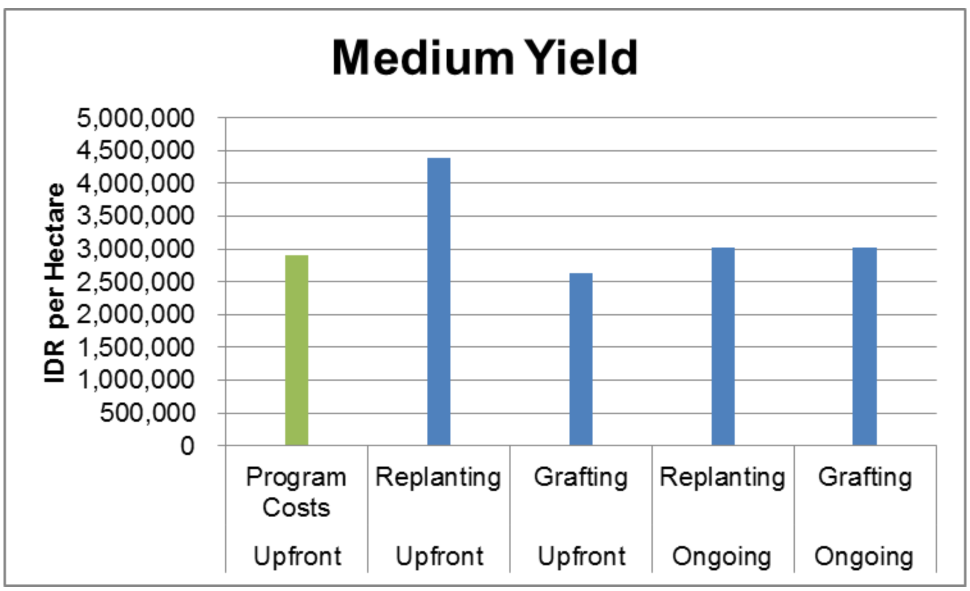


Figure 28. Medium Yield Comparison of per-Hectare Costs

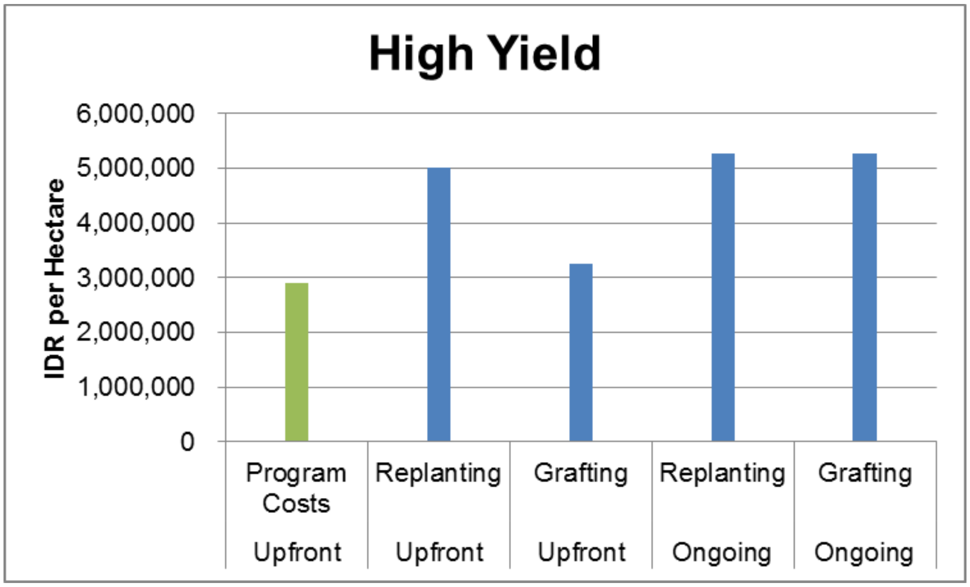


Figure 29. High Yield Comparison of per-Hectare Costs

The nuances specific to the crop budget for an individual farmer do not scale perfectly to a landscape approach, though the methods used here present a reasonable approximation of what is likely to occur in aggregate. The project model averages the impacts of the grafted hectare with the replanted hectare because adding the additional distinction would significantly increase model complexity. The resulting stream of averaged cash flows reasonably approximates the combined cash flows from the grafted and replanted hectares. As is mentioned above, the aggregate model does not include subsequent replanting of the grafted hectare, which may moderately overstate economic results.

3.3 Results

3.3.1 Economic Analysis

3.3.1.1 Economic Rate of Return and Net Present Value

The detailed economic results presented below are calculated without accounting for the anticipated MCA-I overhead burden rate of 35%. The results of the project with the overhead burden are presented in Table 18 (Table 19 show the results without MCA-I overhead). This project performs well economically primarily because two thirds of the targeted area nearly doubles its yield, while 13% of the targeted area almost quadruples its yield with relatively modest increases in costs. Table 20 summarizes reference case assumptions used in the economic model.

Table 18. Economic Results (with MCA-I Overhead Burden)

Economic Results	
ERR	19.00%
NPV (Million IDR)	991,000
NPV (US$)	$88,400,000

Table 19. Economic Results (without MCA-I Overhead Burden)

Economic Results	
ERR	21.00%
NPV (Million IDR)	1,070,000
NPV (US$)	$95,000,000

Table 20. Reference Case Assumptions

Descriptor	Value	Unit
Social Discount Rate (%)	10%	%
National Inflation Rate (%)	4.00%	%/yr
Exchange Rate (IDR/$)	11,212	IDR/$
Average farm size	2	ha/farmer
Total targeted smallholders trained	60,000	smallholders
Total Targeted Cultivation Area (ha)	120,000	ha
Medium-Yield Crop Variables		
CF Smallholders	50,000	smallholders
CF Cultivation area	100,000	ha
CF yield	562	kg/ha/yr
CF yield change rate	0.0%	%/yr
CF Standard price per kg	18,000 IDR	per kg
CF upfront costs	2,802,998 IDR	IDR/ha
CF ongoing costs	2,802,998 IDR	IDR/ha/yr
WP Smallholders	50,000	smallholders
WP Cultivation area	100,000	ha
WP yield	1,000	kg/ha
WP yield change rate	1.0%	%/yr
WP Standard price per kg	18,000 IDR	per kg
WP standard upfront costs	3,520,000 IDR	IDR/ha
WP ongoing costs	3,223,447 IDR	IDR/ha/yr
High-Yield Crop Variables		
CF Smallholders	10,000	smallholders
CF Cultivation area	20,000	ha
CF yield	562	kg/ha
CF yield change rate	0.0%	%/yr
CF price per kg	18,000 IDR	per kg
CF upfront costs	2,802,998 IDR	IDR/ha
CF ongoing costs	2,802,998 IDR	IDR/ha/yr
WP Smallholders	10,000	smallholders
WP Cultivation area	20,000	ha
WP yield	2,000	kg/ha
WP yield change rate	1.0%	%/yr
WP price per kg	18,000 IDR	per kg
WP standard upfront costs	5,306,560	IDR/ha
WP ongoing costs	7,240,471	IDR/ha/yr

Figure 30 shows the CF and WP annual net benefits with incremental benefits displayed in green bars. The project's ERR and NPV are calculated on the incremental net project value flows. Though net benefits are negative in early years as smallholders incur costs of adoption and forgone production, the aggregate benefits in the WP case are still positive.

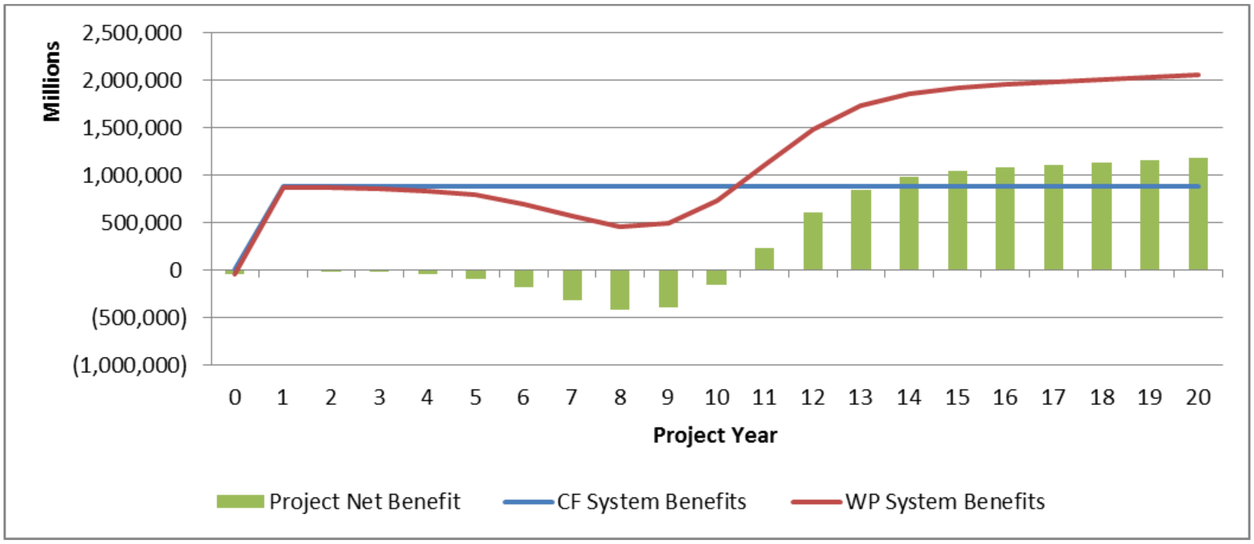


Figure 30. Lifetime net project benefits

Figure 31 shows the project NPV over different time periods. This display is useful for showing when the project pays back on a discounted basis. In this case, the project discounted payback occurs in year 15. The economic results scale predicatably with the number of farmers targeted (and therefore hectares planted). Most of the significant project costs are fixed, while farmer training costs are variable. So, one would expect costs to increase more slowly than benefits as additional farmers and cultivation area are targeted.

As is mentioned above in the individual farmer analysis, the aggregate model does not include subsequent replanting of the grafted hectare. The effect of not considering this aspect likely overstates economic results. The magnitude of this impact on project economic results depends on when the farmers decide to replant their grafted hectare, which cannot be known precisely. Regradless of when the grafted hectare is replanted, farmers would incur additional planting costs and forego three years of yield during this time. Assuming that all adopting farmers in both the medium- and high-yield groups replant their grafted hectares ten years after they adopt, the project NPV declines to 308,000 million IDR from 991,000 million IDR. The model also truncates all future earnings beyond the end of the project – all years beyond year 20. As can be seen from Figure 31, the potential impact of excluding subsequent project years is likely very large because program and upfront costs have all been incurred and trees will continue to produce high yields well beyond the project period.

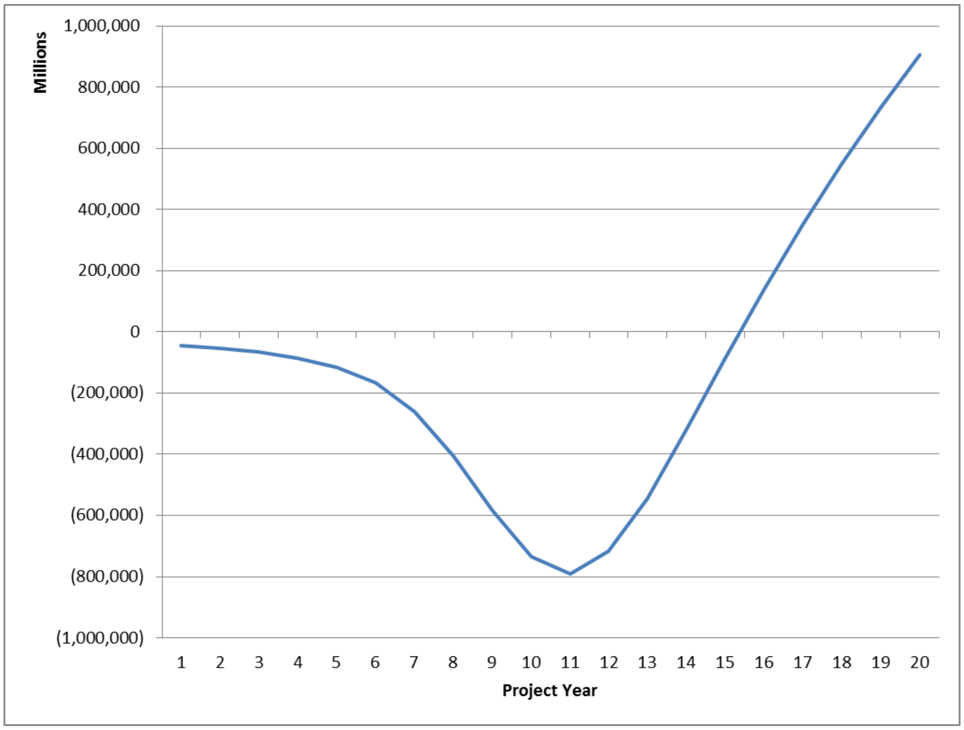


Figure 31. Sensitivity of NPV to time horizon

3.3.2 Beneficiary Analysis

The distribution of benefit streams in this project is fairly straightforward. MCA-I and cocoa industry partners fund training, capacity building, and capital investment, which the smallholders benefit from through increased yields.

Table 21 and Figure 32 show the economic impact of this project on individual stakeholders. The ERR shown represents the real return to that stakeholder only. Likewise, the NPV values are calculated at the social discount rate of 10%. So, while an NPV could be negative, it may still perform positively relative to a given stakeholder's specific discount rate (though the real return would be below 10%). The respective NPV values provide a glimpse of how well these beneficiaries fare in this project design. Note that though the cost sharing between MCA-I and the cocoa industry partners is one-to-one, there are additional costs borne by MCA-I in the form of overhead, which accounts for the larger share in Figure 32.

Table 21. Distribution of Net Benefits

Beneficiary Analysis	ERR	% of Project NPV	NPV (Million IDR)	NPV (US$)
Cacao Smallholders (medium yield)	17.70%	45.0%	436,000	41,300,000
Cacao Smallholders (high yield)	38.39%	77.2%	748,000	70,900,000
MCA-I Funding Window	(a)	-14.7%	(143,000)	(13,500,000)
Cocoa Industry Partners	(a)	-7.5%	(72,200)	(6,850,000)
(a) ERR undefined since all cash flows have the same sign or Excel is unable to calculate a value				

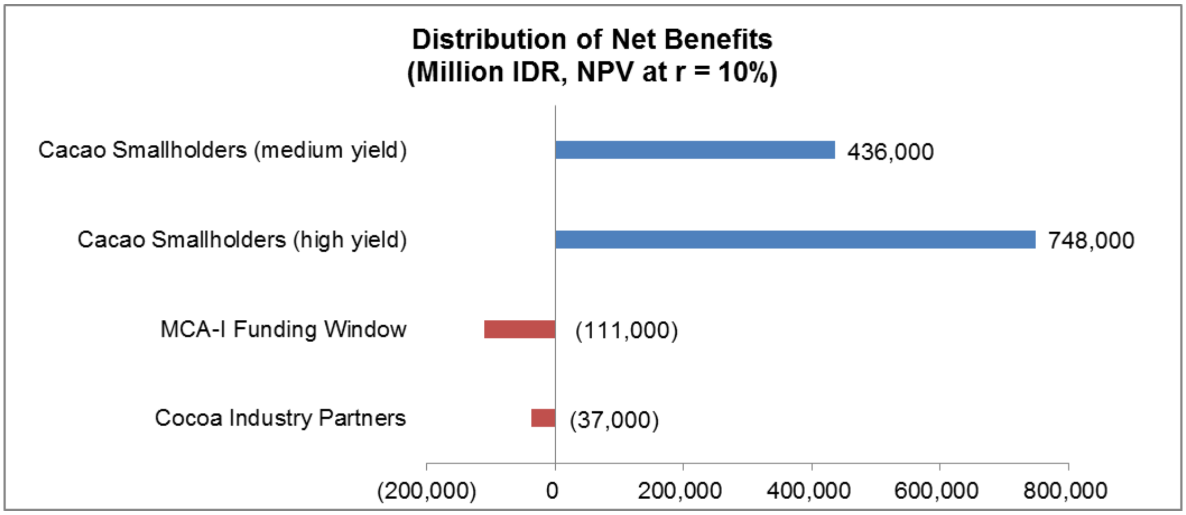


Figure 32. Beneficiary analysis (percent of project NPV)

Cacao collectors earn between IDR 50 and 150 per kg. They are not included in the analysis, but they would also benefit from an increase in volume. Figure 33 displays the incremental benefit to each stakeholder over time. The cocoa industry partners and MCA-I funding window incur costs in early years and as smallholders are trained throughout the project life, while both farmer groups fare relatively worse in the with-project case as they adopt and much better over time as yield increases materialize. The swing in net benefit is greater with the high-yield group because it incurs more costs but realizes higher yields. Again, it should be noted that these results are incremental between the CF and with-project cases, which are negative here but are still positive for the WP case alone; meaning, smallholders still receive income while they transition to new farming techniques.

