TENURE AND GLOBAL CLIMATE CHANGE (TGCC) ZAMBIA PILOT IMPACT EVALUATION

Pre-Analysis Plan

APRIL 2017

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CONTENTS

ACRONYMS AND ABBREVIATIONS

ATE	Average Treatment Effect
CDLA	Chipata District Land Alliance
CO	Contracts Officer
COMACO	Community Markets for Conservation
COP	Chief of Party
COR	Contracts Officer's Representative
CSA	Climate Smart Agriculture
ERC	Evaluation, Research, and Communication
IDIQ	Indefinite Delivery Indefinite Quantity Contract
IE	Impact Evaluation
IRB	Institutional Review Board
ITT	Intent to Treat
LTD	Land Tenure Division
LTPR	Land Tenure and Property Rights
M&E	Monitoring and Evaluation
MDES	minimum detectable effect size
RALS	Rural Agricultural Livelihoods Survey
SSA	sub-Saharan Africa
STARR	Strengthening Tenure and Resource Rights
TGCC	Tenure and Global Climate Change
TGCC	Tenure and Global Climate Change
TOT	Treatment on the Treated
USAID	United States Agency for International Development
USG	United States Government

INTRODUCTION

The USAID Tenure and Global Climate Change (TGCC) Zambia Climate Smart Agriculture (CSA) pilot is a 2.5-year intervention designed to increase tenure security while also supporting agroforestry extension services. The TGCC pilot is being implemented in Chipata District, one of eight districts of Zambia's Eastern Province, from late summer 2014 through the end of 2016. TGCC is a global program created by USAID to explore the relationship between secure resource tenure and the achievement of climate change adaptation and mitigation goals. In Zambia, TGCC will support activities that increase tenure security at the chiefdom, village, and household levels, while also supporting agroforestry extension services, primarily at the village level. The work also addresses USAID/Zambia's objectives of improving governance, reducing rural poverty through increased smallholder agriculture productivity, improving natural resource management, and improving the resilience of vulnerable households.

The TGCC interventions that comprise the impact evaluation's (IE's) focus are:

1. Agroforestry extension in villages to facilitate tree planting adoption and survivorship on smallholder farms; and
2. A village-level land tenure intervention consisting of participatory mapping, village headperson land administration support, provision of land information and dispute resolution training, including the facilitation of customary land use certificates for households[1].

The primary objective of the IE is to determine whether the village and household land tenure interventions under TGCC strengthen the security of land tenure and resource rights for smallholders, thereby increasing farmer investment in sustainable agroforestry and uptake of other CSA practices. The overarching policy question of interest is: "How do changes in property rights that strengthen a farmer's perception of long term security over farmland affect a farmer's decision to practice climate smart agriculture, including agroforestry, on their own farms?" The evaluation breaks this into two key research questions for hypothesis testing. First, does the intervention strengthen farmer's perception of tenure security? And assuming it does, does it make the farmer more willing to adopt climate-smart agriculture.

This document describes the endline analysis plan for the TGCC Zambia Pilot IE. The plan serves as an important guide for assessing the rigor and validity of the final analysis, as the authors will complete and register the plan prior to the collection of endline data. The pre-analysis plan is structured as follows: Sections 1 and 2 provide the research motivation and background. Section 3 presents details of the experimental design. Sections 4 and 5 describe the data and indicators used for hypotheses testing. Sections 6 and 7 outline the empirical strategy. Section 8 covers the ethical considerations. And Section 9 lays out the estimated deliverable schedule.

1 The certificates confirm the right to use the land but not to sell it.

1.0 BACKGROUND

Land tenure security and property rights governance issues have long been a central focus for a range of rural development initiatives in sub-Saharan Africa (SSA) that address poverty reduction, agricultural livelihoods, natural resource management, and gender disparities, among other issues. To motivate the evaluation, this section provides some brief background on land tenure and administration in the Zambian context. It discusses agroforestry as a risk-smoothing activity and form of climate smart agriculture. It considers several known barriers to agroforestry adoption in SSA and examines research on programs and policies in tenure security and agricultural investment.

LAND TENURE AND ADMINISTRATION

Smallholder farmers, particularly in Zambia's Eastern Province, grow subsistence crops of maize, as well as cash crops of cotton and tobacco on customary lands controlled by local chiefs. USAID investments have long focused on improving agricultural production and increasing access to markets. While there has been a great deal of USAID and other donor research on constraints facing smallholder farmers, we do not fully understand the influence of resource tenure and the effects of tenure security on smallholder investment in long-term land productivity in the country. A number of Zambian legal and customary practices related to resource rights could be acting as disincentives to smallholder investment.

The 1995 Land Act of Zambia vests all land in the Zambian President and recognizes only two types of land: customary and state land. State land includes all land occupied by the national government, as well as land held by individuals who lease the land from the state, including those lands that previously were freehold estates. Customary land, which under the law is administered by chiefs, represents the remainder of land in Zambia, estimated at between 66 and 95 percent of land.

While it does not specifically define property rights in land, the Zambian Constitution of 1991 does recognize individual property rights and protects those rights against deprivation by the government, except in cases authorized by law. Customary lands, which are not registered with the government, are largely regulated outside the statutory and official realm of Zambian government. Local chiefs have the authority to administer customary land within their chiefdoms. The traditional leaders grant use and occupancy rights, regulate transfers of land, control use of communal land, and hear disputes (Tetra Tech, 2014).

Customary lands in Zambia therefore fall under the complete control of the chiefs. The chiefs exercise this authority through their headmen/women (often more than 300 per chiefdom) and are advised by a council of *indunas* consisting of a dozen to a few dozen individuals. At the local level, the headmen who have direct authority over the villages within their domain make local land allocations.

Individual smallholders commonly have no documentation of their rights to land, which can result in complex land disputes over boundaries or defense of rights in the event of divorce, death of a family member or arbitrary reallocation of land by chiefs or headman. (Chiefs may make such allocations, for instance, to other villagers or to outside investors via the conversion of customary lands to title deeds.)

Both traditional leaders and subjects are increasingly attuned to the use of documentation, such as customary land certificates, as a mechanism to increase household security over occupancy rights to land and to help resolve conflicts.

Uncertainties over land allocation processes within villages also contribute to ongoing land conflicts. Insufficient access to arable land is a recognized driver of continued impoverishment in rural areas of Zambia (Jayne, T.S., B. Zulu, G. Kajoba, 2009). Prior research points to large variation in farmer landholdings among village households, significant numbers of land-constrained households even in villages where unallocated land is present, and widely varying perceptions around land availability and ease of acquisition of land for farm expansion. Although many factors are likely to feed into such variations, key characteristics include relations to local headmen; distance to markets, roads and district administrative centers; and whether a household is female headed (Jayne, T.S., B. Zulu, G. Kajoba, 2009).

AGROFORESTRY

Agricultural production supports the livelihood of over 70 percent of Zambia's population, including 78 percent of women. Relative to other countries in the region, Zambia, and in particular Eastern Province, has an abundance of fertile land, water, and a favorable climate for agricultural production. Yet, despite these favorable conditions, 80 percent of rural Zambians live in extreme poverty, and stunting and malnutrition impact rural communities at much higher rates than their urban counterparts (Sitko et al., 2011). Individual land holdings are, on average, small and a quarter of the rural population nationwide farms on only one hectare of land (Sitko et al., 2011). The primary crop grown is corn, and for most farmers it is the only crop they grow, which makes them very vulnerable to weather conditions or pests that damage the crop. Yields for crops in Zambia are well below global averages, and despite efforts by the Zambian government and NGOs, adoption rates for chemical fertilizer, hybrid maize seeds, herbicide, and other agricultural investments remain low (Sitko et al., 2011).

Agroforestry is widely perceived as a longer-term sustainable land use practice that can help to meet a range of rural development objectives related to improved land use and farmer livelihoods throughout sub-Saharan Africa. Decades of existing research points to a range of realized or expected farmer benefits from agroforestry investment, including increased crop productivity and reduced variability in yields through such outcomes as increased soil fertility; improved livelihoods from higher and more reliable farm income; risk smoothing through crop diversification; and additional direct benefits provided by trees on farms, such as fuel, wood or fodder (Franzel, Coe, Cooper, Place, & Scherr, 2001; Mbow, Van Noordwijk, et al., 2014; Mercer, 2004). However, several barriers to widespread agroforestry adoption persist.

Prior research has tended to emphasize identifying the biophysical properties and benefits of agroforestry systems rather than examining cultural, demographic, and socioeconomic factors that might impede wider adoption (Ajayi, 2007; Sirrine, Shennan, & Sirrine, 2010). Other barriers to adoption include the financial outlay required, explicit and implicit investments in labor, and the extent to which farmers have the necessary technical knowledge and skills to establish trees on farms and effectively engage in agroforestry. Compared with annual crops, trees require longer periods to produce mature crops — five to eight years for the Msangu and Gliricida trees contemplated in this intervention. These longer time frames may influence the decisions of farmers to engage in such planting, especially given that decisions to plant trees may be influenced by perceived tenure security and expectations about access to and control of the land over longer planning horizons.

Despite decades of advancements in agroforestry research, low adoption rates across the tropics continue to serve as a substantial barrier to wider realization of agroforestry benefits as well as to the theorized improvement in rural development outcomes (Franzel et al., 2001; Mercer, 2004). In more recent years, heightened awareness over projected negative effects of climate change across the region has promoted enhanced interest and effort for expanding agroforestry efforts in sub-Saharan Africa. Advocates of this approach cite it as a type of longer-term sustainable land use that can not only improve farmers' livelihoods but also enable more effective adaptation and mitigation responses to climate-change impacts in already food-insecure regions of the continent (Mbow, Van Noordwijk, et al., 2014).

Favorable Zambian agricultural policy has encouraged CSA, and a number of organizations have actively promoted conservation agriculture and agroforestry, especially in Eastern Province. However, uptake of CSA practices, in particular agroforestry, remains limited. Statistics analyzed from the 2012 Rural Agricultural Livelihoods Survey (RALS) from Chipata District show agroforestry species were planted on 6 percent of fields (N=84) and in 8 percent of households (n=31) surveyed.[2]

Existing syntheses of agroforestry adoption tend to focus broadly on five categories of factors: farmer preferences, resource endowments, market incentives, biophysical factors and risk/uncertainty (Pattanayak, Mercer, Sills, & Yang, 2003). Agroforestry can act as a mechanism for diversification of a farming portfolio. Farmers may use trees to complement rather than replace their crop-planted acreage, for example, through nitrogen-fixing legumes that provide additional nutrients to the soil. They may use trees to improve soil management in order to improve yields or reduce risk. Uncertainty over land security, however, has implications for undertaking investments with future payoffs and may limit incentives that rely on a long time horizon. As a result, the lack of security effectively serves as a disincentive for farmers to engage in agroforestry, who must factor in the required upfront financial, labor and other investments; as well as delays of several years to realize expected soil fertility, yield, livelihoods and other benefits (Mbow, Smith, Skole, Duguma, & Bustamante, 2014).

In their 2003 meta-analyses of barriers to agroforestry adoption across 32 empirical case studies, Pattanayak et al. identified tenure security and extension support as two of the most important determinates of increased agroforestry uptake (finding tenure security significant in 72 percent and extension support significant in 90 percent of cases that included these factors in their analyses) (Pattanayak et al., 2003). Wealth-based and gender aspects of agroforestry uptake are also reported in a number of studies across the sub-Saharan region, suggesting a particular need for monitoring, as well as targeted activities to support women's access to, and representation within, such extension activities (Kiptot, Franzel, & Degrande, 2014; Phiri et al., 2004). Additional disadvantages emerge around women's frequently greater insecurity over land and tree resources, as well as their access to labor, capital and knowledge services (Kiptot et al., 2014).

LINKED LAND TENURE AND AGROFORESTRY INVESTMENT

In sub-Saharan Africa, many questions remain around the efficacy of a number of activities that are hypothesized to strengthen farmer perceptions of the tenure security of their farm holdings. Also as yet undetermined is the extent to which strengthened land tenure security incentivizes farmers to undertake longer-term sustainable land use investments such as agroforestry. Recent literature has paid

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2 If missing responses are included at the field level, the RALS data shows agroforestry planted on only 5 percent of fields.

particular attention to the role of customary land titles as a means of strengthening smallholder perceptions of security of tenure, and to alter their land use decision-making strategies to undertake longer-term land investments in sub-Saharan Africa (Place & Otsuka, 2001; Smith, 2004). Some studies have found very strong evidence of positive impacts (Deininger, Ali, & Alemu, 2011; Deininger & Jin, 2006). However, to date no clear consensus has emerged from empirical studies across varying SSA contexts on whether and how stronger land tenure security may, as a whole, incentivize farmer decision-making and pursuit of different land investment strategies on their farms (Place, 2009).

The TGCC IE is designed to address these evidence and knowledge gaps by rigorously assessing the direct and joint impacts of the agroforestry extension intervention and tenure security strengthening interventions on three main types of outcomes. These categories are:

1. Changes in household perceptions of tenure security over their smallholdings;
2. Planned and actual agricultural investment and other land use plans resulting from perceived tenure security, including improved adoption of agroforestry and related CSA activities; and
3. Distal outcomes around agricultural productivity and livelihood improvements, which are expected to flow from the interventions over longer time horizons and are of broader interest to USAID.

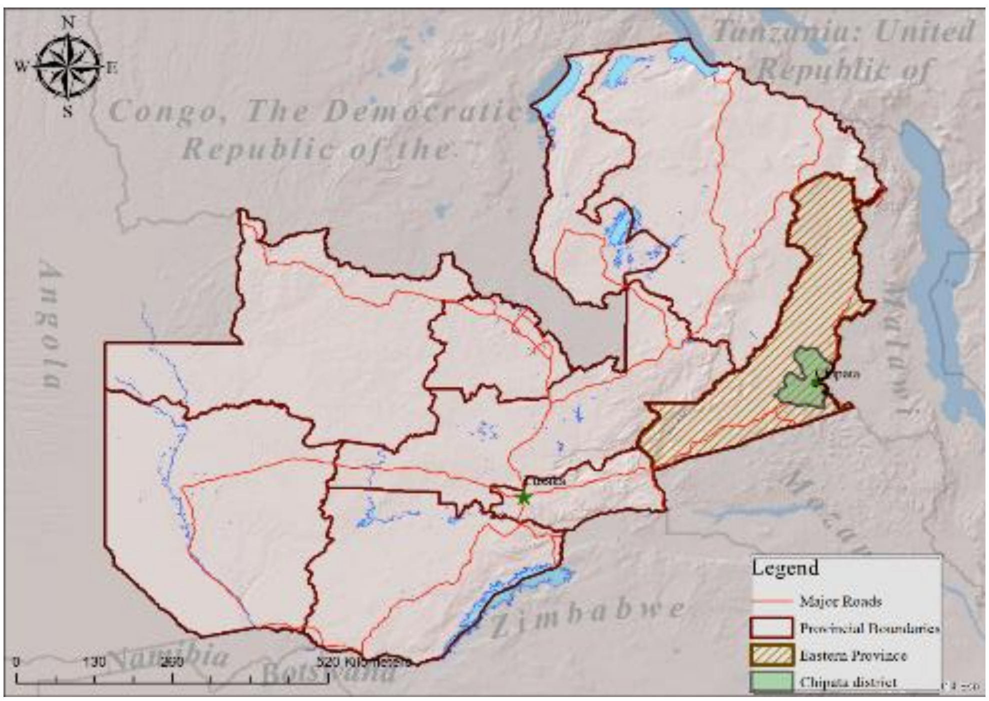
The IE will also advance understanding of several secondary questions:

1. Do chief- and village-level tenure strengthening activities around sustainable land use planning, participatory village mapping, and clarified land allocation processes reduce land disputes within villages?
2. To what extent do improvements in village land management, allocation and adjudication processes contribute to more positive perception of tenure security over farmland, as well as encourage the adoption of longer-term CSA land uses, including agroforestry and soil and water conservation?
3. Are land tenure strengthening activities alone sufficient to change farmer behavior towards greater agroforestry uptake, or is it necessary to couple land tenure strengthening with agroforestry extension in order to see significant change in agroforestry uptake rates?
4. Given existing relevant information, technical and institutional barriers to agroforestry, how does improved farmer access to agroforestry knowledge, inputs and related extension resources alone (absent any land tenure intervention) affect farmer decisions to engage in agroforestry?
5. How does improved farmer access to agro-forestry extension resources additionally impact a farmer’s decision to engage in agro-forestry?

