Evaluation of the One Acre Fund Rwanda tree program impact

Technical proposal prepared for One Acre Fund

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laterite
DATA | RESEARCH | ANALYTICS

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1 Laterite as a research partner

1.1 About Laterite

Laterite is an East African firm specialized in research for social impact. We provide full-service data collection and research services, including technical advice on the design and implementation of research projects, development interventions and socio-economic policies. We strive to carry out impactful research that helps decision-makers find solutions to complex development problems. Honed over more than ten years of experience in East Africa, our approach is structured, data intensive and embedded in the local context. Laterite has been in operation since 2010 and has offices in Rwanda, Ethiopia, Kenya, Tanzania, Uganda and the Netherlands. Our team consists of over 80 full-time researchers and data experts, based primarily in East Africa, and a roster of over 1,800 trained local enumerators across the countries where we work. Learn more at www.laterite.com.

1.2 Our value proposition

10+ years' experience in the design and implementation of research focusing on agricultural programs in East Africa – including One Acre Fund's tree program in Kenya. Laterite was established in Rwanda in 2010 and has since expanded across the region. Kigali is our largest office, with 25 full-time team members working in our research, data quality, program, and data teams. Laterite has significant experience in the design and implementation of a range of projects in the agriculture sector in East Africa. These range from large impact evaluations of coffee agronomy training and tree planting programs (such as our work for One Acre Fund in Kenya); to innovative projects such as asset transfer programs to encourage coffee farmers to adopt the good agricultural practice of stumping; to monitoring and data collection for agricultural programs; to yield measurement studies.

Proven track record implementing large-scale surveys to the highest possible quality across East Africa. Along with our experience designing research projects such as impact evaluations, Laterite has significant experience carrying out the data collection components of large-scale research projects in East Africa. Our Data Team provides all required infrastructure, logistics and management oversight to conduct large-scale quantitative and qualitative surveys. We can also advise on data collection protocols to ensure the highest possible data quality. Examples of relevant successfully completed projects are below.

Examples of relevant projects
Impact evaluation of 1AF's grevillea tree program in Kenya (1AF, 2018-21). The RCT included quantitative interviews with 925 treatment and 925 control farmers with a baseline, midline and endline survey. The study measured the impact of 1AF's Tree Program on i) uptake of tree planting activities, ii) survival rates of planted trees, iii) perceptions and attitudes towards tree planting and iv) financial value of grevillea tree assets. The study also investigated the opportunity costs of planting trees in terms of time and labor spent on other income generating activities. The RCT also included focus group discussions with farmers and key informant interviews with field officers to give a nuanced picture of attitudes and perceptions to tree-planting and tree-use in study communities. Further, Laterite carried out a market study, including interviews with tree traders, to establish prices of Grevillea trees in the study areas. Due to the COVID-19

pandemic, the quantitative component to interview 1,730 farmers was dropped at endline and the tree trader sample was reduced to 150 traders. Read the endline report
Tools for stumping (HereWeGrow, 2019-20). A mixed-methods study to assess the effect of incentivization on the uptake of coffee farming best practices (stumping of coffee trees) among 1,500 treatment and 1,500 control smallholder farmer households in Ethiopia. Read the blog
M&E contractor for the REALMS project (SNV, 2021-ongoing). Laterite acts as monitoring and evaluation (M&E) contractor to manage and deliver the monitoring, evaluation and learning function of the REgenerative Agricultural practices for improved Livelihoods and MarketS (REALMS) project, which aims to create conditions for successful adoption of regenerative agricultural practices in Western Kenya and Western Rwanda. Our work includes developing a learning agenda, preparing quarterly monitoring reports and conducting an evaluation (baseline & endline).
Long-term learning partner for TechnoServe's coffee East Africa initiative (TechnoServe, 2016-ongoing). Our team develops and supports the program's M&E and impact evaluation strategy. We also oversee all data collection efforts and lead data analysis to build greater opportunities for learning into TechnoServe's M&E systems. Our engagement includes: (i) Baseline and endline evaluations of TechnoServe's coffee agronomy program in several East African countries; (ii) Studies of farm support follow-up after coffee training programs have concluded; (iii) Annual sustainability audits of wetmills, hulling stations and farms; (iv) Studies of tree planting, to determine how many coffee trees have been distributed, planted, and survived; (v) Secondary data analysis, and; (vi) Measuring yield and best practice implementation in Uganda, Kenya, Ethiopia, DRC and Zimbabwe.
RCT evaluation of two additional support programs (Farm Support and Farm Ambassador) offered to farmers after the conclusion of the TechnoServe Coffee Farm College (HereWeGrow, 2021-22). The Coffee Farm College (CFC) for the Herz 2019 Cohort in Ethiopia was completed after pruning and rejuvenation training was delivered to the 11 Post-CFC control kebeles in February and March 2021. We conducted a program evaluation to understand the additional impact of post-CFC interventions compared to delivering CFC on stumping and composting only in the short term; the additional impact of post-CFC intervention compared to only delivering CFC on coffee best practices in the longer-term (~1 year). Report shared separately.

Strong team of economists, academics, and data professionals with expertise across the research cycle. Laterite's research team works with clients to draw key insights for policy- and decision-making from data. We strive to innovate and ensure that our research is fit for purpose, timely and useful for our clients. Collecting high-quality data and using statistically rigorous analysis techniques, Laterite assesses progress towards key outcomes and program impacts, both among participants and individuals benefiting indirectly. We have experience in carrying out rigorous experiments, quasi-experimental approaches, tracer studies, and process evaluations for clients such as One Acre Fund (1AF), the World Bank, IFPRI, TechnoServe, the Global Green Growth Institute, the Mastercard Foundation and more. The proposed team for this project hold degrees from top universities in international development research, economics, and econometrics. Our team includes experts in research design (including from our in-house Economist Team) and data analysis, informed by a deep understanding of the context and theme of the study. See below for our proposed team and Annex 1 for their CVs.

1.3 Proposed team

A short description of the roles of our proposed team for this assignment is included below. Full biographies of team members can be found in their CVs (Annex 1).

Team member	Proposed role

Rachel Proefke, Country Director Rwanda	Provide project oversight and financial management support, in line with her role leading the design and implementation of research projects and country operations in Rwanda.
Judith Bayer, Research Associate	Project coordinator, providing day to day project management and technical leadership. Lead on study design, sampling strategy, survey instruments development, and the data analysis
José Rubio Valverde, Associate Economist	Technical backstopping on all technical aspect of the project.
Amani Ntakirutimana, Country Data Manager	Lead all data collection activities, including planning field operations, enumerator training, and day to day supervision of data collection staff.
Denis Kamugisha, Data Quality Manager	Lead data quality team, supervising the implementation of our data quality processes and ensuring high quality survey instruments, timely data quality monitoring, and high quality final data sets.

In addition to our core staff roles, the evaluation will draw on the support of trained and experienced teams of enumerators, drawn from our active enumerator base of 400+ enumerators in Rwanda.

1.4 Our focus on data quality

Laterite takes every possible step to ensure that the data we collect and report for our research projects is of the highest quality, because research is only as good as the data it is based on. Laterite's relentless focus on data quality beings with hiring a strong team of enumerators, and is an integral part of our approach to research design, data quality monitoring during data collection, and transparent data cleaning and analysis.

Hiring and training enumerators

Our dedicated full-time Data team leads hiring, training and supervision of enumeration teams for data collection activities. Our Country Data Manager in Rwanda has more than ten years of experience leading data collection teams in the country, and is supported by a network of Data Managers, Data Operations Associates and Senior Field Supervisors who ensure data collection is carried out to the highest standard.

This starts with a thorough recruitment process to our enumerator pool. Our enumerator teams are selected through a competitive process with minimum criteria set at: fluency in at least one local language as well as English and a university degree. The recruitment process to join our enumerator pool includes the following steps:

- An online logic and attitudes test. Candidates complete an online test with random combinations of questions that test their logical reasoning aptitudes and test their attitudes under certain scenarios. Candidates who score above 80% are selected for the next round.
- A short essay in English. During the online test, candidates are also asked to complete a short essay in English. If they scored above 80% on the test, their short English essay is graded to assess: (i) their ability to write in a structured and logical way; and (ii) their level of English. Successful candidates are invited to an interview with a Laterite staff member.

- In-person interview. The interview is divided into two parts: (i) a discussion around the candidate's responses to open-ended questions; and (ii) a mock-interview, during which the candidate interviews one of our staff using quantitative or qualitative research instruments. They will also have to prove knowledge of some of the local languages used in the survey. Our objective is to assess the integrity and communication capabilities of the candidate. Candidates who pass the interview are included in Laterite's enumerator roster.

Field teams are regularly trained by Laterite to ensure that they have excellent knowledge of field and interview procedures, including ethics standards. Our tried and tested training curriculum comprises the following modules:

- **Introduction** to the project and its research objectives.
- **Research methodology and sampling strategy**. To perform, it is important that the enumerator team understands the research methodology and the sampling strategy. This part of the training explains how the study is set up and the logic of the design; the sampling strategy and how participants are selected; and a discussion about the replacement strategy and its importance.
- **Field team structure and responsibilities**. Everyone on the team needs to have a clear understanding of their roles and responsibilities. This module focuses on: (i) the mission and objectives of the field team; (ii) the team structure, composition and responsibilities; (iii) the structure of the field plan; and (iv) reporting systems and requirements.
- **Professional and research ethics**. Ethics is paramount in all research projects. This section covers: (i) the general professional ethics that the field team should abide by; (ii) the rights of study participants; (iii) research ethics and etiquette; and (iv) what to do if an adverse event arises, including events related to COVID-19.
- **Logistics**. This module focuses on procedures for: (i) the safekeeping of field materials such as tablets, chargers, power banks, extension cords, consent forms; and (ii) accounting processes in terms of the tracking and reporting of fieldwork expenses.
- **Contracts**. Enumerators need to understand the terms of their contracts and what they are signing up to. During this module, we explain: the structure of the contract and contract duration; payment modalities; performance expectations and the importance of integrity; and why we ask that enumerators provide evidence of personal health insurance coverage.
- **Survey instruments**. This module takes most of the training time and combines an overview of the research instruments with a deep dive into the logic of individual survey questions. During this module we focus on the logic of the questionnaire and on potential risks and biases. We alternate theoretical explanations and exercises in which trainees practice the questionnaire with each other and can clarify their doubts concerning any survey questions. We also train enumerators on our COVID-19

protocols, including requirements to administer health screening surveys to respondents, provide masks to respondents, and practice social distancing.

- **Quizzes** to ensure that enumerators understand the training material and are not going to the field unprepared. Performance on the quiz determines whether enumerators will be included in the team or not, whether they will enter the team as alternates, and whether they qualify to be field coordinators.
- **Feedback**. We ask the field team to provide feedback on: (i) how easy survey questions are to understand and their relevance to the local context; (ii) the quality of the translation into local language; as well as (iii) faulty logic in the coding of the survey.

The performance of each individual enumerator is tracked, project by project, to ensure that we can provide constructive feedback and monitor the performance of our teams. We put a special emphasis on quality at each step of the surveying process and the following steps to ensure that the data collection effort runs smoothly:

- Daily briefings for enumerators. We brief the survey team at the start & end of every data collection day. We provide personalized feedback to the enumerators so that mistakes from the previous day are corrected.
- Effective communication structures. The team is structured hierarchically to ensure proper supervision, but also effective communication.
- Ongoing feedback. Throughout the survey period, we may also seek feedback from the field teams through targeted SurveyCTO or SMS-based surveys. These surveys enable us to monitor the morale and satisfaction of the survey teams. The Field Supervisor will supervise the quality of the study and ensure the survey is being administered in the same way by different enumerators.

For this study, we will prioritize enumerators who have previous experience in the study locations and with agricultural data collection.

Field work management and supervision

Laterite puts a strong emphasis on quality control at each step of the surveying process to ensure that data collection runs smoothly. We take the following steps:

- **Ensuring enumerators have all the required documentation.** We do our best to ensure the survey team goes to the field well prepared. We provide enumerators with badges, a letter of recommendation stamped by the local authorities, and a daily communications allowance in case urgent issues arise that need to be communicated and discussed.
- **Morning briefing.** The Senior Field Supervisor briefs the survey team at the start of every day on the field plan for the day. They also provide personalized feedback to the data collectors so mistakes from the previous day are corrected.
- **End-of-day debriefing.** A debrief is conducted in the afternoon, after the completion of surveys for the day, which provides the opportunity for the field team to highlight

any issues and ensure that the data is uploaded from tablets onto the server. Issues that raise further questions will be logged and communicated to the project management team at 1AF.