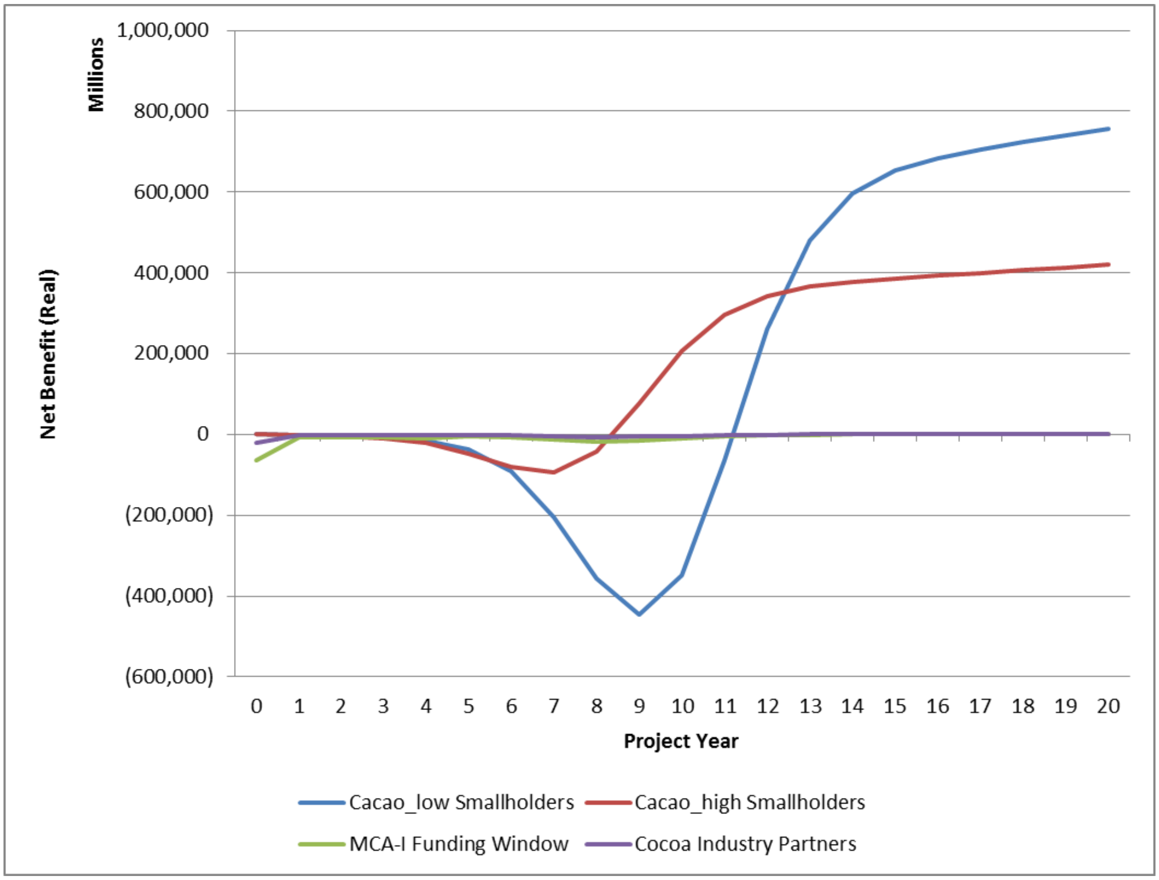


Figure 33. Beneficiary net benefit streams

3.3.3 Sensitivity Analysis

The sensitivity analysis revealed that there were a few highly sensitive inputs. Where possible, values were researched and collected in site visits to minimize the uncertainty range or eliminate variables as sensitivity parameters. Table 22 shows the sensitivity analysis parameters, their default values, and their uncertainty distributions. A full discussion of sources and values is planned for a forthcoming economic model documentation.

Table 22. Sensitivity Analysis Parameters

Descriptor	Value	Unit	Distribution	Upper	Lower
National Inflation Rate	4.00%	%	Triangular	4.4%	3.6%
CF yield	562	kg/ha/yr	Triangular	750	500
CF yield change rate	0.0%	%/yr	Triangular	1%	-1%
CF standard price per kg	18,000 IDR	per kg	Triangular	19,000	17,000
CF upfront costs	2,802,998 IDR	IDR/ha	Triangular	3,000,000	2,000,000
CF ongoing costs	2,802,998 IDR	IDR/ha/yr	Triangular	3,000,000	2,000,000
Medium-Yield Crop					
WP yield	1,000	kg/ha	Triangular	1,100	900
WP yield change rate	1.0%	%/yr	Triangular	3.0%	1.0%
WP standard upfront costs	3,520,000 IDR	IDR/ha	Triangular	4,200,000	3,000,000
WP ongoing costs	3,223,447 IDR	IDR/ha/yr	Triangular	3,500,000	2,500,000
WP crop timing	8	yr	Triangular	10	6
WP crop share	80%	%	Triangular	90%	60%
WP crop flatness	100%	%	Triangular	100%	70%
High-Yield Crop					
WP yield	2,000	kg/ha	Triangular	2,200	1,800
WP yield change rate	1.0%	%/yr	Triangular	3.0%	1.0%
WP standard upfront costs	5,306,560	IDR/ha	Triangular	6,000,000	5,000,000
WP ongoing costs	7,240,471	IDR/ha/yr	Triangular	8,000,000	6,500,000
WP crop timing	6	yr	Triangular	10	6
WP crop share	80%	%	Triangular	100%	80%
WP crop flatness	100%	%	Triangular	100%	70%

Figure 34 show the results for NPV and ERR of a 10,000 trial Monte Carlo simulation using the sensitivity parameters and uncertainty distributions described above in Table 22. The analysis shows that this project would deliver a positive NPV and an ERR above 10% with almost 100% certainty.

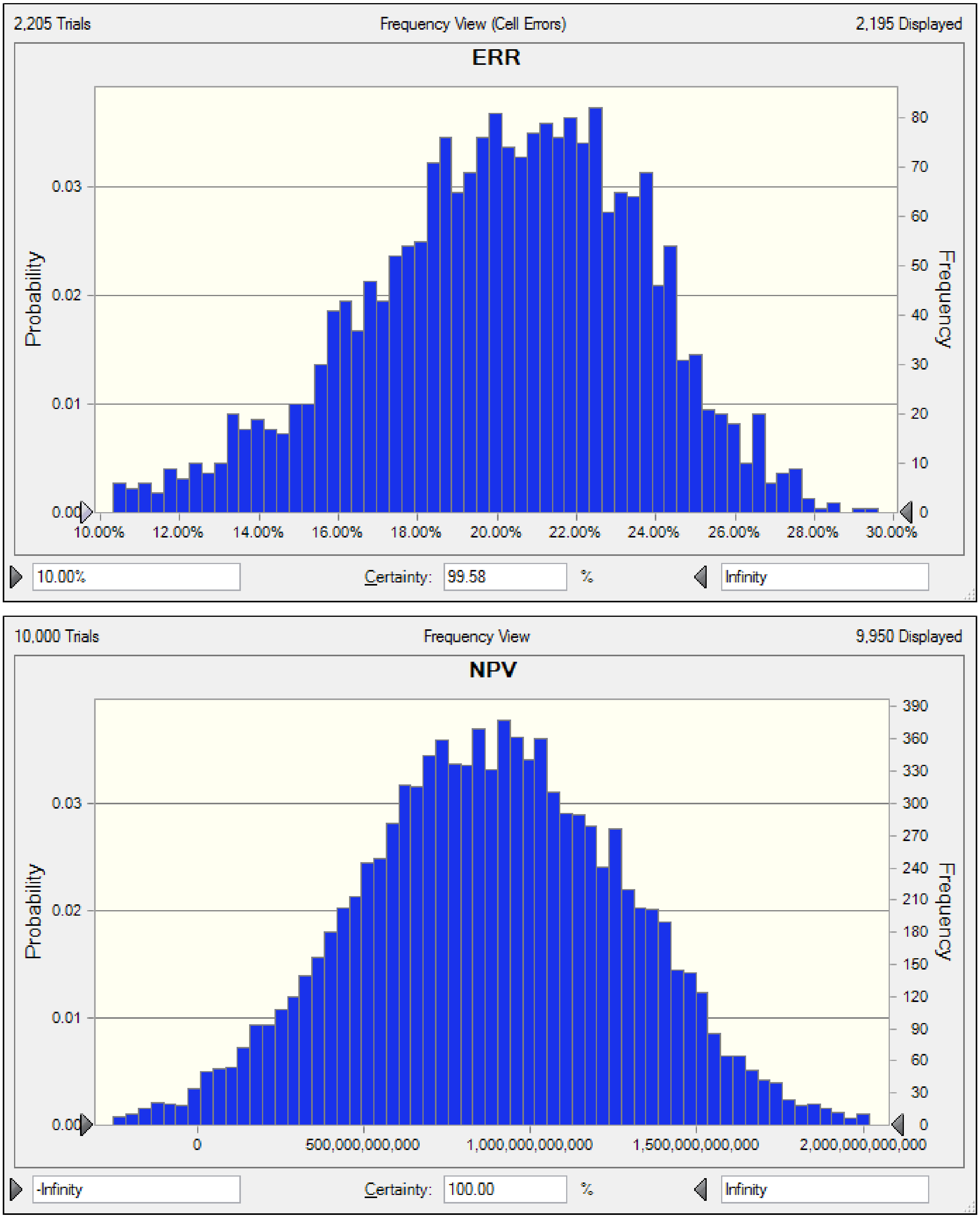


Figure 34. Sensitivity analysis results for NPV and ERR

The Monte Carlo sensitivity analysis also produces a tornado chart of sensitivity parameters showing their respective contribution to ERR variance. Figure 35 shows the tornado chart for this analysis. As expected, the CF yield is the variable with the greatest contribution to variance of the project ERR followed by its long-term change. These values are negative on the tornado chart because the larger their values, the more negative the ERR would be. An important takeaway from this figure is that the only highly sensitive variable is the timing of high-yield adoption, i.e., the year at which half of all eventual adopters have adopted new techniques. This is an expected result because the yield increases are so large that the later they happen (and therefore the higher the input value), the more negative the ERR would be.

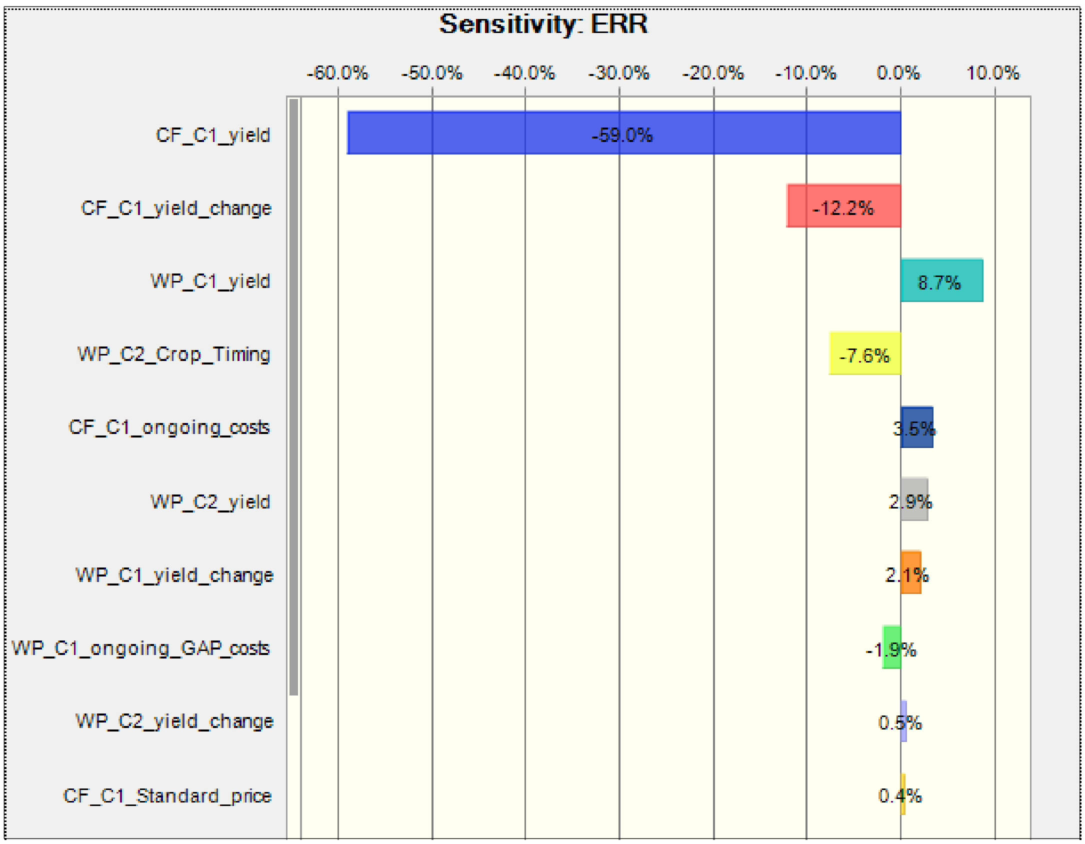


Figure 35. Tornado chart of sensitivity parameters

3.3.4 Single-Variable Sensitivity Analysis

Monte Carlo simulation is a powerful tool because it estimates a range of outputs while allowing multiple inputs to float randomly within defined probability distributions. Yet, it can also be useful to observe the impact of a single variable on the project ERR while keeping all other inputs constant. Figure 36 through Figure 39 illustrate how the project NPV changes with respect to yield, change in yield, and ongoing crop management costs for the CF crop, medium-yield crop, and the high-yield crop. The relative change in project NPV for each of the single-variable sensitivity charts below behave accordingly to the tornado chart in Figure 35. A line with a positive slope indicates that the project NPV moves in the same direction as the variable's value (higher variable value, higher project NPV). The opposite is true for negatively sloped lines—the higher the variable value, the lower the project NPV. Within the range of possible input values, most of these variables still deliver a positive project NPV. However, the yield is the most sensitive input. When all other inputs are held constant, a CF yield above 750 kg/ha produce a negative project NPV. Similarly, considering different changes to yield over the project life shows that counterfactual yield growth above 2.8% leads to a negative NPV.

Project NPV is relatively stable relative to changes in adoption rates. This is predominantly because the down side of non-adopters is minimized by the fact that they would continue their original farming practices. This is true despite the fact that the project would incur costs to train farmers that don't ultimately adopt new practices. Additionally, as is shown above, the magnitude of program costs per-hectare relative to the upfront and ongoing costs incurred by farmers to adopt is comparatively small. This has significant implications for the project design – particularly scale, but also for individual farmer financial needs.

