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TENURE AND GLOBAL CLIMATE CHANGE (TGCC)

Evaluation Report

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DISCLAIMER

The authors' views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

CONTENTS

ACRONYMS AND ABBREVIATIONS

Ag	Agroforestry
Ag+LT	Agroforestry + Land Tenure
CDLA	Chipata District Land Alliance
CLC	Customary Land Certificate
COMACO	Community Markets for Conservation
CSA	Climate-Smart Agriculture
ERC	Evaluation, Research and Communication
IE	Impact Evaluation
ITT	Intent to Treat
M&E	Monitoring and Evaluation
LT	Land Tenure
RCT	Randomized control trial
STARR	Strengthening Tenure and Resource Rights
TGCC	Tenure and Global Climate Change
TOT	Treatment on the Treated
USAID	United States Agency for International Development
VLC	Village Land Committee
YGL	Yield Group Leaders

1.0 EXECUTIVE SUMMARY

Agroforestry is widely perceived as a long-term sustainable land use practice that can help meet a range of rural development objectives in sub-Saharan Africa. Expected benefits include increased crop yields and more effective adaptation and mitigation responses to climate-change impacts (Mbow et al., 2014). Favorable Zambian agricultural policy has encouraged Climate-Smart Agriculture (CSA), and a number of organizations have actively promoted conservation agriculture and agroforestry to encourage food security, especially in Eastern Province. However, uptake of CSA practices, in particular agroforestry, remains limited and dis-adoption is high, despite the expected benefits to Zambia's small holder farmers who struggle with low yields, unreliable access to fertilizer and limited resilience.

Insecure resource tenure is hypothesized to constrain smallholder investment in the long-term productivity of their fields. Many studies provide empirical evidence of the benefits of tenure security for promoting greater field investment outcomes (Deininger et al., 2011; Deininger and Chamorro, 2004; Feder et al., 1988; Holden et al., 2009; Jacoby et al., 2002; Rozelle and Swinnen, 2004). A basic premise of stronger and more secure land tenure is that the enforcement of these rights lessens the risk of forcible displacement and allows for a level of long-term security and a sense of permanence that encourages land-related investment (Besley, 1995).

Consequently, land tenure security and property rights governance issues represent a central focus in Zambia for a range of rural development initiatives to address agricultural livelihoods and poverty reduction. In Zambia, where the majority of the land is under customary management by traditional chiefs, smallholders commonly have no documentation of their land rights, 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 headmen. Uncertainties over land allocation processes within villages also contribute to ongoing land conflicts. This is an especially pressing issue in the rural areas of Zambia, where insufficient access to arable land is a recognized driver of continued impoverishment. Prior research indicates large variation in the size of farmer landholdings among village households, significant numbers of land constrained households even in villages where unallocated land is present and widely varying perceptions about land availability and ease of acquisition for farmland expansion (Jayne et al., 2009).

Nevertheless, many questions remain around the efficacy of activities that are hypothesized to strengthen farmer perceptions of the tenure security of their farm holdings, as well as the extent to which strengthened land tenure security incentivizes farmers to undertake longer-term sustainable land investments such as agroforestry. Although some studies have found strong evidence of positive impacts for land formalization (Deininger et al., 2011; Goldstein et al., 2018), no clear consensus has emerged from empirical studies across varying sub-Saharan Africa contexts on whether and how stronger tenure security may, as a whole, incentivize farmer decision-making and pursuit of different land investment strategies on their farms (Place, 2009).

Recent literature has paid particular attention to the role of customary land registration in sub-Saharan Africa as a means of strengthening smallholder perceptions of tenure security and altering their land use decision-making strategies to undertake longer-term land investments (Place and Otsuka, 2001; Smith,

2004). However, there remains a dearth of rigorous empirical evidence on the efficacy of interventions to strengthen customary land tenure.

With a view towards addressing these limitations, USAID's E3/Land and Urban Office piloted the Tenure and Global Climate Change Program (TGCC) in Zambia to explore the relationship between secure resource tenure and the adoption of agroforestry practices. TGCC was implemented in Chipata District, one of nine districts of Zambia's Eastern Province, from 2014–2017. The intervention was designed to strengthen customary tenure security at the chiefdom, village, and household levels, while also supporting agroforestry extension services, primarily at the village level.

TGCC piloted two treatments:

1. Land Tenure (LT): centered on a village-level land tenure intervention consisting of participatory mapping, village headperson land administration support and the facilitation of informal customary land use certificates for households[1];
2. Agroforestry (Ag): centered on agroforestry extension in villages to facilitate tree planting adoption and survivorship on smallholder farms; and

This report presents the results of an impact evaluation of TGCC. The primary objective of the impact evaluation (IE) was to determine whether TGCC's village and household land tenure interventions 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 research question that motivated this evaluation was:

> "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?"