- **Using effective communication structures.** The team is structured hierarchically to ensure proper supervision and effective communication. Field supervisors will make decisions when there is no ambiguity on the course of action to follow; more complex decisions will be communicated to Senior Field Supervisor. We will also have a team WhatsApp group to ensure smooth communication between the field team and that decisions that affect everyone are communicated effectively.
- **Ongoing feedback.** Field Supervisors accompany a different enumerator team every day to provide personalized feedback to enumerators, to observe that survey protocols are properly followed, and conduct back-checks. Field Supervisors will supervise the quality of the study and ensure the survey is being administered in the same way by different enumerators.
- **Reliable electronic data collection system.** Data collection with tablets in the field is not reliant on the internet or the server's availability. Laterite will provide enumerators airtime for internet to enable data to be uploaded from the tablets to the SurveyCTO server at least once a day.

In addition, Laterite proposes to conduct back-checks on 10% of the data. The back-check protocol (timing, rate of back-checks by enumerator, by team, etc.) will be agreed with the 1AF team at a later stage. Laterite also proposes an additional audio audit of 5% of the data to check on the performance and consistency of the enumerators.

Real time completion tracking and data quality checks

Laterite deploys monitoring dashboards on Google Sheets as a project management and quality control tool during data collection. These dashboards are integrated with SurveyCTO and are updated in real time as our field teams complete their survey work. The dashboard documents indicators such as the number of surveys completed, number of responses recorded and additional information such as completion rates, reasons for non-completion, or the duration of the interviews. This will allow a live stream of completed interview data for the 1AF team and Laterite to monitor. We use the dashboard to identify and rectify issues that occur during fieldwork in real-time, immediately communicating issues to field supervisors who can take corrective actions in the field in a timely manner.

The following figure is a screenshot of a monitoring dashboard prepared for a project on COVID-19-related perceptions and attitudes.

No. of complete interviews (with consent)	**1210**	
Survey Target	1326	
Survey Completion (%)	91%	
Households called	1327	100%
Households reached (who responded)	1210	91%

	Key outcomes		
		#	%
AWARENESS	Respondents that know about locusts	1201	99%
	Respondents that know about fall anyworm	1059	88%
PROTECTIVE MEASURES	1. Washed hands for 20 seconds or more with soap?	1204	100%
	2. Avoided large gatherings / long queues? (such as at church or at markets)	900	74%
	3. Kept at least 2 adult steps away from others	1118	92%
	4. Avoided public transportation	877	72%
	5. Avoided shaking hands or kissing on cheeks	1194	99%
	6. Avoided touching my face	1050	87%
	7. Used hand sanitizers / disinfectants	462	38%
	8. Worn face masks	790	65%
STRESS	Respondent's stresslevel on a scale from 1 (I am not stressed at all) to 10 (I am extremely stressed).	7.94	N/A
INCOME	Total HH income increased since the R1 interview	45	4%
	Total HH income stayed the same since the R1 interview	419	35%
	Total HH income decreased since from the R1 interview	760	63%
	Total loss of HH income since the R1 interview	6	0%
CROP DAMAGE	Crops have been damaged by desert locusts	148	12%
	Vegetation on grazing land has been reduced by desert locusts	105	9%
	Crops have been damaged by fall anyworms	534	44%

The dashboard will be shared with the 1AF team and allows real-time monitoring of the survey's progress. In addition, the data collection team will provide one weekly report using an agreed upon template.

The Research Associate and Data Quality Team will oversee quality control at each step of the survey process. Our standard operational procedure includes:

- **Daily monitoring of collected data using tailored algorithms to check for outliers and discrepancies.** The results will be logged into the monitoring dashboard and discussed with field coordinators to rectify issues during daily debriefing sessions. We check that all data merges as expected and provide full reports on any discrepancies (e.g., if an interviewee is replaced).
- **Back-checks**. A random subset of 5% of households with completed interviews will be interviewed again by a dedicated team for a short back-check survey (maximum 15 minutes). Respondents will be asked if they were interviewed by the Laterite team, and they will answer a set of questions that they compiled during data collection to identify any potential issues with the survey instrument or with specific enumerators. For the purposes of this evaluation, these back-checks will be completed by Field Coordinators in the field, instead of engaging a separate back-check team.
- **Random audio audits**. Laterite will use SurveyCTO to randomly record parts of an interview. Our data quality and audit team will check these audio recordings to ensure that: (i) randomly checked interviews actually took place; and (ii) enumerators were following proper interview procedures and asking questions with a respectful tone, without pushing the respondent or leading them towards a certain response.

Audio checks are tracked using a log, enabling proper follow-up and resolution. We will obtain recordings from a sample of 10% of random surveys for quality checks.

- **Tree picture audits.** For the purposes of this study, we would also find it useful to add in a tree picture audit to cross-check the data captured by enumerators. While in the field collected data on trees, we embed capturing pictures as evidence of the trees that are included in the data collection. Then, at the office, our data quality and audit team will look at the pictures that enumerators have captured to ensure that the tree species has been accurately identified and that the tree falls within the appropriate age range, as well as confirming other data points that can be observed from the tree picture. We will do this for a random sample of 10% of the tree surveys completed, aligned to the audio audits mentioned above.
- **Automated audit algorithms using meta-data**. During surveys, Laterite will collect meta-data on each survey, including the time it takes to complete questions and GPS data. We will use this data to identify unusual patterns or unusual locations. We do this using proprietary audit algorithms that report on a wide range of issues, including: the speed of completion of survey questions, long pauses between survey questions, rapid consecutive surveys, unusual enumerator movements from one survey to the next, late surveys, simultaneous surveys, unusual data patterns, etc. The regular audits also provide reports on the number of surveys completed per day, the number of hours worked per enumerator per day, the length of breaks taken by enumerators, etc. Suspicious cases are tracked and resolved using a structured log.

2 The 1AF tree program in Rwanda

2.1 Background

Founded in 2006, One Acre Fund (1AF) is a non-profit social enterprise dedicated to making smallholder farmers more productive and resilient. It is headquartered in the rural parts of nine African countries - Burundi, Kenya, Malawi, Rwanda, Tanzania, Uganda, Ethiopia, Nigeria, and Zambia. 1AF's 'core program' (direct service model) registers farmers in groups of typically 10-20 in size; it provides farm inputs (often fertilizer and seeds) on credit to farmers and local field officers; and deliver hands-on agricultural training and in-field follow-up on the basics of farming, such as seed spacing and composting.

1AF also launched an agroforestry platform ten years ago, and as of 2021, supports 1.9 million farmers in planting ~40 million trees each year.

- Production: 1AF cultivates seedlings at scale, through centralized nurseries and a network of trained micro-nursery entrepreneurs.
- Distribution: Seedlings are delivered by truck to farmers, or they walk to their local nursery.
- Training: Farmers receive training on seedling planting and care. Trainers highlight the strong economics and environmental benefits trees can have on farmers' livelihood and promote annual tree planting.

1AF believes that smallholder agroforestry is one of the most powerful and cost-effective tools in humanity's anti-poverty arsenal. Farm-level timber tree-planting, especially when integrated with soil improver species, offers Africa's rural households high financial and environmental returns, at low farmer and donor cost. The goal of the agroforestry program is to generate economic returns for farmers from each of these incremental trees, through farmers' own use or the sale of tree products such as timber, firewood, or bean poles. In addition, tree planting has environmental benefits, though these are not modeled as a core outcome of the program.

2.2 1AF tree program in Rwanda

In Rwanda, the 1AF tree program provides 1.4 million farmers with tree seedlings. 1AF has a *whole market* approach to the tree distribution, and more than half of eligible households in each district usually receive the trees. In 2023, around 90% of the program will be designed as a *decentralized nursery model*, in which one single nursery will be set up in a central location in a cell (smallest administrative unit in Rwanda). A nursery manager from the community will nurture the seeds until the seedling stage and will be paid a unit sum for each healthy tree seedling produced. Around three months after planting, farmers of each cell will come to the nursery to pick up the seedlings for free.

Under this program, farmers are offered a combination of three different species among the following: Grevillea, Maesopsis, Alnus, Polscia, Prunus, Newtonia, Carapa, Senna, Cedrella, Calliandra, Leucaena, Markhamia, Jacaranda and Croton. The set of species offered is determined according to the suitability in their Agro-Ecological Zones (AEZ) and the government's priorities in each area.

Figure 1. Summary of 1AF's agroforestry model

Production: We cultivate seedlings at scale, through centralized nurseries and a network of trained micro-nursery entrepreneurs.

Distribution: Seedlings are either delivered by truck to rural villages or farmers simply walk to their local micro-nursery.

Training: Farmers receive trainings on seedling planting and care. Trainers highlight the strong economic and environmental benefits trees can have on farmers' livelihoods, and promote the habit of annual planting.

Stewardship: One Acre Fund follows up with farmers to evaluate survival and growth. Trees are eventually sold as timber; meanwhile, farmers are trained on replanting and sustainable agroforestry.

3 Study design

We propose a cluster randomized controlled trial (RCT) with data collection at two points in time: a planting survey after seedlings are distributed to farmers, and a survival survey shortly before the start of the next planting season. In addition to the RCT with farmers, we will also collect data in a separate survey to inform the value model for trees. This will include data on tree usage and costs, collected during the planting survey of the RCT, and data on tree product prices, collected in a separate survey with tree product vendors and tree traders.

There are four objectives of this study:

1. Providing evidence to benchmark the internal 1AF assessment (more on this in section 9 below) and monitoring results.
2. Generating a robust estimate of the number of incremental trees planted by farmers in the intervention areas, including measures of tree survival and substitution effects on other tree species.
3. Developing an improved model of the income that farmers derive from trees, based on measuring tree uses, prices of tree products and costs of growing trees.
4. Collecting demographic and socio-economic indicators of households participating in the 1AF tree program, to better understand the program's population.

Target group and study sites

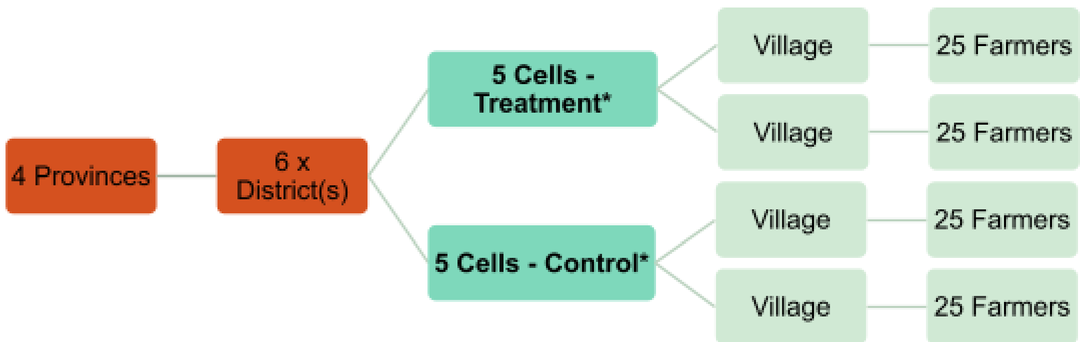
The target population for the RCT are farmers with access to the 1AF tree program. Since 1AF has reached nearly full geographic coverage in Rwanda, and areas that are not yet covered are not representative, the focus will be on areas with continued programming. 1AF is also switching all of its operation from centralized to decentralized nurseries, which means that this is the program model that will be evaluated. Furthermore, since one of the main objectives is to be able to benchmark the 1AF internal evaluation results, 1AF will be ensuring that they can provide credible internal impact results from the same areas as the RCT.. To ensure high external validity to the rest of the 1AF program, we will use a stratified multi-stage clustered sample. Study sites will be selected in each province and within each selected study region, we will select a multi-staged clustered randomized sample. The treatment will be assigned at cell level and blocked based on previous outcomes from 1AF monitoring data to ensure baseline balance between both groups.

4 Sampling strategy

Our proposed study design employs a stratified three-stage clustered random sample. At the first stage, we will stratify the sample based on geographical regions. Within each of the four provinces in which 1AF is implementing the tree program, we will randomly select one or two districts. The definition of the strata will also consider the main tree species distributed, as this is closely correlated with the geographic location. Stratification will ensure that the sample covers a variety of contexts, including the necessary tree species for the value model, and thereby increases the external validity. In total we suggest selecting six districts. The second stage will involve a random sample of cells within each district. In the third stage, two villages within each cell will be randomly selected, and at the last stage a simple random sample of farmers within each village will be selected. Ensuring random selection at each stage increases the representativeness of the sample. However, given that we need to select six districts across four provinces, it is likely that we have some regions that are over-represented in the sample. We address this during the analysis by using survey weights.