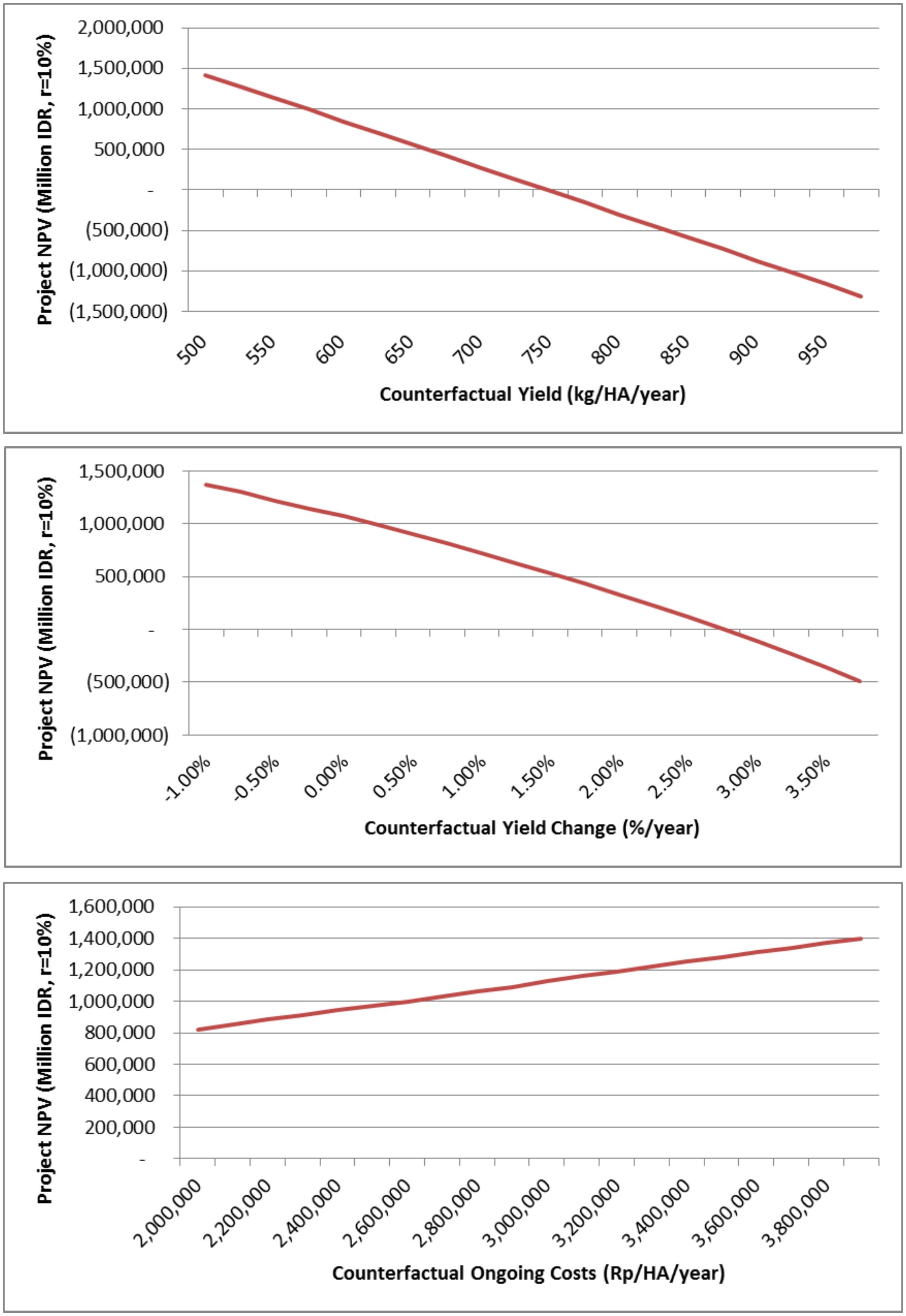


Figure 36. CF crop sensitivities

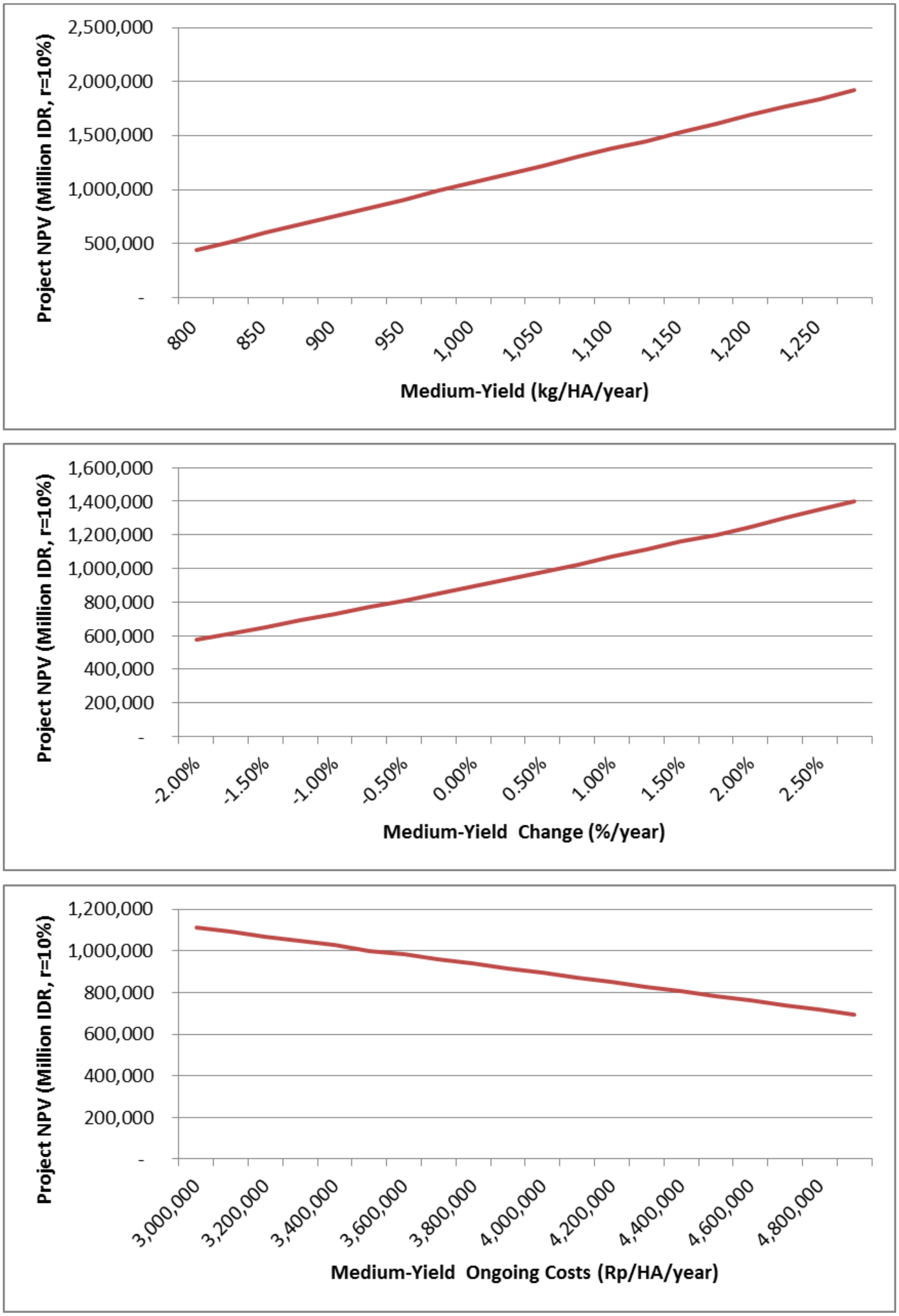


Figure 37. Medium-yield crop sensitivities

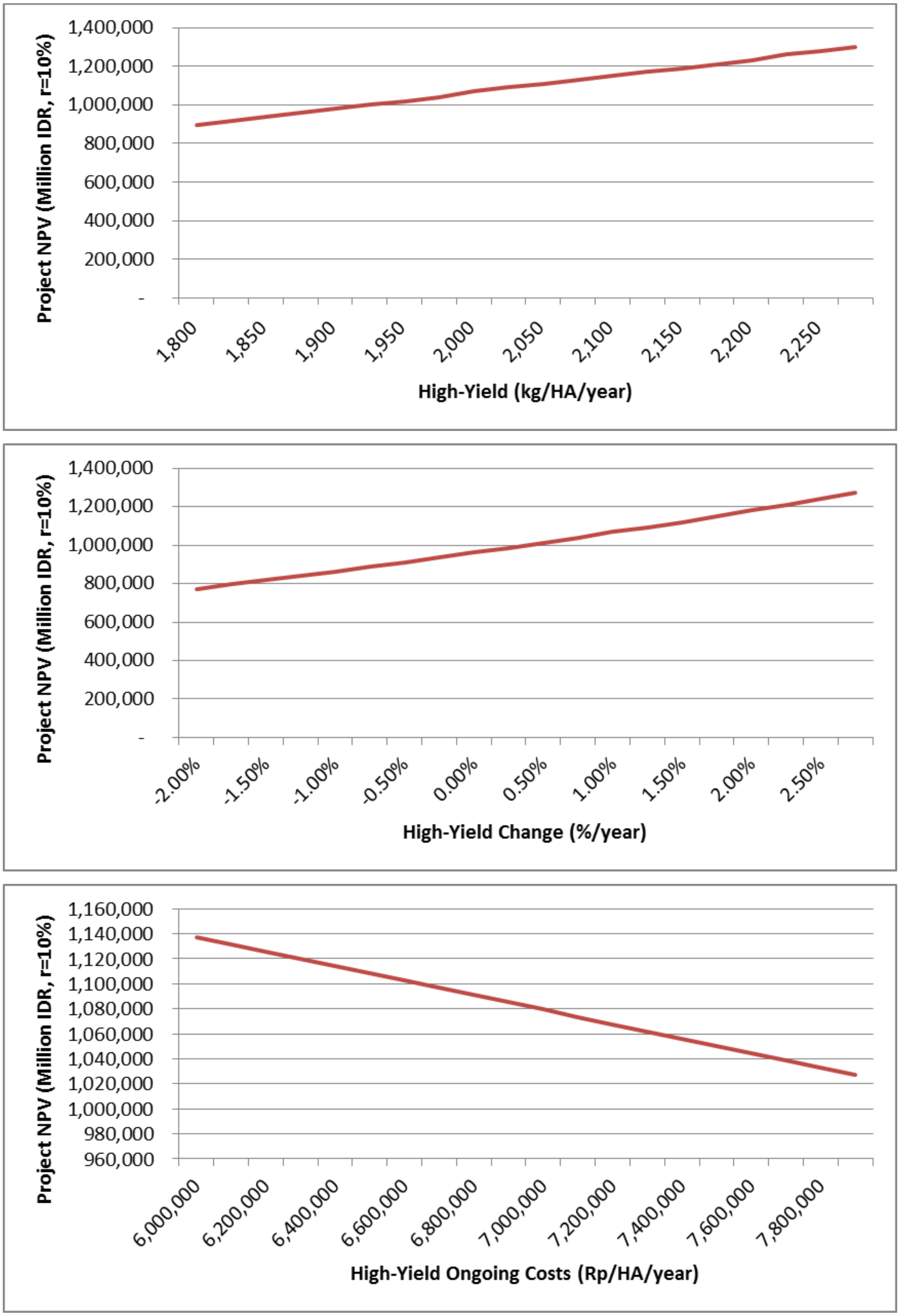


Figure 38. High-yield crop sensitivities

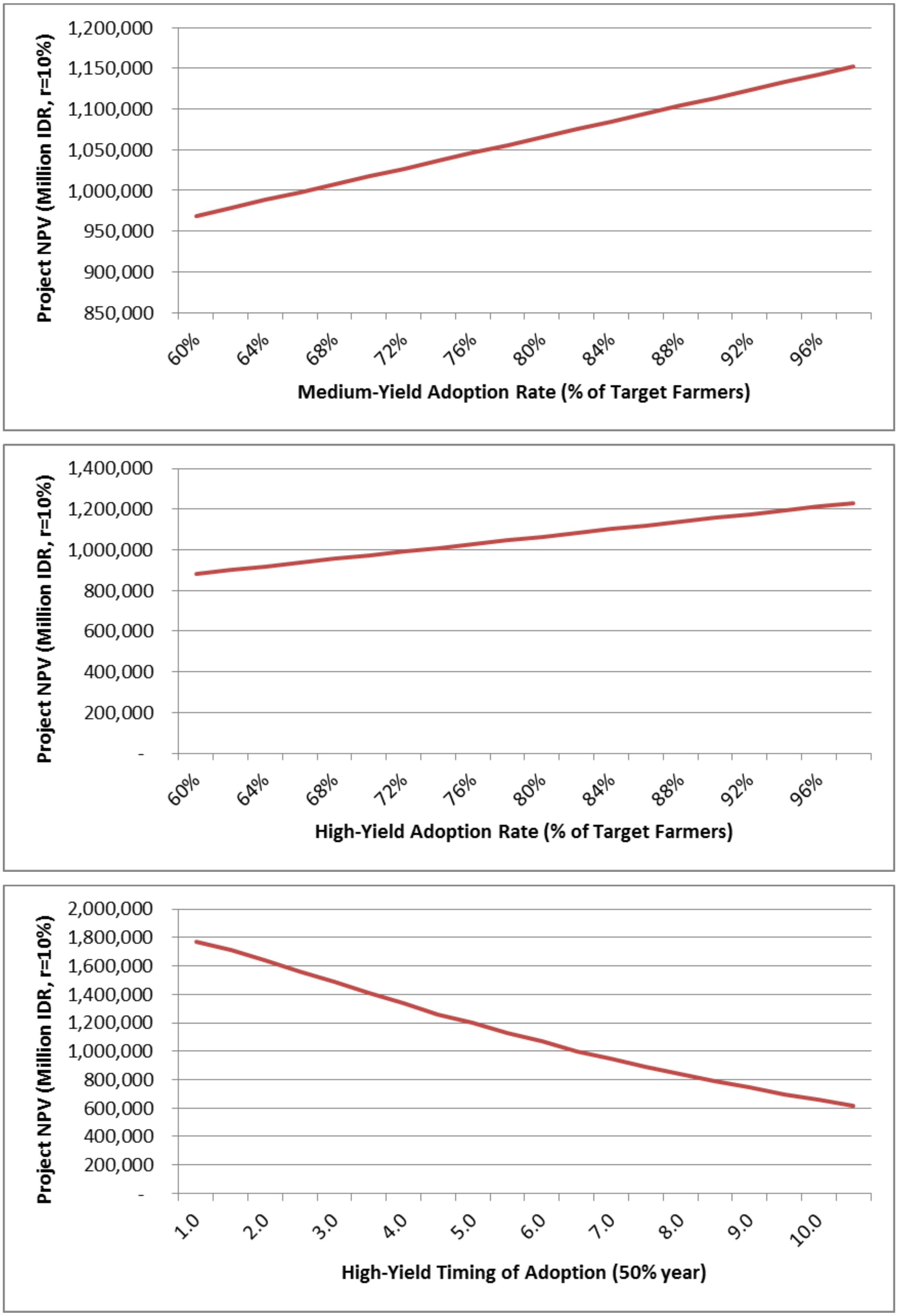


Figure 39. Adoption rate sensitivities

3.4 Economic Risk Assessment

This report presents results with the best estimate of each input variable. Changes to the input parameters would result in different economic results, and the sensitivity analysis presented above reveals the variables that would have significant impact on the economic outcome of the project. The most significant risk to project economic results comes from assumptions about CF yields. If smallholders switch crops, a more dynamic analysis is required to observe economic performance thresholds.

Figure 40 presents a double-variable sensitivity analysis comparing the project NPV to CF yield at different CF crop prices. Each line represents a single price, starting with 15,000 IDR/kg and ending with 25,000 IDR/kg. At annual land productivity values (that is, price per kg by kg per ha per year) above 13,500,000 IDR/ha/yr for alternative CF crops the project NPV is negative (holding all other variables constant). For example, at a price per kg of IDR 20,000 (the green line in Figure 40) and a CF yield of 675 kg/ha/yr, the annual land productivity value is IDR 13,500,000. At yields and prices that yield annual land productivity values above this, the project NPV would be negative. The results in Figure 40 do not include upfront costs which vary between crops. An increase in CF alternative crop management costs would lower the project returns, as would an increase in price and yield for these alternatives.

This is valuable information when considering alternative crops the smallholders might consider growing. Figure 40 enables a simple assessment of whether and how alternative crops in the CF would impact economic outcomes. More specific modeling and additional data collection are required to assess timing of crop-switching, for example; however, this chart can be used to determine thresholds for project economic performance. See Section 2.4.1 for other potential crops.

This double-variable analysis cannot simultaneously account for changes to input and ongoing costs, timing impacts, and changes to price and productivity. Furthermore, this chart assumes the change applies to all crop area under consideration, rather than for a given hectare. A complete analysis would treat only those areas that were likely to change at the margins (for example areas near a palm mill for oil palm, or encroachment areas).

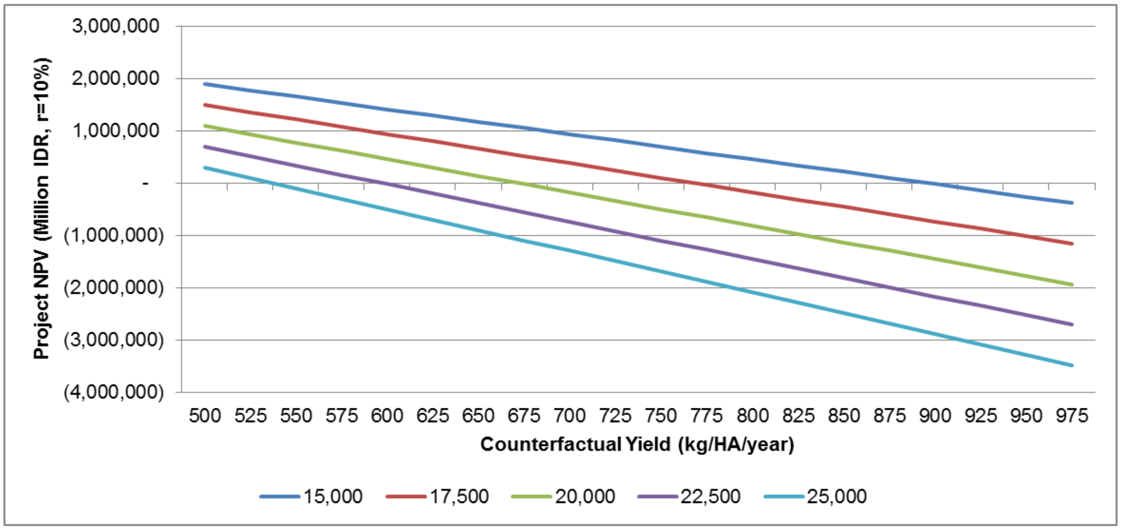


Figure 40. Double variable sensitivity of project NPV to CF yield and CF price

Other risks to project performance include adoption rates for new farming techniques and the resulting performance of cacao production. These are relatively minor risks because their contribution to project ERR is small. Additionally, while adoption rates can never be known with complete confidence, the incremental impact of new techniques is known with more certainty. And even allowing for variation in yield from weather and other risks to crop productivity, at conservative assumptions, the project still delivers a positive NPV and an ERR above 10%.

4 Environmental and Spatial Land Use Assessment

As noted previously, all Green Prosperity Program project investments must meet certain technical, economic, environmental, and social expectations expressed in MCC's Compact with Indonesia. Specific to environmental impacts, the Green Prosperity program is focused on promoting the productive use of low-pollution renewable energy, the management of watersheds, forests and other natural resources, and the sustainable use of lands for agriculture and other purposes.

This project targets farmer training to improve yields and environmental conditions in Sulawesi. Overall, the project appears to be consistent with the Green Prosperity Program's environmental goals. This section provides a preliminary assessment of environmental impacts of this project, which would be further detailed in a full feasibility study.

In this section potential environmental impacts of the project are discussed, followed by consideration of applicable Indonesian environmental laws and regulations, the GHG emissions impact of the project, and spatial land-use considerations.

4.1 Environmental Impact Assessment

Any project activity in Indonesia requires full disclosure of possible environmental impacts at the earliest stages of project development. Projects must ensure that these impacts are addressed by being avoided or mitigated to the greatest extent possible, or that some form of compensation is given to those affected.