2.0 INTERVENTION OVERVIEW

TGCC was implemented over a 2.5-year period, beginning in the third quarter of 2014, across five chiefdoms in Chipata District of Eastern Province, Zambia. The chiefdoms are: Mnukwa, Mkanda, Mshawa, Maguya, and Saili. Figure 1 below presents a map of Zambia with Eastern Province and the study area highlighted.

FIGURE 1. TGCC STUDY AREA, CHIPATA DISTRICT



The TGCC interventions that are the focus for the IE include:

1. A village-level land tenure intervention consisting of participatory mapping, village headperson land administration support, and provision of land information and dispute resolution training, including the facilitation of customary land use certificates for households. This intervention was implemented by the Chipata District Land Alliance (CDLA), a community based organization.[3]

3 DLAs, such as the CDLA, are community-based organizations, founded under the broader umbrella consortium of the national Zambia Land Alliance. They promote greater security of land access and ownership via advocacy activities and community outreach in their respective districts of operation.

2. Agroforestry extension in villages to facilitate tree planting adoption and survivorship on smallholder farms, implemented by the NGO Community Markets for Conservation (COMACO).

TENURE SECURITY STRENGTHENING INTERVENTION

The land-tenure intervention was implemented by the Chipata District Land Alliance (CDLA) in four chiefdoms: Mnukwa, Mkanda, Mshawa, and Maguya. The interventions aimed at strengthening tenure consist of a set of activities that took place at the chiefdom, village and household levels. Although the land-tenure interventions involve activities at each of the three levels (chiefdom, village, and household i.e. micro-level), the IE focuses on identifying the effects of the village and household-level interventions. A description of the land tenure intervention at each level is provided below:

Chiefdom level:

The chiefdom-level activities aim to increase transparency of land allocation, administration and decision processes and to strengthen smallholder rights to land and trees by:

- Facilitating a dialogue on land use management and improved tenure governance with chiefs and their *indunas* (advisory councils);
- Identifying and developing opportunities to make decisions on land allocation and land disputes more transparent;
- Chiefdom level mapping of customary resources within the Chiefdom, particularly communal resources;
- Supporting the Chief through facilitating the delivery of household/family level customary land certificates, following a boundary clarification process;
- Documenting customary rules around land administration and management; and
- Providing basic training in administrative support, such as record keeping and map reading, where relevant.

Village and household level:

Activities under the land tenure intervention consisted of establishing Village Land Committees (VLCs), conducting participatory mapping, and facilitating the issuance of customary land certificates.

These efforts consisted of:

- Holding community workshops to establish VLCs;
    - Half of the members of the VLC were required by CDLA to be women. However, the recruitment of women proved to be more difficult, as women did not readily volunteer. Instead, village leadership would suggest women, and the women had to be told that the role was mandatory.
- Providing training to VLCs about land management, conflict resolution, customary land certificates, and the customary land certification process.
- Conducting participatory mapping through the development of a common village map that can be used as a tool by headmen when allocating land.
- VLCs and CDLA providing households with information on land law and rights, as well as information about customary land certificates.

- VLCs and CDLA facilitating the process for households to obtain customary land use certificates. Women's names could be listed as the primary or joint land holder, depending on the preferences of the household. The certification process included:
  - Demarcation of land through boundary walks;
  - Adjudication and support for land dispute resolution;
  - Providing opportunities to review maps of their individual plot boundaries and the village boundaries and request changes;
  - Distribution of land certificates that confirm the right to use the land, but not to sell it; and,
  - Ongoing support to post-certification activities in Chipata.

AGROFORESTRY EXTENSION INTERVENTION

Through the agroforestry intervention, an extension agent provides support related to planting and establishment of *Msangu* (*Faidherbia albida*) trees and/or *Gliricidia* on cropland. The agroforestry intervention is primarily focused on activities at the village level but also includes basic interactions with chiefs at the chiefdom level. The agroforestry and land tenure interventions were implemented through a randomized field experiment in four chiefdoms: Mnukwa, Mkanda, Mshawa, and Maguya.

Because membership in the Agroforestry group is linked to the amount of inputs received, there are limits on the number of household members who can officially join the agroforestry group. For each one lima of land a household owns, one member may join. This member is typically the household head, but does not have to be. Household members who are not official members are welcome to attend meetings and trainings, and frequently, a household head sends his wife to attend training. Married women were unlikely to join independently from their husbands, though they were allowed to if they wished. Female headed households were as likely as male headed households to join, and when women did join, they were more likely to participate in meetings and trainings then men.

The fifth chiefdom, Saili, was added to serve as a 'pure' control for evaluating the impacts of the agroforestry intervention because no chiefdom level interventions took place in Saili. Therefore, unlike the other four chiefdoms which contain a mix of control villages as well as villages that received the land and agroforestry interventions, Saili *only* contains villages that received the agroforestry treatment.

Village and household level:

Activities under the agroforestry intervention consisted of establishing Farmer Groups in treatment villages, establishing nurseries and distributing seedlings, and providing training and agricultural extension support services about agroforestry to farmer groups.

These efforts included:

- Conducting awareness meetings with chiefs and headmen;
- Forming village-level farmer groups open to any household in the village;
- Facilitating the use of lead farmers to disseminate information within their villages
- Leading trainings on agroforestry with farmer groups;
- Distributing high-quality *Gliricidia* and *Msangu* seedlings and supplies for nurseries;

- Leading additional trainings on nursery management and field establishment, including information on best planting times, sites, and intercropping;
- Assisting with field-planting crops and trees and promote best practices to ensure seedlings are protected during establishment;
- Providing additional resources, such as groundnut seeds[4] or wells,[5] as necessary; and,
- Collecting monitoring data on seed/seedling planting, survival, and threats through TGCC mobile data collection units.

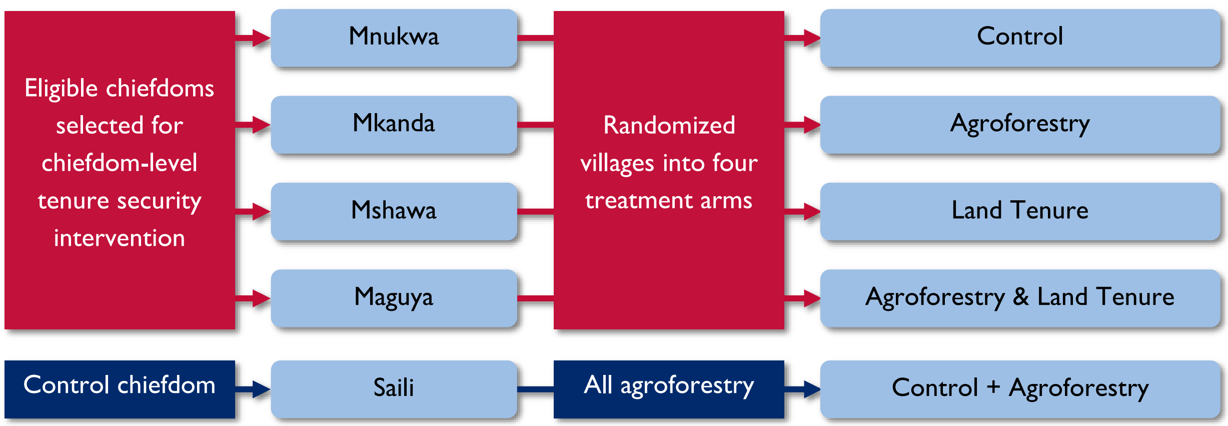
4 In year 2, every village was given access to a groundnut "seed fund" to provide groundnut seeds to households who wished to intercrop their trees with groundnuts. This was not part of the original intervention design, but developed organically from community needs.
5 As a result of severe water shortages that threatened seedling survival, 47 communities were provided with a well as part of the agroforestry intervention.

3.0 RESEARCH DESIGN

FACTORIAL DESIGN

The study utilizes a factorial design to test the impacts of each component of the program, in addition to the marginal impact of strengthening land tenure on agroforestry and investment outcomes. To assess the individual and joint effect of each of the tenure and agroforestry interventions, the evaluation design is a four-arm village-level RCT. Figure 2 illustrates the four treatment arms of the IE, consisting of the different interventions or combination of interventions that treatment villages received (agroforestry extension, tenure-security strengthening activities, or both). Villages were randomized into these four treatments across four chiefdoms: Mnukwa, Mkanda, Mshawa, and Maguya. A comparison of findings in agroforestry villages versus control and land tenure versus control provides the average program impact on each of these components. The comparison of the average outcomes in the group receiving both program components provides evidence about the additional effect of land tenure certification in promoting investment and CSA.

FIGURE 2. PROGRAM IMPLEMENTATION DESIGN



In Saili, no chiefdom level land tenure activities were complete and there are no villages that received the land tenure intervention. Saili is not included in the RCT, as no interventions were randomized across this chiefdom. Instead, the villages in the Saili chiefdom only received an agroforestry intervention. The main objective of studying the impact of the agroforestry program in Saili is to better understand the impact of the chiefdom-level land-tenure intervention by comparing the "Agroforestry" group in the RCT with the "Agroforestry Control" group in Saili. Also, by comparing Saili with the main RCT sample we can measure spillovers or what economists sometimes call "general equilibrium effects."

SAMPLING

There were three levels of sampling—chiefdom, village, and household. Four chiefdoms were selected in the Chipata district for the RCT: Mnukwa, Mkanda, Mshawa, and Maguya. Chiefdoms with past, ongoing, or planned agroforestry extension problems or COMACO programing were excluded to ensure that the selected chiefdoms were as similar as possible on the characteristics most relevant to the desired program outcomes. As described above, separate from the RCT design, Saili was selected as the 5th chiefdom to serve as an agroforestry control with no chiefdom-level interventions.

From the 5 chiefdoms involved in the study, a village list was collected from each chief of all villages that contained 15 or more households and were accessible by motorbike during the rainy season. These criteria were used to facilitate program implementation and the inclusion of villages with the desired sample size.

The proposed sample size for the original RCT evaluation design was 300 villages, with 75 villages in each treatment arm and 50 additional villages in the "Agroforestry Control" arm of Saili Chiefdom. However, there were only 276 total villages on the village list received from chiefs. Therefore, the evaluation included all villages on the list in the sample. Each of these villages was randomly assigned to one of the four treatment arms: Control (69 villages), Agroforestry (69 villages), Land Tenure (69 villages), or Agroforestry + Land Tenure (69 villages). The sample was stratified by chiefdom so that each of these four groups is appropriately represented in each of the chiefdoms. An additional 50 villages were randomly selected from a village list prepared by the chief in the "Agroforestry Control" arm of Saili Chiefdom.

TGCC CERTIFICATE DISTRIBUTION

The distribution of certificates to households at the time of the endline survey represents an important deviation from the original TGCC IE research design. In particular, although all chiefs and villages completed the customary land certification *process*, several chiefs have not signed and distributed certificates to households in their villages. As a result, certificates will not be distributed to all households by the period of the endline survey data collection. As of April 2017, the breakdown of certificate distribution across chiefdoms is as follows: Mkanda (complete); Maguya (ongoing, completion expected by endline data collection); Mnukwa (distribution possible but unlikely by endline); and Mshawa (distribution will not take place by endline).

Despite this deviation, the research seeks to capitalize on the study design to explore differences in outcomes across households that received certificates versus those who completed the process but did not receive a physical certificate. Based on inputs from TGCC, the evaluation team included a series of questions in the household survey to assess household level of engagement in the customary land mapping process. This set of questions will be used to develop a weighted index of participation to provide an even more nuanced understanding of how varying levels of engagement with the program impacted outcomes of interest.

The randomization of villages within chiefdoms enables this analysis and prevents the inconsistent distribution of certificates across chiefdoms from affecting the validity of the evaluation design. We anticipate that this additional sub-group analysis will be highly valuable to policy makers and implements, as the results will seek to quantify the added benefits of household receiving physical certificates, as well as the marginal benefits from various levels of engagement.

To determine whether there is sufficient power for this sub-group analysis, we conducted a series of power calculations that assume varying levels of certificate distribution. In these scenarios, we built datasets from the baseline data consisting of the entire control group, and a random sample of one-half or one-third of households for treatment groups that received land tenure programming. Next, we ran power calculations on a series of key tenure security and governance indicators and repeated this process 100 times, averaging the results.

While the number of treated respondents has been reduced by half, the minimum detectable effect size (MDES) did not double. For the land tenure group, we see an increase in MDES by 0.02 to 0.04 points per indicator. The results for the agroforestry + land tenure group are similar—with an increase in MDES around 0.02 to 0.04. Again the agroforestry + land tenure group is slightly larger, so the MDES is slightly better overall, but not substantially different. *Overall, the MDES change is not alarming and the study has sufficient power to detect sub group effects.*

Likewise, when losing one-third of treated respondents, the MDES does not triple. However, there is an additional increase in MDES of about 0.03 points for both the land tenure, and agroforestry + land tenure groups.

For more information, please see the power calculations in Annex 4.

4.0 DATA

DATA SOURCES

Baseline and endline data collection use five primary data collection instruments: (1) household survey, (2) headperson survey, (3) land-tenure key informant interview, (4) agroforestry key informant interview, and (5) focus group protocol for women, youth, and land-constrained households. Whereas the two key informant interviews were originally designed as qualitative instruments for baseline, for the endline data collection these were updated and redesigned as quantitative instruments. The evaluation also relies on secondary data from project M&E and geospatial data.