To sample farmers at the village level, we will use the registration lists provided by 1AF. Each year local farmer promoters register farmers that are interested in receiving trees from the nursery. The registration list covers at least 50% of households in the cell. This process will be the same in treatment and control cells. Since in control cells the registration will be a mock exercise, it will be necessary to compensate implementation partners, community nursery operators and farmers to maintain their goodwill and trust in 1AF. The compensation for implementation partners should be approximately equivalent to the forgone benefits, while farmers will be compensated by receiving the forgone trees as well as additional high value trees in next year’s seedling distribution. 1AF internal studies show that farmers’ total tree planting goals are very high, and that their demand is not saturated even when large numbers of seedlings are repeatedly distributed. We, therefore, do not anticipate that farmers will be discouraged from planting trees in the first year, by the prospect of receiving trees in the next year.

Figure 2. Overview of sampling strategy.



* Note that assignment to treatment and control will be done after sample selection, to ensure a balanced distribution of expected outcomes in treatment and control cells drawing on 1AF monitoring data (see section 5 below).

5 Randomization strategy

The treatment assignment will be randomized at the cell level since the tree program is delivered through decentralized nurseries at this level (see Figure 2). To ensure a fair comparison between treatment and control cells we will use measures of incremental tree survival from 1AF monitoring data to block the treatment assignment. This means that after the selection of the sample, we will group cells into blocks with similar outcomes. Within each block, half of the cells will be assigned to the treatment group and half to the control group. This method reduces the risk that randomization of treatment assignment results in imbalanced groups by chance.[1]

Since the 1AF tree program already has nearly country-wide coverage, there are no suitable control areas outside of the program areas. Only regions that are particularly hard to reach or otherwise differ significantly from the existing program areas have not yet been reached by the program. Thus, we have decided to use cells from within the existing program areas as controls. To create a valid counterfactual the program will have to be paused for one year in control cells (see Table 1). With this design the impact estimates will capture the incremental effect of delivering the tree program for one additional year.

Table 1. Overview of treatment by subgroup (dark shade indicates treatment is received).

		Year -1	Year 0	Year 1
Established program areas	Continued treatment			
	Paused control			

One important consideration for the randomization strategy is spillovers and non-compliance with treatment assignment. By spillover we refer to farmers in the control group being affected by the tree program, without receiving trees directly. This might be through learning from treatment farmers about the benefits of tree planting or being gifted seedlings that treatment farmers don't want to plant. By non-compliance we refer to either treatment or control farmers not adhering to their treatment status: Treatment farmers might not receive trees, while control farmers might receive trees. Assignment of treatment status at cell level rather than at individual level already limits the likelihood for both spillovers and non-compliance. Nonetheless, it is possible that control farmers could pick up trees from a nearby nursery in a neighboring cell. Since the tree program is an opt-in program, we also must assume a certain level of non-compliance in the treatment group. Non-compliance can lead to biased impact estimates, as well as a loss of precision. While we can address some of this bias with the choice of analysis methods, it is important to minimize the bias at the design stage already.

In addition to clustered treatment assignment, we will make use of two mechanisms that reduce the likelihood of control farmers receiving 1AF seedlings: increased travel distance and restricted distribution of seedlings. To increase travel distance to nurseries, control villages need to be surrounded by a buffer zone, in which no nursery should be

[1] For a short description of randomized block designs see https://conjointly.com/kb/randomized-block-designs/.

established during the RCT. Given that farmers usually travel by foot to pick up seedlings, we anticipate that a no-nursery buffer zone including all neighboring villages from a control village should suffice to prevent spillover and non-compliance. The buffer zone might also include villages from a neighboring cell. In this case, where possible the nursery of that cell will be located in a village outside of the buffer zone. If that is not possible, due to a lack of adequate land with water access, the whole cell might be added to the buffer zone, and no nursery will be established there. However, in any case, farmers from the buffer villages, outside control cells, will be allowed to pick up tree seedlings from their cells nursery or neighboring nurseries to limit the number of farmers that are excluded from the project.

Restricted distribution will be used as a second mechanism to reduce the risk of control farmers receiving 1AF seedlings. Nurseries in cells neighboring control cells will switch to a restricted distribution model for the duration of the RCT. This means that only farmers registered for tree distribution within that cell or other non-trial cells will receive seedlings from the nursery. The identity of farmers is usually verified using their national ID and previous registration data at the time of seedling pick-up at the nursery which makes this a feasible strategy.

While these two strategies are likely to reduce non-compliance significantly, the risk can never completely be eliminated. In addition to reducing spillover and non-compliance through the study design, we will account for potential bias in our analysis by including data on received 1AF seedlings from farmer self-report as well as farmer data collected during the distribution of seedlings. Furthermore, we will use estimation methods such as the instrumental variable approach to account for non-compliance in our analysis.

Figure 3. Methods to reduce spillovers and non-compliance

6 Sample size

6.1 Power and sample size calculation

Based on internal monitoring data from 1AF Rwanda, we can estimate the necessary sample size to detect meaningful differences between treatment and control and point estimates of outcomes with sufficient precision. The required sample size depends on:

- **Statistical characteristics of our key outcomes** such as the mean (or proportion), standard error, and intra-cluster correlation
- **The sample design**, particularly the number of clusters in relation to the number of participants per cluster.
- The **minimum detectable effect size (MDE)**, or level of precision we want to be able to estimate
- The **uptake of the program** among sampled farmers. On average we assume that 70% of farmers registered pre-distribution will eventually pick-up seedlings from 1AF
- The **spillover** of treatment to the control group. Since we cannot fully eliminate this risk, we assume that 2% of control farmers will pick up seedlings from 1AF nurseries
- **Attrition** from the study sample between the first and second data collection. Based on our experience with household data collection in Rwanda, we estimate attrition to be 3%.

Using 1AF internal monitoring and evaluation data, we have estimated the required sample size for the three main outcomes: A) overall tree survival rate, B) number of incremental trees between treatment and control, and substitution for which we use two different measures, C1) measures substitution as the difference in absolute number of trees planted by species, and C2) measures substitution on changes of combined value of trees planted. All calculations have been performed using Stata's *power* command for cluster randomized trials. The statistical power is set at 80%, and the significance level alpha at 0.05.

Table 2. Overview estimated sample size by key outcome.

Outcome	Parameters	Sample Size	Number of clusters	MDE with sample size (n=3.000)
A) Tree survival rate	S1 = 0.73 S2 = 0.77 (4% precision) M = 50 individuals per cluster ICC = 0.05	**Total 3,000** Treatment: 1,500 Control: 1,500	**Total 60 cells** Treatment: 30 cells Control: 30 cells	**MDE = 2.4 trees**
B) Incremental trees survived	Mean Control = 3.8 Mean Treated = 8.4 SD Control = 9.5 SD Treated = 7.5	**Total 900** Treatment: 450 Control: 450	**Total 18 cells** Treatment: 9 cells Control: 9 cells	

	M = 50 individuals per cluster ICC = 0.13			
C1) Substitution of trees in absolute numbers (Senna)	Mean Control = 0.01 Mean treated = 0.12 **MDE=0.1 trees** SD Control=0.3 SD Treated = 0.8 M=50 individuals per cluster ICC=0.01	**Total 1,600** Treatment: 800 Control: 800	**Total 32** Treatment: 16 cells Control: 16 cells	**MDE=0.08 trees**
C2) Substitution of trees based on combined tree value	Mean Control=4.76 Mean Treated=7.23 **MDE=2.47 trees** SD Control=6.34 SD Treated =10.53 M=50 individuals per cluster ICC=0.155	**Total 3,400** Treatment: 1,700 Control: 1,700	**Total** 68 Treatment: 34 cells Control: 34 cells	**MDE= 2.61**

For A) the **overall tree survival rate**, we estimate the sample size for a prevalence study with 4% precision. This means that we expect the 95% confidence interval to be between 69-77%, with a proportion of 73% surviving trees. The required sample size to detect a prevalence of this magnitude is 3,000 individuals, divided into 60 clusters of 50 households per cluster.

For B) the **incremental number of trees survived** between the treated and control groups, we use parameters derived from 1AF datasets to estimate the required sample sizes for the difference between two means. The recommended sample size given the parameters in Table 2 is 900 individuals, divided into 19 clusters. The small sample size is due to a relatively large difference between the two means, and small standard deviations of both means.

For C1) the **substitution of trees in absolute numbers** we estimate the sample size based on the treatment and control means of trees planted and group specific standard deviation for each species in the 2021A 1AF evaluation. While we calculated the sample size for each species, we only report the results for Senna, since this species requires the highest sample size, at a total sample of 1,600, divided into 32 cluster. A full list of all results can be found in Annex 4.

For C2) the **substitution of trees based on combined tree value**. We define the combined value as the sum of the average number of trees planted multiplied by the species value. We only include species not distributed by 1AF. The results of these calculations are limited by the extremely small number of observations. Only 10 farmers in each treatment and control group have planted any tree of the non-1AF species listed in the data. In addition, fruit trees with their value being 20 – 40 times higher than that of all other tree species, are heavily skewing the results. For this reason, we decided to exclude fruit trees from the sample size calculation at this point.

Using 1AF internal data at farmer level, we estimated the mean combined tree value for non-1AF tree species is USD 4.76 for the control group and USD 7.23 for treatment farmers. Based on the standard deviation and intra-cluster correlation from the 1AF data, we estimate a required sample size of 3,400, with 68 cluster to detect this difference.

6.2 Sample size recommendations

Based on the above calculations we recommend a sample size of 3,000 farmers for the RCT, split across 60 clusters of 50 farmers each. This corresponds to 10 clusters, i.e. cells, per district. A sample size of 3,000 means that we can estimate survival rates with a high precision and are well powered to detect the impact of the tree program on incremental trees. For substitution we will be able to detect changes in the absolute number of trees of 0.08 for the species requiring the highest sample size, and changes in the combined value of USD 2.61.

In addition to the data collected to estimate the main outcomes, we will also be collecting data to inform the tree value models. Since the tree usage and value survey is very time intensive, we recommend only conducting this survey with a subsample of farmers. Since we anticipate that the variation of tree use per species is relatively low, we propose a sample size of 1,560 households. We will interview approximately half of the farmers from each cell that have existing mature trees. This corresponds to 60 clusters (cells) with 26 respondents each.

For the tree market checks and the tree trader survey, we propose a sample size of 360 tree product vendors and 360 tree traders. While there might be regional price differences, we anticipated these to be relatively small. We recommend sampling six tree product vendors from a local market and six tree traders in each of the 60 clusters.

Table 3. Recommended sample size by survey.

Survey	Recommended sample size
Planting and survival survey	3,000 farmers
Tree use and value survey	1,560 farmers
Tree market check	360 tree product vendors
Tree trader survey	360 tree traders

7 Modelling tree value

To estimate the monetary value of a selected number of tree species, we propose using a model to predict the net present value (NPV) for selected tree species. NPV is the net present value of all future cashflows, both positive and negative related to a tree. For each year of a tree's life, we will model the expected positive and negative cashflow related to a tree. A discount rate will be applied depending on the year in which the cashflow is realized. The discount rate accounts for the opportunity cost of the investment in trees, as well as the risk of losing the investment. The longer in the future a cashflow is realized, the smaller its value in present day terms.

Given the large amount of data needed to accurately calibrate a NPV model, we suggest grouping trees into categories by their main usage and collecting data only on the most prevalent tree species within each tree category. Based on conversations with 1AF tree experts, we suggest a maximum of four categories and hence collecting data on four tree species. This allows us to balance the costs of the necessary in-depth data collection, with the generalizability of the model. We assume that trees within one category will have a similar value profile. A desk study on significant differences between tree species within one group could inform adjustments of the modelled tree value for other species.

The NPV model requires a monetary estimate of costs and benefits, as well as an estimate of the point in time at which costs, and benefits are incurred. These will be estimated based on primary data collected at the planting and survival survey. In addition, a few key parameters such as the discount rate would be based on desk research and input from research partners.

Costs associated with tree planting can be divided into financial investment, time investment, and land use. The first includes the input costs required to successfully grow the seedling into a tree. The second comprises time for care and maintenance of the tree. The third refers to the potential opportunity costs of repurposing farmland for trees rather than crops. For the estimation of the NPV, opportunity costs in the form of time and land may be monetized based on local minimum wages and crop prices. In addition, we need to account for costs related to pest and disease of trees, which might either kill or significantly reduce the short-term productivity of a tree. On the cost side the relation might also be non-linear as the required labor might be higher during planting and immediately after. On the other hand, the maintenance costs and risks of diseases and pests could increase with a tree size.

Farmers can derive economic benefits from trees in different ways. For the purpose of this study, we will focus on direct benefits such as income generation and household consumption only. This would for example entail household consumption of firewood, timber for construction, or wood products such as bean poles. Trees might also have significant environmental benefits, and long-term benefits for farm productivity, but estimating these effects is beyond the study's scope. On the income side we expect the cashflow from a tree to be non-linear, since trees take a long time to reach maturity and become economically productive.