The Cacao intensification project is a training program, which would have little to no environmental impact. The main potential environmental impacts from this training activity are diesel fuel use for travel to the CDC facility and construction of a covered classroom to accommodate the training of cocoa doctors. FFS would be held where smallholders live; therefore, there would be travel just by the facilitator to reach each FFS.

The project expects to train 6,000 smallholders per year for 10 years, totaling 60,000 over the life of the project. Aging trees, pests, and lack of access to credit to purchase inputs have caused a significant decline in yield from cacao trees in recent years. Training would focus on helping smallholders understand why their yields have declined and help them improve the health of trees on their existing land, improving future yields from the current average of 500 kg/ha to 1 t/ha or more. Of the 60,000 total smallholders trained over 10 years, it is estimated that 10% would use fertilizer and pesticides.[40]

There is the potential for environmental impacts as FFS trainees begin implementing the interventions they learned. In general, the main concerns with agroforestry intensification projects in Indonesia are biodiversity loss and land-use change [32]. While smallholders would be utilizing existing farmland, there is a potential for negative impacts to biodiversity through frequent pesticide applications impacting beneficial species such as pollinating bees and predatory ants [33]. Ants are negatively impacted in cacao plantations where pesticide-use and land-use changes occur. The diminished number of ant species can negatively impact soil

[40] Lack of access to credit is being addressed by USAID's e-MITRA project.

nutrient levels. The handling of fertilizer poses an environmental hazard, which will be mitigated through the training program by teaching safe handling, storage, and disposal of agrichemicals. It is assumed that of 60,000 smallholders trained, only 8,000 will apply agrichemicals to their lands.

The farmer training program has the potential for positive environmental impacts on community forests in the region that have degraded in recent years. Pruning and grafting would result in healthier trees, greater photosynthesis activity, more branches, cocoa pods, and biomass positively impacting the land. The sanitation of removing dead pods, leaves, and branches and burying them would return nutrients to the soil. The increase in cocoa pods would further help the soil as empty pods are placed in rows between trees returning organic matter to the soil. Some cacao smallholders are returning to harvest rattan and other wood out of the forest as a source of income, which did not occur much during good cacao production years and could negatively impact forests [1]. This activity may negatively impact forests through encroachment and deforestation. The decline in cacao production has caused some smallholders to abandon their farms leading to weeds and unhealthy trees, which pose a fire threat. Training resulting in greater yield could encourage smallholders to return and manage their cacao land, which would reduce fire risk. If the program is very successful and yields grow rapidly, there is the risk that smallholders would encroach onto forest and other lands to grow more cacao. Potential positive environmental impacts of this project include:

- 60,000 trained smallholders over 10 years, increasing yields through better farming practice.
- Pruning and grafting lead to more photosynthetic activity, and sanitation and production of more pods back into the soil improves organic matter
- Reduction in fire threats from abandoned farms
- Improved environmental conditions in community forests.

Potential negative environmental impacts of this project include:

- Tiny impacts from diesel fuel use and construction
- Impacts to land and biodiversity from fertilizer and/or pesticide use.

There is little information on the environmental impacts of agricultural intensification on existing lands. A full feasibility study should further explore this topic with the assistance of the cacao industry and perhaps the International Institute of Tropical Agriculture, which has studied environmental impacts of cacao in West Africa.

4.2 Compliance with Legal Requirements and Performance Standards

Initiating any project in Indonesia would require permits and/or licenses from the government of Indonesia. This includes an environmental permit for projects with potential for environmental impacts. An environmental permit is issued following approval of an Analisis Mengenai Dampak Lingkungan (AMDAL) or a Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan

Lingkungan Hidup (UKL-UPL) documents. An AMDAL is a full environmental assessment, required for projects that are considered to have potentially significant environmental impacts, while a UKL-UP is an environmental management and monitoring plan for projects that are not expected to cause significant impacts. Small-scale activities may be required to prepare a Surat Pernyataan Kesanggupan Pengelolaan Dan Pemantauan Lingkungan Hidup (SPPL), which acts as a letter of commitment to manage the environment. The type of environmental document required is governed by the Regulation of the Minister for Environment No. 5 Year 2012 on Types of Projects and/or Activities that Require an AMDAL [34].

The issuance of specific permitting requirements comes from regional, district, or local governments. The environmental permit and approval of AMDAL or UKL-UPL documents for GP projects is likely to be the authority of the provincial or district-level government, depending on the size and location of the project. The national government only issues environmental permits for projects that cross provincial boundaries or are strategic in nature.

MCC requires that Green Prosperity projects adhere to the IFC Performance Standards. These standards support a process to ensure that any project is exercising due diligence of environmental and social risks from start to finish. Table 23 lists the IFC Performance Standards related to environmental impacts.[41]

Table 23. IFC Environmental Performance Standards

IFC Performance Standard	Description
Performance Standard 1: Assessment and Management of Environmental and Social Risks	Describes the importance of identifying environmental and social risks and impacts, and managing environmental and social risks throughout the life of a project. This standard applies to all projects.
Performance Standard 3: Resource Efficiency and Pollution Prevention	Recognizes that increased industrial activity and urbanization often generate higher levels of air, water and land pollution, and that there are efficiency opportunities.
Performance Standard 5: Land Acquisition and Involuntary Resettlement	Recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement. For this particular project there would be no land acquisition.
Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Promotes the protection of biodiversity and the sustainable management and use of natural resources.

4.2.1 Relevant Indonesian Laws

The government of Indonesia has many laws that pertain to MCC projects. Selected laws are available in Table 24.

[41] Other IFC Performance Standards not cited here address: Performance Standard 2: Labor and Working Conditions, Performance Standard 4: Community Health, Safety, and Security, Performance Standard 5: Land Acquisition and Involuntary Resettlement, Performance Standard 7: Indigenous Peoples, and Performance Standard 8: Cultural Heritage.

Table 24. Relevant Indonesian Environmental Laws

GP application	GOI Laws & Regulations
GP as a whole	Act No. 32, 2004 on Regional Autonomy
	Act No.7, 2004 on Water Resources
	Act No. 32, 2009 on Environmental Protection & Management
	Act No. 14, 2008 on Public Information Disclosure
	Act No.39, 1999 on Human Rights
	Act No.41, 1999 Forestry
	Act No.18, 2004 Plantation
	Act No. 5, 1990 on Conservation of Biological Resources & Ecosystems
	Ministry of Forestry 5-year Strategic Plan (RENSTRA) 2009 – 2014 with a program focus on Community-based Watershed Management
	Ministry of Forestry Decree, P.7/Menhut-II/2011 re Public Information Service of Forestry Sector, 02 February 2011
	Ministry of Forestry Decree on Information Transparency, 27 February 2006
	Government Regulation 6 of 2007 on Forestry
	Ministry of Forestry (2000), General Framework and Criteria & Standards for Forest and Land Rehabilitation. Directorate for Land Rehabilitation and Soil Conservation, Directorate General for Land Rehabilitation and Social Forestry, Jakarta, 2000
	Presidential Instruction (INPRES) No.1 of 2000 on Gender Mainstreaming
Participatory land-use planning	Law 26 of 2007 on Spatial Planning, specifically Article 48, (1), (a), on Empowerment of Local People through Spatial Planning
	Ministry of Home Affairs Guidelines 27 and 28 of 2006 on village boundary-setting
	Spatial Planning Act 26 of 2007 and Spatial Planning Act 27 of 2007 for Coastal Regions and Small Islands
	Government Regulation 15 of 2010 on Spatial Planning Implementation
GP facility	Act No.30 Year 2009 on Electricity
	Ministerial Regulation of Agrarian Minister/ Head of National Land Agency No. 2, 1993 on Procedures to Obtain Location Permit and Land Use Rights for Investing Corporations Investing Ministerial Regulation of Agrarian Minister/ Head of National Land Agency No. 2, 1999 on Issuance of Location Permit for National and Foreign Direct Investments
	Presidential Regulation No. 5 Year 2006 on National Energy Policy
	Presidential Regulation No. 61 Year 2011 on National Action Plan on Greenhouse Gas Emission Reduction

Source: Marifa, I., Field, S. "Draft Environmental and Social Management System Tier 2". August 2013

As projects of this type move toward implementation, MCA-I's Environmental Social Management System (ESMS) should be consulted to ensure awareness of and adherence to all relevant requirements of Indonesian law and MCC corporate practice.

4.2.2 Application to the Proposed Project

The project under consideration has no significant regulatory requirements. The UKL, an environmental management effort, and the UPL, an environmental monitoring effort, provide an overview of potential environmental impacts with a focus on management and monitoring efforts by the project owner. Typically, these are triggered by small renewable energy projects or if smallholder plantation sizes are above 1,000 ha which is extremely unlikely. The UKL-UPL is provided to the appropriate authority, which may be a Minister of Environmental Affairs, governor, or regent; and the notice of the application must be announced in the media within 5 days after submission.

Smallholders in Sulawesi may be required to have a Hak Guna Usaha (HGU), or right of cultivation title. HGU title may be owned by Indonesian citizens or legal entities established under Indonesian law. In most cases, the final authorization comes from the local village head. This ownership may be relevant to individual smallholders, but is most likely beyond the scope of the training program.

4.3 Greenhouse Gas Emissions Impact

This section provides an overview and, where possible, quantitative estimates of the potential GHG emissions impacts associated with cacao intensification. Emissions from the training program activities (e.g., transportation of facilitators and cocoa doctors to and from training locations) have not been estimated and are assumed to be negligible relative to any changes in cacao farming practices that are implemented as a result of this training.

The carbon balance on croplands depends on numerous factors, including crop type, management practices, and location-specific soil and climate variables. The dynamics of these factors and their ultimate influence on carbon stocks and emissions are highly complex. In the absence of detailed site data and cacao growth models for the areas targeted for the training program, the quantitative calculations in this section apply the Intergovernmental Panel on Climate Change (IPCC)'s default (Tier 1) methodologies for calculating emissions from aboveground and belowground carbon stock changes on croplands remaining croplands, as well as emissions from fertilizer use [35] The IPCC's Tier 1 methodologies rely on coarse, aggregated emission factors based on climate zone. Because farmers who implement practices included in the proposed training will intensify existing cacao plots rather than convert these lands to a new crop or land-use, the IPCC's default methodologies generally are not able to account for the finer land-use change nuances, such as the impacts of pruning and shade trees on carbon stocks. Therefore, estimates based the IPCC methodologies are supplemented with qualitative and quantitative information from existing literature related to cacao intensification and agroforestry in Indonesia and elsewhere. Conservative estimates are used wherever possible.

Due to the manifold uncertainties and lack of data associated with this analysis, the emissions calculations presented below should be treated as illustrative examples that provide ranges of possible impacts associated with some of the expected cacao farming interventions. The results of this analysis are inconclusive as to whether this training program will increase or decrease net GHG emissions; however, recommendations are provided on practices that are likely to lead to sequestration. A more robust estimate of GHG emission or mitigation potential would require well-validated, species-specific growth models and sampled data to estimate annual biomass growth rates and carbon stock changes.[42]

4.3.1 Carbon Stocks in Aboveground Biomass

Unlike annual crops that release and sequester carbon in equal amounts over the course of a year's growth and harvest, perennially woody plantations, such as cacao farms and agroforestry systems, store carbon in long-lived wood of trees [35]. Thus, for cacao plantations in which fruit rather than timber is the economic product, annual harvests generally have negligible impact on carbon storage [36].

For the proposed cacao intensification project, net carbon storage in aboveground biomass will occur if farmers adopt farming practices that promote land-use systems having higher carbon content than existing cacao plantations. The magnitude of potential carbon sinks on intensified cacao farms depends on site characteristics, species type and age, density, growth rates, and harvesting and pruning practices. Literature on carbon sequestration through agroforestry suggests that high carbon stocks are most likely to be achieved when low-biomass land-use systems are converted to agroforestry systems characterized by high tree density, long-lived species, and proper soil management [36]. Specific impacts associated with cacao tree clearing and replanting, addition of shade trees, and pruning practices are discussed below.

Tree clearing and replanting. As stated in the economic analysis, 48,000 out of the 60,000 smallholders trained are expected to replant half of the trees on their 2-ha plots with new cacao species and to graft new species to the other half. To provide a simplified and conservative estimate of GHG impacts, this analysis assumes that 1 ha on each of the 48,000 farms will be cleared and replanted in the same year.[43] A conservative analysis also assumes that the remaining trees (which are grafted with the new species) are no longer accumulating carbon because they have reached a steady state in which growth rates have slowed and are offset by natural mortality, pruning, and other losses.

In the IPCC default Tier 1 methodology, all carbon stored in the trees that are cleared for new planting is assumed to be emitted during the year of removal. According to a logarithmic growth regression model developed for biomass growth in cacao plantations in Sulawesi, a cacao tree stores an average of 8.05kg of above ground biomass over a period of 25 years [37].[44] Total

[42] Additional tools for estimating GHG emissions related to the agriculture sector are available and may be appropriate during the feasibility study phase. A recent study titled *Review of GHG Calculators in Agriculture and Forestry Sectors* and an associated multi-criteria GHG tool selector that describe these tools are available online at http://www.fao.org/tc/exact/review-of-available-ghg-tools-in-agriculture/en/.

[43] It is unlikely that the hectare would be completely replanted in one year; this was used for modeling purposes.

[44] This per tree carbon storage figure is used for illustrative purposes in the calculations below; actual carbon accumulation in aboveground biomass before and after intensification practices are implemented is best determined through on-site measurements and species-specific growth models. That said, the 8.05kg C/tree estimate is fairly consistent with at least two other field studies, assuming that trees are planted at a 800-1,000 tree/ha density: one study estimates mean aboveground and belowground carbon stocks at 8.00t C/ha for 13.4 year-old Sumatra home garden systems source: Roshetko, J.; Delaney, M.; Hairiah, K.; Purnomosidhi, P. (2002). Carbon stocks in Indonesian Homegarden Systems: Can Smallholder Systems be Targeted for Increased Carbon Storage? *American Journal of Alternative Agriculture, 17,* 138-148. Another study estimates slightly higher levels of aboveground carbon stocks in Sulawesi cacao/*Gliricidia* agroforests, with annual carbon fixation in aboveground cocoa shoots

carbon losses from clearing depend on the density of the existing trees. In villages such as Lumika, density of cacao on current farms is as low as 500-700 trees/ha; although, smallholders in areas, such as the Kalukku district, who are participating in SCPP are planting at higher densities of 800-1,000trees/ha [FIRST]. Using 500 and 1,000 trees/ha as lower and upper bounds, respectively, for tree density, clearing a single hectare of mature cacao trees results in a one-time emission of approximately 15-30 tCO_2e (8 t C). Across all 48,000 farms, this loss equates to 708,400-1,416,800 tCO_2e.

Each smallholder is assumed to replant 800 cacao trees on the hectare that has been cleared. Over the course of their maturation (25 years or less), these trees will slowly accumulate carbon in aboveground biomass. The rate of accumulation depends on the tree species; and because the details of carbon accumulation in proposed new, high-quality cacao species relative to existing trees are unknown and this analysis assumes that cacao trees will ultimately accumulate as much carbon as they have lost (8.05kg /tree). Therefore, for farms on which the density of trees after intensification exceeds the density before, carbon stocks in cacao biomass will increase, and vice versa. Table 25 uses these data to illustrate how cacao tree density in the initial plantation impacts net GHG emissions associated with the clearing and replanting of cacao. This high-level estimate indicates that across all 48,000 farms implementing intensification best practices, net emissions associated with the clearing and replanting of cacao could range from a net sequestration of 425,000 tCO_2e to a loss of 283,400 tCO_2e.

Table 25. Illustrative Relationship between Original Cacao Tree Density and Net GHG Emissions in Aboveground Biomass in Intensified Systems (1-ha area)

Original cacao tree density (trees/ha)	500	700	800	1,000
Aboveground carbon stock in cacao at time of clearing (t C/ha)	4.0	5.6	6.4	8.1
Equilibrium aboveground biomass carbon stock in intensified plantations, 800 trees/ha (t C/ha)	6.4	6.4	6.4	6.4
Net carbon stock change (t C/ha)	2.4	0.8	0.0	-1.6
Net GHG emissions for 1 ha (t CO_2e)[45]	*-8.9*	*-3.0*	*0.0*	*5.9*
Net GHG emissions for 48,000 ha (tCO_2e)	*-425,040*	*-141,680*	*0*	*283,360*

Grafting. If grafting increases aboveground biomass, additional carbon will likely be stored. No quantitative data are available on carbon storage in grafted cacao trees, nor on the rate of biomass accumulation in grafted trees. As an illustrative example, if grafted trees accumulate 10% additional carbon over their lifetimes relative to the baseline Sulawesi cacao tree (accumulating 8.86 kgC/tree over 25 years), net carbon sequestration could increase by 1.5-3.0 tCO_2e/ha (depending on tree density), or 70,840-141,680 tCO_2e over all 48,000 plots. However, a conservative analysis assumes that the trees grafted with the new species are no longer accumulating carbon over their lifetimes because they have reached a steady state in which growth rates have slowed and are offset by natural mortality, pruning, and other losses.

reaching an average of 1.5tC/ha/year in two study areas, yielding carbon stocks of 12.2tC/ha in one 8-year old plantation and 21.0tC/ha in a 15 year-old plantation [41].

[45] The conversion factor from carbon to CO_2e is 44/12.