QUANTITATIVE DATA SOURCES

For endline data collection, the household and headperson surveys, as well as two key informant interviews, are structured quantitative instruments. The household survey collects data on a number of measures including livelihoods, local resource governance, land tenure, land conflict, climate-smart agricultural practices and investment, in addition to basic social, economic, and demographic characteristics. The headperson survey includes modules on land conflict, land tenure, and agroforestry.

The land tenure and agroforestry key informant interviews are directed to a member of the Village Land Committee and the COMACO Yield Group Leader, respectively. These surveys seek to enhance our understanding of how the land tenure and agroforestry interventions were implemented, and include questions related to village land committees, customary land certificates, and agroforestry activities.

For the baseline data collection, in each village, field-team supervisors created a sampling frame of households for random selection. The supervisors recorded data in each village about household size and the numbers of households available in each of the key strata into mobile tablets. The strata of interest included female-headed households, households with tin roofs (a proxy for income), and whether the household was the same tribe as the village headman. Women were surveyed if they were the head of household, or if their male spouse was unavailable at the time of the interview. In villages with more than 15 households, a Python script was run to determine the selection of households. There are an average of 13 households in each village, with a mean of 4 female-headed households, 4 with tin or iron roofs, and 3 households where the respondent is not the same tribe as the village headperson.

The household and headperson surveys were collected using electronic data collection. Baseline data was collected using Open Data Kit, and structured surveys for the endline will be collected using SurveyCTO, a similar but more customizable computer-assisted interviewing platform.

Baseline data was collected by a Zambian survey firm, Rural Net, in the local language of Chinyanja, in close cooperation with ERC. Training consisted of a seven-day training-of-the-trainers led by the ERC Country Coordinator, and an eight-day training for enumerators, concluding with a pilot activity in the survey area, overseen by the Country Coordinator. Baseline data collection took place over eight weeks from mid-June 2014 to mid-August 2014.

Endline data collection will follow a similar training process and is scheduled for implementation from June-August 2017. Baseline survey respondents will be re-interviewed at endline. The survey firm will be provided with baseline respondent names, nicknames, NRC numbers, and age to help identify the correct respondent. The endline survey has additional checks to confirm the respondent interviewed is the same person, including comparing the respondent's tribe and years of education to ensure the information matches. The survey firm will attempt three visits to each respondent before replacing the respondent with a new household from the village.

Similar to baseline data collection, endline data collection will undergo a series of quality checks. These include audits of 15% of surveys, supervisor spotchecks of 10% of surveys, and a series of high frequency checks conducted by Cloudburst to screen the data for irregularities as data collection progresses. Please refer to Section 6 for more details about the evaluation timeline and deliverable schedule.

Once all endline quantitative data is collected from the field, the data will be de-identified, cleaned, and labeled to produce a final STATA dataset and csv file that will be submitted to USAID's Data Development Library and made available to the public through USAID's E3/Land Office Data Hub. Table 1 below provides the household and village sample sizes for each treatment group.

TABLE 1—TGCC TREATMENT GROUPS

Chiefdoms	Chiefdom N	Villages	Mean Village N	Agroforestry households, total	Land tenure households, total	Agroforestry + land tenure households, total	Control households, total	Agroforestry control households, total
Mnukwa	642	59	11.02	149	170	136	182	2
Mshawa	1024	88	11.75	184	283	315	239	0
Mkanda	581	60	9.68	173	132	137	136	0
Mguya	644	52	12.59	167	180	180	115	0
Saili	634	48	13.45	0	0	0	0	634

QUALITATIVE DATA SOURCES

The qualitative instruments serve two primary purposes: 1) to add a social context to ground the econometric results and 2) to add depth and nuance to the overall research effort. Qualitative data was collected to provide context to the quantitative data and to triangulate responses from the household and the headperson survey, particularly about sensitive topics, like land disputes and governance.

IE hypotheses and indicators will be used to guide and focus the analysis of the data obtained from focus group discussions. Topics of interest include local perceptions of tenure security, prevalence of land disputes, levels of agricultural investment, and reasons for agroforestry and CSA adoption. Analysis will involve reading and re-reading the transcripts of the key informant interviews and focus group discussions, carefully coding and grouping the data according to similar or related pieces of information presented. This process will allow the IE team to organize and compare similar and related pieces of information in the qualitative data and to identify key themes and trends across the project area. The analysis will add depth and social context to inform the interpretation of the results of the empirical analysis and shed light on the multiplicity of perspectives and potential mechanisms surrounding outcomes of interest to the evaluation.

As part of endline data collection, the evaluation will conduct 62 focus group discussions in 27 purposefully selected villages across all five treatment arms. This sampling plan is described in Table 2 below. Using M&E data collected from the program implementation team (data and process described below), villages were selected that would capture a variety of experiences within the Agroforestry and Land Tenure treatment arms. These criteria were chosen based on focus group discussions with implementers about various factors that influenced a village's success with the agroforestry or land-tenure intervention, and on quantitative surveys completed by the implementers. The chosen criteria and the number of villages selected that meet that criteria are as follows:

AGROFORESTRY

- Villages with headmen who are competent and engaged with the agroforestry program (1)
- Villages with headmen who are less competent and disengaged with the agroforestry program (1)
- High seedling survival rate (2)*
- Low seedling survival rate (2)*
- Village experienced water shortages that inhibited the growth of agroforestry seedlings (1)
- Active farming group (2)*
- Inactive farming group (1)

LAND

- Villages with headmen who are competent and engaged with the land certificate program (1)
- Villages with headmen who are less competent and disengaged with the land certificate program (1)
- Active Village Land Committee (2)**
- Inactive Village Land Committee (1)
- Village experienced many conflicts within the village, with neighboring villages, or with the chiefdom during boundary walks (2)**
- Village experienced few conflicts within the village, with neighboring villages, or with the chiefdom during boundary walks (2)**
- Village has fields that overlap with the boundaries of neighboring villages (1)

* One village belongs to agroforestry treatment, and one to the agroforestry + Land treatment
** One village belongs to the land tenure treatment, and one to the agroforestry + Land treatment

TABLE 2—FGDs PER TREATMENT ARM

Treatment	Number of villages	Number of FGDs
Agroforestry	7	14
Land	8	16
Agroforestry + Land	6	20
Control	4	8
Agroforestry Control	2	4
TOTAL	27	62

Chiefdom and village size also contribute to the selection of our village sample for the endline FGDs. Except for villages in the Agroforestry Control arm, which are only present in one chiefdom, all treatment groups are divided as evenly as possible amongst the four chiefdoms, averaging 6 villages per chiefdom. Larger villages were also purposefully selected to ensure enough households in each village to capture our subgroups of interest.

SELECTING PARTICIPANTS

The FGD sampling plan is designed to capture the experiences of a variety of subgroups across all treatment categories.

AGROFORESTRY

In agroforestry and agroforestry control villages, we are most interested in the experience of program participants compared to non-participants. Due to the small size of most villages and therefore the small number of households who participated in the program in each village[6], we are unable to subdivide participants by gender or age. Given the choice between recruiting a homogeneous FGD that only reflects the experiences of older men and a more diverse group including women and youth, we have chosen to recruit a heterogeneous group of participants that includes women and youth when applicable. Though this runs counter to qualitative data collection norms, we believe that the questionnaire does not include any questions that could be sensitive to gender or age, and our past experience conducting focus groups in this region of Zambia lead us to believe that women and youth will be comfortable sharing their opinions in a mixed-gender and mixed-age group.

LAND

The land-tenure treatment encompassed all or nearly all households in a village. Thus, instead of a focus on participants and non-participants, we are instead interested in the experience of men, women, and youth who are listed on a customary land certificate as a land holder. Each selected land treatment village will have one focus group with males, and then either a focus group with women or with male youth. Two large villages will have three focus groups, one with each of the three subgroups of interest.

AGROFORESTRY + LAND

Selecting participants for villages that received both the agroforestry and land tenure interventions is the most complex of the five treatment groups. The first subgroup of interest is older males listed as a land holder on a customary land certificate who *also* participated in the agroforestry program, followed by older males listed as a land holders on a customary land certificate who *did not* participate in the agroforestry program. We will also conduct focus groups with young men and women who are listed as land holders on a customary land certificate. All six agroforestry + Land villages will hold focus groups with these two groups. If there are enough program participants to allow for it, four large villages will hold two additional FGDs with one of two sets of subgroups: women who are land holders and did or did not participate in the agroforestry program, and youth who are land holders who did or did not participate in the agroforestry program.

CONTROL

In control villages, we are interested in the experiences of our three primary subgroups of interest—men, women, and youth. All four control villages will hold a FGD with women, half will hold an additional discussion with male youths, and the other half will hold a discussion with older men.

6 Unlike the land intervention, which encompassed the entire village, agroforestry uptake was voluntary and only a subset of households participated.

SECONDARY DATA

ERC M&E DATA

ERC designed four rapid assessment Monitoring and Evaluation (M&E) data collection tools in April 2016, to obtain additional program implementation information from implementers of the land tenure and agroforestry set of activities under the TGCC Zambia pilot. The first round of data collection with these tools also took place in April 2016. The M&E data provides important information for endline data collection, analyses planning, and to better inform the interpretation of endline results. The data establish how the TGCC land tenure and agroforestry interventions are proceeding in practice, relative to how the program was planned, and enable the IE team to verify the nature and timing of the different land tenure and agroforestry activities. The data also make it possible for the IE team to identify any major variations in program implementation across villages, be aware of potential outlier cases or issues that could influence results, and make appropriate updates to the planned analyses as needed.

The M&E data was used to:

- Gain a better understanding of implementation and contextual processes that may moderate program impacts, such as variation in headperson capacity and engagement across villages;
- Assess whether and how program implementation and context variation should be incorporated into the endline analysis and construct indicator variables for potential moderators in the endline analysis;
- Add additional questions and response categories to the endline survey to better clarify key outcomes or control variables;
- Provide rich descriptive and supporting program implementation and contextual information to enable better interpretation of the evaluation results.

The M&E data collection tool consisted of two short structured surveys and two short open-ended qualitative questionnaires that were administered to implementers of the TGCC land tenure and agroforestry interventions. The qualitative and quantitative Chipata District Land Alliance (CDLA) M&E tools provide an understanding of household land registration processes under the program and the different types of land categories used for registration. The instruments were used to collect data on the headperson and village land committee interest and capacity to engage with the program. The data also provides information on the extent of disputes both between and within villages during the boundary mapping process. This information was used to construct endline questions that appropriately capture these distinctions and provide contextual information to better interpret results.

The qualitative and quantitative COMACO tools describe implementation activities in detail, including the process that was used for offering the agroforestry intervention to households in the agroforestry treatment villages and some of the observed reasons for stronger or weaker interest in agroforestry among targeted households. This description enables stronger identification of household selection factors for the agroforestry intervention. COMACO M&E data also provides information on the extent of water shortages, placement of wells, as well as seed failure rates and the primary reasons for seed failure across villages. Similar to CDLA, the instruments were used to collect data on the headperson, lead farmer, and farmer group’s interest and capacity to engage with the program.

PROJECT M&E

ERC received the following M&E datasets or information from the TGCC field teams:

- COMACO farmer's list database;
- COMACO farmer baseline surveys data for 2014 and 2015 agricultural seasons;
- Governance rules and regulations database collected from a sub-sample of TGCC villages; and
- GPS points and village names with well installation sites.

The COMACO farmer's list data was triangulated with the baseline survey data to obtain an estimate of the representation in the baseline sample of agroforestry-participating households in each of the agroforestry intervention villages. Using fairly conservative matching methods (government ID and names within village) we matched 500 of the 2435 farmers in the COMACO data to the baseline data. There are likely many more matches to be made, but we do not have the data needed to match different respondents within the same household or individuals who go by multiple names. While this is only 16 percent of the baseline dataset, the matched respondents are well distributed across treatment chiefdoms.

The COMACO agroforestry farmer baseline survey data provides an independent data source from TGCC villages for farmer-reported estimates of yields, amount of crop sold, and sale price of crops sold. This may provide useful context on season-to-season and village-to-village variation in these farmer-reported outcomes in the program area. The governance data provides a village-by-village qualitative description of general land use rules; land administration rules; and access, rights, responsibilities, and dispute processes. The information demonstrates fairly strong similarity in these governance processes across the different villages but also highlights some potentially important differences, such as regulations against planting certain crops in some villages. The governance data may be useful for endline results interpretation and to provide additional rich contextual information around land-related governance processes in the program area. Given the importance of water availability for agroforestry survival rates, the well installation data will enable the study to track implementation differences that affect treatment impacts.

PROJECT GEOSPATIAL DATA

ERC will request Chipata District Land Alliance's (CDLA) geospatial data on villages boundaries and disputes across the four treatment chiefdoms, as well as to parcel level data for households with the associated dispute and claimant details. ERC currently has access to CDLA geospatial data from a subset of villages that received the land tenure set of activities in Mnukwa chiefdom. Based on a preliminary investigation of that data, ERC proposes to use CDLA's geospatial data from all four chiefdoms to supplement the overall analysis plan for the TGCC impact evaluation. An examination of spatial relationships in land treatment areas will provide context information to enable better interpretation of the evaluation findings and help identify how program implementation and context variation should be accounted for in the endline analysis.

In particular, geospatial analysis of CDLA data will complement the household and community survey data by:

- verifying survey data indicators related to distance estimations;
- constructing village-level indicators to assist with explaining variation in land outcomes within treatment areas;

- supporting an investigation of the factors driving single primary versus multiple joint holders during the certificate registration process, as well as husband/wife registration versus extended family;
- exploring spatial patterns of disputed parcels and areas; and
- evaluating spillover between treatment and control communities.

GEOSPATIAL DATA OVERVIEW

CDLA's geospatial information includes village-level data such as village boundaries, disputed areas, and shared resources such as hills, gardens, and water sources. Village boundaries were defined through boundary walks. The data also contains parcel-level information including parcel area and boundaries, if a parcel is disputed or shared, and the associated claimant registration details such as date of birth, gender, and National Registration Card (NRC) number. It is important to note that this data is only available in treatment villages.

A key distinction between CDLA's geospatial parcel data and ERC's non-spatial field data is how they were defined. ERC's field data is defined by how fields are used for cultivation—for example a field used for maize cultivation versus a field that has been left fallow. In contrast, CDLA's parcel data is defined by ownership. CDLA allowed households to delineate each of their fields as a single parcel or by multiple parcels depending on who claimed ownership. CDLA's geospatial data shows that most claimants own contiguous parcels that are all located within the same village. For individuals that own parcels in different villages, this is generally since a village boundary is separating two adjunct parcels.