To answer this central question, TGCC was implemented as a four-arm village-level randomized control trial (RCT) with three key sub questions for hypothesis testing:

1. Whether an agroforestry extension program increased farmer investment in sustainable agroforestry;
2. Whether a village and household informal land registration and governance intervention strengthened perceptions of land tenure security and resource rights for smallholders in a customary context; and,
3. Assuming farmers' perception of tenure security were strengthened, whether stronger perceptions of tenure security increased farmer investment in sustainable agroforestry.

Villages in the evaluation sample were randomized into four treatments (Agroforestry, Land Tenure, Agroforestry and Land Tenure, and Pure Control) across four chiefdoms. The implementation of TGCC as an RCT enabled a rigorous assessment of the direct *and* joint impacts of the agroforestry extension and tenure security strengthening interventions.

The analysis for this report relies primarily on a household panel dataset consisting of approximately 3,200 respondent observations across 246 villages. Baseline data was collected from June to August 2014, prior to the start of the TGCC program, and follow-up data was collected from June to August 2017, following the completion of the program. To supplement the primary outcome analysis, we analyze several additional sources of data, including a quantitative village level survey conducted with the

1 Note that TGCC program did not have sufficient scope and capacity to undertake institutional capacity building for a land administration system.

village headman or headwoman and quantitative key informant interviews with a lead farmer and a village land committee member in each village. In addition, 62 focus group discussions were conducted in 28 villages, with special attention paid to women and youth. Additional focus groups were held with TGCC program staff to collect information about variation in implementation and other village-level data.

To investigate each research question, we developed a series of primary and secondary indicators across five outcome families: tenure security, land governance, agroforestry uptake and survivorship, investment in agriculture, and agricultural productivity and livelihoods. For each indicator, we present the average treatment effects, in addition to heterogeneous impacts for female-headed, youth, elderly, poor and land constrained households. This is our primary impact analysis for the evaluation and relies on the household panel dataset.

Additionally, we support this primary analysis with descriptive statistics based on the panel results, as well as full follow-up survey sample results for the section that discusses the agroforestry results. We also include a secondary "within-treatment" analysis for subgroups to assess whether there were differential effects within the treatment groups to gauge the tendency for elite capture. Finally, we incorporate additional qualitative findings from key informant interviews and focus group discussions to further ground the analysis.

To our knowledge there is no experimental evidence studying the impact of strengthening customary land tenure on perceived tenure security, and little or no evidence of any sort on whether granting customary documentation to a producer makes her or him more likely to adopt new technology. As such, the TGCC evaluation has generated new knowledge around the impacts of informal customary land registration on household-level development outcomes. This contributes towards enhanced policy and programming and provides insights on the role of land rights clarification and enhancement in customary contexts for meeting broader development objectives.

KEY HOUSEHOLD FINDINGS

The evaluation results for the household panel analysis suggest:

- significant and positive impacts of informal customary land registration on short and long term perceived tenure security and decreased perceived expropriation risk by internal and external actors;
- a positive impact of the agroforestry extension program on uptake of agroforestry tree planting, although the actual rate of tree planting and seedling survival remain low;
- no evidence that greater perceived tenure security motivated higher rates of agroforestry investment;
- no evidence of treatment impacts for indicators measuring land governance, agricultural productivity, or livelihoods. Given the short timeline between the close of the intervention and follow-up data collection, the absence of a treatment impact for long-term indicators, such as crop yields and welfare impacts, was expected.

The findings indicate that the TGCC land registration and governance intervention successfully increased perceptions of tenure security. The process of boundary demarcation and the expectation (if not the actual delivery[2]) of receiving customary certificates for fields did indeed make households feel more secure in their property rights. Treatment households perceive that their fields are more secure from reallocation or unauthorized appropriation from both internal and external threats in the next three

2 Delivery of customary land certificates was not uniform across the treatment areas, as detailed in Section 3.

years and beyond four years. Looking across the binary measures for the six sources of dispossession, we find that the land registration and governance intervention raised the probability that households think encroachment or unauthorized appropriation is "impossible" by 5 to 6 percentage points for headman, neighboring villages and other households within their home village.

Almost by definition, marginalized groups—particularly women, youth and poor households—are most vulnerable to unauthorized appropriation. These households often lack the social power to resist expropriation by elites or encroachment by other households. In addition to strong household effects, the analysis finds evidence of positive subgroup treatment impacts for primary and secondary indicators in villages that received the Land Tenure intervention. These are found across tenure security, land governance, agroforestry uptake and investment outcomes. The regression results, in combination with a secondary analysis that shows an absence of systematic "within-treatment" differences between subgroups and the average household results, point to important equity benefits to the TGCC program and an absence of elite capture.