There are two limitations to the estimation of the net present value of trees that we want to highlight here. First, given the country wide scale of the 1AF tree program, the distribution of trees at such a large scale might affect the future price of trees and tree products, as the supply side will be significantly altered over the years. These market equilibrium effects are not predictable at this point. Second, as mentioned above the proposed tree value model does not include environmental services by trees. While households currently cannot derive direct income from those environmental services, this might change in the future. There is a realistic possibility that tree growing might be financially rewarded through climate-change initiatives such as carbon credits.

8 Measurement of key outcomes and data collection

In line with the study objectives the key outcomes to be measured are:

1. Incremental trees planted, including measures of
    a. Total trees planted
    b. Total trees survived
    c. Substitution effects on planted tree species
2. Modelled value of selected tree species, based on measures of
    a. Tree uses
    b. Timing and frequency of tree uses
    c. Prices of tree products
    d. Costs of growing trees
    e. Timing and frequency of costs for growing trees
3. The average impact of the 1AF tree program per farmer

For each of these outcome indicators, we will benchmark against and leverage how 1AF captures internal monitoring and evaluation data against these indicators. In addition, basic demographic and socioeconomic characteristics of households will be measured to serve as control variables in the analysis and to benchmark overall project impact.

We propose to collect the necessary data to estimate these key outcomes using three different data collection activities:

1. A tree count survey with farmers, which will aim to collect data on tree the impact of the 1AF tree program on tree planting, survival, and household characteristics.
2. A tree usage and value survey with farmers, which will help us generate insights on how households use and derive value from their trees.
3. A tree price survey with tree product traders and tree traders to measure market prices for trees and tree products.

For all three surveys there will be two rounds of data collection. In the case of the farmer survey, the two rounds will consist of a planting survey and a survival survey:

- The **planting survey** will be conducted immediately following the planting season and timed to align to 1AF's tree planting survey, in order to benchmark against that exercise.[2] This data collection will be conducted in January 2024,[3] and focus on capturing data on newly planted trees.

- The **survival survey** will be conducted before the following year's tree distribution to assess tree survival. Aligned to 1AF's survival survey, this survey will be conducted in late September to early October 2023.[4]

8.1 Development of survey instruments

The quality of the research instruments is paramount to ensure reliable estimates of key outcomes. The survey instruments will be developed in close collaboration with 1AF to exchange knowledge and align outcome measures for benchmarking. During the survey design stage, we will also conduct focus group discussion and semi-structured interviews with some of the farmers, tree traders and tree product vendors in the target population. The information from this qualitative data collection will ensure that our survey tools accurately reflect the local context and improve data accuracy by using the context appropriate wording, categories, and units.

8.2 Tree count survey

The tree count survey will comprise a visual tree count of newly planted trees and a module on household characteristics.

The objective of the visual tree count is to estimate the number of trees planted, by species and plot, focusing specifically on all trees planted in the most recent planting season (Season 2023A). The visual tree count will be conducted by an enumerator together with the respondent. At endline all surviving trees planted during previous years planting season will be counted. To increase the accuracy of the tree count, the survey will be conducted before the following planting season has started. Tree numbers by species will be recorded and photos will be used to back-check tree species identification. Our understanding is that the average farmer has two plots in addition to planting trees around their homestead – but that a farmer could have as many as 5 plots. The goal is to visit and count trees on all of the farmer's plots. Where that is not possible, for example because the farmer is not willing to visit all plots with the enumerator, we will record self-reported numbers of planted trees by species. We will compare the mean and variance of observed and reported trees to verify whether the self-reported number of trees yields comparable results. Depending on the extend of the differences between the two measures, we might adjust the number of self-reported trees downwards, or in the worst case need to drop self-reported values all together.

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[2] We understand that benchmarking is a key focus of this evaluation exercise. So, we have aligned our data collection timelines and approaches to 1AF's internal monitoring and evaluation approaches.

[3] This timeline aligns to 3 months after the seedlings have been distributed. We will conduct this data collection in early January to avoid the logistical difficulties of conducting data during the holiday period.

[4] This timeline will not equate exactly to 12 months after tree distribution because otherwise it would overlap with the distribution of the following year's trees, complicating the measurement of newly planted trees. So, we will closely time this data collection as close to the next tree distribution as possible – but not overlapping with it. However, it would still capture the most critical component of tree survival – that the trees will have survived the first dry season.

A module on **household characteristics** will capture household demographics such as number, and age of household members, the education level of the head of household, and land size. In addition, we will include two measures of socio-economic status: The self-reported household income over the past 30 days, and an asset-based wealth index. Asset-based indexes tend to be a more stable measure of household economic welfare, and the individual items can usually be collected with high reliability.

Our index of choice would be the **EquityTool**. The EquityTool is based on the Demographic and Health Survey (DHS) wealth index, including 15 simple questions. The resulting scores allow us to categorize each household into a national wealth quintile, as well as urban/rural wealth quintiles. In addition, the complementary Asset to Income Estimator (A2IE) allows us to map the wealth quintiles to average household income. The EquityTool for Rwanda will be updated in the first quarter of 2023 to the latest DHS data from 2019/2020, which will make the EquityTool one of the most up-to-date wealth indexes. While we do not recommend using the income estimates from the EquityTool to measure a programs impact on individual household's income, it is a very efficient way to get an estimate of the average income levels within the target population.

8.3 Tree usage and value survey

For the **tree usage and value survey** we will select four species of trees, each representing a group of similar trees. The sample will include farmers who have indicated in the tree count survey that they have mature trees of the four species of interest on their land. The enumerator will randomly select a small sample of these trees to achieve a good coverage of different species and ages. Farmers will be asked about how they have used each of the selected trees in the past 6 months, what volume of the different products they derived from each tree, how frequently they can harvest a similar amount from each tree, and whether they are planning to cut down each tree within the next year, or its remaining lifetime. Households will also be asked about the typical prices they pay for such products when purchasing them from local markets or traders. Finally, we will record the age of each selected tree and measure its stem circumference to triangulate the reported age.

Using specific trees as visual prompts can help farmers to increase the accuracy of their recall on usage. It also may help reduce hypothetical bias especially on questions regarding the timing of tree use and intentions to cut down whole trees. Data accuracy may be further improved by using visual prompts for standard units such as an "example stick" as a unit of firewood.

To complement the data from the example trees, we will also ask farmers to report how they use other trees from the same species. This will help to gain a more comprehensive understanding of usage across the whole tree stock.

8.4 Tree price survey

The **tree price survey** with tree product vendors and tree traders will focus on current market prices for various tree products from different species, as well as prices for fully harvested trees by species. We will ask vendors and traders to report prices by species as well as other characteristics that might affect prices such as tree age or circumference.

Collecting these data alongside both the planting and survival survey will ensure that we have data that includes a sufficient amount of seasonal variation, as we expect tree usage and product values may vary by season.[5]

Table 5 below displays which data collection approach will be used to capture the specified outcomes.

Table 4. Outcome and proposed data source

Outcome	Data Source
Incremental trees	Visual tree count
Total trees planted	Visual tree count
Total trees survived	Visual tree count
Substitution effects	Visual tree count
Value of an average tree	Tree value and usage survey Tree product trader survey
Household demographic and socio-economic characteristics	Household characteristics module

Table 6 below presents the types of data that we will capture through each of these data collection approaches.

Table 5. Data collection tools and survey question focus.

Data collection tool	Respondent	Indicative focus of survey questions
Household characteristics module[6]	Main household farmer	• Household size and composition • Education level of the main farmer • Size of owned land • Self-reported household income category • EquityTool and ubudehe category
Visual tree count module	Main household farmer	• Visual count of all trees planted in the 2023A season, differentiated by tree species[7] • Photographs of all trees planted • Number of trees seedlings obtained, their sources and associated costs
Tree value and usage survey	Main household farmer	*Asked of randomly selected individual trees on the farmer's plots and at their homestead:* • The tree species and its age • The stem circumference • Different uses of the example tree and the proportion of the tree used for of each use case • Relative use for each use case across total stock of trees of the same species

[5] Previous data from 1AF internal monitoring showed some significant seasonal variation. It was, however, unclear whether this was due to non-random attrition, or actual seasonal variation. 1AF is currently conducting an additional round of data collection which might shed more lead on the necessity of collecting usage and price data at more than one point in time.
[6] These data points will predominantly serve as controls in our analysis.
[7] Because we will be grouping tree species of interest based on their use case, we will ask farmers and traders for data reported by these tree groupings. Tree group categories will be agreed on with 1AF and Give Well.

		● Estimated units, prices, and volumes of various tree products that they have recently sold (suggested recall period: in the last 6 months), differentiated by tree species ● Expected age to start harvesting these products[8] from the tree as well as the expected volume of harvests in a year and the wait time required between harvests (to establish the frequency that a tree is used for each use/product) ● Number of full trees that were cut down and sold in the past year by species, and the respective tree's age at harvest. ● Number of full trees that they plan to cut down and sell in the next year by species, and the respective tree's age. ● Direct input costs associated with tending to the tree (suggested recall period: in the last month) ● Time/labor costs associated with tending to the tree, including opportunity costs from focusing on other activities ● Opportunity cost of using land for tree cultivation
Tree price survey	Tree product traders & tree traders	● Value of each tree product – and volume of sales for these products ● Average cut age of trees, differentiated by tree species, and average value of tree cut sales (suggested recall period: in the last month)

8.5 Definition of key outcomes for analysis

Tree survival rates will be measured as the proportion of seedlings planted that are still alive at endline, pooling both treatment and control group observations. This effect might be further split up by tree species and survival of tree seedlings provided by the 1AF program and seedlings from other sources as far as sample size allows.

$$Survival\ Rate = \frac{surviging\ trees_{T+C}}{planted\ trees_{T+C}}$$

The **difference in total trees planted** will be defined as the difference between the treatment and control in total trees planted. Trees planted will be measured as all tree seedlings planted in soil counted during the planting survey.

$$\Delta\ trees\ planted_{total} = trees\ planted_{total,T} - trees\ planted_{total,C}$$

The **incremental trees** will be measured as the difference in the number of surviving trees planted in the last planting season, in treatment and control. This effect might be further split up by species, or other relevant categories as far as sample size allows.

$$Incremental\ trees = surviving\ trees_{T} - surviving\ trees_{C}$$

The **tree substitution effect** describes the potential of 1AF provided trees merely replacing trees of other species that farmers would have planted in the absence of the program. We will use two different outcomes to measure substitution:

[8] Anticipated tree products captured in both the farmer survey and market checks include – but may not be limited to: mulch, firewood, fodder, timber, bean poles, and other poles.

1. The difference in the total number of trees planted per species. This measure is similar to the total planted tree measure, however, it is disaggregated by species. The aim is to understand better whether farmer plant trees provided through 1AF in addition or instead of the trees they would have planted in the absence of the program.

$$\Delta\, trees\ planted_S = trees\ planted_{ST} - trees\ planted_{SC}$$

2. The difference in the combined value of all trees planted for species that are not provided by 1AF. This is a monetary estimate of the counterfactual value a farmer would have gained through planting trees in the absence of the program. The measure excludes species provided by 1AF, because the effect for those species is already included in the incremental trees measure. Since we do not have tree value data for species beyond the 1AF tree package, we would need to use available tree values of comparable species as a rough estimate.

$$\Delta\, combined\ tree\ value = \sum_{S_1}^{S} trees\ planted_{ST} * tree\ value_S - \sum_{S_1}^{S} trees\ planted_{SC} * tree\ value_S$$

Where the subscript S denotes the tree species, and the subscript T denotes the treatment and C control group values.

Tree costs will be a function of tree related costs and frequency and timing of cost incurred. Input costs might be estimated based on the inputs needed and their average price. Labor costs will be estimated based on the average time spent per year in workdays, multiplied with the minimum daily wage. Opportunity costs will be estimated based on the average area of agricultural land a tree uses, and the average revenue from producing a staple crop on the same area. Costs of pest and disease will be modeled on the frequency of the event and the average loss of tree value as a percentage.

Tree benefits will be the sum of the value of all tree usages. Whereby the value of the tree usage is determined by the volume of the various tree products harvested multiplied with the respective market price for that product. The derived value will be adjusted for the frequency at which the tree product can be harvested to arrive at a yearly average.

Tree product prices will be based on standardized units and calculated as averages per product and species.

The **average impact of the 1AF tree program per farmer** will be based on the number of incremental trees for each species multiplied by each species estimated value. The impact measure will be expressed in USD.

$$Impact = \sum_{S_1}^{S} incremental\ trees\ survived_S * tree\ value_S$$

9 1AF internal assessment

One Acre Fund (1AF) calculates the impact from its tree programs based on the rigorous measurement of two components: i) the number of incremental trees farmers realize impact from because of the 1AF intervention, and (ii) the value of each tree for the farmer.