CDLA's geospatial data also indicates whether or not parcels were disputed. Initial disputes were flagged based on overlap with another parcel's boundaries. An initial review of the spatial patterns of the disputed parcels indicates that the parcels are largely located near village boundaries (see Figure 3). CDLA's data also reveals that there are groups of villages that have several disputed parcels, while other villages have no such conflict, even at the borders. Without the existence of control group data, we cannot make unbiased inferences, however, the research will have the capacity to note correlations within the treatment group and whether there is a reduction in disputes over parcel boundaries closer to village boundaries. CDLA's data consists of villages that received either the land treatment or both the land and agroforestry treatment. The proximity of treatment area types to one another in CDLA's geospatial data varies between being clustered in villages with shared boundaries or being distributed across the chiefdom (see Figure 4).

These patterns are based on a subset of geospatial data the Mnukwa chiefdom. ERC expects to see similar patterns across villages in the other three chiefdoms, Mkanda, Mshawa, and Maguya. This will be confirmed once ERC receives the remaining geospatial data.

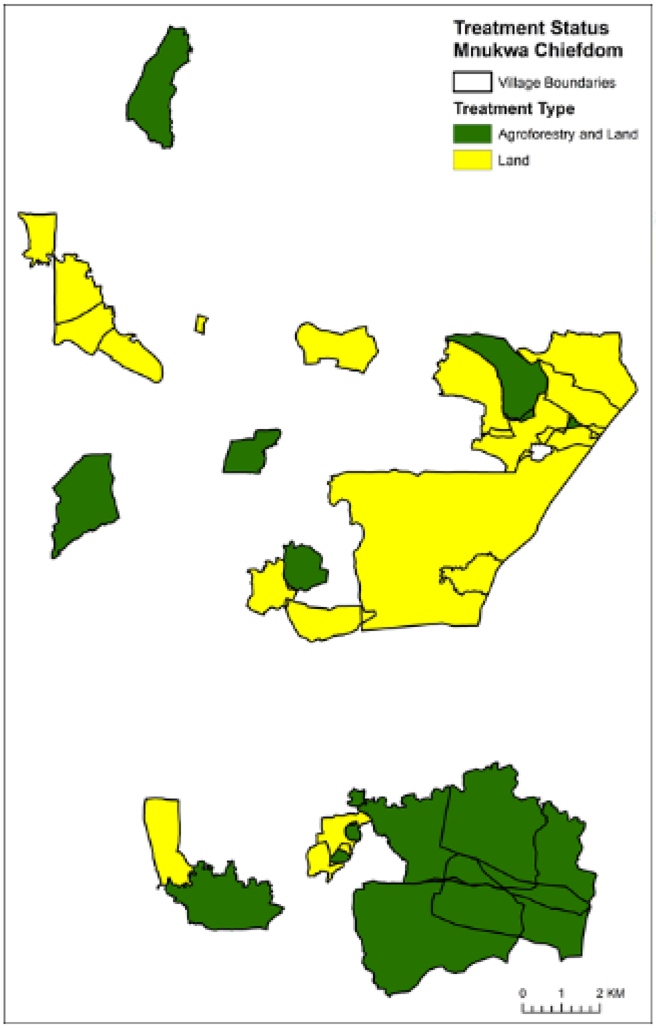


FIGURE 3. TREATMENT STATUS OF VILLAGES IN MNUKWA CHIEFDOM

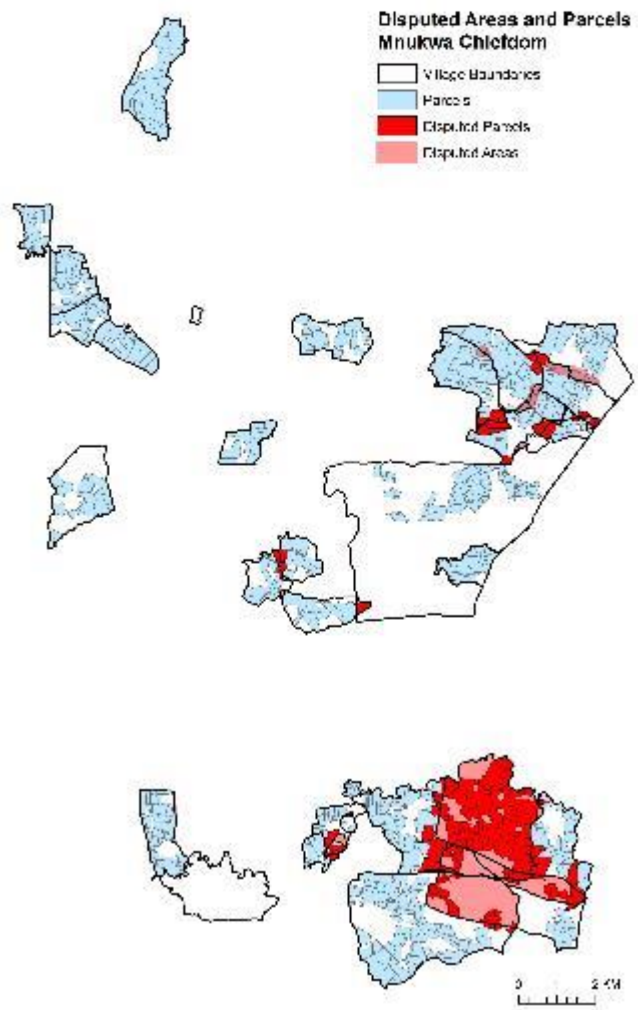


FIGURE 4. DISPUTED AREAS AND DISPUTED PARCELS IN VILLAGES IN MNUKWA CHIEFDOM.

5.0 INDICATORS

This study uses three sets of outcome measures. In addition to the primary outcome indicators, we construct a series of secondary measures that augment our understanding of the program effect. We also employ a set of measures designed to identify the mechanisms that link the intervention to these outcomes. The majority of dependent and independent variables were constructed through household and headperson survey data. We also utilize several geospatial controls created from secondary data. Annex 3 provides a detailed description of all indicators and how they are constructed.

Data will be sex disaggregated and that all of the secondary questions will address, when possible, how each answer differs depending on gender, including male vs female headed households.

DEPENDENT VARIABLES

TENURE SECURITY

Outcome Family 1, Tenure Security, is constructed primarily through a series of variables pertaining to the overall perceived potential for land expropriation and reallocation by any party and the incidence of land disputes at the village and field levels. Indicators from Outcome Family 1 will be used to test the following hypotheses:

- *H: Villages receiving the land tenure intervention have different levels of village-wide incidence of land conflicts.*
- *H: Households in villages receiving the land tenure intervention perceive different levels of tenure security.*

Outcome Family 1 is measured by the following primary indicator:

- TS-1: Perceived expropriation risk index among households (Index)
- TS-2: Length of fallowing period

Secondary variables used in measuring tenure security pertain to perceived potential for land expropriation and reallocation by specified actors, perceived changes in incidence of land disputes. Outcome Family 1 is measured by the following secondary indicators:

Key secondary variables:

- TS-3: Perceived expropriation risk among households from internal sources
- TS-4: Perceived expropriation risk among households from external sources
- TS-5: Experienced at least one dispute on field
- TS-6: Number of disputes experienced on field

Other secondary variables:

- TS-7: Perceived expropriation risk among households from other households within the village
- TS-8: Perceived expropriation risk among households from elites
- TS-9: Perceived expropriation risk among households from neighboring community
- TS-10: Perceived expropriation risk among households from chief
- TS-11: Perceived expropriation risk among households from headman
- TS-12: Perceived expropriation risk among households from extended family
- TS-13: Village experienced any land conflicts, as reported by headperson

- TS-14: Number of land disputes experienced by household
- TS-15: Perceived change in intensity of land related disputes among headperson
- TS-16: Perceived expropriation risk index among headpersons across secondary variables list
- TS-17: Perceived expropriation risk among headpersons from neighboring community
- TS-18: Perceived expropriation risk among headpersons from chief
- TS-19: Perceived change in frequency of land related disputes among headpersons

LAND GOVERNANCE

Outcome Family 2, Land Governance, will be assessed through variables measuring incidence of land management meetings and household participation, overall household perceptions of equity in land allocation, and number of rules regulating land use. Indicators from Outcome Family 2 will be used to test the following hypotheses:

- *H: Villages receiving the land tenure intervention perceive different levels of transparency regarding the land allocation process and accountability of land allocation decision makers.*
- *H: Households in villages receiving the land tenure intervention have different levels of satisfaction regarding the resolution of land disputes.*

Outcome Family 2 is measured by the following primary indicator:

- G-1: Overall land governance indicator (Index)

According to the theory of change, the interventions are expected to generate a series of changes in knowledge, empowerment, and equity that will subsequently lead to the improvements tested in the primary outcomes above. We will assess the program impact on the following secondary outcomes of interest.

Key secondary indicators:

- G-2: Dispute resolution satisfaction
- G-3:Household perception of land leaders (Index)
- G-4: Household perception of land allocation (Index)
- G-5: Land Rules (Index)
- G-6: Household believes vulnerable groups have been disadvantaged in decisions about land allocation
- G-7: Equity in land allocation across vulnerable groups
- G-8: Household participation in land management-related meetings
- G-9: Number of rules in village regulating activity on village land

Secondary indicators:

Participation

- P-1: Land management-related meetings held in village in past year

Rules

- R-1: Number of rules in village regulating activity on village land that are monitored for rule breaking
- R-2: Number of rules in village regulating activity on village land that have penalties for rule breaking
- R-3: Percentage of rules in village regulating activity on village land that are monitored for rule breaking
- R-4: Percentage of rules in village regulating activity on village land that have penalties for rule breaking

- R-5: Existence of rule in village about grazing livestock
- R-6: Existence of rule in village about cutting trees
- R-7: Existence of rule in village about ownership over trees on shared fields
- R-8: Existence of rule in village about use of communal land by neighboring villages
- R-9: Existence of rule in village about use of communal land by outsiders or investors
- R-10: Existence of rule in village about setting fires for land clearing, land preparation, or post-harvest burning

Equity

- E-1: Household feels women have been disadvantaged in land allocation decisions
- E-2: Household feels elderly have been disadvantaged in land allocation decisions
- E-3: Household feels poor have been disadvantaged in land allocation decisions
- E-4: Household feel that other households not sharing tribe with headman have been disadvantaged in land allocation decisions

INVESTMENT IN AGRICULTURE AND AGROFORESTRY

Outcome Family 3, Investment in Agriculture and Uptake of Agroforestry Practices, is evaluated through variables counting the number of households which have, at the field level, engaged in agriculture or agroforestry practices and invested in field improvements. Indicators for Outcome Family 3 will be used to test the following hypotheses:

- *H: Villages receiving the agroforestry intervention have different agroforestry and CSA uptake rates and planting survivorship.*
- *H: Households in villages receiving the agroforestry intervention adopt agroforestry practices and engage in agroforestry and related CSA activities at a different rate*

Outcome Family 3 is measured by the following primary indicators:

- I-1: Agroforestry seedling survival rates
- I-2: Household engages in CSA investment to improve field(s) (Index)

Outcome Family 3 is measured by the following key secondary indicators:
Key secondary indicators:

- I-3: Household engages in short term field investment
- I-4: Household engages in long term field investment
- I-5: Household engages in agro-forestry
- I-6: Field(s) planted with agroforestry trees or shrubs

Other secondary indicators:

- I-7: Percentage of field(s) planted with agroforestry trees or shrubs
- I-8: Household engages in fallowing
- I-9: Household constructed planting basins in field
- I-10: Household practiced zero tillage on field
- I-11: Household invested in ridging, mounding, or terracing on field
- I-12: Household applied manure or compost on field
- I-13: Household used crop rotation on field
- I-14: Household practiced fallowing of field
- I-15: Number of seasons field left fallow

- I-16: Household used fertilizer on field
- I-17: Secondary benefits from agroforestry that promote adoption of fodder/feed

AGRICULTURAL PRODUCTIVITY

Outcome Family 4, Agricultural Productivity, measures household perceptions of crop growth and yield as a direct result of agroforestry practices, as well as explicitly quantified reported crop yields in standardized units.

Outcome Family 4 is measured with the following key secondary indicator:

Key secondary indicator:
- AP-1: Household reported experiencing improved crop growth around trees as a result of planting agroforestry tree/shrub planting

Other secondary indicators:
- AP-2: Agricultural yield per hectare (crop yield in standardized unit/hectare; disaggregated by crop type)
- AP-3: Household reported experiencing higher overall crop yield as a result of planting agroforestry tree/shrub planting

LIVELIHOODS

Livelihoods, Outcome Family 5, is evaluated using secondary indicators that measure household socioeconomic standing and household engagement in land-related transactions. The household's standing will be evaluated based on household assets and the changes in those assets since baseline. Outcome Family 5 is intended to test the following hypothesis:

- *H-7: Households in villages receiving the land-tenure intervention have different livelihood outcomes, including the adoption of soil conservation farming practices.*

The indicators used in Outcome Family 5 are:
Key secondary indicator:
- L-1: Asset-based wealth index: Assets (counts), Livestock (counts), land area owned, roof construction/material

Other secondary indicators:
- L-2: Household engages in land rental activity as landlord
- L-3: Household obtained formal loan from bank or microcredit institution

INDEPENDENT VARIABLES—TREATMENT INDICATORS

We test for the effect of four different treatments, which are measured by the following indicators:

- An indicator variable that equals 1 if a village was assigned to receive the land certification (CDLA) intervention, 0 if a village was not assigned to receive the land certification CDLA intervention.
- An indicator variable that equals 1 if a village was assigned to receive the agroforestry extension (COMACO) intervention, 0 if a village was not assigned to receive the agroforestry extention COMACO intervention.

- An indicator variable that equals 1 if a village was assigned to receive the combined land certification intervention and agroforestry extension treatment, 0 if a village was not assigned to receive the combined land certification intervention and agroforestry extension treatment
- An indicator variable that equals 1 if a village is in Saili chiefdom ("agroforestry control") and received the agroforestry extension (COMACO) intervention, 0 if a village is outside Saili chiefdom

CONTROL VARIABLES

As Section 7 below describes, the analysis methods include the value of the *dependent* variable at baseline as the primary control. This is the most important and will lead to the greatest increase in the power of the study. We may also include a vector of *independent* variables for control in our regressions (all measured at baseline) to improve the precision (power) of our estimates. These include variables that were not balanced at baseline, as defined by imbalance at the 10 percent significance level and percent bias greater than 25 percent.

VILLAGE LEVEL CONTROL VARIABLES

- C-1: Gender of the headperson
- C-2: Age of the headperson
- C-3: Distance from village to tarmac road
- C-4: Distance from village to a place to board a minibus
- C-5: Distance from village to a place with mobile phone service
- C-6: Distance from village to secondary school
- C-7: Distance from village to health clinic
- C-8: Distance from village to borehole
- C-9: Distance from village to district agricultural office
- C-10: Distance from village to market

FIELD LEVEL, AGGREGATED TO HOUSEHOLD

- C-11: Field has fertile soil
- C-12: Field area (in ha)
- C-13: Field is borrowed

HOUSEHOLD LEVEL

- C-14: Gender of household head
- C-15: Area of land owned (in ha)
- C-16: Number of fields cultivated

6.0 BALANCE AND POWER

POWER

To assess the power of this evaluation, we estimate the minimum detectable effect size (MDES) for each variable using the processes described by Optimal Design and PowerUp![7]. The calculations for household-level outcomes and village-level outcomes are different; it is typically more difficult to detect changes at the village level than the household level. Field-level variables have been aggregated to the household level.