Nevertheless, the Land Tenure intervention had no effect on agroforestry adoption. Households that received both the Land Tenure and Agroforestry interventions were 15 percentage points more likely to use agroforestry on their plots—an effect almost identical to that on households that received *only* the Agroforestry intervention.

These results suggest that either tenure insecurity does not actually deter households from making agroforestry investments, or only after households have felt secure for some time do they begin adopting technology and making investments.

The presence of significant tenure security results, despite no changes in the governance indicators examined for this study, suggest that changes for these governance indicators do not necessarily represent a pre-condition for improved perceptions of tenure security. This has important implications for the Theories of Change that inform development programming related to customary land protection.

Tenure Security

The TGCC Land Tenure intervention had a positive impact on perceived tenure security for *all* primary perception indicators, although there is no evidence that TGCC had an impact on the actual prevalence of land disputes.[3] In addition, we find positive subgroup treatment impacts for female-headed and elder-headed households receiving the Land Tenure intervention.

The planting of agroforestry trees is not linked to greater perceived secure tenure for the full household sample or for the subgroup results for primary indicators. However, we do find some evidence of marginal improvements for the joint Agroforestry + Land Tenure treatment group among *secondary* indicators for female-headed households. This means that women may experience additional tenure security benefits from involvement in the agroforestry extension program, compared to only participating in the Land Tenure intervention. However, this is the only evidence that we find of a positive marginal effect for tenure security on agroforestry investment.

Furthermore, the regression analysis indicates a potential dampening effect on perceptions of tenure security for elderly and land-constrained involved in the Agroforestry program. Despite the strong Land

3 The number of disputes is low at both baseline and follow-up, which may explain why the tenure security intervention found no impact on prevalence of land disputes

Tenure effects across primary and secondary indicators for elderly respondents, there is no evidence of a positive treatment effect in the Agroforestry + Land Tenure group for this subgroup.

Although the analysis is descriptive, we do not find evidence of elite capture or uneven program impacts for women and marginalized groups receiving the Land Tenure intervention. Women and other vulnerable subgroups experience similar positive treatment impacts to their counterparts *within* the treatment sample. This provides some positive evidence of equity benefits for the program participants receiving the Land Tenure intervention.

Land Governance

There is no evidence of a treatment impact on primary land governance outcomes, which measure households' perceptions of the transparency of land allocation and accountability of leaders, as well as satisfaction with the resolution of land disputes.

For secondary outcomes, on average, we see increased participation in land related meetings for households in villages receiving the Land Tenure treatment and greater trustworthiness of leaders. The participation result most likely reflects program output versus outcomes, but should be tested through a longer-term study. The subgroup results are somewhat mixed for the Land Tenure intervention and there does not appear to be a clear narrative to explain the findings. We find consistently positive results for secondary indicators for elderly- and youth-headed households but several negative findings spread across female-headed, poor- and land-constrained households.

There are also unexpected results for this outcome family for some subgroups that received the Agroforestry treatment. Households in villages that received the agroforestry extension perceive less fairness in leaders' decision-making regarding land management issues and less equity in land distribution for vulnerable groups.

For the within-treatment analysis, we find some evidence of positive subgroup benefits for the Land Tenure intervention for primary indicators compared to the average treatment effect. These results—in combination with the Tenure Security Outcome Family findings—lend further support to an argument that the program was not subject to elite capture and provided important benefits to vulnerable groups.

Agroforestry Uptake

The agroforestry uptake findings speak to the fundamental research question driving the study—whether stronger property rights affect a farmer's decision to practice climate-smart agriculture, including agroforestry. The results show a positive aggregate TGCC Agroforestry treatment impact for our two primary agroforestry uptake measures. Correspondingly, all subgroups—female-headed, youth, elders, poor, and land constrained—show significant uptake in agroforestry and increased agroforestry planting across fields for the Agroforestry intervention.

However, there is no evidence of marginal improvements in agroforestry uptake for households that also received the land registration and governance intervention.[4] Thus, for the *overall household sample*, there is no evidence to support a link between perceived tenure security and agroforestry uptake. In contrast, the subgroup findings for female-headed households, poor and elderly respondents indicate

4 This finding holds across the village-wide analysis of the program's intent to treat (ITT) and for the treatment on the treated, where we focus on the results for only those households that actively participated in COMACO training (Treatment on the Treated (TOT)). TOT results are presented in the Annex 3, whereas the body of the report presents the ITT findings. In fact, unexpectedly, the ITT results are greater in magnitude and present for both Land Tenure and Agroforestry + Land Tenure, in contrast to the TOT results. This could be due to inaccurate reporting by respondents about their involvement in COMACO.

marginal benefits to linking land tenure and agroforestry. This lends some limited support to the argument that, at least for more marginalized groups, stronger property rights affect a farmer's decision to practice CSA including agroforestry. For the long term, it will be valuable to track whether there is a relationship between tree survival and perceived tenure security.