In Rwanda, each year we run surveys with around 2,000 farmers to measure the program's impact on tree planting behavior. The internal surveys cover every district where 1AF provides trees - 27 in total in 2021. Due to the ubiquitousness of the tree program in Rwanda and feasibility barriers to run an experimental study design for annual internal measurements, we take a random population draw of the areas we provide trees and compare tree growing between those who take 1AF trees and those who do not. We compare participating farmers with these non-participating farmers and attempt to control for any observable differences in a regression analysis. Using a random draw of the population has the benefit of allowing us to also measure the depth of the reach of the tree program in the areas of our operation, apart from measuring the impact on each tree adopter.

Our survey teams count the number of trees that 1AF and non1AF (comparison) farmers plant after the season for tree planting has closed. Several months later, after a dry season is completed and the rains have begun, enumerators re-visit these farms and count the total number of seedlings alive. The total number of incremental trees is then calculated by removing the number of surviving seedlings that comparison farmers have from the total surviving seedlings that 1AF farmers have. We also take into account substitution effects that the program may be having on planting behavior of other tree species. We test to see if 1AF farmers are planting more of the 1AF provided species at the cost of other tree species they would have planted without program intervention. In case substitution is taking place, we incorporate substitution in the impact calculations.

To understand the value of a tree to a farmer, we conduct farmer and market surveys to determine the typical use, age of sale and price of the tree products (usually sold in the markets), as well as the value and timing of input and labor costs to calculate a net present value per tree. For example, we assign a value to firewood and then estimate which years farmers will start using what % of their trees for those values. This is combined with cost data, which includes input, labor, and land opportunity costs. The data is then added to an Impact Model which calculates the NPV impact per tree per year using a 7.5% discount rate. Since environmental and soil benefits are difficult to precisely monetize, these have been omitted from our (financial) impact measurement, but they are surely highly important benefits to the smallholder farmers planting trees.

Please see here for a detailed overview of 1AF's internal measurement methodology for tree-planting.

9.1 Adjustments to 1AF's Internal Tree Impact Assessment for Benchmarking

1AF will modify its strategy for the tree planting and survival surveys to benchmark 1AF's internal measurement results to Laterite's RCT results with precision in the following manner:

1. **Sample sizes in the 6 RCT districts:** 1AF typically follows 2000 farmers across all districts of the tree program that allows us to measure the impact of incremental trees surviving for 1AF adopters versus controls. However, for the sake of benchmarking, we also want to ensure that we can rule out that Laterite's and 1AF's measurements are different due to random variation. By focusing on the key indicator on average trees surviving for 1AF adopters, we estimate the sample size for a precision 0.8 trees, with an average of 10.3 trees surviving. That is, we expect the 95% confidence interval to be between 9.6-10.9 trees, with an average of 10.3 trees surviving. The required sample size to detect a prevalence of this magnitude is approximately 3,000 individuals.

   For the year 2024 when the RCT will be conducted, 1AF will follow 3000 farmers specifically in the 6 RCT districts. This is in addition to the 2000 samples we require for the total program, where usually only 467 samples would have been covered in the 6 districts. This means that 1AF will increase its sample size by approximately 2533 farmers in the 6 districts in the internal evaluation specifically for the benchmarking exercise.
2. **Selection of Villages for Internal 1AF Study:** A cell typically consists of 5-6 villages. For the RCT, Laterite will randomly pick 2 villages in each cell to draw their samples. To ensure we select farmers for the internal evaluation that are as geographically close to the RCT farmers, we will draw our sample from 2 of the remaining villages in the cell where the RCT will not survey. This strategy will allow us to draw samples from the same nursery in both the RCT and the internal evaluation while still avoiding inadvertently interfering with the RCT surveys or confusing farmers.
3. **Samples per Cell/Village:** In total, 1AF will select 5 cells per district which will be the exact same as the treatment cells in the RCT. In each cell, 1AF will select 2 villages for the survey. In each village, 1AF will randomly select 50 farmers for the planting and tree survival surveys using random walk selection across each village. Using our regular approach, we should expect some of these randomly selected farmers to be either 1AF tree adopters or non-adopters.

1AF will use the following modifications to ensure the tree value assessments are comparable to the Laterite's study:

- 1AF's internal tree value assessments are conducted every five years. These most recent assessments will be in the year 2022, the results of which are being analyzed at the time of writing this study design. We will plan to use this assessment to benchmark against the Laterite tree assessment model.

- In early 2023, 1AF will look at the internal tree value data to see if there is significant regional variation in tree usage and tree prices. If we find evidence that these are significantly different in the 6 districts compared to the rest of the tree program, we will create tree value models specifically for the 6 RCT districts. If we have few data points, we will also collect additional data points specifically where we see regional divergence from the 6 districts. For example, if wood prices vary significantly across districts, we will collect specific information on that datapoint from the RCT districts.

9.2 Important notes about the benchmarking exercise

While we are making all attempts to ensure that we can compare the internal estimates to the external RCT, we foresee that there might be variance in the results of the two studies for the following reasons:

1. There is a structural difference in both the study designs. The Laterite study will be an experimental study design using a clustered RCT approach. The internal 1AF methodology yields a weaker control group in comparison to the RCT because they are selected from the same villages and had the chance to participate in the tree program but did not. We use this methodology due to the ubiquitousness of the tree program in Rwanda and real feasibility barriers to run an experimental study design for annual internal assessments.
2. 1AF has created substantial demand for trees due to continuous presence of the tree program over the years. For the RCT, we will revive interest in trees again through a registration process in the treatment and control cells. Once we withhold treatment in the control cells, it will create an opportunity for other NGOs and tree nursery operators to move in to fulfill the demand that 1AF created but did not meet (due to the RCT). This does not really reflect the reality of the “usual” without the 1AF tree program because that demand may not have existed to a certain extent if it was not for the 1AF program providing trees in the area. We will mitigate this to the extent possible by taking the following steps. We will work closely with the government partners to ensure they neither encourage nor deny other nursery operators to work in the control cells any more than they would have done without the RCT. We will also compensate the nursery operators in the control areas with their missed earnings or engage them elsewhere.

10 Pre-analysis plan

Prior to the data collection, we will develop a detailed pre-analysis plan. This will ensure that our study design is focused on measuring key outcomes that will be relevant for analysis and thereby providing the best value for money. In addition, a pre-analysis plan ensures that the approach to data processing and analysis does not suffer from ad-hoc adjustments that can introduce bias to the study results. If desired the pre-analysis plan could be registered online, for example at the American Economic Association's registry for RCTs.

The plan will include details on (i) the sample: randomization design, sample size calculations, and process to test for randomization balance and potential non-random attrition, (ii) Data collection activities; (iii); Research questions and hypothesis tests to be included in the final analysis; (iv) Indicator definition and operationalization; (v) Effect models to be run for each outcome; and (vi) Approaches to treating non-response, outliers, non-compliance and non-random attrition.

Since the study background, sampling, and randomization and outcomes are already described in previous section, we will focus in this section on describing the research questions, hypotheses, and analysis methods.

10.1 Research questions and hypotheses

1AF Tree program impact estimates

Average tree program $ impact per farmer

RQ1: What is the average value created by the 1AF tree program for participating farmer?

- H_0: There is no difference between the combined tree value in the treatment and control group.
- H_a: The average combined tree value is higher in the treatment group compared to the control group.

Trees planted

RQ2: What is the effect of 1AF tree program on the average number of trees planted by farmer during the Season A planting season?

- H_0: There is no difference between the average number of trees planted in the treatment and control group.
- H_a: The number of average trees planted is higher in the treatment group compared to the control group.

Incremental trees

RQ3: What is the effect of the 1AF tree program on the average number of surviving trees a farmer has on their plot at the beginning of the next year's planting season (Season A)?

- H_0: The number of trees surviving at the beginning of the following planting season is the same in treatment and control.
- H_a: The number of trees surviving is higher in the treatment group compared to the control.

Substitution

RQ4: What is the effect of the 1AF tree program on the planting of species not provided in the program?

- H_0: There is no substitution effect: The number of other species planted are the same in treatment and control group.
- H_1: The number of other species planted differs between the treatment group and the control group.

RQ5: What is the effect of the 1AF tree program on the average combined tree value of trees planted?

- H_0: There is no substitution effect: The average combined tree value is the same in treatment and control group.
- H_a: The average combined tree value differs between treatment group and control group.

Population parameters

In addition to the impact estimates of the RCT, the proposed study will also collect data on secondary outcomes to inform the cost-benefit analysis of the tree program. The secondary outcomes are population parameters that will inform the calibration of a net-present value model for four different tree species. For this reason, no hypothesis tests are needed.

RQ: What is the **survival rate** of trees planted by farmers in the population of farmers eligible for the one 1AF tree program?

RQ: What is the average net present **value of a tree** to a farmer?

RQ: What is the average household size of a farmer?

RQ: What is the average household income of a farmer?

10.2 Analysis

We will use three different methods to estimate the effect sizes for the RCT outcomes: trees planted, incremental trees and two measures of substitution.

First, for each outcome we will estimate intention to treat effect (ITT) using a regression model that adjusts for the lagged dependent variable, which allows us to both adjust for potential baseline differences between both trial groups, as well as including covariates in the analysis to increase the power of the analysis to detect the program's impact. A regression that adjusts for the lagged dependent is more desirable than a difference-in-difference approach in this case, since we know from experience that with tree count data the assumption of parallel trends, central to any difference-in-difference regression, does not hold. This is because in the absence of any treatment, small differences in the lagged outcome variable between the treatment and control group can lead to divergent trajectories across both groups for the outcome variable over time.

Second, we will use an instrumental variable (IV) approach to estimate the Local Average Treatment Effect (LATE). This is the effect of the tree program on the subgroup of farmers that complied with the treatment assignment, that is they picked up tree seedlings if they were in a treatment cell, and they didn't pick up trees if they were in a control cell. Using the IV model enables us to account for non-compliance due to the opt-in model of the tree program. The LATE is the most relevant impact estimate for the cost-effectiveness analysis, since the costs of the program delivery are only incurred for farmers that pick up trees.

Third, we will use a causal forest approach to study heterogeneous effects on each of the outcome variables of interest. The goal of this exercise will be to explore how the estimated ITT varies by population sub-group or other characteristics of interest. We will double check our results using sub-group analysis and using interaction effects in our regression with a lagged outcome, to address the question of confounding. We expect that characteristics such as location, gender, age, education, total land ownership, number, and type of trees at baseline, to influence the treatment effect.

The covariates we expect to include in the regression analysis will be household characteristics measured during the planting survey that are likely to have some effect on tree planting and survival. This would be for example the household socio-economic status, measured by an asset-based index of household economic status (EquityTool), the education level of the head of household, the size of the household, and the size of land owned. Covariates might be dropped from the analysis in the case of multicollinearity or if their explanatory power is so low, that their inclusion reduces the model's efficiency rather than increasing it.

Population parameters will be estimated using standard estimation methods for population means and proportions.

Multiple comparison adjustment

The proportion-based substitution outcome requires multiple comparisons, since any of the tests returning a significant difference will lead to a rejection of the null-hypothesis. We therefore need to adjust the p-values to multiple comparisons. To do that we propose to use the Benjamini–Hochberg method to control for the False Discovery Rate (FDR)[9]. The Benjamini–Hochberg method works by ranking all of the p-values from the individual tests in ascending order and then comparing them to a predetermined threshold value. If the p-value is below the threshold, the null hypothesis is rejected, and the result is considered significant. This method is widely used in the fields of genomics and bioinformatics, where researchers often need to test many hypotheses at once.

[9] See Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: a practical and powerful approach to multiple testing. *Journal of the Royal statistical society: series B (Methodological)*, *57*(1), 289-300.

Standard errors

The standard errors used in the analysis will need to be clustered both because of the clustered sample design and the clustered random assignment. In addition, we always expect some degree of heterogenous treatment effects, which makes clustering standard errors necessary even if models include fixed effect at cluster level.[10] Our standard approach is to use the Liang and Zeger clustered standard errors.[11]

Missing Data

While missing data is usually low for in-person surveys in Rwanda, there is always a risk that some observations have missing values for variables included in one of our main analysis models. In these cases, we follow the standard approach of listwise deletion. We also perform an analysis of missing values, to check whether they are correlated with specific household characteristics or other outcome variables. This might give us an indication on why this data might be missing.