The parameters used are:

- $\alpha = 0.5$ —the probability of a false positive (Type I) error
- $\mathrm{P} = 0.8$ —the power we would like to estimate effect size with
- rel —cluster (village?) level reliability
- ρ —intraclass correlation; calculated for each variable
- K —number of blocks
- J —number of clusters within each block,
- n —average cluster size across all blocks; calculated for each variable
- μ —mean; calculated for each variable
- σ —standard deviation; calculated for each variable

In the context of this evaluation, K is the number of chiefdoms that we are randomizing within, J is the average number of villages within each chiefdom, and n is the average size of each village. By considering the blocked design of this project, we are able to more accurately predict power. More can be read about the blocked design in Annex 1: TGCC IE Design Report.

In addition to calculating MDES, we calculate the point change as $MDES \times \sigma$, and the percent change as

$$\frac{MDES*\sigma}{\mu} \times 100.$$

Where the point change is the detectable change expressed in the variable's units (e.g. for land area cultivated, the point change would be given of hectares), and the percent change is the detectable change given as a percent of the baseline measurement. While MDES can be compared across indicators, point change should only be compared with indicators on the same scale. Percent change, in particular, can be deceptive. When variables have a mean close to zero, the detectable percent change may appear to be very high—though it is not necessarily a large substantive change. This is often the case with variables measuring rare events. For example, we see that only 1 percent of respondents from either the Agroforestry or Control treatment arms have paper documentation for their land at baseline. With a detectable point change of 0.02, this means that we will only be able to detect a 200 percent change (i.e. endline documentation rates of 0.03 or higher). While this implies we will only be able to

7 We also intend to use simulated data based on either Rural Agriculture Livelihoods Zambia data or Living Standards Measurement Study Malawi data. This method of calculating power can be more accurate, but requires an existing panel dataset that is very similar to the data to be collected.

detect very large changes, consider that a 200% change in paper documentation rates among households only requires an additional 26 households obtain documentation (going from 13 to 39 households). We highlight rare event indicators as necessary. Typically, the number of responses and the ICC have the biggest impact on MDES, where a higher number of responses gives a smaller MDES, and a higher ICC gives a larger MDES.

Of the 7 primary indicators analyzed, 3 have MDES between 0.15 and 0.2, one in the 0.25 to 0.30 range, and two above 0.45. Of these, agricultural investments, and the tenure security index appear to be the most well-powered, while improvements in crop yield due to agroforestry and agroforestry seed survival will be the hardest to detect. It is worth noting that relatively few households at baseline used agroforestry, so it is reasonable to expect large gains. With respect to the 8 secondary indicators, 4 have MDES between 0.15 and 0.2, 3 have MDES between 0.2 and 0,25, and 1 has MDES of 0.38. As with the primary indicators, long and short term agricultural investments are the well-powered, along with the other secondary variables are also well powered. Only satisfaction with dispute resolution may be hard to detect, though this is likely due to the relatively rare occurrence of disputes. Finally, of the 8 mechanisms, 5 will have MDES from 0.15 to through 0.2, 2 have MDES from 0.2 to 0.25, and the remaining indicator (a village level indicator) has a MDES above 0.6. In particular, household participation in land meetings, and sensitivity to fairness of land allocation for disadvantaged groups are well-powered. On the other end, the village level indicator for number of land rules is underpowered.

Overall, the analysis shows that we have sufficient power to measure change across primary indicators for our 5 outcome families. However, as expected in the initial evaluation design, longer-term outcomes, such as CSA investment, agricultural productivity and livelihoods, are underpowered at baseline and these outcomes will require a longer time horizon before significant outcomes are detected. For example, relatively few respondents had already planted agroforestry trees at baseline, and even fewer have had agroforestry trees planted on their fields at baseline for a long enough period to see any benefits from their pre-intervention investment in agroforestry. Because of this, MDES measurements are based on few households. We also see very low ICC values in these indicators, likely for the same reason. Given the fact that TGCC is only a 3-year program, we do not anticipate seeing many of the expected agroforestry benefits in such a short time frame; additional waves of data collection will be required to detect larger and longer term effects.

Please refer to Annex 4 for a detailed Power analysis for each proposed indicator used in the study.

BALANCE

As described above in the research design section, TGCC uses a blocked cluster randomized design, where treatment is randomized at the village level, within chiefdoms. There are two treatments: one focused on improving land tenure and one focused on teaching agroforestry practices. Both treatments are applied separately in the Land Tenure and Agroforestry arms and concurrently in the Agroforestry + Land Tenure arm. This design results in four groups: (1) Agroforestry, (2) Land Tenure, (3) Agroforestry + Land Tenure, (4) and the Control group. There is also a fifth group that we will refer to as the Agroforestry Control, which receives the same agroforestry intervention; however, this group of villages, and only this group, is located exclusively in the Saili chiefdom, where no land tenure interventions of any kind (including at the chiefdom level) were implemented.

Balance and power is assessed for each of these treatment arms against the Control for variables across six different outcome groups: (1) tenure security, (2) land governance, (3) investment in agriculture, (4) long-term agricultural productivity, and (5) long-term livelihood improvements. Outcomes are measured at the household and village level. Note that field-level indicators are aggregated to the household level.

TABLE 3—HOUSEHOLD AND VILLAGE N PER TREATMENT ARM

Treatments	Treatment N Households	Villages	Mean Village N
Agroforestry	632	48	11.28
Land Tenure	681	51	11.16
Agroforestry + Land Tenure	755	62	11.79
Control	597	46	10.85
Agroforestry Control	612	39	13.90

There are two caveats to be noted. First, it is important to distinguish between statistical significance and substantive significance. In some cases, we may see a 'statistically significant' difference, but in real or 'policy' terms, the substantive difference may be quite small. For example, a 2–3 percent difference may be statistically significant but not represent a large difference as far as the policy is concerned. Second, we must pay attention to indicators that measure events or practices that are not common in the sample, for example fires or disputes. It can be difficult to assess the balance of variables that measure rare events, as a single occurrence of an events in one group can cause the groups to look highly imbalanced. Table 4 shows variables which have been determined to be rare event indicators.

TABLE 4—RARE EVENT INDICATOR VARIABLES

Variable	Description	Dataset	Sample Mean	Sample SD
tensec_hhloan	HH obtained formal loan from bank or microcredit institution	HH	0.048	0.212
agroinv_hhagrof	HH engages in agro-forestry on at least one field	HH	0.105	0.307
agroinv_fieldagrof	Field planted with agroforestry trees or shrubs	HH-F	0.046	0.210
agroinv_agseedglir	Gliricidia seedlings planted on field	HH-F	0.003	0.062
agroinv_hhfallow	HH engagement in fallowing to improve field(s)	HH	0.139	0.346
agroinv_plantbasin	HH used plant basins on field	HH-F	0.103	0.304
agroinv_manure	HH added manure or compost on field	HH-F	0.304	0.383
agroinv_fallow	HH practiced fallowing on field	HH-F	0.075	0.265
agprod_agbencrop	HH reported improved crop growth around trees on field as result of planting agroforestry trees (conditional on having agroforestry trees)	HH-F	0.020	0.143
agprod_agbencropyld	HH reported higher overall crop yld. on field as result of planting agrfrst. trees	HH-F	0.003	0.051

Overall, the balance assessment shows that the randomization was successful. For the 150 variables and 600 group comparisons being tested for balance, 28 comparisons demonstrate highly significant differences, and 42 have significant differences. These significant comparisons occur across 53 variables in both the household and headperson datasets. Please refer to Annex 5 for a detailed description of the balance tests across indicators and across treatment arms.

ATTRITION, OUTLIERS, AND MISSING VALUES

ATTRITION

The expected attrition rate at endline is 5 percent. This is considerably lower than the attrition rate for large national surveys, such as the RALS, which reported a 17.9 percent attrition rate between the 2012 and 2015 rounds of data collection, but is comparable to the attrition rate for other surveys in Chipata District conducted with a similar sample size and study population and with similar respondent tracking strategies in place.

The endline data collection will take several steps to minimize attrition to the extent possible. Baseline data collection included multiple questions to help track respondents at endline, including information about alternative names of respondents, landmarks near the respondent's dwelling, multiple phone numbers for respondents or their relatives, and physical descriptions of respondents. This information will be shared with enumerator teams before they survey a village to help locate the correct respondent and reduce instances of attrition where the correct respondent cannot be identified.

Two additional weeks of data collection have been allocated for tracking respondents who were not surveyed on the initial visit to their village. The survey firm will be instructed to make a minimum of three visits to each respondent. Whenever possible, appointments will be made in advance to maximize the ability to survey the respondent during a visit. Mobile phone numbers will be collected and appointments confirmed by mobile phone whenever possible. Households who are traveling within Chipata District during the entirety of the data collection period will be tracked and surveyed at their current location. However, due to the nature of the interventions, households who have moved from their village to another village not included in the study sample will be replaced, not tracked.

Survey respondents will also receive a monetary incentive for participating in the endline survey. New IRB rules in Zambia passed in 2016 require all respondents participating in a survey lasting longer than 20 minutes receive 50 ZMW in cash, approximately 5 USD. This is a large sum of money for rural Zambians and will likely have a large impact on respondent's willingness to participate at endline.

The attrition rate will be calculated from the baseline sample (N=3523 households). Several tests will be run after endline data collection is complete in order to determine if there is attrition bias. These tests include t-tests and ANOVA tests to answer the following questions:

- Is the magnitude of attrition different between treatment and control households?
- Are the baseline characteristics of attenuated households in the control group significantly different than the baseline characteristics of the attenuated households in the treatment group?

If statistical tests reveal attrition to be happening at random, and attrition is rare enough to not strongly affect the power of the design, attenuated households will be dropped from the analysis. However, if statistic tests reveal non-random differences in magnitude or baseline characteristics of the attenuated in the treatment and control areas, the analysis will adjust the sample using imputation, weighting or Lee bounds so the share of observed individuals is equal for both treatment and control groups.

OUTLIERS

We will address outliers by capping continuous variables at the 99th percentile of the observed values in our data.

MISSING VALUES

For missing outcome measures, we will use the method proposed by Kling, Liebman and Katz (2007) and impute missing observations by setting them equal to the mean of each outcome variable for the relevant treatment arm.

For missing control variables, we will use the following rules proposed by Lin & Green (2016).

- For covariates missing less than 10 percent of observations, we will recode missing values to the overall mean.
- If more than 10 percent of observations are missing for a given covariate, we will include a dummy variable for missingness and recode the missing value with a filler estimate.

Annex 4 presents this analysis.

VARIABLES WITH LIMITED VARIATION

We have removed variables that have 95 percent of observations with the same value for a response category from the analysis. These variables will not be included as covariates or indicators. Annex 5 presents this analysis.

7.0 ANALYSIS

MAIN EFFECTS: INTENT TO TREAT (ITT)

The IE is designed to rigorously assess the direct and joint impacts of the agroforestry extension intervention and tenure security strengthening interventions on the five outcome families described above. The analysis will test the impact of TGCC on the primary and secondary variables described in section 5.0 Indicators at the household and community level. Our estimation will compare the following three groups:

Group 1) Each treatment arm (Agroforestry, Land, Agroforestry + Land) to the pure control.

Group 2) The Agroforestry + Land arm to the Agroforestry arm. This estimation of the joint effect of strengthening land tenure in areas receiving agroforestry extension represents the primary objective of the IE. It will enable the research to determine whether or not the village and household land-tenure interventions under TGCC strengthen the security of land tenure and resource rights for smallholders, thereby increasing farmer investment in sustainable agroforestry and uptake of other CSA practices.

Group 3) The Agroforestry + Land arm to the Land arm. This estimation of joint effects is designed to assess whether tree planting and the promotion of other field level investments motivates higher levels of perceived tenure security than the standalone land intervention.

Group 4) The Agroforestry arm to the Agroforestry Control. The Agroforestry Control was not included in the randomization; however, the balance check indicates good balance between the Agroforestry Control group, which was based in Saili, to the standard Agroforestry arm, which draws from villages in the other four chiefdoms. Thus, we will compare outcomes between these two groups to assess the impact of agroforestry extension in areas that received only community-level agroforestry interventions (Agroforestry Control) to areas that received both community-level treatments and chiefdom-level support, including on land tenure at the chiefdom level (Agroforestry treatment).

The effect of each treatment arm of interest will be estimated with the following specification for household outcomes:

$$[1a] \qquad Y_{ij} = \beta_0 + \beta_1 T_{ij}^{AGRO} + \beta_2\ T_{ij}^{TENURE} + \beta_3\ T_{ij}^{TENURE} \ * \ T_{ij}^{AGRO} \ + \beta_4 X_{ij} + Y_{ij}^0 \ + \phi_d + u_{ij}$$

where Y_{ij} is the outcome measure of household i in village j. T_{ij} is the treatment dummy for each of the three treatment arms of interest. X_{ij} is a vector of control variables, described in section 5.0 Indicators, and included imbalanced covariates. Y_{ij}^0 is the baseline vectors for the outcome measure, ϕ_d is chiefdom-fixed effects, and u_{ij} are robust standard errors clustered at the village level, using Huber-White sandwiched standard errors (Lin et al., 2013).

This specification will enable us to strip out the direct effect of agroforestry and tenure before assessing whether the two together have an even larger effect. It also accounts for correlation in the error term and had more power than other specifications.

We will also estimate equation 1b below for outcomes measured at the community level. The parameters of the equation are the same as equation 1a, with the exception of household measures i and the inclusion of standard errors clustered at the village level.

$$[1b] \quad Y_{ij} = \beta_0 + \beta_1 T_j^{AGRO} + \beta_2\ T_j^{TENURE} + \beta_3\ T_j^{TENURE} \ * \ T_j^{AGRO} \ + \beta_4 X_j + Y_j^0 \ + \phi_d + u_j$$

The equations described above represent our primary specifications of interest. However, we will also run a series of secondary specifications without covariate adjustment. Because of the clustered design, we will not run the simple difference in means estimator (Aronow & Middleton, 2013).

MAIN EFFECTS: TREATMENT ON THE TREATED (TOT)

Since not all individuals who were selected for treatment actually participated in the interventions, and some of the control group may have attended some trainings, we will also estimate the impact of the program on those individuals in the treatment arms who actually received the intervention. This is especially important for the Agroforestry arm, which did not have widespread uptake across villages.

To measure the treatment on the treated for household outcomes, we will estimate the following equation across Groups 1–3:

$$Y_{ij} = \beta_0 + \beta_1 C_{ij} + \beta_2\, Y_{ij}^0 + B_3 X_{ij} + \phi_d + u_{ij}$$

$$[1b] \quad Y_{ij} = \beta_0 + \beta_1 T_j^{AGRO} + \beta_2\ T_j^{TENURE} + \beta_3\ T_j^{TENURE} \ * \ T_j^{AGRO} \ + \beta_4 X_j + \beta_5 C_{ij} + \ Y_j^0 \ + \phi_d + u_j$$

C_{ij} is an indicator for attending treatment i, which is instrumented by assignment to treatment status, T, as described in section 4.1.