4.3.1.1 Addition of Shade Trees

Relative to unshaded systems, agroforestry systems that incorporate shade trees have been shown to store more carbon and are receiving increasing attention as a method to sequester carbon while offering economic benefits to resource-poor smallholders [38] In the target training villages in Mamasa and Mamuju, cacao is currently intercropped with fruit trees—such as coconut, papaya, and banana—and timber trees such as gamelina, teak, and red jabon [1]. The proposed cacao intensification training program would encourage smallholders to increase shade trees over current levels, using both timber and other commercial species such as coconut and gamal. Though numerous studies have been conducted on the carbon sequestration potential of agroforestry systems in general, little specific information is available regarding the relationship between the number and type of shade trees and carbon stocks on Indonesian cacao plantations in particular. Table 26 shows estimates produced by a modeling analysis of the relationship between shade tree canopy coverage and carbon stocks (including aboveground biomass and soil carbon) on cacao plantations in Sulawesi over a 25-year period.

Table 26. Relationship between Shade Tree Coverage and Carbon Stocks on Cacao Plantations in Sulawesi

Shade tree canopy coverage	Net carbon accumulation (tCO_2e/ha)
>85%	67
66-85%	64
35-65%	62

Source: Seeberg-Elverfeldt, C., Schwarze, S., and Zeller, M. "Carbon finance options for smallholders' agroforestry in Indonesia." International Journal of the Commons, 3(1), 108-130. 2009. Last accessed November 21, 2013: http://www.thecommonsjournal.org/index.php/ijc/article/view/96/63

To provide an illustrative example of the impact of adding shade trees on carbon storage in cacao plantations, this analysis assumes that current farming practices involve shade tree coverage of 35%-65% (which is consistent with current estimates provided in [39] and that the proposed training will lead to the addition of shade trees such that the coverage falls between 66%-85%. Using the values in Table 26, each 2-ha farm will then accumulate a net 4 tCO_2eq in the intensification scenario relative to the baseline system. Across all 48,000 farms, a total sequestration of 192,000 tCO_2e could be realized as a result of adding shade trees. Increasing shade tree canopy coverage to 85% or higher on all farms would result in sequestration of 480,000 tCO_2e relative to the lower-shade systems but may impact yield.

Accelerated shade tree removal has been witnessed in Sulawesi, and the removal of shade trees after the establishment of cacao is relatively common [40]. One important consideration related to the use of shade trees is the tradeoff between carbon sequestration and economic returns: higher yields are associated with lower levels of shade, and therefore, lower sequestration potential [37]. One study, based data from 199 cacao farming households in 12 Sulawesi villages, observed, "intensified cacao production increases annual net returns from 285 €/ha on plots with 65–80% shade tree cover to 564 €/ha on plots with 35–50% cover, and to 780 €/ha in cacao plantations without shade trees" [39]. This study and others note that the complete removal of shade trees and the conversion to full-sun systems is much more likely to result in negative long-term impacts (such as an increase in pest attacks and disease incidence for some species) that offset short-term yield improvements [40]. Therefore, the study suggests that reducing shade tree coverage from >80% to 35-50% will double income and result in only limited losses of ecosystem functioning, including species richness, soil fertility, herbivory rates, and other factors. However, the study did not directly quantify impacts of the shade gradient on carbon sequestration potential. Reaching the 35-50% shade coverage that optimizes yield and biodiversity benefits may require maintaining baseline tree densities or possibly even removing shade trees, which will reduce sequestration.

Because of the potential tradeoff between shade and optimal yield, encouraging farmers to maintain or even increase long-term shade on cacao plots may require additional education, and possibly incentives. To encourage shade levels that maintain or improve carbon storage, the proposed training program should seek to train smallholders on the value of shade trees to provide environmental services, including GHG mitigation, biodiversity, and physiological resilience of cacao itself. Management practices that could enable sequestration and the realization of these other benefits include encouraging shade tree species that promote species richness (even at low densities), pruning of shade trees as well as cacao trees to retain biomass and discourage disease while improving yields; and reduced clearing of detritus of the plantation floor [39][40]. Financial mechanisms such as Reducing Emissions from Deforestation and Degradation (REDD) or price premiums for shade-grown cacao may also warrant additional study as potential ways to provide payments for carbon storage.

4.3.1.2 Pruning

The proposed training program will encourage regular pruning relative to current practices. The relationship between pruning and carbon storage is complex: pruning removes aboveground biomass and can reduce soil carbon sequestration by accelerating detritus-turnover rates. However, pruning also promotes biomass production in the understory and stem development, which could partially or completely offset carbon losses, especially if pruned residues are returned to the soil [38]. Quantitative estimates of the impacts of pruning on carbon stocks are not available to inform this analysis.

4.3.2 Soil Carbon Impacts

The majority of carbon in cacao farms and agroforests is stored in the soil. For instance, in two cacao-gliricidia agroforests studied in Sulawesi, soil carbon contributed approximately 80% of total carbon storage (representing 96 tC/ha in Napu's 8 year-old agroforest and 161 tC/ha in Palolo's 15 year-old agroforest) [41]According to the IPCC Tier 1 methodology, three primary factors influence soil carbon stock on croplands: land-use change (e.g., from long-term cultivated land to paddy rice or idle land), management regime (which accounts only for tillage), and input of organic matter (e.g., crop residues and manure).[46] For the smallholder farms impacted by the cacao intensification training program, none of these factors are anticipated to change significantly relative to the baseline scenario. Both the baseline and intensification scenarios will be characterized by long-term cultivation land-use, a no-tillage management regime, and high inputs without manure.[47] Thus, the GHG impacts of cacao intensification on soil carbon stocks

[46] This approach assumes that the areas influenced by the cacao intensification project do not include cultivated organic (e.g., peat) soils and do not involve the application of agricultural lime.

[47] The IPCC's "High—without manure" input category assumes significant crop residue due to the production of high-residue yielding crops and cover crops among other factors. Though pruning and the addition of shade trees

are assumed to be negligible for the purposes of this high-level analysis. A more rigorous assessment would involve site-specific soil carbon baseline measurements and estimations or modeling of organic carbon in living root biomass, microbial biomass, and soil aggregates [38].

The training programs provided by the FFS can incorporate information on GAP that is likely to maintain or increase soil carbon stocks on cacao plantations. These practices include:

- Incorporating shade trees into cacao plantations. As is the case with aboveground biomass, encouraging cacao agroforestry systems that intercrop shade trees with cacao trees is likely to increase soil carbon. Studies from around the world have shown that agroforestry systems store higher amounts of carbon compared to single-species cropping, both aboveground and belowground [38].
- Maintaining residues on fields. Intensive practices such as clearing or relocating residues, weeding, and burning are associated with a loss in soil carbon, as the decomposition of plant residues and other organic materials is a source of carbon and nutrients in soil [36]. Best practices for maintaining storage carbon stocks include maintaining and returning biomass (e.g., from cacao tree or shade tree pruning) to the soil, and controlling soil erosion can maintain and even increase soil carbon stocks.

Anecdotal evidence indicates that smallholders in the target villages for cacao intensification training are currently incorporating these practices, so training should focus on reinforcing these concepts and highlighting potential carbon sequestration benefits [1].

4.3.3 Emissions Impacts of Fertilizer Use

Of the 60,000 smallholders trained in cacao intensification through the proposed program, 8,000 are anticipated to adopt practices that result in high yield (2 t/ha or greater), including the use of fertilizer and pesticides. Additions of nitrogen to the soil via synthetic fertilizers will increase the production of the nitrous oxide (N_2O), a potent GHG. The calculations below estimate the GHG emissions associated with increased fertilizer use by smallholders implementing higher-yield practices and account for the following impacts [42]:

- Direct emissions from an increase in available nitrogen and subsequent production of N_2O from the addition of synthetic fertilizers
- Indirect emissions from the leaching and runoff from land of nitrogen from synthetic fertilizer additions
- Indirect emissions from the volatilization of nitrogen as ammonia and oxides of nitrogen, and the deposition of these gases and their products onto soils and water surfaces
- Emissions associated with the production of fertilizer.[48]

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may increase residue inputs to the soil on intensified cacao farms, these increases are too minor to be accounted for in the IPCC Tier 1 method.

[48] The industrial process of producing fertilizer is energy intensive and is therefore associated with GHG emissions related to the consumption of fossil fuels. Additionally, the production of nitrogen fertilizers generates N_2O as well as carbon dioxide through the processes of nitric acid and ammonia production. This prefeasibility analysis accounts for the GHG emissions impacts of fertilizer production to the extent that relevant emission factors are documented in the literature [44].

Currently, cacao smallholders use very little (if any) fertilizer, so fertilizer is not included as an emissions source in the counterfactual scenario. Additionally, the 40,000 smallholders who adopt medium-yield (1 t/ha) or do not change their practices as a result of the training are not anticipated to use fertilizer, and therefore, are not included in these calculations.

The calculation methodology for estimating GHG emissions from fertilizer management is described in the documentation for USAID's Agriculture, Forestry, and Other Land Use Carbon Calculator [43]. This methodology adapts the IPCC Tier 1 approach based on the 2006 Guidelines on Agriculture, Forestry and Other Land Use; and thus relies primarily on default IPCC factors and other literature values, summarized in Table 27.

Table 27. Parameters for Estimating GHG Emissions Impacts of Fertilizer Use

Parameter	Value	Source
Fertilizer application area (ha)	16,000	Project area, assuming 2 ha per smallholder and 8,000 smallholders implementing high-yield practices
Cacao tree density (trees/ha)	800	Project estimate
Application rate for SP36 (g/tree)	At planting: 100	Data provided by agronomist at Cocoa Development Centre in Wotu
Application rate for NPK (g/tree)	Year 1: 220 Year 2: 320 Year 3: 600 Year 4+: 700	Data provided by agronomist at Cocoa Development Centre in Wotu
Emission factor for direct emissions from nitrogen inputs from mineral fertilizers, organic amendments and crop residues, and nitrogen mineralized from mineral soil (kg N_2O-N/kg N input)	0.01	ACC (IPCC default factor, Table 11.1)
Emission factor for indirect emissions from volatilization and re-deposition of nitrogen on soils and water surfaces [kg N_2O-N/(kg NH_3N + NO_x-N volatilized)]	0.01	ACC (IPCC default factor, Table 11.3)
Emission factor from leaching/runoff (kg N_2O-N/kg N leaching or runoff)	0.0075	ACC (IPCC default factor, Table 11.3)
Fraction of synthetic fertilizer that volatilizes [(kg NH_3-N + NO_x-N)/(kg N applied)]	0.1	ACC (IPCC default factor, Table 11.3)
Fraction of all nitrogen added to/mineralized in managed soils that is lost through leaching/runoff (kg N/kg N additions)	0.3	ACC (IPCC default factor, Table 11.3)
Conversion factor from N_2O-N to N_2O	44/28	IPCC methodology
Global warming potential of N_2O	298	IPCC methodology
Emission factor for the production of SP36 (kgCO_2e/kg fertilizer)	Low: 0.1777 High: 0.2632	Mean phosphate fertilizer emission factor (based on analysis for Germany), as summarized in Wood and Cowie (2004) [44]
Emission factor for the production of NPK fertilizer (kgCO_2e/kg fertilizer)	Low: 0.2477 High (mix): 0.2632 High (acid): 1.1243 High (nitro): 1.1844	Low value estimated using Clean Development Methodology (assuming 15% nitrogen content); [45] high values for NPK (15-15-15) as reported in Wood and Cowie [44]

Using these parameters as input, GHG emissions estimates are summarized in Table 28. During the first 4 years following smallholder adoption of intensification practices, emissions vary according to fertilizer type and application rate as new trees are established. In addition to these annual variations, Table 28 shows the sensitivity of GHG emissions to production method for SP36 and NPK. NPK emissions in particular vary according to whether the fertilizer is produced through 1) mixing dry fertilizers, 2) the mixed acid route, or 3) the nitrophosphoric acid route

[44]. Emissions from these processes vary primarily because of the differing levels of required energy input as well as the variation in N_2O released during the production of ammonia and nitric acid associated with each process. No information is available at this time about processes applied and the resulting emissions to produce SP36 and NPK fertilizer in Indonesia, so the emission estimates below reflect a range of values from existing literature, which is primarily based on data from U.S. and European fertilizer industries.

Table 28. Upper- and Lower-Bound Estimates GHG Emissions from Fertilizer Application

Scenario	**Total emissions (tCO_2e/yr)**				
	At planting (SP36 only)	***Year 1 (NPK only)***	***Year 2 (NPK only)***	***Year 3 (NPK only)***	***Year 4+ (NPK only)***
Lower bound	8,170	18,170	26,429	49,555	57,814
Upper bound (NPK produced by mixing dry fertilizers)	8,279	18,571	27,012	50,648	59,089
Upper bound (NPK produced though mixed acid route)	8,279	20,639	30,020	56,287	65,669
Upper bound (NPK produced though nitrophosphate route)	8,279	20,808	30,266	56,749	66,207

Based on this estimation, if 8,000 smallholders apply fertilizer at the recommended rates to increase cacao yield 2 t/ha, GHG emissions from fertilizer use could increase by up to approximately 58,000-66,000 tCO_2eq/yr after the first 4 years of tree establishment. This estimate represents a conservative upper bound for fertilizer emissions that would be reached if all farmers implementing high-yield practices applied fertilizer at the recommended rate.

This estimate does not take into account the potential for synthetic fertilization to improve soil carbon storage and offset some of these emissions, as this process has not been rigorously studied in tropical trees. Likewise, no conclusive information is currently available on the impact of adding herbicides and pesticides on carbon storage in agroforestry systems [38]. These impacts therefore are not estimated in this analysis. Like fertilizer, the production of herbicides and pesticides are associated with energy-related emissions. However, consistent with IPCC methodology, these emissions are not estimated in this analysis.

4.3.4 Potential Impacts of Avoided Encroachment

Encouraging intensification via the proposed training program will result in a variety of GHG emission impacts on smallholder cacao farms. Additionally, cacao intensification has the potential to impact carbon stocks on the surrounding landscape, for example, by influencing deforestation and land conversion activities that would likely increase GHG emissions.

With their high carbon content, Indonesia's tropical forests and soils represent a significant carbon sink; however, land conversion, deforestation, and peat fires have been estimated to contribute as much as 85% of Indonesia's national GHG emissions [46]. Avoiding emissions associated with deforestation is therefore an important consideration at both the national and local levels.

As a significant source of income, particularly for smallholders, agricultural expansion for has been a primary historical driver of deforestation (and associated GHG emissions) in Indonesia [37]. In the target district of Mamuju, for example, cacao has become a less viable livelihood for smallholders since 2010, when pests and diseases began devastating yields. As a result, some smallholders are reportedly beginning to shift their economic activities away from cacao farming. These shifts have included renewed "exploration" of the forest for alternative livelihoods, which is leading to forest degradation that was not prevalent in these areas during the cocoa boom [1]. Similar trends have been observed in cacao boom-and-bust cycles across Indonesia and elsewhere and have contributed to a growing field of literature that explores different mechanisms (such as REDD+ and payments for ecosystem services) that could reduce forest conversion by encouraging improved agricultural productivity [40, 47, 48].

Unfortunately, as stated in a previous study, "there is no simple, unequivocal relationship between changes in agricultural systems and deforestation [49]." While some studies provide evidence and analytical modeling to support the theory that GHG emissions can be mitigated through agricultural intensification, others highlight a dearth of historical instances that demonstrate the validity of this linkage [50, 51, 52]. In some cases, intensification may even drive deforestation by reducing prices and increasing demand for agricultural products, leading to the cultivation of new lands. Intensification of existing farmlands is likely only one of several factors that influences forest conservation; additional conservation policies and incentives are likely necessary complements to agricultural intensification to avoid deforestation.

In light of the lack of conclusive evidence that improved productivity alone can reduce deforestation, this prefeasibility study does not consider cacao intensification to be a direct mechanism for reducing emissions associated with deforestation in Sulawesi. Furthermore, as discussed in the economic analysis, a robust assessment of the relationship between the cacao intensification training program and encroachment on adjacent forestlands is beyond the scope of this study. However, *for illustrative purposes only and to inform future analyses,* the calculation below estimates, on a per hectare basis, the GHG benefits of protecting forests in West Sulawesi.

For the purposes of this prefeasibility analysis, USAID's ACC Forest Protection Tool was used to estimate the following emissions impacts from protecting forests [43]:

- Avoided emissions from deforestation
- Sequestered emissions in forest areas that would have been deforested under the business-as-usual scenario ("foregone sequestration")
- Avoided peat and mineral soil emissions from conversion of forest to cropland.

The ACC provides a simplified interface for producing 1-year estimates of GHG sequestration and/or emissions reductions associated with sustainable land use and land management activities. To estimate emissions impacts of agriculture, forestry, and other land-use projects, the ACC contains and draws heavily from default data (on deforestation rate, soil carbon content, peat bulk density) for West Sulawesi. The precise parameters for smallholder cacao plantations in Mamasa and Mamuju may differ from these area-weighted average values, which are representative of the province as a whole. However, in the absence of site-specific measurements, these defaults are sufficient to provide an initial estimate of the potential magnitude of GHG impacts to inform the prefeasibility study. The sources for the default data are described in the ACC documentation, as are the methodologies and calculations used to produce emissions estimates. Table 29 summarizes the inputs to the ACC Forest Protection Tool.