Outliers

The main sources of outliers are measurement errors or data entry errors and natural variation. We try to pre-emptively reduce the risk of the former through intentional survey design that precludes enumerators from entering data that is not realistic and providing them with exact guidance on measurement of different variables. In addition, during data collection we perform real-time data quality checks that highlight. This allows us to immediately follow up with the field team and if necessary, correct the value. Outliers that are clearly caused by data entry errors and cannot be corrected, will be deleted. In the case of natural variation, we would not want to exclude an observation, as it contains valuable information on the population distribution. Our preferred approach would be to use a log, square root or other transformation that reduces the impact of the outlier on the model estimates. Trimming outliers will only be employed if alternative methods have not solved the issue, and the outlier's effects are such that it prevents us from making any meaningful conclusions about the rest of the data. In such a case a clear cut-off threshold will be defined and equally applied to treatment and control, both the results with and without outliers will be reported, and the limitations of the trimmed results will be discussed in detail.

Randomization balance and potential non-random attrition

For the experimental identification of the tree program's impact, the assumption that both treatment and control groups are on average equal across observable and non-observable characteristics, is crucial. Since we will not have detailed enough baseline data at farmer level prior to randomization, we have to trust our randomization process to yield a reasonably balanced sample. We have chosen a sampling process, including 'blocking' treatment assignment on previously measured outcomes, and geographical stratification as

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[10] See Abadie, A., Athey, S., Imbens, G. and Wooldridge, J. (2022). 'When Should You Adjust Standard Errors for Clustering?' arXiv, 19 September. http://arxiv.org/abs/1710.02926.
[11] Liang, Kung-Yee, and Scott L Zeger. (1 April 1986). 'Longitudinal Data Analysis Using Generalized Linear Models'. Biometrika 73, no. 1 13–22. https://doi.org/10.1093/biomet/73.1.13.

ways to reduce the risk of having an unbalanced randomization. Nevertheless, we will analyze the household characteristics from the planting and survival survey to check whether there are any significant differences between the treatment and control.

A major source of imbalances during follow-up data collection can be non-random attrition. If the household characteristics of farmers who we lost from the sample are significantly different, this may have two effects. First, if the group of farmers we lost is the same across treatment and control, but different from the remaining farmers, the external validity of the results is reduced. The remaining sample is no longer representative of the initial target population. Our results would only be valid for farmers similar to the farmers remaining in the study. Second, the attrition might be non-random, and differ between treatment and control group. In that case, we would not only lose external validity but also internal validity.

Our standard approach to these issues is twofold. We adjust survey weights at the endline to rebalance the sample and increase its representativeness and we include household characteristics in the analysis as control variables to account for any potential imbalance.

Non-compliance with treatment assignment

In an ideal experiment the participants assigned to the treatment group take up the treatment and the control group does not take the treatment. The 1AF tree program is however an opt-in treatment, which means while everyone in a specific cell is eligible to receive the treatment, farmers are free to choose whether they will do so. This leads to a large share of participants that are assigned to a treatment cell, but do not receive trees from 1AF. In the context of this study, and the specific study objectives, the best approach to this issue is to use the treatment assignment as an instrument for having received trees from 1AF and estimate the LATE, as described in the analysis section.

Sensitivity analysis of combined tree value and substitution

The analysis of overall program impact hinges on some fundamental assumptions. One of the most important is the assumption that we can use the tree value of four representative species for other trees in the same tree group. To test how sensitive our impact estimate is to this assumption we will conduct a sensitivity analysis, where we will test different scenarios of the value assignment and see whether this will change the overall conclusion on the impact of the program.

A similar issue arises for the substitution measure based on combined tree value of non-1AF trees. Since we do not have an NPV estimate for each of these species, we would assign each non-1AF species a value, based on the most similar species that we have values for. We will therefore also do a sensitivity analysis for this outcome. In addition, the combined value substitution measure is based on very low frequency data. This means that on average the impact of changes in value is minimal, because these tree species have such a small share in the total trees planted.

11 Work plan

	2022	2023				2024				2025			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Evaluation Design													
Co-create full evaluation design with 1AF													
Develop Survey Instruments													
Selection of clusters & treatment assignment													
Register pre-analysis plan													
Registration & Sampling													
Farmer registration – *1AF-led*													
Process farmer lists													
Draw farmer sample													
Baseline (Tree Planting Survey)													
Secure IRB approval (for both rounds)													
Secure local approvals													
Conduct training and piloting													
Hold appointment calls													
Collect data													
Analyze data and write report													
Endline (Tree Survival Survey)													
Secure local approvals extension													
Conduct training and piloting													
Hold appointment calls													
Collect data													
Analyze data and write report													

12 Budget

12.1 Consolidated budget

	2023	2024	2025	Total
Laterite	$320,360	$665,866		$986,226
One Acre Fund	$154,000	$184,312	$13,850	$352,162
Total	**$474,360**	**$850,178**	**$13,850**	**$1,338,388**

12.2 Indicative Laterite budget

1AF Rwanda Tree Evaluation Total Budget				
	Design	**Baseline (Planting)**	**Endline (Survival)**	**Total**
Research Services				
Study Design	$ 15,180			$ 15,180
Data Analysis - RCT Analysis		$ 18,535	$ 18,535	$ 37,070
Data Analysis - NPV Modelling			$ 24,365	$ 24,365
Report Writing		$ 16,830	$ 16,830	$ 33,660
Project Management	$ 23,760			$ 23,760
Total	**$ 38,940**	**$ 35,365**	**$ 59,730**	**$ 134,035**
Instrument Design Budget				
Project Planning	$ 3,685			$ 3,685
Field Preparation - Appointment Calls	$ 288			$ 288
Training and Pilot	$ 3,850			$ 3,850
Data Collection	$ 3,416			$ 3,416
Transcription and Translation	$ 4,062			$ 4,062
Analyzing Data	$ 4,400			$ 4,400
Total	**$ 19,701**			**$ 19,701**
Tree Count Survey Budget				
Survey Tool Development		$ 3,597	$ 1,799	$ 5,396
Data Collection Planning		$ 9,312	$ 6,984	$ 16,296
Field preparation - Local Approvals		$ 2,412	$ 2,412	$ 4,824
Field Preparation - Listing		$ 5,778	$ 2,889	$ 8,667

Field Preparation - Appointment Calls		$ 4,452	$ 4,452	$ 8,904
Training and Piloting		$ 27,439	$ 27,439	$ 54,878
Data Collection		$ 123,348	$ 123,348	$ 246,696
Back-checks, Data Quality Audit, Data Cleaning and Field Report		$ 9,077	$ 9,077	$ 18,154
Total		**$ 185,415**	**$ 178,400**	**$ 363,815**

Tree Usage and Value Survey Budget				
Survey Tool Development		$ 3,597	$ 1,799	$ 5,396
Data Collection Planning		$ 5,071	$ 3,803	$ 8,874
Field Preparation - Listing		$ 2,805	$ 1,403	$ 4,208
Field Preparation - Appointment Calls		$ 2,492	$ 2,492	$ 4,984
Training and Piloting		$ 23,660	$ 23,660	$ 47,320
Data Collection		$ 72,924	$ 72,924	$ 145,848
Back-checks, Data Quality Audit, Data Cleaning and Field Report		$ 7,250	$ 7,250	$ 14,500
Total		**$ 117,799**	**$ 113,330**	**$ 231,129**
Tree Price Survey Budget				
Survey Tool Development		$ 2,409	$ 1,205	$ 3,614
Data Collection Planning		$ 4,675	$ 3,506	$ 8,181
Field Preparation - Listing		$ 5,115	$ 2,558	$ 7,673
Field Preparation - Appointment Calls		$ 1,444	$ 1,444	$ 2,888
Training and Piloting		$ 13,837	$ 13,837	$ 27,674
Data Collection		$ 24,983	$ 24,983	$ 49,966
Back-checks, Data Quality Audit, Data Cleaning and Field Report		$ 5,154	$ 5,154	$ 10,308
Total		**$ 57,617**	**$ 52,686**	**$ 110,303**
Total Budget excluding VAT	**$ 58,641**	**$ 396,196**	**$ 404,146**	**$ 858,983**
VAT				$ 122,243

Total Budget including VAT				**$ 981,226**
COVID Contingency	*$5,000*	*(only to be used in case of COVID symptoms on the field team)*		

12.3 Indicative One Acre Fund budget

	2023	2024	2025	Total	Notes
Project leadership	$16,000	$16,800	$8,820	$41,620	Overall management support and leadership to roll out the key impact activities.
Internal Evaluation for Benchmarking	$0	$27,983	$2,260	$30,243	MEL staff time for managing incremental surveys to ensure benchmarking to the RCT is possible.
Field Management of the Tree Program	$17,414	$7,729	$0	$25,143	Incremental staff time to ensure the execution of field activities and treatment assignment is done as required.
Field scouting	$3,881	$0	$0	$3,881	1AF will employ field scouts to walk around the control cells to create clear delineation between the control and buffer areas. The scouts will help identify which villages need to be kept as buffer areas, and which villages can receive limited tree distribution based on the likelihood of spillover.
Field incentives	$66,855	$67,500	$0	$134,355	1AF will compensate: 1) The farmers from control cells; 2) The nursery operators to counter the losses they would face due to nil or limited sales in the control and buffer regions; 3) The field promoters in the control cells for mock registrations and for keeping the farmers motivated for tree planting until after the RCT period.
Additional trees distributed	$10,800	$0	$0	$10,800	1AF will ensure provision of the same total number of trees to districts, once control cells are removed, in order to generate buy in. To do this, 1AF will produce via central nurseries which is $0.02 more expensive per tree due to logistics costs.
Office-based mapping	$1,500	$0	$0	$1,500	
Planting & Survival Surveys	$0	$27,438	$0	$27,438	Regular survey and measurement activities with an additional sample of 1533 farmers to compare with the results from Laterite RCT. The cost includes enumerator wages and field supervision.
Transport costs for incentive distribution	$6,750	$0	$0	$6,750	Transport costs for delivery of incentives.

Support Costs	$30,800	$36,862	$2,770	$70,432	Non-field staff supporting the program through logistics, government relations, human resource management, financial advisory, planning & reporting, sourcing and leadership.
Total Costs	**$154,000**	**$184,312**	**$13,850**	**$352,162**	

12.4 Budget narrative

Prepared for One Acre Fund, December 2022

Background on the project

Laterite has divided our work on this project into five primary components:

- **Research Services:** includes all of the costs of finalizing the evaluation study design – in particular, finalizing and registering the pre-analysis plan and building all of the study instruments – and costs of analysis and reporting as well as the day-to-day project management and coordination across the evaluation.
- **Instrument Design Budget:** includes the costs of qualitative data collection with respondent groups in order to gather inputs to fine-tune the eventual evaluation research instruments.
- **Tree Count Survey Budget:** includes the costs of conducting a count of farmer's seedlings and trees less than a year of age on all of the farmer's plots and at their homestead. At the same time, we will capture data on household characteristics, income data, and information on where they acquired their seedlings/trees and to whom they sell trees/tree products.
- **Tree Usage and Value Survey Budget:** includes the costs associated with capturing data from farmers with mature trees (a sub-sample of those with surveyed during the tree count exercise) to capture data on how they use their trees, input costs (including labor) to tend to their trees, and information on pricing of their sale of trees and tree products – all of which will serve as inputs to the calculation of net present value of trees.
- **Tree Price Survey Budget:** includes the costs of capturing price data from both traders in whole trees and sellers of various tree and timber products, as additional inputs in the net present value calculation to triangulate with farmer-reported information.

All survey budgets include the costs of: technical and logistics preparation and local approvals ahead of data collection, as well as ongoing data quality processes during data collection and data cleaning/processing costs following data collection.

The budget reflects evaluation costs by three major time periods, aligned to the workplan provided in the technical proposal:

- **Design:** which will precede all evaluation data collection and will entail the finalization of the pre-analysis plan and the development of all evaluation instruments.
- **Baseline (Planting):** which involves a baseline timed to follow when farmers have planted new trees for the season, in order to capture data immediately following tree distribution.

- **Endline (Survival):** which involves an endline to assess tree survival, timed to come before the next planting season but following the first dry season – when the tree seedlings are most vulnerable.

All survey data will be conducted both at baseline and endline in order to account for potential seasonal variability in prices. RCT analysis will happen at both time periods, while the net present value analysis will only happen at

The following sections in this narrative describe each tab in our Financial Proposal workbook and the assumptions that inform our budget.

Total Budget
The line items of the budget are in US dollars in line with our accounting structure. Each component of the project is budgeted separately.

We are required to remit value added tax (18%) on all costs incurred Rwanda. Research advisory services in the Netherlands are exempt from VAT, given One Acre Fund's VAT registration in Rwanda.

Research
This tab outlines our assumptions for activities associated with the evaluation's technical design, as well as the analysis and reporting for each phase of the evaluation. It also includes the costs that are associated with the ongoing project management and coordination of the evaluation along its lifespan, which includes both liaising with the client team as well as with the Burundi data collection partner.