HETEROGENEOUS TREATMENT EFFECTS

Based on the program theory and literature, we expect to find variation in the treatment effect across a number of subgroups. Where applicable, outcomes will be tested for heterogeneous treatment effects across a number of household and village subgroups. This represents a secondary versus primary analyses, and will be applied across Groups 1–3 described above.

Our household sub groups of interest include:

- Households that received physical land certificates versus households only completing the land tenure process;
- Household head gender (male-headed households versus female-headed households);
- Household baseline wealth status (continuous asset-based wealth index, and lowest quartile vs. others);
- Household baseline landholding (continuous, and land-constrained vs. others);
- Age of household head at baseline (continuous, and under 35 vs. others);
- Education level of household or HH head at baseline (continuous); and
- Matrilineal versus Patrilineal system[8].

8 We have included 4 questions in the household survey to determine matrilineal versus patrilineal status. While our instruments are relatively robust to categorize this, it is difficult to accurately determine the status.

The initial IE design document for this evaluation also mentioned exploring heterogeneity of impacts by household farming system (cash crop vs. subsistence farming) and by whether the household was from a different tribe than the village headperson. These factors were dropped during pre-analysis planning because the baseline data indicates they are not meaningful distinctions in the study context (there is little to no variation on farming system across households, and no indication from baseline data that differences in tribe within villages plays a role in perceived tenure insecurity or land allocation dynamics).

To test for heterogeneous treatment effects across these subgroups, we estimate the following equation:

$$[4a]\quad Y_{ij} = \beta_0 + \beta_1 T_{ij}^k + \beta_2 T_{ij}^k * Het_{ij} + \beta_3 Het_{ij} + \beta_4 Y_{ij}^0 + \beta_5 X_{ij} + \phi_d + u_{ij}$$

T_{ij}^k represents the treatment dummy for treatment indicator k, where k represents which treatment arm we are assessing from Groups 1–3. Het_{ij} is the indicator variable for the subgroup of interest. β_2 is the marginal increase in treatment effect in villages in the subgroup under evaluation. All other parameters are the same as those described above for Group 1.

Our village sub groups of interest include:

- Baseline presence of land use rules in the village (number of land use rules); and
- Village distance to urban center (continuous, expressed as travel time).

To test for heterogeneous treatment effects across village subgroups, we estimate equation 4b below:

$$[4b]\quad Y_j = \beta_0 + \beta_1 T_j^k + \beta_2 T_j^k * Het_j + \beta_3 Het_j + \beta_4 Y_j^0 + B_5 X_j + \phi_d + u_j$$

As with the main effects analysis described in section 4.1 and 4.2 above, we will present the results of specifications for heterogeneous effects with and without controls for ITT and TOT.

MULTIPLE TESTING CORRECTION

Given the number of outcomes that we will test in the evaluation, we expect to find false positives in our results. As such, our evaluation results will report both uncorrected p-values and corrected p-values using the Benjamini & Hochberg (1995) False Discovery Rate Correction. Our main findings and summary sections will rely on the uncorrected values, because we are analyzing a number of closely related interdependent outcomes and, therefore, the standard corrections for the false discovery rate are likely too conservative (Gelman, Hill, and Yajima, 2012)[9].

SPILLOVERS

There are a number of techniques for estimating the Average Treatment Effect (ATE) in the presence of spillovers (see Aronow and Samii, 2015; Athey and Imbens, 2016). However, these require significant assumptions about how spillover works. Specific survey questions have been included in the endline surveys and focus group discussions to measure the likelihood and/or extent of spillover and qualitative

9 Gelman and his co-authors note here that for most social science studies, where the effects may be small but are unlikely to be exactly zero, the corrections are likely too conservative.

data might be used to assess spillover. If we determine that spillover is a serious problem, we will use inverse propensity score weighting to calculate an ATE (Aronow and Samii, 2015).

GEOSPATIAL ANALYSIS OBJECTIVES

The evaluation team also seeks to conduct geospatial analysis using CDLA geospatial data on villages boundaries and disputes. There are four primary objectives for the geospatial analysis: verifying survey data and planning for endline analysis, constructing village-level indicators, identifying spatial patterns of disputes, and assessing the spillover effects of land certification.

DATA PROCESSING

Prior to analyzing CDLA geospatial data, we will determine overlap between CDLA and ERC study areas. This overlap exists at two levels—villages and households. Matching each level of data will require varying levels of effort and has different implications for data analysis.

At the household level, CDLA's parcel data can only be matched to ERC household and field data through a combination of claimant name with NRC number and date of birth. This makes the household level matching more complex and time-intensive, since many households do not have NRCs, and claimant names are not consistent across the databases. Since most households in treatment villages registered their land as part of the CDLA intervention, the analysis will assume parcel registration for all households in villages receiving the CDLA intervention. [10]

At the village level, matching CDLA villages names to ERC village names is consistent and therefore not as complex as household level matching.

SURVEY DATA VERIFICATION AND ENDLINE SURVEY ANALYSIS

The TGCC headman survey questions ask respondents to estimate approximate distances in kilometers to the nearest and farthest fields that their villages use for cultivation. While respondents have a general sense of how far the fields are away from them, using geospatial data to confirm respondents' answers allows for a more accurate distance calculation and will be useful for endline analysis. Instead of relying solely on the headman's response, ERC will compare their responses to a linear calculation using CDLA's village boundaries and parcel delineations within the CDLA treatment area.

VILLAGE-LEVEL INDICATORS

CDLA's geospatial data will also be used to construct village-level variables that are useful for exploring or explaining variation in land outcomes within treatment areas. These variables will focus on village parcel characteristics including (1) average parcel distance from the village center, (2) average number of parcels per village, and (3) average parcel size per village.

Using these indicators in combination with data on disputes, we will examine, for example, whether a higher degree of land fragmentation is correlated with more land conflict within the treated areas.

10 Although we can assume uniform registration, the amount of time that households have held their certificates may vary within a village. If this is the case, it will be important to match at the household level to the best of our ability. We are waiting for confirmation from TGCC on this issue.

SPATIAL PATTERNS OF DISPUTES

Exploring the spatial patterns of disputed parcels will provide a stronger understanding of the spatial context for resolved disputed parcels over time. Initial disputes were defined by parcels or layers overlapping with one another. As part of this exploration, we may generate maps as well as descriptive statistics including (1) percent of total demarcated area that was initially flagged as a dispute and then resolved (2) percent of disputes that were not demarcated ("unresolved") from total initially flagged as a dispute.. This is dependent on the capabilities of the dataset, and will be determined through conversations with Tetra Tech and USAID's geospatial team.

Additionally, further exploration will be conducted to identify any patterns in the spatial distribution of disputes in comparison to the village treatment types. ERC will also explore how field level tenure security data on perception corresponds with CDLA's dispute data. This is dependent upon the matching level chosen for analysis.

ANALYSIS OF CERTIFICATE REGISTRATION

The CDLA geospatial parcel data provides detailed information on parcel registration within households. An analysis of this data would enable the research to better understand why some people/families decided to register either a single primary holder or multiple joint holders, and for joint holders why they registered husband/wife only or also extended family members. The prevailing assumption in the field based on existing research is that joint certification is preferable to all others, however, the TGCC project found that families were (at least initially) unwilling to subdivide family land to the "household" (i.e. husband and wife) level, perhaps at least in part because of concern over TGCC's aims. If, after becoming more familiar with the program, people's preferences changed (or did not change) for primary/joint spouses/joint family registration, it would be good to capture this to inform future programs.

SPILLOVER EFFECTS OF LAND CERTIFICATION

CDLA's geospatial data will also be used to measure spillover between treatment and control communities. Villages that received land interventions or both agroforestry and land interventions often share village boundaries. ERC will calculate and develop indicators for (1) what percent of a village's border is shared with another treatment group village and (2) how far away villages are from one another.

8.0 ETHICAL CONSIDERATIONS

Participation in the study is voluntary, and all respondents were required to give their informed consent at the beginning of the survey process. Institutional Review Board (IRB) protocols have been approved at US and Zambian IRBs. Approval was received from the Clark University IRB in May 2014 and since then has been renewed annually. Approval was received from Zambia's ERES Converge IRB on June 10, 2014. Informed consent was received from each participant after reading a statement about the purpose of the research, the content of the survey, any risks or benefits, and the time commitment. Participants were assured their participation was voluntary and could be withdrawn at any point and their answers would be kept confidential. If respondents agreed to participate, they were asked to sign or fingerprint the informed consent document.

Respondents receive compensation for their time. At baseline, they received a bar of soap, valued at approximately 1 USD, and at endline, they will receive approximately 5 USD to complete the survey, as mandated by the Zambian IRB.

As described in section 4.0 Data, quantitative data is collected through the Survey CTO platform on Android tablets. Tablets are password protected, and data is uploaded to an encrypted server every day.[11] Data is stored on password encrypted computers, with PII removed.

11 When network connectivity is low, data is uploaded every other day.

9.0 DELIVERABLES & CALENDAR

On the following page is an estimated deliverable and planning timeline for the endline data collection and analysis activities. All dates and deliverables are estimated assuming timely feedback from reviews and barring impediments outside of ERC control. The ERC team will coordinate with the TGCC team on relevant planning activities through the TGCC COR early in the sub-task timeline. Planning activities are currently underway and will continue to progress through the rest of ERC Year 4. The data collection activities will take place in Year 5. The analysis and total data cleaning processes are expected to be completed before the end of the life of the ERC contract.

TABLE 5—TGCC ENDLINE DATA COLLECTION TIMELINE.

	2016				2017												2018				
Activity	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	**J**	**F**	**M**	**A**	**M**
Endline Pre-Analysis Plan—draft for E3/Land review	■																				
Endline Pre-Analysis Plan—draft for 3rd party review				■																	
Final pre-analysis plan						■															
Survey instruments 3rd party review				■																	
Survey instruments finalized							■														
Updated and programmed instruments							■														
Survey translation								■													
Issue RFP for data collection, proposal review, and survey firm selection					■																
IRB renewal									■												
Country approvals, initial setup and electronic device shipping								■	■												
Data collection—training										■											
Data collection—launch										■	■	■									
Qualitative translations due from the survey firm														■							
Data cleaning for submission to DDL															■	■	■				
Data analysis for Endline evaluation													■	■							
Drafting Endline report for E3/Land review													■	■	■						
Revised Endline report for 3rd party review																■	■				
Final Endline report																			■		
End of ERC contract																					■

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ANNEX 1: TGCC IE DESIGN REPORT

The TGCC IE Design Report can be found in PDF format at https://www.land-links.org/evaluation/tenure-global-climate-change-tgcc-zambia/.

ANNEX 2: TGCC IE BASELINE REPORT

The TGCC IE Baseline Report can be found in PDF format at https://www.land-links.org/evaluation/tenure-global-climate-change-tgcc-zambia/.

ANNEX 3: TGCC IE INDICATORS

Please refer to the Microsoft Excel file titled "Outcome and Control Vars_8_17".

ANNEX 4: POWER

mechanism_indicators

	var	level	mean_sd	icc	cluster_n	n_per_cluster	mdes	pnt_chng	pct_chng
c_a_dispute_any	dispute_any	HH	0.23 (0.42)	0.04	30.25	11.37	0.18	0.08	35%
c_lt_dispute_any	dispute_any	HH	0.22 (0.42)	0.03	32.5	11.29	0.17	0.07	32%
c_alt_dispute_any	dispute_any	HH	0.21 (0.41)	0.01	32.25	11.5	0.15	0.06	29%
cac_a_dispute_any	dispute_any	HH	0.23 (0.42)	0.03	33.8	12.12	0.15	0.06	26%
c_a_dispute_count	dispute_count	HH	0.44 (2.65)	0.01	30.25	11.37	0.16	0.42	95%
c_lt_dispute_count	dispute_count	HH	0.4 (2.54)	0.01	32.5	11.29	0.16	0.39	98%
c_alt_dispute_count	dispute_count	HH	0.39 (2.53)	0.01	32.25	11.5	0.15	0.39	100%
cac_a_dispute_count	dispute_count	HH	0.43 (2.3)	0.01	33.8	12.12	0.14	0.32	74%
c_a_vuln_disad	vuln_disad	HH	0.53 (0.5)	0.02	30.25	11.01	0.17	0.08	15%
c_lt_vuln_disad	vuln_disad	HH	0.52 (0.5)	0.05	32.5	10.89	0.18	0.09	17%
c_alt_vuln_disad	vuln_disad	HH	0.53 (0.5)	0.06	32.25	11.1	0.19	0.09	17%
cac_a_vuln_disad	vuln_disad	HH	0.55 (0.5)	0.04	33.4	11.75	0.16	0.08	15%
c_a_vuln_real	vuln_real	HH	3.24 (1.06)	0.01	30.25	11.28	0.16	0.17	5%
c_lt_vuln_real	vuln_real	HH	3.3 (1.1)	0.04	32.5	11.14	0.18	0.19	6%
c_alt_vuln_real	vuln_real	HH	3.27 (1.06)	0.07	32.25	11.37	0.19	0.21	6%
cac_a_vuln_real	vuln_real	HH	3.23 (1.05)	0.02	33.8	12.01	0.15	0.15	5%
c_a_land_participate	land_participate	HH	3.86 (1.54)	0.04	30.25	11.17	0.18	0.28	7%
c_lt_land_participate	land_participate	HH	3.81 (1.59)	0.07	32.5	11.09	0.19	0.31	8%
c_alt_land_participate	land_participate	HH	3.86 (1.56)	0.06	32.25	11.33	0.19	0.29	8%
cac_a_land_participate	land_participate	HH	3.91 (1.52)	0.04	33.8	11.85	0.16	0.24	6%
c_a_num_rule	langov_totlandrules	Vil	3.01 (1.13)	NA	23	NA	0.71	0.8	27%
c_lt_num_rule	langov_totlandrules	Vil	2.94 (1.29)	NA	24	NA	0.69	0.89	30%
c_alt_num_rule	langov_totlandrules	Vil	3.25 (1.34)	NA	26.75	NA	0.65	0.88	27%
cac_a_num_rule	langov_totlandrules	Vil	3.05 (1.14)	NA	26.2	NA	0.59	0.67	22%
c_a_agroinv_hhagrof	agroforest	HH	0.1 (0.3)	0.1	30.25	11.19	0.22	0.07	70%
c_lt_agroinv_hhagrof	agroforest	HH	0.1 (0.3)	0.11	32.5	11.13	0.22	0.06	60%
c_alt_agroinv_hhagrof	agroforest	HH	0.11 (0.31)	0.07	32.25	11.27	0.19	0.06	55%
cac_a_agroinv_hhagrof	agroforest	HH	0.1 (0.3)	0.07	33.8	11.94	0.18	0.05	50%
c_a_agroforest	agroforest	HH-F	0.05 (0.16)	0.07	30.25	10.92	0.2	NA	20%
c_lt_agroforest	agroforest	HH-F	0.04 (0.15)	0.1	32.5	10.87	0.21	NA	21%
c_alt_agroforest	agroforest	HH-F	0.05 (0.18)	0.04	32.25	11.02	0.18	NA	18%
cac_a_agroforest	agroforest	HH-F	0.05 (0.15)	0.05	33.8	11.66	0.17	NA	17%