Table 29. Parameters for Estimating GHG Emissions Impacts of Forest Protection Activities

Parameter	Value	Source
Annual deforestation rate (%/yr)	0.71	ACC default for Sulawesi Barat province
Forest carbon stock (t C/ha)	163.24	ACC default for Sulawesi Barat province
Annual forest growth (t C/ha)	4.81	ACC default for Sulawesi Barat province
Soil carbon (t C/ha)	58.43	ACC default for Sulawesi Barat province
Peat swamp percentage (%)	0.0	ACC default for Sulawesi Barat province
Peat bulk density (g/cm^3)	0.14	ACC default for Sulawesi Barat province
Average depth of peat drained (cm)	46.0	ACC default for Sulawesi Barat province

Based on these parameters, the ACC calculates that protecting 1 ha of forestland in West Sulawesi from deforestation and degradation will avoid 4-5 tCO_2e/year. If, for example, training through the FFS (coupled with other policy measures and incentives beyond the scope of this project) were to discourage 15,000 of the 60,000 farmers trained in cacao intensification from encroaching on 1 ha of forest each, avoided emissions would total approximately 66,000 tCO_2e/year, enough to offset all of the emissions anticipated from increased fertilization. Again, this calculation is provided for purely illustrative purposes; to realize these emissions benefits, conservation policy and other enabling measures beyond the farmer training envisioned in this model project would be necessary.

4.3.5 Summary

Table 30 summarizes the ranges of emissions impacts (over 25 years) associated with the cacao intensification practices discussed in this analysis. Based only on the quantitative estimates that are included this study, this project will not reduce GHG emissions even under optimistic conservative assumptions. Due primarily to the emissions associated with the production and application of fertilizer, this project could increase GHG emissions by 327,500-1,856,000 tCO_2e over 25 years. To realize net carbon sequestration, fertilizer application across the farms adopting high-yield practices would need to be approximately halved. However, because the potentially positive impacts of practices such as pruning and phytosanitation were not quantified due to data and methodological limitations, actual GHG emission impacts associated with cacao intensification may be marginal. It is possible that a better accounting—and different results—could be achieved using more analytically-intensive growth models and site-specific data that accounts for the positive impacts of improved management practices.

Table 30. Summary of 25-year GHG Emissions and Sequestration Ranges Associated with Cacao Intensification Practices[a]

Farming Practice	Lower-Bound (Optimistic) Emission Estimate (tCO_2e)	Upper-Bound (Pessimistic) Emission Estimate (tCO_2e)
Cacao clearing and replanting	-425,040	283,360
Cacao grafting	-141,680	0
Shade tree planting	-480,000	0
Pruning	*No estimate*	*No estimate*
Residue management	*No estimate*	*No estimate*
Fertilizer production and application	1,374,240	1,572,660
Net GHG emissions over 25 years	*327,520*	*1,856,020*

[a] Note: Negative emissions values represent carbon sequestered or GHG emissions reduced

Based on project assumptions and existing literature, the following conclusions can be drawn:

- The production and application of synthetic fertilizers on high-yield farms would result in significant GHG emissions [up to 58,000-66,000 t carbon dioxide equivalent (CO_2e)/year, or up to 1.5 million tCO_2e over 25 years, assuming all high-yield farms applied fertilizer at the recommended rates]
- The initial clearing of farmland to plant higher quality cacao species would result in high one-time emissions (708,000-1,417,000 tCO_2e). However, these emissions would be offset as the new cacao trees grow and store carbon in aboveground woody biomass. Assuming that the new and current cacao species store equal amounts of carbon at maturity, the greatest net carbon storage will occur on farms where the density of new cacao trees exceeds the density of the original trees. Conservatively, carbon sequestration associated with planting new trees would reach 141,000-425,000 tCO_2e over 25 years. On the other hand, if new trees are planted less densely, approximately 283,000 tCO_2e may be emitted.
- No quantitative data are available on carbon storage in grafted cacao trees, nor on the rate of biomass accumulation in grafted trees. As an illustrative example, if grafted trees accumulate 10% additional carbon over their lifetimes relative to the baseline Sulawesi cacao tree, net carbon sequestration could increase by 70,840-141,680 tCO_2e (depending on the original density of cacao trees) over all 48,000 plots that graft 1 ha of trees. However, a conservative analysis would assume that the trees grafted with the new species are no longer accumulating carbon over their lifetimes because they have reached a steady state in which growth rates have slowed and are offset by natural mortality, pruning, and other losses.
- The addition of shade trees to intensified cacao plantations has the potential to improve aboveground carbon stocks relative to the baseline system (by 192,000-480,000 tCO_2e over 25 years); however, training and awareness-building, and possibly incentives, may be needed to encourage farmers to maintain shade when higher cacao yields are associated with full-sun systems.
- Several impacts that have not been quantitatively estimated in this prefeasibility analysis may have positive effects on carbon stocks in cacao plantations. These impacts are associated with practices—such as pruning and sanitation—that will add biomass and return more nutrients to the soil. Additionally, the impact of fertilizer on soil carbon

storage and aboveground biomass has not been estimated in this study, but may help to offset some of the losses associated with fertilizer use. On the other hand, increased emissions associated with the production of pesticides and herbicides have also not been estimated.

- Due to the lack of historical evidence that improved productivity alone can discourage deforestation and degradation of local forestlands, this prefeasibility study does not consider cacao intensification to be a direct mechanism for reducing emissions associated with deforestation in Sulawesi. Though intensification may play a role in influencing land conversion, policy and economic interventions beyond the scope of this model project would very likely be necessary to ensure sustained forest conservation and realize the (potentially significant) GHG benefits associated with avoided deforestation.
- A more conclusive study of GHG emissions from cacao intensification, suited to a full feasibility study, should be based on the development and use of land-use and growth models, as well as site-specific data that can account for the numerous factors and dynamics at play in cacao intensification scenarios.

4.4 Spatial Land Use Planning

Spatial land-use planning refers to the “landscape approach” for planning environments. This means that a combined geographical and socio-economic approach to managing land, water, and forest resources is taken to ensure that the goals of food security and inclusive green growth are met [52].

Since 2007, spatial land-use planning has been required in Indonesia for all terrestrial and coastal resource planning. Any new project activity is required to create a spatial land-use plan that considers the social and environmental resources inside and outside the project area.

Large areas of Mamuju and Mamasa are forested. Community forests in the region have become degraded over time, but could potentially regenerate under new conditions and farming techniques from the training program. It is not clear whether this would lead to changes in the categorization of forested lands. It is not anticipated that land use would change over the 10 years of the training program, with farming continuing on existing plantations. Historically there has been little land-use change, but the most recent data are not available. Figure 41, Figure 42 and Table 31 highlight land use in Mamuju and Mamasa

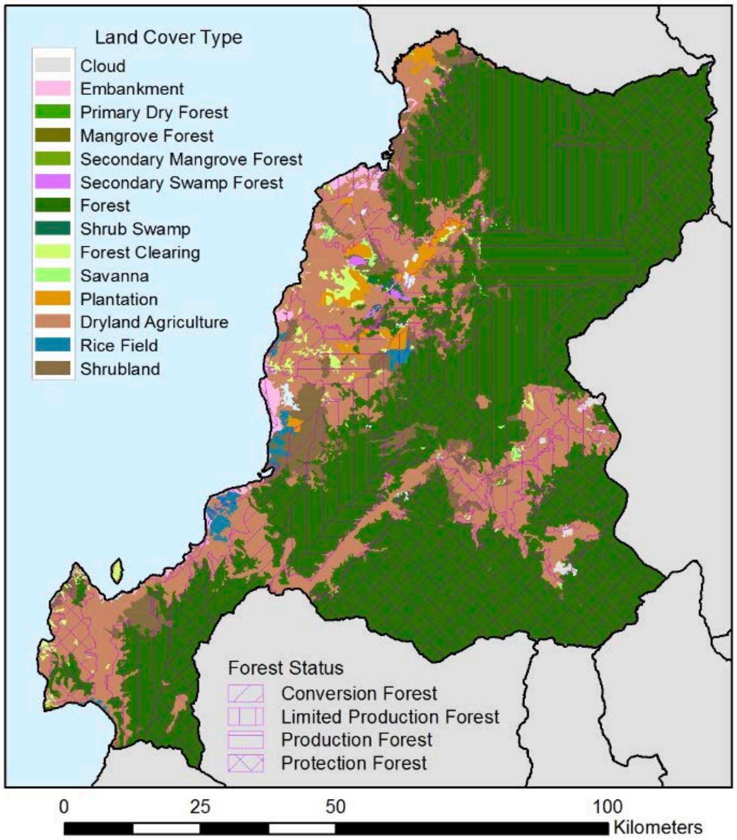

Figure 41. Land use in Mamuju

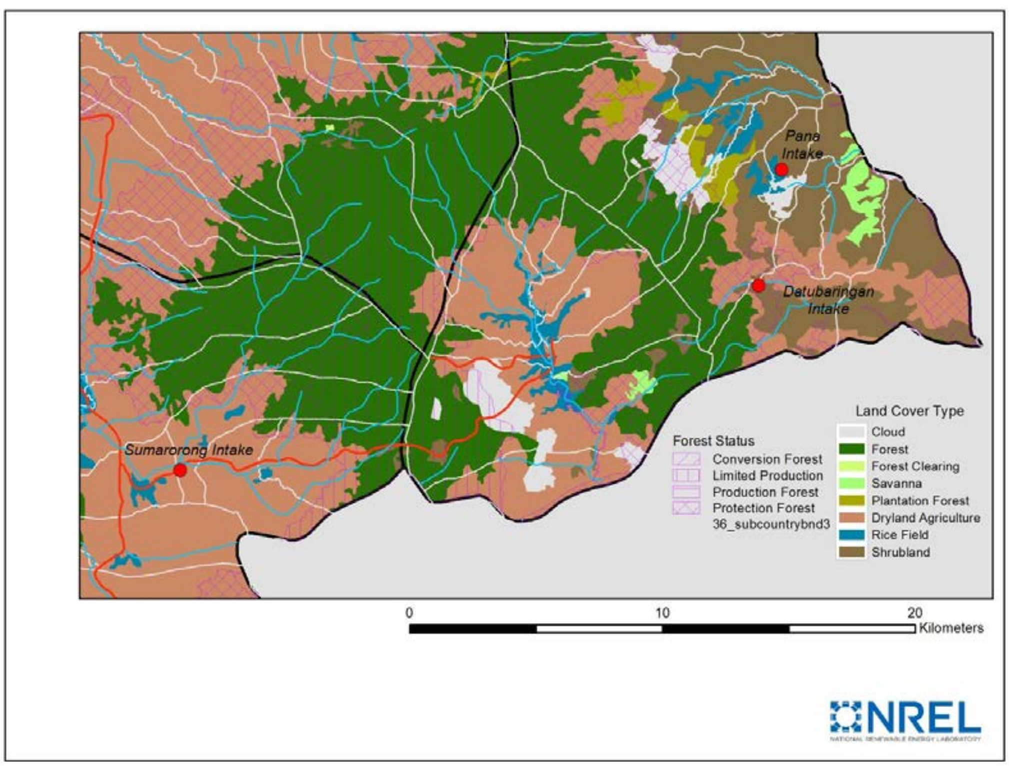

Figure 42. Land use in Mamasa

Table 31. Mamasa Land Use Area

Land Use (Bahasa)	Land Use (English)	Area (km^2)	Land Cover Type
Awan	Cloud	21.16	0.70%
Hutan Primer	Forest	1,507.00	51.00%
Hutan Tanaman	Plantation Forest	6.6	0.20%
Pertanian Lahan Kering	Dryland Agriculture	1,112.91	37.70%
Savana	Savanna	13.24	0.40%
Sawah	Rice Field	60.94	2.10%
Semak/Belukar	Shrubland	230.74	7.80%
Tanah Terbuka/Kosong	Forest Clearing	1.73	0.10%

Source: PT Desainas

5 Social Assessment

5.1 Community Impacts

The material discussed in this chapter is the result of a multi-day site visit by a team of social scientists and gender specialists from Bogor Agricultural University (IPB) who visited three villages in Mamuju, West Sulawesi [53]. Due to the pre-feasibility level of this model project report, a full community engagement process, with identification of all related impacts through detailed participatory action research, was not identified. The site visits were undertaken to get an initial assessment of the social and gender characteristics of these communities, and to understand potential impacts that a cacao training project would have on these communities. It is not clear if the social assessment in Mamuju would be applicable to villages in Mamasa.

West Sulawesi is politically divided between mountain people and costal people related to the traditional royal history when two major kingdoms existed. Lohe was a traditional mountain kingdom dominated by the Mangki ethnic while the historic costal kingdom of Pitu 'Uluna Salu consisted of seven ethnicities (Rantai Bulahan, Bambang, Mambi, Aralle, Tabulahan, Mattanga, and Tabang. Leadership in the three villages is dominated by those with good knowledge of past history, customs, religious knowledge, and familial linkages with past royals or the village founder. Villages are led by a custom leader called a tobara who has responsibility for maintaining social laws and mitigating disputes through custom laws. The tobara and local government mitigate disputes between villagers on land boundaries. At the time of this report, the governor of West Sulawesi and the regent of Mamuju represent the mountain and costal people respectively. It is important that the project pay attention to the needs of various ethnic groups and ensure that the methods and training materials are applicable to all groups. Adoption of techniques taught are essential to the success of this project and prior to implementation would be an ideal time to determine if FFS need to be altered in any way to address specific groups.

Village leaders tend to have strong relationships with both the government and NGO with development programs in Mamuju. There are two types of NGOs operating in Mamuju: type 1 are affiliated with local governments and receive funding support from the government (APBD/APBN) to carry out organization activities. Type 1 tends to work on issues of community and regional development and is typically well connected with local village leadership. Type 1 NGOs include Karangpuang Foundation and Marindo Foundation. Type 2 is NGOs that obtain funding from international or non-government sources. Type 2 NGOs typically promote conservation, community capacity building, and advocacy and are not well connected with village leadership. Examples of Type 2 NGOs operating in Mamuju include Wasiat, Walhi, and LP Sulbar.

The three villages visited were Kalumpang in Kalumpang subdistrict; Lumikka in Bonehau subdistrict; and Keang in Kalukku subdistrict. The Kalumpang and Lumikka villages are mostly Mangki ethnicity with small minority populations of Toraja, Bugis, Mandar, and Mamuju. The Lumikka community includes a transmigration resettlement unit (UPT) which consists of minority Java Sunda, Toraja, and Bali migrants. The ethnicity of Keang is equally divided among Rantai Bulahan, Mangki, and Bambang. The main activity in all three villages is farming. The ethnicities in these villages are a mix of Christianity and Islam which affects the clustering of people in settlements within the villages. Table 32 provides data on land, demographics, and agriculture for the three villages. While there is no system of dry land inheritance, there is an emerging inheritance system for coffee, cocoa, and rice farms but it is not clear to IPB's research team how families decide to distribute land in a family.

The main activity in all three villagers is agriculture with rice, corn, potatoes, banana, and papaya for subsistence while cacao is grown for income. Other economic activities include raising pigs and chickens and a small portion of residents are running stalls selling food. Other residents are civil servant and some are going outside the village to become day laborers and reported rates during NREL site visits ranged between IDR 35,000 to IDR 50,000 per day sometimes including lunch. During the cocoa boom, villagers did not go into forests to remove timber for wages; however, the decline in cocoa bean production has resulted in some villagers in Keang and Lumikka returning to forests as a source of income [1].

Of most importance to smallholder households in the villages visited, is food security through the production of rice in both wet and dry fields. The second most important livelihood strategy is generating cash income through a combination of cocoa bean sales, candle nuts, cutting and selling teak, and potentially gold mining. A third strategy is diversification of crops to avoid risk of economic collapse. While not possible for all households, further diversification is possible through owning and/or operating a stall or shop.

The Indonesian Statistics Office (BPS) reports that cacao farmland in Kalukku and Kalumpang is 10.96% and 5.27% respectively of all Mamuju cacao farmland [53]. Some smallholders have experienced a decline in cacao production and have turned to either subsistence farming, labor outside of the village, or harvesting rattan and timber from forests. Kalumpang and Lumikka are both located over four hours on four-wheel drive roads from Mamuju city and suffer from poor road infrastructure limiting access to agricultural markets. There is no cooperation of agriculture management between different ethnicities and religions thus farmers groups are established along ethnic and religious ties. Both formal and informal farmers group exist in each of the villages with the former established when government programs fund farmer groups and the latter by sisaro, a system of social gathering of labor of more than 10 people. It would be important for the project to ensure FFS and CDC training is available to smallholders from all groups.

Table 32. Villages in Study Area Statistics and Information

Village	Land Area	Altitude	Population	Household	Income from Agriculture	Cacao Farm Condition	Road Conditions
Kalumpang	172 km^2	90-1,400 m	716	151	79%	Poorly maintained	Poor
Lumikka	25 km^2	200-500 m	910	215	93%	Somewhat maintained	Poor
Keang	30 km^2	100-500 m	3,034	711	87%	Well maintained	Good

Source: "Natural Resource Management and Sustainable Land Use: Mamuju District, West Sulawesi". Prepared for NREL by Bogor Agricultural University (IPB). November 2013.

The most important income in Kalumpang village is selling cocoa beans as well as other agriculture commodities. A few members of the community derive income from other activities such as service (12%), transportation (3.2%), trade (3.1%), construction (1.0%), electricity (0.8%), and mining (0.4%) [1]. Kalumpang village cacao smallholders do little to maintain their farms and do not prune or attempt to control pests which are problematic in the area. The lack of maintenance has led to low production estimated at less than 400 kg/ha [1]. Agricultural sales are further impacted by poor road conditions, distance to Mamuju, and lack of public transport. Kalumpang also has forest lands of approximately 20,000 ha of which about 4,300 ha are community forest and the remainder state-owned forest [53].