Assumptions
This tab functions as a calculator so that One Acre fund can review how costs are built up. We have stated our assumptions for each of the research components listed above: instrument design; the tree count survey; the tree usage and value survey; and the tree price survey. For each of these separately, we showcase our assumptions on: sample sizes and geographic coverage; how we plan to collect the data (enumerator team sizes and structure); how we will deliver the activities that must precede data collection (such as local approvals); and which data quality assurance processes that will be delivered alongside data collection (such as back-checks and audio audits, both of which are included for all quantitative data collection for this study.).

Design_budget
This tab builds up the costs for conducting FGDs and SSIs to gather inputs from tree farmers and sellers in tree products, respectively, that will be used during instrument design. This component will occur prior to the baseline as part of the finalization of the study design and development of the research instruments.

TreeCount_budget
This tab builds up the costs of farmer-level data for the survey of tree farmers where we will count their seedlings/young trees and capture data on household demographics and

characteristics, leveraging the assumptions on this activity in the Assumptions tab. This is also when we will capture pictures of seedlings/young trees on all of the plots that the farmer has, including their homestead. As reflected in the top sheet ("Total Budget"), these data will be collected at both baseline (assessing planting of seedlings) and endline (assessing the survival of newly planted trees.

TreeUsageValue_budget
This tab builds up the costs of farmer-level data on how farmers of mature trees use their trees, which inputs are required to sustain their trees, and what prices they have received for trees products sold as inputs into the net present value calculation, leveraging the assumptions on this activity in the Assumptions tab. As reflected in the top sheet ("Total Budget"), these data will be collected both at baseline and endline in order that usage and pricing data are not biased based on seasonality.

TreePrice_budget
This tab builds up the costs for collecting market-level price data from tree traders and sellers in tree products as inputs into the net present value calculation, leveraging the assumptions on this activity in the Assumptions tab. As reflected in the top sheet ("Total Budget"), these data will be collected both at baseline and endline in order that pricing data are not biased based on seasonality.

ANNEXES

Annex 1: CVs

Rachel Proefke

Country Director, Rwanda

Nationality: American

Rachel is a mixed methods researcher with over 8 years' experience designing and leading research studies across sub-Saharan Africa. She has particular expertise in developing methods, training and mobilizing teams, and providing technical backstopping for large-scale qualitative research projects. At Laterite Rachel oversees all Rwanda country office operations and the office's research project portfolio. Prior to joining Laterite, Rachel conducted evaluations assessing the impact of several agriculture-based livelihoods interventions and led a 7 country study on the design and adoption of agricultural technologies.

Education

2014	**American University, School of International Service** ***MA International Development*** Specialization in research methods	Washington D.C., USA
2010	**University of Washington** ***BA in International Studies, BA in English***	Seattle, USA

Experience

2022 -present	**Laterite**	Kigali, Rwanda
	Country Director, Rwanda	
	1. Lead on managing client and partners relationships and on designing research projects. 2. Provide operational leadership across the office – and technical leadership across the research portfolio. 3. Oversee Laterite Rwanda's research portfolio, including providing project management and technical backstopping to all projects, with particular emphasis on Laterite's qualitative research.	
2021 -2022	**USAID /Uganda Learning Activity (ULA), QED**	Kampala, Uganda
	Program Advisor, Education, Youth and Child Development (EYCD) Technical Office	
	4. Provided research and evaluation technical guidance to USAID's EYCD Technical Office and holistic Program Office, as well as monitoring, evaluation, and research to USAID/Uganda implementing partners. 5. Drove the development of a 5-year learning strategy for the EYCD Technical Office.	
2017 - 21	**Restless Development**	Kampala, Uganda
	Restless Uganda Acting Director (2020-21) / Senior International Research Manager (2017-20)	

	6. Acting Director: Operationalized Restless Uganda's 2-year strategic vision; responsible for quality control along the entire program lifecycle; represented Restless Uganda externally, leading on public and partner engagement; led on evidence to inform and influence policymakers and development practitioners. 7. Senior International Research Manager: Led the global research function (as many as 8 simultaneous projects) and research business development; developed and delivered research guidance, toolkits, and training for young researchers and research implementers. Provided bespoke, needs-based technical research assistance to partner organizations. 8. Provided technical leadership to the largest research project in the portfolio – the Youth Think Tank, a 5-year research initiative supporting 100 young researchers from 7 sub-Saharan Africa countries to lead 6 qualitative research studies.	
2013 - 17	**BRAC**	Kampala, Uganda
	Senior Research Associate	
	9. Worked with Director to develop the unit's strategic vision and design new research projects. 10. Provided specialized technical oversight of large-scale livelihoods and youth-focused experimental evaluations, the majority of which focused on the outcomes of agricultural income-generating activities. 11. Provided technical research and evaluation assistance to BRAC International, USA, South Sudan, and Myanmar staff. 12. Consulted with BRAC USA's ultra-poor graduation program, including providing technical assistance to the Government of Kenya.	
2015	**Socha (subgranted by QED)**	Kampala, Uganda
	Evaluation consultant	
	13. Technical consultant on a team evaluating the implementation of a USAID Activity, using a qualitative outcome harvesting/QCA approach.	
2012, 2013	**ZOA** Food Security and Thematic Program	Katigiri, South Sudan
	Evaluation Researcher | MERL Intern	
	14. In 2012, reviewed and revised the MERL system and data collection protocols for agricultural production and agribusiness outcomes. 15. In 2013, conducted in-depth qualitative analysis investigate the program's agribusiness impact pathways.	
2011-12, 2012-13	**American University**	Washington D.C., USA
	Graduate Research Assistant	

Skills

Countries of work experience: Uganda, Rwanda, Kenya, South Sudan, United States – including experience leading research projects in an additional 19 other countries in sub-Saharan Africa, South Asia, and the MENA region.

Languages: English, French (intermediate), Kiswahili (lower intermediate)

IT: Stata, NVivo, SPSS, GIS, R

Judith Bayer

Research Associate

Nationality: German

Judith has experience with quantitative and qualitative research projects and policy evaluations across a range of international development organizations, government agencies, and research institutes. She is versed in translating research insights into meaningful policy advice. Judith holds a Master of Public Administration (MPA) from the London School of Economics and a B.Sc. in International Development from Leiden University. Her specialization is in social development, economics, and public health.

At Laterite Judith is the project coordinator for the Monitoring, Evaluation and Learning partnership for the SNV regenerative agriculture project, REALMS, in Kenya and Rwanda. She is also involved in the evaluation of an early childhood development intervention in Rwanda.

Education

2017 **London School of Economics & Political Science** London, UK

MPA Public and Economic Policy, Distinction

Select courses: Political Economy of Development, Rural Development and Social Policy, Social Security Policies, Sexual and Reproductive Health Programmes, Principles of Modern Epidemiology, Micro- and Macro-economics, Methods of Economic Policy Analysis, Public Economics,

2015 **Leiden University** The Hague, Netherlands

B.Sc. in International Development, Summa Cum Laude

Select courses: Advanced Quantitative Research Methods, Key Issues in the Politics of Development: Sub-Saharan Africa, Comparative Political Economy

Experience

2020 -present **Laterite** Amsterdam, the Netherlands

Research Associate

- Coordinates the Monitoring, Evaluation and Learning partnership with the SNV regenerative agriculture project, REALMS, in Kenya and Rwanda.
- Leads the early childhood development portfolio in Rwanda.

2018 - 2021 **Netherlands Bureau for Economic Policy Analysis, Ministry of Economic Affairs** The Hague, the Netherlands

Research Officer

- Designed and conducted research and evaluations on, among others, refugees' access to psychosocial youth services, innovation in education, regional economic development, energy transition and mobility;

- Prepared policy briefs and research reports for the ministries;
- Project management: developing project plans, overseeing work progress, coordination and liaison with ministries and external partners.

2016 - 2017 **Sea-Watch e.V.** Greece & Netherlands
Project leader

- Led a team of 4 on the Aegean Humanitarian Monitoring Mission;
- Created tools to monitor the local migration and human rights situation as well as the conduct of official actors in the Aegean Sea;
- Advised the board on EU migration policies, international refugee law;
- Represented Sea-Watch in government events in the Netherlands.

2016 - 2017 **Overseas Development Institute, UK** London, UK
MPA Capstone Consultant

- Evaluated the effectiveness of a large-scale programme in DR Congo;
- Compiled, streamlined and statistically analysed programme data and two large household surveys (n=2762);
- Developed a strategy for a randomized impact evaluation for the second round of the WASH programme.Insert tasks / projects worked on

2016 **Gesellschaft für Internationale Zusammenarbeit (GIZ)** Bonn, Germany
Intern, BACKUP Health

- Performed a needs assessment for future technical assistance measures on HIV, malaria and tuberculosis as well as health system integration;
- Conducted and analysed a survey of financed projects to identify implementation challenges;
- Sketched a new strategy to improve grant and risk management of Global Fund partners.

Skills

Countries of work experience: Germany, The Netherlands, United Kingdom, Georgia, Greece

Languages: English, German, Dutch, Spanish

IT: Stata, R, SurveyCTO, Python (Basic)

Jose Rubio Valverde

Associate Economist

Nationality: Ecuadorian / Dutch

Jose is an Ecuadorian health economist working as Associate Economist for Laterite. Jose provides methodological support for study designs and analysis across Laterite's portfolio of research projects. His experience in agriculture includes studying measurement error in agronomic practice adoption among Kenyan farmers; and studying how remoteness (e.g., distance from urban areas) is associated with coffee productivity in Kenya. Jose is currently finalizing a PhD in Public Health at the Erasmus Medical Center in Rotterdam. His doctoral research is focused in international comparisons describing, explaining and projecting educational inequalities in disability and health expectancy in Europe. Prior education includes an MSc in Health Economics from the London School of Economics and a BA in Economics from Macalester College in the US.

Education

2022 — **Erasmus Medical Center** — Rotterdam, the Netherlands

PhD in Public Health

Dissertation: Educational inequalities in health expectancies in Europe: Description, explanation, projection

2014 — **London School of Economics and Political Science (LSE)** — London, UK

MSc in International Health Policy (Health Economics)

2012 — **Macalester College** — Saint Paul, Minnesota, USA

Bachelor of Arts in Economics

Thesis: The impact of anti-retroviral therapy (ART) on economic grown in sub-Saharan Africa

Experience

2022 - present — **Laterite** — Amsterdam, the Netherlands

Associate Economist

- Provide methodological support to global team
- Support professional development of research and data quality teams
- Strengthen the technical quality of our work
- Contribute to high quality external publications.

2021 -22 — **Laterite** — Amsterdam, the Netherlands

Research Analyst

- Drafted an academic paper about measurement error in agronomy
- Drafted an academic paper about coffee productivity, agronomic practices and remoteness
- Led Laterite’s GeoLab, which involved exploring the uses of geospatial data in Laterite’s work to deliver new insights and make our work more efficient.

2015 - 2020 **Erasmus Medical Center** Rotterdam, the Netherlands
Junior Researcher

- Published several academic articles in high impact public health journals
- Collected and harmonized European mortality and survey data
- Produced metadata and summary statistics
- Presented in international conferences.

2013 - 2015 **London School of Economics (LSE)** London, UK
Research Assistant

- Developed research related to non-contributory pensions in Latin America
- Performed statistical analyses and literature reviews.

2012 - 2013 **Ecuadorian Ministry of Health** Quito, Ecuador
Analyst

- Performed analyses related to traffic accidents
- Supervised monitoring tool for projects of the Vice-Ministry of Vigilance and Governance
- Interpreter (English / Spanish).

Skills

Countries of work experience: Ecuador, UK, Netherlands

Languages: English, Spanish, Dutch (fair), Portuguese (fair)

IT: Stata, QGIS

Amani Ntakirutimana

Data Manager

Nationality: Rwandan

Amani is one of the most experienced field researcher in Rwanda. He specializes in operations management, field logistics and the training of survey teams. At Laterite Amani has directly managed large survey teams and projects involving complex logistics.

Amani has worked on projects across a range of sectors including gender, public health, education, early childhood development, youth & labor, poverty, agriculture and more. Examples include leading the data collection from 1,000 smallholder farmer households for the baseline evaluation of SNV's REgenerative Agricultural practices for improved Livelihoods and MarketS (REALMS) project, in Western Rwanda. This included quantitative surveys as well as observations of farmer practices to determine use of regenerative agricultural practices.