primary_indicators

	var	level	mean_sd	icc	cluster_n	n_per_cluster	mdes	pnt_chng	pct_chng
c_a_tensec_index	tensec_index	HH	1.79 (0.95)	0.05	30.25	11.28	0.19	0.18	10%
c_lt_tensec_index	tensec_index	HH	1.75 (0.93)	0.09	32.5	11.2	0.21	0.19	11%
c_alt_tensec_index	tensec_index	HH	1.74 (0.92)	0.03	32.25	11.35	0.17	0.16	9%
cac_a_tensec_index	tensec_index	HH	1.78 (0.95)	0.04	33.8	12.02	0.16	0.15	8%
c_a_fallow_seasons	fallow_seasons	HH	1.46 (3.42)	0.12	29.5	6.55	0.26	0.9	62%
c_lt_fallow_seasons	fallow_seasons	HH	1.57 (3.39)	0.15	32.25	6.31	0.27	0.9	57%
c_alt_fallow_seasons	fallow_seasons	HH	1.38 (3.13)	0.13	31.75	6.35	0.26	0.81	59%
cac_a_fallow_seasons	fallow_seasons	HH	1.44 (3.17)	0.12	32.6	7.26	0.23	0.73	51%
c_a_landgov_overall	landgov_overall	HH	2.16 (0.53)	0.07	30.25	11.36	0.2	0.11	5%
c_lt_landgov_overall	landgov_overall	HH	2.14 (0.53)	0.08	32.5	11.26	0.2	0.11	5%
c_alt_landgov_overall	landgov_overall	HH	2.16 (0.53)	0.06	32.25	11.46	0.19	0.1	5%
cac_a_landgov_overall	landgov_overall	HH	2.17 (0.5)	0.07	33.8	12.08	0.18	0.09	4%
c_a_agseedsurv	agseedsurv	HH-F	71.16 (370.28)	0	14.5	2.16	0.51	189.28	266%
c_lt_agseedsurv	agseedsurv	HH-F	27.88 (89.22)	0	15.75	2.11	0.5	44.23	159%
c_alt_agseedsurv	agseedsurv	HH-F	24.41 (84.6)	0	17	2.19	0.47	39.56	162%
cac_a_agseedsurv	agseedsurv	HH-F	52.54 (302.99)	0	17.8	2.11	0.44	132.62	252%
c_a_agroinv_aginvest	agroinv_aginvest	HH	0.97 (0.17)	0.01	30.25	11.37	0.16	0.03	3%
c_lt_agroinv_aginvest	agroinv_aginvest	HH	0.97 (0.17)	0.01	32.5	11.29	0.16	0.03	3%
c_alt_agroinv_aginvest	agroinv_aginvest	HH	0.97 (0.18)	0	32.25	11.5	0.15	0.03	3%
cac_a_agroinv_aginvest	agroinv_aginvest	HH	0.97 (0.17)	0.01	33.8	12.12	0.14	0.02	2%
c_a_agforben	agforben	HH	0.15 (0.36)	0	15	2.2	0.5	0.18	120%
c_lt_agforben	agforben	HH	0.16 (0.37)	0.06	16	2.16	0.5	0.19	119%
c_alt_agforben	agforben	HH	0.18 (0.39)	0.06	17.25	2.26	0.47	0.18	100%
cac_a_agforben	agforben	HH	0.18 (0.38)	0	18.4	2.13	0.43	0.16	89%
c_a_score_assetindex1	score_assetindex1	HH	-0.1 (1.8)	0.04	30.25	11.32	0.18	0.33	330%
c_lt_score_assetindex1	score_assetindex1	HH	-0.08 (1.78)	0.02	32.5	11.21	0.16	0.29	362%
c_alt_score_assetindex1	score_assetindex1	HH	-0.02 (1.82)	0.06	32.25	11.42	0.19	0.34	1700%
cac_a_score_assetindex1	score_assetindex1	HH	0.06 (1.89)	0.04	33.8	12.03	0.16	0.3	500%

secondary_indicators

	var	level	mean_sd	icc	cluster_n	n_per_cluster	mdes	pnt_chng	pct_chng
c_a_tensec_internal	tensec_internal	HH	1.83 (1.08)	0.05	30.25	11.28	0.19	0.2	11%
c_lt_tensec_internal	tensec_internal	HH	1.81 (1.06)	0.07	32.5	11.2	0.19	0.21	12%
c_alt_tensec_internal	tensec_internal	HH	1.78 (1.03)	0.03	32.25	11.35	0.17	0.17	10%
cac_a_tensec_internal	tensec_internal	HH	1.83 (1.07)	0.03	33.8	12.02	0.15	0.16	9%
c_a_tensec_external	tensec_external	HH	1.75 (0.97)	0.04	30.25	11.28	0.18	0.18	10%
c_lt_tensec_external	tensec_external	HH	1.7 (0.94)	0.09	32.5	11.2	0.21	0.19	11%
c_alt_tensec_external	tensec_external	HH	1.7 (0.95)	0.03	32.25	11.35	0.17	0.16	9%
cac_a_tensec_external	tensec_external	HH	1.74 (0.97)	0.04	33.8	12.02	0.16	0.15	9%
c_a_dispute_satis	dispute_satis	HH	2.31 (1.21)	0.07	24.25	2.69	0.37	0.45	19%
c_lt_dispute_satis	dispute_satis	HH	2.25 (1.21)	0.12	25	2.7	0.38	0.46	20%
c_alt_dispute_satis	dispute_satis	HH	2.16 (1.15)	0.07	25.75	2.55	0.37	0.42	19%
cac_a_dispute_satis	dispute_satis	HH	2.27 (1.17)	0.07	27	2.78	0.33	0.38	17%
c_a_leadsatindex	leadsatindex	HH	2.34 (0.53)	0.08	30.25	11.36	0.21	0.11	5%
c_lt_leadsatindex	leadsatindex	HH	2.32 (0.53)	0.09	32.5	11.26	0.21	0.11	5%
c_alt_leadsatindex	leadsatindex	HH	2.33 (0.52)	0.06	32.25	11.46	0.19	0.1	4%
cac_a_leadsatindex	leadsatindex	HH	2.36 (0.51)	0.07	33.8	12.08	0.18	0.09	4%
c_a_leader_fair	leader_fair	HH	2 (0.93)	0.03	30.25	11.14	0.18	0.16	8%
c_lt_leader_fair	leader_fair	HH	1.99 (0.96)	0.06	32.5	11.05	0.19	0.18	9%
c_alt_leader_fair	leader_fair	HH	2.03 (0.95)	0.03	32.25	11.19	0.17	0.16	8%
cac_a_leader_fair	leader_fair	HH	2.02 (0.93)	0.03	33.8	11.83	0.15	0.14	7%
c_a_land_rules	land_rules	HH	0.46 (0.24)	0.11	30.25	11.33	0.22	0.05	11%
c_lt_land_rules	land_rules	HH	0.47 (0.25)	0.11	32.5	11.24	0.22	0.05	11%
c_alt_land_rules	land_rules	HH	0.46 (0.25)	0.09	32.25	11.46	0.21	0.05	11%
cac_a_land_rules	land_rules	HH	0.46 (0.24)	0.1	33.8	12.07	0.19	0.05	11%
c_a_agroinv_aginvest_short	agroinv_aginvest_short	HH	0.37 (0.18)	0.08	30.25	11.27	0.21	0.04	11%
c_lt_agroinv_aginvest_short	agroinv_aginvest_short	HH	0.37 (0.17)	0.08	32.5	11.2	0.2	0.03	8%
c_alt_agroinv_aginvest_short	agroinv_aginvest_short	HH	0.37 (0.18)	0.08	32.25	11.34	0.2	0.04	11%
cac_a_agroinv_aginvest_short	agroinv_aginvest_short	HH	0.38 (0.18)	0.07	33.8	12.01	0.18	0.03	8%
c_a_agroinv_aginvest_long	agroinv_aginvest_long	HH	0.33 (0.18)	0.05	30.25	11.27	0.19	0.03	9%
c_lt_agroinv_aginvest_long	agroinv_aginvest_long	HH	0.33 (0.18)	0.09	32.5	11.2	0.21	0.04	12%
c_alt_agroinv_aginvest_long	agroinv_aginvest_long	HH	0.33 (0.18)	0.06	32.25	11.34	0.19	0.03	9%
cac_a_agroinv_aginvest_long	agroinv_aginvest_long	HH	0.33 (0.18)	0.05	33.8	12.01	0.16	0.03	9%

ANNEX 5: BALANCE

hh_field_level_control_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
conhhfld_claysoil	0.093 (0.265)	0.107 (0.286)	0.136 (0.319)	0.105 (0.287)	0.181*** (0.351)
conhhfld_sndloamsoil	0.407 (0.446)	0.388 (0.448)	0.34** (0.429)	0.422 (0.454)	0.43 (0.448)
conhhfld_loamysoil	0.19 (0.363)	0.181 (0.359)	0.21 (0.375)	0.178 (0.352)	0.187 (0.36)
conhhfld_siltsoil	0.018 (0.115)	0.024* (0.144)	0.017 (0.118)	0.011 (0.097)	0.026** (0.149)
conhhfld_gravelsoil	0.008** (0.083)	0.02 (0.129)	0.012* (0.099)	0.027 (0.153)	0.008** (0.079)
conhhfld_blacksoil	0.001 (0.013)	0.001 (0.018)	0 (0.009)	0.001 (0.022)	0.002 (0.034)
conhhfld_othrsoil	0.283 (0.418)	0.28 (0.418)	0.285 (0.418)	0.256 (0.406)	0.166*** (0.334)
distance_field	1835.713** (2824.005)	1953.929* (2315.527)	1978.04* (2339.898)	2510.584 (5160.086)	2325.636 (3144.893)
farea	0.684*** (0.453)	0.639*** (0.413)	0.772 (0.809)	0.821 (0.782)	0.619*** (0.439)
conhhfld_fldinherit	0.426 (0.179)	0.424 (0.175)	0.436 (0.181)	0.431 (0.172)	0.43 (0.175)
conhhfld_fldallocated	0.068 (0.135)	0.079 (0.146)	0.065 (0.131)	0.072 (0.144)	0.065 (0.138)
conhhfld_fldpurchased	0.002 (0.025)	0.004 (0.044)	0.001 (0.018)	0.002 (0.023)	0.001 (0.018)
conhhfld_fldrented	0.01 (0.048)	0.01 (0.047)	0.009 (0.043)	0.007 (0.044)	0.013* (0.051)
conhhfld_fldborrowed	0.012 (0.051)	0.006 (0.035)	0.011 (0.049)	0.009 (0.047)	0.011 (0.051)
conhhfld_fldacqother	0.001 (0.019)	0 (0.005)	0 (0.009)	0.001 (0.022)	0 (0)
paperdoc	0.011 (0.101)	0.013 (0.109)	0.015 (0.118)	0.012 (0.105)	0.005 (0.071)
tensec_index_hh	1.785 (0.956)	1.726 (0.939)	1.707 (0.905)	1.752 (0.866)	1.747 (0.935)

agricultural_productivity_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
Agricultural Productivity					
agforben_4	0.044 (0.207)	0.028 (0.165)	0.011 (0.105)	0.016 (0.125)	0.016 (0.125)
agforben_6	0 (0)	0.014 (0.118)	0 (0)	0 (0)	0 (0)
crop_sell	0.603* (0.917)	0.662*** (0.858)	0.602** (0.873)	0.496 (0.845)	0.714*** (0.968)
Livelihood Improvements					
score_assetindex1	-0.176 (1.828)	-0.12 (1.775)	-0.024 (1.865)	-0.029 (1.776)	0.406*** (2.019)
score_assetindex2	-0.256 (1.761)	-0.131 (1.826)	-0.081 (1.794)	-0.088 (1.681)	0.638*** (2.09)
score_assetindex3	-0.177 (1.73)	-0.054 (1.792)	-0.058 (1.766)	-0.079 (1.657)	0.419*** (2.01)
Climate Resilience					
agforben_61	0 (0)	0.014 (0.118)	0 (0)	0 (0)	0 (0)

agroforestry_uptake_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
Agroforestry Uptake					
agroforest	0.105 (0.306)	0.097 (0.296)	0.121 (0.327)	0.097 (0.296)	0.103 (0.304)
agroforest1	0.046 (0.156)	0.041 (0.142)	0.061 (0.188)	0.046 (0.156)	0.043 (0.147)
agextent	3.591 (1.496)	3.653 (1.375)	3.8 (1.306)	3.469 (1.532)	4.031** (1.195)
agseedmus	78.485 (119.082)	34.638 (40.665)	68.607 (145.324)	56.282 (110.558)	36.196 (50.091)
agseedglir	165.278 (257.771)	145.706 (257.76)	103.429 (192.191)	92.875 (165.235)	39.167 (35.273)
Agricultural Investment					
fallow	0.127 (0.333)	0.114 (0.318)	0.141 (0.348)	0.141 (0.348)	0.179 (0.383)
agroinv_aginvest	0.488 (0.116)	0.488 (0.119)	0.489 (0.118)	0.494 (0.121)	0.5 (0.114)
agroinv_aginvest_short	0.366 (0.156)	0.367 (0.147)	0.369 (0.162)	0.369 (0.193)	0.393* (0.178)
agroinv_aginvest_long	0.301*** (0.159)	0.297*** (0.159)	0.308*** (0.169)	0.352 (0.183)	0.347 (0.15)
plantbasin	0.1*** (0.24)	0.082*** (0.202)	0.105*** (0.251)	0.153 (0.307)	0.097*** (0.242)
zerotill	0.072 (0.227)	0.078 (0.232)	0.074 (0.227)	0.099 (0.254)	0.107 (0.273)
ridge	0.87** (0.287)	0.878*** (0.276)	0.845 (0.318)	0.813 (0.347)	0.837 (0.323)
manure	0.155 (0.288)	0.14** (0.269)	0.186 (0.32)	0.193 (0.335)	0.235 (0.334)
croprotate	0.784 (0.356)	0.795 (0.362)	0.782 (0.366)	0.807 (0.358)	0.793 (0.348)
fallow1	0.073 (0.22)	0.059** (0.192)	0.077 (0.218)	0.09 (0.247)	0.097 (0.236)
fallowyr	2.219*** (1.231)	1.839 (1.052)	2.003 (1.268)	1.764 (1.228)	2.067* (1.266)
agroinv_fertilizer	0.181*** (0.143)	0.182*** (0.148)	0.19** (0.154)	0.218 (0.171)	0.23 (0.133)
agroinv_fertperhect	219.612 (191.079)	290.475 (1098.661)	225.375 (216.99)	248.241 (631.434)	358.21*** (744.156)
fertilizer_kgs	165.556 (219.202)	162.287 (168.383)	182.964 (213.1)	166.649 (164.963)	232.348*** (343.259)