In Lumikka, cocoa beans are the most important income source with 50% of families growing cacao. The community derives 93% of their income from agriculture with the remainder earning income from trade (6%) and service (1%) [1]. Cacao smallholders make an effort to maintain their farms which tend to range between 500 and 700 trees per hectare. They prune, weed, try to control pests, and occasionally fertilize. A result of the decline in cocoa bean production is an increase in villagers collecting rattan in the forest 8km by foot from the village., about 40% of the villagers collect rattan since from the forest in an area about 8km from town accessible only by foot. About 40% of villagers collect rattan with villagers entering the forest for 3 weeks for and each person collecting 1 ton with a price of IDR 1,000,000/ton, however, the laborer typically only keeps 25% of this price as it is reduced by costs associated with gathering, transporting, and selling it [1].

Keang village benefits from being only an hour from Mamuju by paved roads. IPB reports that compared with Kalumpang and Lumikka, agricultural output and community life are relatively better in Keang. Cocoa beans sales are the primary method of income and 87% of the population earns income from agriculture while others earn income from service (5%), trade (3%), electricity (3%), transportation (2%), industry (1%), and construction (1%) [1]. Keang started experiencing issues with cacao pests in 2010 and while the GERNAS program intervened in their community, the villagers did not find the program helpful with their pest issues. Some smallholders graft with high quality budwood clones S1 or S2 known to perform well in Sulawesi. However, some smallholders are leaving cacao due to pests and diseases to collect rattan or grow corn. Rattan is collected by 70 to 100 villagers in the forest around Keang and also from the Tamarandan forest, a day's walk away. The villagers generally collect four times a year for two weeks at a time with wages for the two week period of approximately IDR 370,000 [1]. Recently, a coffee company approached the village and 30 villagers have started planting coffee trees with each smallholder receiving 1,000 seeds and input costs of IDR 1,500 [1]. The coffee harvest will begin in 2 years in cooperation with the coffee company who will pay coffee prices less the costs incurred by the company for planting with the net going 2/3 to the smallholder and 1/3 to the company coffee. Local coffee prices at the time of this report were IDR 15,000 to 20,000/litre.

Cacao farming began in the area in the late 1980's and early 1990's and the soil is reported as low quality in these villages. All three villages suffer from similar cacao issues including aging trees, pests (pest and disease began negatively impacting yield in 2007), limited varieties of high quality seeding clones and budwood, limited fertilizing and pruning. Cocoa bean yields were reported between 200 to 500 kg/ha and some land which is minimally harvested due to pest infestation is only yielding 100 kg/ha [53]. Lumikka suffers from low yields and IPB reports many cacao farms are either abandoned or planted in dryland rice or corn. Table 33 shows that the three villages harvest at different times. Smallholders in these communities have never fermented cocoa beans and at the time of IPB's visit were receiving IDR 17,000 to 19,000/kg. Smallholders growing cacao in these villages use income from cocoa bean sales to send their children to secondary school. Few smallholders in these villages are aware of side-grafting and other interventions to improve yields. Information on other crops in the three villages and Mamuju subdistricts is available in Appendix B.

Table 33. Cocoa Farming Harvest Frequency

<table>
<tr><th rowspan="2">Month</th><th colspan="3">Village</th><th rowspan="2">Climate</th></tr>
<tr><th>Kalumpang</th><th>Keang</th><th>Lumikka</th></tr>
<tr><td>January</td><td rowspan="3">Harvest frequently</td><td rowspan="3"></td><td rowspan="12">Low yield harvested anytime</td><td rowspan="6">Rainy Season</td></tr>
<tr><td>February</td></tr>
<tr><td>March</td></tr>
<tr><td>April</td><td>Harvest</td><td rowspan="3">Harvest</td></tr>
<tr><td>May</td><td rowspan="8">Harvest frequently</td></tr>
<tr><td>June</td></tr>
<tr><td>July</td><td rowspan="2"></td><td rowspan="2">Dry season</td></tr>
<tr><td>August</td></tr>
<tr><td>September</td><td rowspan="3">Harvest frequently</td><td rowspan="3">Rainy season</td></tr>
<tr><td>October</td></tr>
<tr><td>November</td></tr>
<tr><td>December</td><td></td><td></td></tr>
</table>

Source: "Gender and Social Assessment". Cacao Green Prosperity Program in Mamuju District. Bogor Agricultural University. October 2013.

IPB visited a trained farmer group in Kalukku subdistrict and found the conditions different than the communities they visited. The farmer group has 30 members each with about 1 hectare with 800-1,000 trees/ha [1]. The area was planted in cocoa in 1983 and rejuvenated with side-grafting over time with budwood clones S1 and S2 from Polewali. The farmer group members' plant shading trees, prune, and fertilize in April and October with 200 grams of NPK and 200 grams of urea per tree. The farmer group controls pests largely by sanitation and with pesticide when needed usually using Nureal and Penalty. The farmer group ferments beans and sells them for a premium to BT Cocoa of IDR 22,600-24,600/kg [1].

IPB conducted a Participatory Welfare Assessment (PKP) where villagers identified the indicators determining community welfare. Table 34 shows how community members in the three villages rank the importance of various economic indicators. There are three social economic stratification levels: Suki'/tomakaka/Sugi (rich), Mala-mala (middle/simple life), and Mase-mase (poor). The majority of residents in all three villages are classified as Mala-mala.

Table 34. Participatory Assessment Community Ranking of Welfare Indicators

Ranking	Kalumpang	Keang	Lumikka
1	transportation	house	job
2	house	household supplies	income
3	household supplies	job	transportation
4	stature in community	income	education
5	job	garden	stature in community
6	education	field	
7	loan	education	
8		livestock	
9		electricity	
10		transportation	
11		stature in community	

Source: "Gender and Social Assessment". Cacao Green Prosperity Program in Mamuju District. Bogor Agricultural University. October 2013.

Additionally, an IPB team visited several villages in Mamasa as a part of a sustainable land use and natural resource management study. Masos village in Bambang subdistrict has a yield of 300-500 kg/ha and DatuBaringin in Pana subdistrict has a yield of around 500 kg/ha [2]. Neither village prunes nor fertilizes and pricing in August 2013 was IDR 16,000-18,000/kg [2]. Overall yields and prices in the subdistricts of Bambang, Nosu, and Pana were between 500 and 750 kg/ha and IDR 17,000 to 18,000/kg. Both Bambang and Pana subdistricts have old cacao trees and both participated in the government's GERNAS program with each participant smallholder receiving 250 somatic embryogenesis seedlings to replace aged trees in 2012 (these seedling have had issues in the past, see section 2.3.1 of this report). Additionally budwood was provided for side-grafting in 2013 but IPB reports that the program is not running well due to a lack of training and mentoring in the field and poor condition of the budwood [2].

5.1.1 USAID e-MITRA Project

USAID's mobile phone project e-MITRA conducted a survey of finical habits of 700 Sulawesi cacao smallholders [4].The main income activity of those surveyed is selling cocoa beans and about 70% earn additional income from other agricultural activities such as rice. A small minority derive income from other activities including buying and selling cocoa and fish, working at a shop, construction, motorcycle taxi, mining, and non-cacao agricultural labor. There are risks for both smallholders and collectors traveling with cash during peak harvest which could be reduced by the use of mobile financial services. Selling as a farmer group is less common but sales value is typically over IDR 5 million and is paid by a bank transfer to the group leader. Smallholders may be able to obtain a better price by selling through a farmers group as it enables them to collectively bargain for the best price and deal directly with global trade groups. Excerpts of social data gathered from the survey of 700 cacao smallholders are available in Table 35.

Table 35. e-MITRA Survey Results

Education
o 21% little or no formal education o 36% primary school o 20% secondary school o 3% university
Household Data
o Average household size is 4.5 people o 60% hold land certificate(s) o Mobile phones: 67% of cacao farmers and 79% of cacao households have mobile phones - 90% of these farmers use mobile phones to send and receive text messages - 21% of the mobile phones can access the internet but it was usually the children - Cacao prices are sent by text - Minutes are purchased at local kiosk with average of IDR 50,000 per month or less - All use government owned Telkosel due to coverage in Sulawesi - 65% of cacao farmers view potential mobile phone financial services favorably
Income
o A typical farmers sells cocoa beans between 13 and 24 times per year o 51% of farmers reported an average cocoa bean sale of IDR 500,000 o 25% of farmers negotiate cocoa bean price with the buyer o 98% of cocoa bean sales are cash o 81% of farmers sell to local collectors/traders o 69% of cacao farmers earn income from other activities such as rice farms o Income for agricultural products or labor is 97% paid in cash o Approximately 25% have sent money to family within or outside Indonesia either once per month or year with average transaction value of IDR 500,000 usually sent through the post office o Few farmers reported receiving money from relatives
Savings
o 46% of farmers reported having savings - 56% keep savings at home for ease of access to pay for daily living expenses and bills - 54% of have bank accounts for savings
Credit
o 36% have borrowed money with half using the money for cacao farm costs o Loan source: 25% government programs; 24% from banks; 18% from cocoa bean collectors
Bill Payment
o 67% pay bills out of their home to collectors; the remainder pay them to the village chief or local service provider office o Bill payments are 97% cash o The convenience of paying from home adds a fee of IDR 1,000 to 2,000 per bill o Bills are dominated by food and other daily essentials (82%), education (33%) and agricultural inputs (28%); the remainder is loan repayment (5%) and electricity (4%) o Electricity bills range between IDR 20,000 to 50,000 per month o Few farmers have government water access; those who do pay IDR 20,000 to 25,000 per month

Source: "Market Insights into the Financial Behaviors and Design of Mobile Financial Services Products for Cacao Farmers in Indonesia". e-MITRA. USAID. May 2013.

Figure 43 highlights the reasons cacao smallholder save money with a strong emphasis on education for their children followed by farm costs and daily needs such as food cost. Little money is spent on revitalizing cacao trees, which is essential to increasing production and income. While most savings is in cash, some women keep savings as gold since it can be easily used as collateral for a loan. Figure 44 highlights sources of income besides cocoa bean sales.

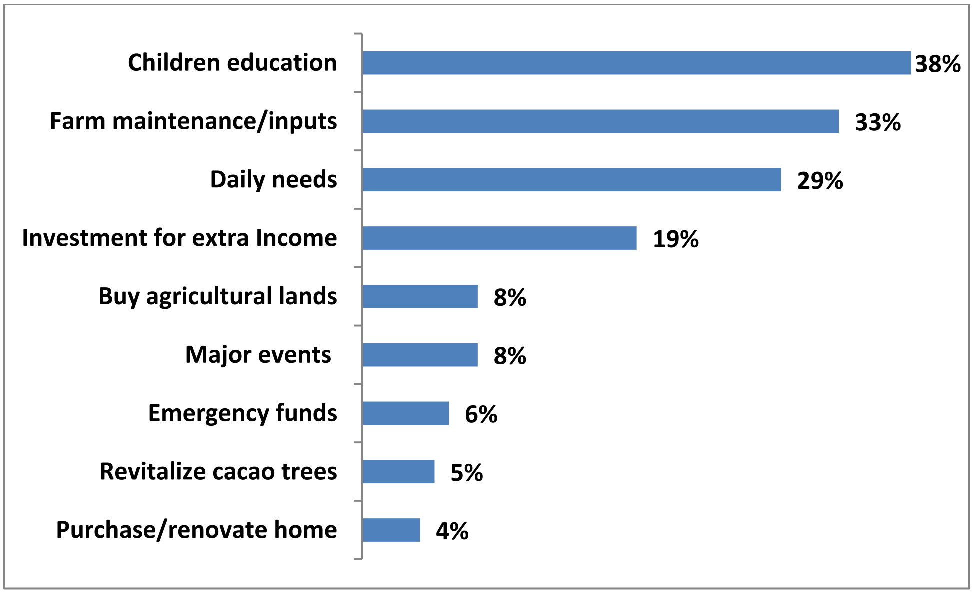

Figure 43. Reasons cacao smallholders save

Source: "Market Insights into the Financial Behaviors and Design of Mobile Financial Services Products for Cacao Farmers in Indonesia". e-MITRA. USAID. May 2013.

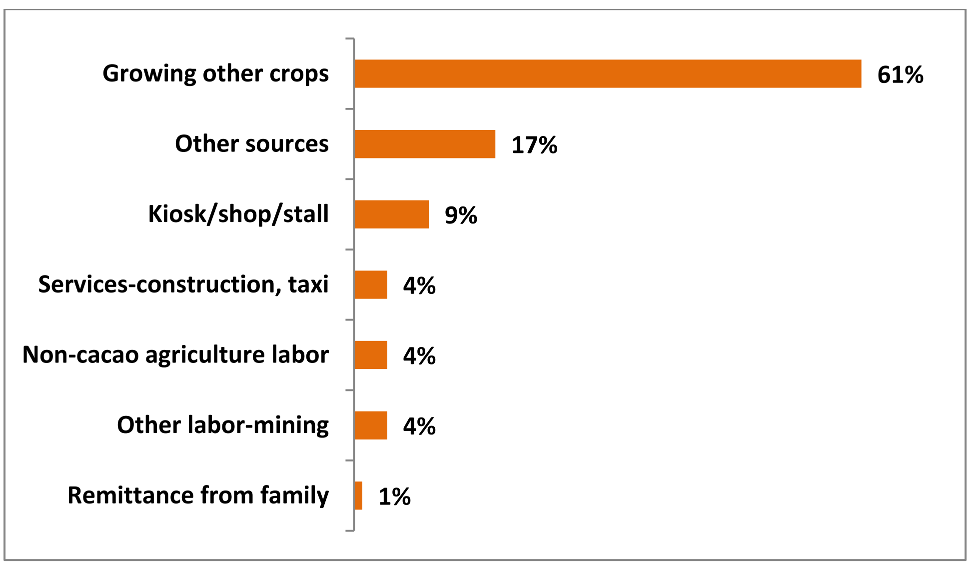

Figure 44. Other sources of income

Source: "Market Insights into the Financial Behaviors and Design of Mobile Financial Services Products for Cacao Farmers in Indonesia". e-MITRA. USAID. May 2013.

5.1.2 Role of Gender in Cacao

Both men and women have agricultural responsibilities in the three study villages as shown in Table 36. Men and women work in the agriculture fields and in rice men plow and women harvest and weed. In Keang and Kalumpang, women harvest, dry, and sell cocoa beans. During NRELs site visits in June 2013, most cacao farm work was done by men while women handled the household finances. Women in cacao doctor households tend to help with the nursery by gathering mud or dirt and maintaining seedlings as they grow. In a household with livestock, men handle larger livestock such as cows and women are responsible for smaller livestock such as chicken. In coffee, division of labor between men and women is similar to cacao. Women also have off-farm economic activities by selling a variety of cookies made from local raw and sewing clothes.

All household activities are dominated by women including cooking, washing, ironing, raising children, clothing, and cleaning. In social situations, both men and women attend devotions, celebrations, and custom meetings. Typically only men are included in village and farmer group meetings while women attend children health meetings. Due to women managing household finances, both men and women have equal access to credit/lending. Men and women's access to resources is available in Table 37. Decisions on selling crops and buying new agriculture land are made jointly by men and women (Table 38).

Table 36. Division of Labor

Activity	**Division of labor and Responsibilities (Dominant)**		
	Men	Women	Together
Rice in dryland			x
Rice field			x
Traders	x		
Milling businessman	x		
Shop/ Kiosk groceries		x	
Reproductive activity		x	
Social activity			x
Cacao Activities			
Field preparation	x		
Land processing	x		
Nurseries			x
Planting			x
Planting shade trees	x		
Pruning	x		
Harvesting			x

Source: "Gender and Social Assessment". Cacao Green Prosperity Program in Mamuju District. Bogor Agricultural University. October 2013.

Table 37. Access to Resources

Resources	Access (Dominant)		
	Men	Women	Together
Cacao land	x		
Dryland			x
Rice field		x	
Labor (cooperation)			x
Seeds		x	
Training and counseling	x		
Farmer groups	x		
Social organization			x
Kinship organization			x
Income		x	
Credit			x

Source: "Gender and Social Assessment". Cacao Green Prosperity Program in Mamuju District. Bogor Agricultural University. October 2013.

Table 38. Decision and Gender

Issue	Decision-Maker		
	Men	Women	Together
Land inheritance			x
Buy new land			x
Activities in garden	x		
Activities in dryland			x
Activities in rice fields		x	
Labor (group)			x
Seeds			x
Training and counseling	x		
Farmer groups	x		
Social organization			x
Kinship organization			x
Marketing			x
Income used		x	
Obtaining credit			x

Source: "Gender and Social Assessment". Cacao Green Prosperity Program in Mamuju District. Bogor Agricultural University. October 2013.

A separate report on sustainable land use and natural resource management in Mamasa identified the sources of income for both men and women. Nearly 70% of men and over 70% of women earn income from agriculture [2]. Women derive more income than men in the trade, hotel, and restaurant category.

Table 39. Mamasa Income Source by Gender

Income Source	Men	Women	Total
Agriculture, forestry	70%	73%	71%
Services	16%	14%	15%
Trade, hotel, restaurant	5%	9%	7%
Other	9%	2%	6%
Processing industry	1%	1%	1%

Source: "Natural Resource Management and Sustainable Land Use: Mamasa District, West Sulawesi". Prepared for NREL by Bogor Agricultural University (IPB). November 2013.