Education

2011 — **Kigali Institute of Science and Technology** — Kigali, Rwanda

Faculty of Engineering

Bachelor of Water and Environmental Engineering

Concentration: Research in environmental impact evaluation projects

Awards: Generation Rwanda Scholar, Certificate of the Most Outstanding Student in Environmental Engineering at KIST

Experience

2014 -present — **Laterite** — Kigali, Rwanda

Data Manager

- Manage all aspects of large-scale data collection projects, including designing survey instruments for impact evaluation projects; programming questionnaires using SurveyCTO; overseeing data collection schedule and field preparation; developing field plans and budgets; coordinating and providing training and pilots; conducting back-check interviews in the field; supervising data collection; testing questionnaires and sampling strategies in the field; documenting issues that arise and communicating them to the field coordinator; securely transmitting data collected on a daily basis; and drafting a field report at the end of each project.

2013 - 14 — **The World Bank** — Kigali, Rwanda

Rwanda Branch

Field Manager Consultant

- Trained a team of 45 enumerators and 6 supervisors for a large-scale impact evaluation; piloted the questionnaire to ensure each household was visited; tested questionnaires; liaised with the management team on questions and issues that arose during field work to ensure successful completion of surveys; assisted ongoing training and provided answers to enumerator and supervisor questions; conducted independent audits; reported on the work plan and data collection to the project coordinator.

2013 **IPA Rwanda** Rusizi, Rwanda

Field Manager

- Served as Field Manager for the Community Based Environmental Health promotion program in Rusizi.
- Responsibilities included translating and piloting the questionnaire; providing feedback on pilot surveys to improve research instruments; coordinating and managing a team of 70 enumerators and ensuring management of transportation and logistics; collecting water samples and ensuring they were ready for provision to the lab; ensuring completion of the assignment by each enumerator and tracking missing households; presenting a daily report to project coordinators.

2013 **Sagaci Research** Kigali, Rwanda

Field Manager

- Recruited enumerators and field staff; translated and piloted questionnaire; provided feedback on pilot surveys to help improve research instruments used in final survey; trained team of 30 enumerators and 5 team leaders; assisted on training and answered questions from enumerators and supervisors; conducted an independent audit; reported on the work plan and data collected to the project coordinator.

Skills

Countries of work experience: Rwanda

Languages: Kinyarwanda (native), English (fluent), French (fluent), Swahili (excellent)

IT: SurveyCTO (intermediate), Stata (basic)

Denis Kamugisha

Data Quality Manager

Nationality: Rwandan

Denis works as a Data Quality Manager at Laterite. Before joining Laterite's Data Quality Team, he worked on the Data Team part time as an enumerator, field coordinator on a number of qualitative and quantitative research projects including a social protection case study for the FAO, a Winrock International study on the prevalence of child labor in tea growing areas in Rwanda and the GSMA/TIGO Rwanda Connected Women Program and then joined the Data Team full time as a Senior Field Supervisor. Recently, Denis led survey coding, data monitoring and co-led data cleaning for the baseline evaluation of a project focusing on regenerative agriculture for SNV in Kenya and Rwanda.

In addition to his work at Laterite, Denis has worked with the Institute of Policy Analysis and Research (IPAR-Rwanda) as a Research Assistant, Tigo Rwanda as a Business Research Analyst and at a local social protection NGO – Safer Rwanda as a Programs Officer.

Education

2017 **University of Rwanda** Huye, Rwanda

BSc. Applied Statistics

Experience

2022 -present **Laterite** Kigali, Rwanda

Data Quality Manager

16. Developing systems, tools and processes to improve quality control and monitoring at all stages of the research process, including field preparation, data collection and data analysis; Leading the day-to-day activities of the Quality Team, focusing in particular on: (i) the staged development of different tools, processes and systems; (ii) the ongoing work of ensuring quality control for specific components of projects; and (iii) managing teams to deliver this work, both in the office and in the field; Identifying, collecting and analyzing data from research projects to improve internal processes and data quality; Supporting the analysis and write-ups of research documents; Ensuring that timelines and benchmarks are met for our clients; Providing management support, as needed, to Senior Management; Supporting the Country Data Manager in recruiting and training the Data and Data Quality Teams, as well as the enumerator/moderator teams.
17. Example project: Led survey coding, data monitoring and co-led data cleaning for the baseline evaluation of a project focusing on regenerative agriculture for SNV in Kenya and Rwanda.

2019 -21 **Laterite** Kigali, Rwanda

Data Quality Associate

18. Devising and implementing monitoring strategies for selected projects, including the implementation of ethics and adverse event protocols; Coding complex research instruments; Leading the development/ improvement of data

quality processes, monitoring and processing tools; Administering and analyzing enumerator feedback questionnaires; Leading client engagement on small to medium projects; Supporting and onboarding Data Quality Analysts.; Supporting wider team on SurveyCTO.

19. Example project: Supported qualitative study to determine the effectiveness of the Leaders in Teaching initiative on teacher quality in secondary education in Rwanda conducted in 12 case study schools employing semi-structured interviews, visual and participatory student based activities as well as semi-narrative classroom observations.

2018 - 19 **Laterite** Kigali, Rwanda

Data Quality Analyst

20. Pro-actively supported the process of developing Laterite's Quality Team,; Developed systems, tools and processes to improve quality control and monitoring at all stages of the research process, including field preparation, data collection and data analysis; Supported the day-to-day activities of the Quality Team; Identified, collected and analyzed data from research projects to improve internal processes and data quality; Assisted in overseeing that timelines and benchmarks were met for our clients; Supported the Data Quality Manager in recruiting and training the Data Quality Teams, as well as the enumerator/moderator teams; Pro-actively improved knowledge of analytic tools, including Survey CTO and Stata.

2016 - 17 **Laterite** Kigali, Rwanda

Senior Field Supervisor

21. Data lead on several projects, including the Comprehensive Evaluation of the Community Health Program in Rwanda project for the Liverpool School of Tropical Medicine. Tasks included: survey programming, compiling training materials, organizing training logistics, training enumerators, field supervision and troubleshooting issues in the field, as well field reporting.

2015 - 16 **Millicom International Cellular (Tigo Rwanda)** Kigali, Rwanda

Business Research Analyst

22. Quantitative: Translation of brand tracker instruments; Supervision of brand tracker enumerator teams; Designing service centre and call centre surveys in Survey Monkey; Analysis (using pivot tables in excel) of service centre and call centre survey data & reporting to management
23. Qualitative: Moderation of focus group discussions (FGDs); Compiling FGD notes and analysis; Reporting recommendations to management.

Skills

Countries of work experience: Rwanda

Languages: English, Kinyarwanda, French, Luganda, Runyankore

IT: SurveyCTO, Stata, Power BI

Annex 2: References

References for relevant projects are listed below.

Project	Contact
One Acre Fund Randomized Control Trial (RCT) evaluation of the Grevillea Tree Program in Kenya (2018 – 21)	Haley Kawaja - Deputy Director, Product Innovations, One Acre Fund haley.kawaja@oneacrefund.org
HereWeGrow RCT evaluation of two additional support programs (Farm Support and Farm Ambassador) offered to farmers after the conclusion of the TechnoServe Coffee Farm College (2021 – 22)	Tobias Voigt – Monitoring and Evaluation Manager, HereWeGrow tvoigt@herewegrow.org
TechnoServe Long-term learning partners on East Africa coffee initiative, developing the program's monitoring & evaluation and impact evaluation strategy (2016 – ongoing)	Carole Hemmings – Global Coffee Sustainability Director, TechnoServe chemmings@tns.org

Annex 3: Sample reports

We have also attached the following sample reports:

- One Acre Fund tree program: endline report – available online
- Study of smallholder farmers' willingness to pay for crop micro-insurance in Ethiopia for the Global Green Growth Institute – full report and policy brief available online
- Evaluation report from a study of the effectiveness of incentives to increase the adoption of stumping (a rejuvenation practice) in Ethiopia for HereWeGrow – submitted separately (please keep this document confidential, as it has not yet been shared publicly).

Annex 4: Sample size calculations

Table 6. Overview estimated sample size by species for incremental trees survived.

Tree species	Parameters	Sample Size	Number of clusters	MDE with sample size (n=3.000)
Grevillea Observations: T=401, C=133 (Timber/Poles)	Mean Control = 3.8 Mean Treated = 8.4 **MDE=4.6 trees** SD Control=9.5 SD Treated = 7.5 M=50 individuals per cluster ICC=0.13	**Total 900** Treatment: 450 Control: 450	**Total 18 cells** Treatment: 9 cells Control: 9 cells	**MDE=2.4 trees**
Calliandra Observations: T=123, C=48 (Shrubs)	Mean Control=3.2 Mean Treated=4.0 **MDE=0.8 trees** SD Control=6.7 SD Treated = 5.6 M=50 individuals per cluster ICC=0.13	**Total 12,800** Treatment: 6,400 Control: 6,400	**Total 256** Treatment: 128 cells Control: 128 cells	**MDE=2.3 trees**
Cedrella Observations: T=88, C=4 (Light wood/ medicine/fodder)	Mean Control=1.3 Mean Treated=1.9 **MDE=0.6 trees** SD Control=2.3 SD Treated = 2.5 M=50 individuals per cluster ICC=0.13	**Total 3,200** Treatment: 1,600 Control: 1,600	**Total 64** Treatment: 32 cells Control: 32 cells	**MDE=0.9 trees**
Senna Observations: T=8, C=3 (Light wood/ ornamental)	Mean Control=2 Mean Treated=1.8 **MDE=-0.2 trees** SD Control=2 SD Treated = 2.8 M=50 individuals per cluster ICC=0.01	**Total 7,000** Treatment: 3,500 Control: 3,500	**Total 140** Treatment: 70 cells Control: 70 cells	**MDE=0.6 trees**
No native species and fruit data				

Table 7. Overview estimated sample size by species for incremental trees planted.

Tree species	Parameters	Sample Size	Number of clusters	MDE with sample size (n=3.000)
Grevillea Observations: T=410, C=1,116 (Timber/Poles)	Mean Control=1.2 Mean Treated=10.1 **MDE=8.9 trees** SD Control=8.3 SD Treated = 4.5 M=50 individuals per cluster ICC=0.13	**Total 200** Treatment: 100 Control: 100	**Total 4 cells** Treatment: 2 cells Control: 2 cells	**MDE=1.9 trees**
Calliandra	Mean Control=0.3	**Total 1,100**	**Total 22**	**MDE=1.0 trees**

Observations: T=421, C=1,119 (Shrubs)	Mean Treated=2.0 **MDE=1.7 trees** SD Control=2.3 SD Treated = 4.5 M=50 individuals per cluster ICC=0.13	Treatment: 550 Control: 550	Treatment: 11 cells Control: 11 cells	
Cedrella Observations: T=421, C=1,119 (Light wood/ medicine/fodder)	Mean Control=0.3 Mean Treated=2.0 **MDE=1.7 trees** SD Control=2.3 SD Treated = 4.5 M=50 individuals per cluster ICC=0.25	**Total 1,100** Treatment: 550 Control: 550	**Total 22** Treatment: 11 cells Control: 11 cells	**MDE=1.0 trees**
Senna Observations: T=425, C=1,113 (Light wood/ ornamental)	Mean Control=0.01 Mean Treated=0.12 **MDE=0.1 trees** SD Control=0.3 SD Treated = 0.8 M=50 individuals per cluster ICC=0.01	**Total 1,600** Treatment: 800 Control: 800	**Total 32** Treatment: 16 cells Control: 16 cells	**MDE=0.08 trees**
No native species and fruit data				

Tree species	Parameters	Sample Size	Number of clusters	MDE with sample size (n=3.000)
Non-OAF tree Observations, all farmers: T=835, C=933 (Timber/Poles)	Mean Control=1.71 Mean Treated=1.72 **MDE=0.01 USD** SD Control=20.7 SD Treated = 29.1 M=50 individuals per cluster ICC=0.08	**Total >100k** Treatment: >100k Control: >100k	**Total >1000 cells** Treatment: >1000 cells Control: >1000 cells	**MDE=5.65 USD**
Non-OAF tree Observations, only farmers that planted at least one of the non-1AF species: T=10, C=10 (Timber/Poles)	Mean Control=159.86 Mean Treated=143.53 **MDE=16 USD** SD Control=243 SD Treated =132 M=50 individuals per cluster ICC=0.08	**Total 23,100** Treatment: 11,550 Control: 11,550	**Total >1000 cells** Treatment: 231 cells Control: 231 cells	**MDE=44 USD**
Excluding fruit trees:				
Non-OAF tree	Mean Control=4.76 Mean Treated=7.23	**Total 3,400**	**Total** 68 Treatment: 34 cells	**MDE= 2.61**

Observations, only farmers that planted at least one of the non-1AF species: T=10, C=10 (Timber/Poles)	**MDE=2.47 trees** SD Control=6.34 SD Treated =10.53 M=50 individuals per cluster ICC=0.155	Treatment: 1,700 Control: 1,700	Control: 34 cells	

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From data to policy