land_governance_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
Land Management					
vlc	0.167 (0.377)	0.22 (0.418)	0.145 (0.355)	0.174 (0.383)	0.128 (0.339)
hvmeet_bin	0.333 (0.476)	0.373 (0.488)	0.226 (0.422)	0.261 (0.444)	0.385 (0.493)
hvmeet	1 (1.726)	1.353 (2.591)	0.565 (1.223)	0.913 (2.127)	0.872 (1.38)
VLC	0.19* (0.392)	0.193 (0.395)	0.217 (0.413)	0.251 (0.434)	0.133*** (0.34)
land_participate	3.965** (1.482)	3.862 (1.586)	3.946* (1.52)	3.747 (1.589)	4.018*** (1.49)
land_satisfaction	2.042 (0.935)	1.987 (0.944)	2.008 (0.851)	1.976 (0.918)	2.098** (0.846)
leader_trust	1.963 (0.917)	1.911 (0.915)	1.97 (0.908)	1.895 (0.906)	1.948 (0.808)
leader_protect	1.888** (0.845)	1.783 (0.787)	1.885** (0.837)	1.763 (0.783)	1.863* (0.771)
decisions_transparent	3.627 (1.013)	3.637 (1.119)	3.598 (1.05)	3.596 (1.07)	3.674 (1.039)
leadsatindex	2.38* (0.529)	2.333 (0.529)	2.353 (0.525)	2.307 (0.524)	2.39** (0.465)
Land Allocation					
vuln_disad	0.53 (0.499)	0.507 (0.5)	0.535 (0.499)	0.533 (0.499)	0.574 (0.495)
leader_fair	2.006 (0.933)	1.977 (0.972)	2.064 (0.954)	1.989 (0.936)	2.073 (0.917)
women_status	3.104 (1.327)	3.231 (1.385)	3.121 (1.339)	3.114 (1.311)	3.079 (1.327)
elderly_status	3.417 (1.2)	3.526** (1.241)	3.489 (1.185)	3.354 (1.223)	3.459 (1.193)
poor_status	3.183 (1.283)	3.275 (1.332)	3.253 (1.268)	3.231 (1.277)	3.129 (1.28)
tribe_status	3.223 (1.262)	3.327 (1.296)	3.261 (1.27)	3.318 (1.269)	3.127** (1.273)
vuln_real	3.229 (1.053)	3.334 (1.121)	3.285 (1.049)	3.251 (1.068)	3.2 (1.04)
decisions_fair	1.989 (0.83)	1.913 (0.856)	2.052 (0.892)	2.008 (0.91)	1.95 (0.735)
leader_transparent	1.98 (0.909)	1.943 (0.925)	2.033 (0.943)	2.014 (0.972)	2.005 (0.869)
leaders_accountable	1.983 (0.772)	1.979 (0.846)	1.972 (0.757)	1.93 (0.781)	2.021* (0.753)
tensec_allocatindex	1.985 (0.667)	1.947 (0.675)	2.017 (0.684)	1.987 (0.68)	1.999 (0.588)
Land Rules and Governance					
rules_clear	1.949 (0.845)	1.901 (0.877)	1.963 (0.854)	1.973 (0.902)	1.952 (0.771)
landgov_overall	2.178 (0.521)	2.135 (0.522)	2.18 (0.525)	2.149 (0.533)	2.191 (0.434)
hgraze	0.812** (0.394)	0.804** (0.401)	0.887 (0.319)	0.957 (0.206)	0.947 (0.226)
htree	0.792 (0.41)	0.72 (0.454)	0.855 (0.355)	0.804 (0.401)	0.846 (0.366)
hown	0.104 (0.309)	0.157 (0.367)	0.242 (0.432)	0.13 (0.341)	0.128 (0.339)
hneigh	0.255 (0.441)	0.24 (0.431)	0.323 (0.471)	0.289 (0.458)	0.211 (0.413)
hout	0.191 (0.398)	0.28 (0.454)	0.258 (0.441)	0.178 (0.387)	0.237 (0.431)
hfire	0.833 (0.377)	0.66 (0.479)	0.806 (0.398)	0.783 (0.417)	0.842 (0.37)
landgov_totruleenf	2.729 (1.25)	2.471 (1.317)	3.097 (1.422)	2.87 (1.087)	2.949 (1.255)
hgrazwenf	0.897 (0.307)	0.976 (0.156)	0.964 (0.189)	0.955 (0.211)	0.972 (0.167)
htreewenf	0.895 (0.311)	0.75* (0.439)	0.887 (0.32)	0.919 (0.277)	0.879 (0.331)
hownwenf	0.8 (0.447)	0.875 (0.354)	0.8 (0.414)	0.5 (0.548)	1* (0)
hfirewenf	0.925 (0.267)	0.818 (0.392)	0.88 (0.328)	0.917 (0.28)	0.906 (0.296)
landgov_percruleenf	0.925 (0.2)	0.901 (0.197)	0.931 (0.153)	0.929 (0.208)	0.933 (0.193)
hgrazrenf	0.949 (0.223)	1 (0)	0.964 (0.189)	0.977 (0.151)	1 (0)
htreerenf	0.895 (0.311)	0.8* (0.406)	0.868 (0.342)	0.946 (0.229)	0.938 (0.246)
htownrenf	0.8 (0.447)	0.875 (0.354)	0.933 (0.258)	0.667 (0.516)	1 (0)
hfirerenf	0.875 (0.335)	0.848* (0.364)	0.92 (0.274)	0.971 (0.169)	0.906 (0.296)
landgov_hpercpun	0.889 (0.257)	0.881 (0.168)	0.867 (0.209)	0.92 (0.194)	0.921 (0.152)
landgov_htotpun	2.646 (1.246)	2.392** (1.168)	2.903 (1.277)	2.87 (1.002)	2.872 (1.08)
landgov_lndruleindx	2.701 (1.223)	2.444* (1.227)	3.032 (1.333)	2.87 (1.022)	2.923 (1.178)

hh_level_control_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
a14_gender_respondent	0.922 (0.269)	0.94** (0.239)	0.933* (0.251)	0.873 (0.334)	0.881 (0.325)
head_age	43.97 (17.006)	42.962* (16.06)	44.477 (16.612)	44.923 (16.765)	43.831 (16.116)
head_youth	0.359 (0.48)	0.381 (0.486)	0.364 (0.482)	0.334 (0.472)	0.352 (0.478)
ed_head	6.722 (3.803)	6.74 (3.82)	6.939 (3.816)	6.658 (3.663)	6.859 (3.572)
b17_size_hh	5.152 (2.668)	5.215 (2.667)	5.138 (2.525)	5.34 (2.805)	5.443 (2.708)
c1_landarea_own	1.955 (2.252)	2.013 (2.028)	2.039 (1.798)	2.036 (1.842)	1.74** (1.849)
num_field	2.525*** (1.091)	2.618*** (1.185)	2.531** (1.174)	2.314 (1.063)	2.827*** (1.252)
conhh_lndcnstrain	0.285 (0.452)	0.298 (0.457)	0.25 (0.433)	0.266 (0.442)	0.323* (0.468)
c21_reallocate	0.019 (0.138)	0.018 (0.134)	0.018 (0.134)	0.018 (0.133)	0.017 (0.131)
poor_stat3	0.276 (0.448)	0.29* (0.454)	0.242 (0.429)	0.242 (0.429)	0.186** (0.39)

village_level_control_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
hgender	0.021 (0.144)	0.078 (0.272)	0.177*** (0.385)	0.022 (0.147)	0 (0)
hage	54.896 (15.014)	58.02 (12.225)	57.763 (14.259)	57.63 (14.121)	58.816 (13.331)
hvsize	33.938 (30.346)	31.843 (30.157)	34.656 (28.811)	27.326 (18.319)	54.103*** (48.001)
hvconflict_bin	0.438 (0.501)	0.471 (0.504)	0.387 (0.491)	0.37 (0.488)	0.538 (0.505)
vlc	0.167 (0.377)	0.22 (0.418)	0.145 (0.355)	0.174 (0.383)	0.128 (0.339)
landgov_lndruleindx	2.701 (1.223)	2.444* (1.227)	3.032 (1.333)	2.87 (1.022)	2.923 (1.178)
hboma	33.723 (12.868)	32.86 (10.242)	33.194 (11.778)	36.478 (17.26)	37.026 (10.514)
htarmac	13.872 (13.682)	14.961 (12.814)	15.21 (15.043)	14.848 (19.416)	28.205*** (12.568)
hroad	4.106 (6.044)	3.451 (4.872)	5.145 (7.613)	5.378 (8.459)	6.41 (7.433)
hfra	9.109 (10.727)	9 (5.522)	7.661 (6.249)	10.087 (14.777)	9.154 (5.138)
hpublic	4.255 (5.632)	4.392 (5.196)	3.887 (5.823)	5.087 (5.428)	5.128 (6.363)
hmobile	0.292 (1.202)	0.392 (1.498)	0.306 (1.478)	1.065 (3.241)	0.077** (0.354)
hsell	4.234 (5.301)	6.843 (7.487)	5.387 (5.916)	5.543 (9.683)	10.154** (10.723)
hmarket	6.848 (8.181)	9 (8.116)	7.177 (7.561)	8.652 (10.916)	11.385 (9.369)
hprimary	2.957 (2.758)	3.42 (3.671)	2.823 (2.258)	2.891 (2.618)	3.154 (3.368)
hsecond	17.761 (14.518)	20.88 (11.192)	15.742 (10.553)	19.413 (13.91)	22.667 (12.179)
hclinic	6.34 (7.467)	7.94 (6.001)	5.194 (4.097)	6 (6.172)	4.821 (2.999)
hbank	31.809 (13.725)	32.941 (10.003)	30.194 (13.404)	35.13 (18.953)	36.436 (9.88)
hbore	0.896 (1.627)	1.627 (4.354)	0.935 (1.782)	1.457 (3.74)	1.385 (1.726)
hagoffice	6.957 (7.63)	7.58 (6.587)	5.452 (4.307)	8.239 (11.186)	3.795** (3.164)

tenure_security_v9

	Agroforestry	Land Tenure	Agroforestry and Land Tenure	Control	Agroforestry Control
Land Expropriation and Reallocation					
tensec_index_hhs	1.759 (0.922)	1.692 (0.895)	1.677 (0.864)	1.723 (0.836)	1.706 (0.88)
tensec_index_hhl	1.812 (1.016)	1.759 (1.014)	1.737 (0.98)	1.78 (0.931)	1.788 (1.03)
tensec_index_hh	1.785 (0.956)	1.726 (0.939)	1.707 (0.905)	1.752 (0.866)	1.747 (0.935)
villhh_encroach	2.077*** (1.378)	1.914 (1.284)	1.944 (1.302)	1.835 (1.267)	1.869 (1.241)
elite_encroach	1.756 (1.199)	1.598 (1.074)	1.628 (1.107)	1.658 (1.061)	1.638 (1.085)
neighvill_encroach	1.751*** (1.211)	1.648 (1.103)	1.624 (1.106)	1.543 (0.965)	1.639 (1.076)
chief_reallocateh	1.835** (1.23)	1.821** (1.225)	1.851** (1.25)	2.012 (1.298)	1.903 (1.273)
headman_reallocate	1.511 (1.013)	1.521 (1.008)	1.479** (0.961)	1.609 (1.034)	1.501* (0.989)
family_encroach	1.625 (1.113)	1.651 (1.09)	1.534** (1.015)	1.684 (1.113)	1.685 (1.118)
tensec_index_hp	2 (0.98)	2.19 (0.852)	1.833 (0.719)	2.109 (0.916)	2.325 (0.957)
helite1	1.5 (0.945)	1.588 (0.92)	1.419 (0.759)	1.543 (0.982)	1.59 (0.751)
hneigh1	2.104 (1.387)	2.255 (1.383)	1.887 (1.294)	2.065 (1.511)	2.615* (1.48)
hchiefsell1	2.396 (1.484)	2.725 (1.429)	2.194* (1.365)	2.717 (1.573)	2.769 (1.459)
Land Disputes and Conflict					
hvconflict_bin	0.438 (0.501)	0.471 (0.504)	0.387 (0.491)	0.37 (0.488)	0.538 (0.505)
hvconflict	0.667 (0.975)	0.922 (1.73)	0.581 (0.841)	0.587 (0.909)	0.897 (1.095)
hvconbound	1.19 (0.75)	1.583 (1.954)	1.083 (0.929)	0.882 (0.781)	1.19 (0.981)
hvconallocation	0.286 (0.561)	0.542 (1.25)	0.25 (0.442)	0.353 (0.493)	0.19 (0.512)
tensec_disputefreq	2.62** (0.444)	2.49 (0.505)	2.548* (0.417)	2.397 (0.424)	2.506 (0.464)
tensec_disputeintense	2.594** (0.446)	2.52 (0.452)	2.573* (0.408)	2.413 (0.416)	2.506 (0.439)
dispute	0.143 (0.287)	0.118 (0.251)	0.108** (0.241)	0.141 (0.303)	0.125 (0.268)
boundarydispute_bin	0.732 (0.444)	0.697 (0.456)	0.662 (0.467)	0.736 (0.436)	0.679 (0.464)
disputecount	1.21 (0.895)	1.249 (1.089)	1.239 (0.942)	1.992 (7.566)	1.316 (1.292)
dispute_restime	3.546 (2.343)	3.65 (2.412)	3.507 (2.344)	3.443 (2.408)	3.924 (2.457)
dispute_satis	2.36 (1.219)	2.259 (1.211)	2.062 (1.089)	2.254 (1.209)	2.193 (1.079)
chief_enforce	1.831 (0.807)	1.763 (0.873)	1.849 (0.793)	1.817 (0.792)	1.84 (0.746)
Land Documentation					
tensec_papdochh	0.012 (0.108)	0.014 (0.119)	0.017 (0.129)	0.012 (0.109)	0.006 (0.079)
paperdoc	0.011 (0.101)	0.013 (0.109)	0.015 (0.118)	0.012 (0.105)	0.005 (0.071)
tensec_custdoc	0.625 (0.518)	0.545 (0.522)	0.667 (0.492)	0.556 (0.527)	0.333 (0.577)
Land Rental Activity					
tensec_hhlandlordIND	0.028 (0.166)	0.025 (0.156)	0.025 (0.156)	0.022 (0.148)	0.044** (0.205)
Access to Credit					
loan	0.03** (0.17)	0.029** (0.168)	0.042 (0.2)	0.075 (0.263)	0.074 (0.262)

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