MCC requires that Green Prosperity projects adhere to the IFC Performance Standards. These standards support a process to ensure that any project is exercising due diligence of social risks from start to finish. While IFC performance standards somewhat blend environmental and social performance standards, the table below references those performance standards closely aligned with social risks (Table 40).[49]

Table 40. IFC Social Performance Standards

IFC Performance Standard	Description
Performance Standard 1: Assessment and Management of Environmental and Social Risks	Describes the importance of identifying environmental and social risks and impacts, and managing environmental and social risks throughout the life of a project. This standard applies to all projects.
Performance Standard 2: Labor and Working Conditions	Recognizes that the rights of workers should be protected during the pursuit of economic growth through employment creation and income generation.
Performance Standard 4: Community Health and Safety	Recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. Also recognized is that climate change may be accelerated and/or intensified due to project activities.
Performance Standard 5: Land Acquisition and Involuntary Resettlement	Recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers to both physical displacement and to economic displacement.
Performance Standard 7: Indigenous Peoples	Recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population.
Performance Standard 8: Cultural Heritage	Recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this standard focuses on protection of cultural heritage.

49 Refer to section 4: Environmental and Spatial Land Use Assessment for environmental performance standards.

5.1.3 Results from Impact Assessment

Improving the yield of cacao trees would lead to greater incomes for smallholders. How they would spend this money cannot be predicted, however, data in Section 5.1.1 suggests it would be spent on education expenses for children, daily food/essential costs, and agricultural inputs. It is possible that smallholders would spend money earned from cocoa bean sales on rice farms since many reported owning or working nearby rice land. There would be more labor required to improve yield as diseased pods would need to be buried, trees would require pruning, and grafting and replacement of trees, and application of fertilizer and/or pesticide are all time consuming activities. How much additional time these activities would require is a function of how much or how little a smallholder is currently caring for their trees. Mars estimates maintenance of a hectare at 47 labor days and harvesting of 34 labor days. There would be additional costs for agricultural inputs including seedlings, budwood for grafting, and additional costs for smallholders who apply fertilizer and pesticide.

Cacao households would further develop knowledge of understanding impacts on their cacao farms and how to better manage the farms and the quality of resulting cocoa beans through farmer field schools. Cocoa doctors have a greater opportunity to be community leaders and earn high incomes after applying the knowledge they learned in CDC and sharing that knowledge with other cacao smallholders and supplying them with inputs from a nursery and other services.

The IPB Mamuju Natural Resource Management and Sustainable Land Use and Gender and Social Assessment studies found that cacao smallholders need mentoring to improve their cacao farms and greater open access to markets. There is an opportunity to engage women labor-based groups in cacao farming and improvements. Recommendations for this project include

- Training, capacity building, and mentoring through FFS are recommended by the IPB study teams. It is important to improve awareness of the equal participation between men and women during the meeting in the hamlet and village levels. Designing programs that suit the different needs of men and women is also important.
- The availability and use of high quality seedlings and development of nurseries to grow the seedlings is important to improve production.
- Rejuvenation of abandoned cocoa farms that have not been well maintained through side grafting and replanting.
- Access to infrastructure is an important factor to promote the progress and economic activities of the villages in Mamuju.
- Programs should be made through the consultation mechanism at the village levels that should be attended by all citizens (men and women).
- Develop cooperation among organizations, local government, and local religious leaders to strengthen implementation of the program.

5.2 Community Engagement Plan

The training project of FFS and CDC are community projects. The project sponsor would need to work with the local government, local collectors/traders, and agriculture extension officers to identify communities needing and wanting training and further finding leadership candidates to attend CDCs. The project sponsor would need to determine where FFS have already been held as to not repeat training to an existing group. The project needs to establish timing of FFS with community members on when it would work best for optimal attendance by smallholder households. The project would need to determine with local organizations the best methods to include women in FFS training as well as other marginalized groups. Past cacao training programs have had success in meeting their goal of at least 20% participation in FFS by women which could be increased and also focus the additional nutrition and vegetable garden management training for women in cacao households. The project should set requirements at the beginning for participation by gender and marginalized groups in order to gain higher participation rates.

5.3 Impact on Local Labor, Goods, and Services

The project would result in the need for more trainers and agronomists to teach FFS and CDC. It is assumed that trainers for FFS would be available from local communities such as staff from agricultural extension offices and local cocoa bean collectors and traders. It is important to have trainers who live and work in the targeted areas of Sulawesi because they would be able to pass on knowledge after the donor project is complete. Cocoa industry project sponsors are expected to use their agronomists to staff CDCs.

Since it is a training program, the impact on local goods and services are minimal. Cocoa doctors trained at CDCs would benefit from selling inputs and services to area smallholders but it would take time for them to realize profits as they develop their nurseries and budwood gardens. KUD may see an increase in agricultural input sales, especially fertilizer and pesticide, for those trainees who decide to use these products.

5.4 Mitigation Plan for Identified Social/Gender Risks

Past FFS for Indonesian cacao smallholders have targeted and achieved 20% participation by women. The interventions taught in FFS tend to focus more heavily on work done by men (pruning, side-grafting, planting quality seedlings, fertilizer, pesticide, and fermentation); however, women working on cacao farms are responsible for phytosanitation and planting seedlings. It would be important to ensure that FFS are available across targeted districts for participation by farmers groups from different ethnic and religious backgrounds. The project sponsor would need to engage a variety of local government and village leaders to ensure that all groups have equal access to training. Additionally, FFS should be available to all who labor in cacao farms, not just land owners which has been a requirement in past FFS. CDCs would train the most motivated cacao smallholders and its intensive nature would likely mean participation in the training of smallholders from different ethnic and religious backgrounds. Some farmer groups may be weary of training if they experienced issues with seedlings from the GERNAS program. Other villages might have a high proportion of abandoned cacao farms and it would take more upfront interaction to determine if smallholders are interested in FFS training to restore their cacao lands.

There is the obvious risk that smallholders could attend FFS training and expend lots of labor on interventions and not realize yield due to climatic conditions such as floods or draught which is risk to all agriculture projects. Despite receiving training, smallholders may decide that other crops or economic activities provide a better income opportunity.

5.4.1 Monitoring and Evaluation Plan Ensuring Social/Gender Equity

The project sponsor needs to develop an effective ESMS that would establish a process between the project owner, staff, and communities where training would take place [54]. The project should evaluate farmer groups in the months and years after training to establish if FFS taught interventions are being adopted and the impacts on production and income. Early monitoring may help to identify areas of training that could be enhanced to improve smallholders understanding of the intervention and how to implement it. The project should be monitored to ensure that farmers groups of different ethnic and religious backgrounds are receiving equal access to training as well as ensuring that women are attending FFS too. The ESMS would define the relationships and responsibilities of all parties involved in the project. The project sponsor must establish an official method for villages to communicate issues with the project both as it develops and is operational. The ESMS would also determine an effective way to communicate how these issues are being resolved. Representatives from area communities should be a part of the monitoring and evaluating benefits over the life of the project.

5.4.2 Suggested Next Steps

The next steps toward project implementation could begin with discussion of a path forward involving all stakeholders, including cocoa industry sponsors, local government and agriculture extension offices in the targeted districts, and local cocoa bean collectors/traders.

This report may inform discussions leading to such a consensus. The following steps should be considered in moving toward a successful project:

1. Project Identification and Planning:
    - Develop the full description of the project.
    - Summarize any issues that could impair the feasibility of the project.
    - Describe the proposed financial structure for the project.
    - Provide details of the proposed project team, any additional assistance that would be needed, and documentation needed to complete the project team. Form any legal entities needed for the project team.
    - Determine locations for CDCs; enter into long-term contract with land-owner.
    - Determine if any permits and licenses are needed and the status of securing each.
    - Develop a project schedule for timing of training FFS facilitators and agroeconomists as well as timing and locations of FFS and CDC activities.
    - Ensure that all project risks are identified, analyzed in detail, and mitigation plans are developed.
    - Review existing cacao FFS training materials and determine if there are any gaps or need to update the materials.
2. Economic Plan:
    - Update and refine the economic model with new information from the full feasibility study, including proof of proposed costs and revenues and strong evidence (such as local surveys) for benefit streams.

- Provide separate plans for monitoring and managing variables that affect economic return.
- Refine the long-term economic risk assessment with updated and more complete data, with a mitigation plan that addresses the economic risks identified.

3. Environmental Plan:
   - Work with cocoa and agriculture industries to further quantify environmental effects of agricultural intensification.
   - Conduct the public consultations and scoping analysis required by IFC and others, if required, or develop the UKL-UPL.
   - Develop Terms of Reference for the environmental and social analyses.
   - Develop the Environmental Monitoring Efforts Reports, Environmental Impact Assessment, and Environmental Assessment Application to ensure compliance with Indonesian government regulations.
   - Comply with the requirements of the IFC's Performance Standards.
   - Document that the communities impacted by the project plan support the proposed environmental plans.
   - Refine the GHG impact analyses with more complete and up-to-date information.
4. Social and Gender Plan:
   - Provide more quantitative detail for project impacts on women, minorities, and other vulnerable groups; land use and community resources; and the local/community economy in terms of job creation, business development, and new supply chains.
   - Action plan to engage women in empowerment activities in the project.
   - Complete stakeholder consultations, and document community engagement, such as who has been engaged; their level of support; plans for further engagement, training, or methods for further behavioral change required; and strategy for continued consultations and community feedback during project implementation.
   - Develop lists of agreements, contracts, and other details that prove the benefits to local stakeholders.
   - Refine the long-term social risk assessment with updated and more complete data and mitigation strategies for any negative impacts on the community, such as job training, small business startup funds, etc.

5.4.3 Potential Complementary Activity

Past FFS have offered optional nutrition and vegetable garden training as a one or two day training after the FFS is complete. The training is targeted towards women since they typically prepare meals and work in their household vegetable and fruit garden. This activity would require additional training for FFS facilitators and funding to pay them for the additional training days.

6 Conclusions

Cacao smallholders are suffering economic hardship due to declines in their productivity over the past several years, and this project could help to sustain and grow an existing cash commodity that not only supports an estimated one million smallholders, but also many downstream marketing and manufacturing jobs. Opportunities for using their land for other crops are somewhat limited as rice requires irrigation, oil palm requires proximity to a palm mill, coffee grows optimally at higher elevations, and crops like corn or potatoes are unlikely to provide a higher income. The interventions to improve yield are well known, but even smallholders aware of these techniques may not have the knowledge of how and when to apply the interventions. FFSs explain the reasons for yields loss and teaches through classroom lessons and practice the interventions, which could improve production. Additionally, training cocoa doctors at CDCs provides an opportunity for greater income, extends the donor program to reach more smallholders and provides for expert knowledge to exist after the project ends. The cocoa doctors would operate for-profit businesses providing knowledge, training, services, and inputs to smallholders in their area. Both of these activities serve Green Prosperity's primary goal of reducing poverty, however, impacts on GHG emissions could be marginal or potentially negative and therefore must be assessed carefully in a full feasibility study since net GHG emissions reduction is a Compact requirement for NRM/SLU projects. Green Prosperity could have a solid sponsor with the participation of cacao industry stakeholders, supporting the project through funds and experienced staff. Certainly any agricultural project is subject to the risk of climatic conditions where smallholders could do all that is necessary to improve their yield only to have negative impacts of drought, floods, or other weather impacts.

This project evaluation is intended to provide helpful guidance to sponsors developing similar projects, and to evaluators of agriculture intensification proposals submitted to MCA-I in application for Green Prosperity funding.

Appendix A: Details of Economic Calculations and Modeling

Descriptor	Value	Unit	Distribution	Upper	Lower
Social Discount Rate (%)	10%	%			
National Inflation Rate (%)	4.00%	%/yr	Triangular	4.4%	3.6%
Exchange Rate (Rp/$)	11,212	Rp/$			
Average farm size	2	ha/farmer			
Total targeted farmers trained	60,000	farmers			
Total Targeted Cultivation Area (ha)	120,000	ha			
Medium-Yield Crop Variables					
CF Farmers	50,000	farmers			
CF Cultivation area	100,000	ha			
CF yield	562	kg/ha/yr	Triangular	750	500
CF yield change rate	0.0%	%/yr	Triangular	1%	-1%
CF Standard price per kg	18,000 Rp	per kg	Triangular	19,000	17,000
CF input costs	2,802,998 Rp	Rp/ha	Triangular	3,000,000	2,000,000
CF ongoing costs	2,802,998 Rp	Rp/ha/yr	Triangular	3,000,000	2,000,000
WP Farmers	50,000	farmers			
WP Cultivation area	100,000	ha			
WP yield	1,000	kg/ha	Triangular	1,100	900
WP yield change rate	1.0%	%/yr	Triangular	3.0%	1.0%
WP Standard price per kg	18,000 Rp	per kg			
WP standard input costs	3,520,000 Rp	Rp/ha	Triangular	4,200,000	3,000,000
WP ongoing GAP costs	3,223,447 Rp	Rp/ha/yr	Triangular	3,500,000	2,500,000
High-Yield Crop Variables					
CF Farmers	10,000	farmers			
CF Cultivation area	20,000	ha			
CF yield	562	kg/ha			
CF yield change rate	0.0%	%/yr			
CF price per kg	18,000 Rp	per kg			
CF input costs	2,802,998 Rp	Rp/ha			
CF ongoing costs	2,802,998 Rp	Rp/ha/yr			
WP Farmers	10,000	farmers			
WP Cultivation area	20,000	ha			
WP yield	2,000	kg/ha	Triangular	2,200	1,800
WP yield change rate	1.0%	%/yr	Triangular	3.0%	1.0%
WP price per kg	18,000 Rp	per kg			
WP standard input costs	5,306,560	Rp/ha	Triangular	6,000,000	5,000,000
WP ongoing GAP costs	7,240,471	Rp/ha/yr	Triangular	8,000,000	6,500,000

Appendix B: IPB Supporting Agriculture Data

Table B-1. Agricultural Activity Calendars in Three Village Study Site

Month	Agriculture and Plantation commodity												Information
	Rice field			Rice in dryland			Corn			Vegetables			
	Kalumpang	Lumika	Keang	Kalumpang	Lumika	Keang	Kalumpang	Lumika	Keang	Kalumpang	Lumika	Keang	
January	Growing season II	Growing season		Growing season					2-3 times/year				Rainy season
February			Harvest season I										
March		Harvest season		Harvest season	Harvest season	Harvest season							
April	Harvest season II												
May			Growing season II										
June													
July													Dry season
August			Musim Panen II	Season to work	Season to work	Season to work							
September	Growing season I							Growing season			Growing season	Growing season	Rainy season
October			Growing season I		Growing season Growing season	Growing season Growing season	Growing season Growing season			Growing season			
November				Growing season									
December	Harvest season I	Growing season					Harvest season	Harvest season		Harvest season	Harvest season	Harvest season	

Table B-2. Agriculture/Plantation Commodities in Three Village Study Site

Month	Agriculture/Plantation commodities														
	Rice in dryland/garden			Corn in dryland/garden			Cassava/Bean in dryland			Rice field			Cocoa		
	Kalumpang	Lumika	Keang	Kalumpang	Lumika	Keang	Kalumpang	Lumika	Keang	Kalumpang	Lumika	Keang	Kalum-pang	Lumika	Keang
January										Growing season II					
February			Harvest season			Harvest season						Harvest season I			
March	Harvest season	Harvest season	Harvest season			Growing season					Harvest season				
April	Harvest season			Growing season	Growing season					Harvest season II			Harvest	Harvest	Harvest
May						Harvest season						Musim Tanam II	Harvest	Harvest	Harvest
June				Harvest season	Harvest season	Growing season									Harvest
July															
August	Cut down	Cut down	Growing season			Harvest season					Lahan Tidur	Harvest season II			
September	Cut down	Cut down	Growing season	Growing season	Growing season	Growing season	Growing season	Growing season	Growing season	Growing season I					Harvest
October	Cut down	Growing season	Growing season										Harvest	Harvest	Harvest
November	Growing season					Harvest season						Growing season I	Harvest	Harvest	Harvest
December	Growing season			Harvest season	Harvest season	Musim Tanam	Harvest season	Harvest season	Harvest season	Harvest season I	Growing season				

Calendar Season in 3 (Three) Village

Table B-3. Kalumpang Village

Month	Wet season						Dry season		Wet season			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Dryland :												
1. Rice	Growing season		Harvest season					Preparing			Growing season	
2. Corn										Growing season		Harvest season
3. Vegetables										Growing season		Harvest season
Rice field	Growing season II			Harvest season II					Growing season I			Harvest season I
Cocoa	Harvest frequently			Harvest	Harvest frequently							

Table B-4. Lumika Village

Month	Wet season						Dry season		Wet season			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Dryland :												
1. Rice	**Growing season**		Harvest season					Cut down		Growing season		
2. Corn									Growing season			**Harvest season**
3. Vegetables									Growing season			**Harvest season**
Rice field			Harvest season II							Season to work		**Growing season**
Cocoa	Few yield can be harvest anytime											

Table B-5. Keang Village

Month	Wet season							Dry season				Wet season
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1. Rice planted in dryland	Growing season		Harvest season					Cut down		Growing season		
2. Corn	All season can be grow and harvest (2-3 times growing season/year)											
Rice field									Growing season			Harvest season
Cocoa				Harvest					Small harvest			
Collect rattan												

References

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