Finally, there is no strong or systematic evidence of within-treatment differences between subgroups and the aggregate treatment estimates. Similar to other outcome families, this bodes well for equity in the distribution of program benefits and absence of elite capture.

In comparison to a 50–75 % survival rate found in other studies (Fink et al., 2014), the seedling and tree survival rates for the program are low. Across all years of the intervention, over a third of households who engaged in agroforestry report that less than 25% of their Musangu and *Gliricidia* seedlings have survived. For Musangu, the rate of survival is even lower. Only 22% (N=23) of treatment households have a survival rate above 75% for trees planted in 2014, and the percentage is even lower for trees planted in 2015 (17%, N=14). These low survival rates do not appear to correlate with the geographical location of the villages, or with the location of wells or water points. However, it is important to note that the entire Chipata District was impacted by a drought in both the 2014–2015 and 2015–2016 agricultural seasons, which impacted seedling survival. Moreover, the seedling survival declines over time and is the lowest in 2016. This suggests that the support provided by Community Markets for Conservation (COMACO) during the agroforestry program was critical to the survival of seedlings, and withdrawing this support has had negative impacts on seedling survival rates.

The difficulty and demands of agroforestry—combined with perceptions of relatively small and distal benefits—suggest a need to reconsider agroforestry as a key CSA development intervention in this context. Other interventions, such as fruit trees or woodlots, or other CSA methods like minimal tillage, may prove more worthwhile.

Field Investment

We do not find significant treatment effects for field investments measured at the household level.[5] Our data suggest fallowing may increase tenure insecurity (or at least its perception). This is driven by a fear that unproductive land will be reallocated by the headperson, given increasing land scarcity and a growing population. For example, households that have recently left land fallow are 10 percentage points more likely to report a fear of expropriation. Fear of expropriation is especially high for the largest plots (2 to 3 hectares) as compared to smaller plots (less than 1 hectare), by a difference of 10 percentage points. The plots that may most benefit from agroforestry or fallowing are also those perceived to be the least secure.

The results also show a mix of positive and negative heterogeneous treatment impacts on subgroups. Positive results for investment indexes are found among youth and land constrained in the Land Tenure group. However, we also find that the poor are significantly less likely to fallow in the Land Tenure group, whereas there is weak evidence that youth are less likely to have fallowed in the Agroforestry + Land Tenure treatment. There are no differential impacts for female or elder-headed households.

In line with the other outcome families, the findings do not reveal systematic evidence of a difference between the average treatment effects and subgroup results for female-headed, elderly, poor or land constrained households. The exception to this is the results for youth. We find that compared to the

5 Note that subsequent research conducted at the field level reveals positive Land Tenure treatment impacts on field investments (See Huntington et al., 2018).

average treatment effect for 'non-youth,' youth receiving the treatment are less likely to have fallowed in the past 3 years.

CONSTRAINTS AND LIMITATIONS

Full certification versus boundary demarcation

The distribution of certificates to households at the time of the follow-up 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 had not signed and distributed certificates to households in their villages at the time of data collection. As a result, certificates were not distributed to all households before the follow-up survey took place. As of June 2017, based on program Monitoring and Evaluation (M&E) data, the breakdown of certificate distribution across chiefdoms expected by the evaluation team was as follows: Mkanda (complete); Maguya (complete); Mshawa (distribution ongoing but not complete by follow-up); and Mnukwa (distribution did not take place by follow-up).

Just over half of households receiving the Land Tenure treatment (57%, N=709) have a paper document for at least one of their fields, and these documents are overwhelmingly identified as customary land certificates. However, there is some confusion about which households took part in the land registration process *within* villages. We know from M&E data that nearly every household in a treatment village took part in the land registration process. The low number of households reporting that they have a paper document *within* villages for their field is likely related to the fact that physical certificates were not distributed to every chiefdom at the time of the follow-up survey.

Unfortunately, the household data regarding certificate distribution does not match the headperson data—and there are some discrepancies between the headperson and program M&E data regarding certificate distribution.[6] Moreover, in the 33 villages where the headperson says 75% to 100% of households have received certificates, only 45% (on average) of households say they received a certificate.

Furthermore, certificate distribution is not random, which introduces selection bias into the comparison of chiefdoms/villages with and without certificate distribution. For example, chiefdoms where certificate distribution took place quickly may have customary leaders who are more supportive of the Land Tenure program. Villages certified first may have more effective leaders and better governance, fewer foreigners[7] and be easier to access or less remote than villages that have not yet received paper documentation.

As a result, the evaluation relies on the intent-to-treat estimates of household engagement in the process of customary land mapping and the *expectation* of receiving a paper certificate. This is the primary analysis for this study and preserves the rigor of the RCT design. We use qualitative focus group data to highlight the importance of respondents' expectation of receiving documentation for their responses to survey indicators. The household sample is used to conduct an exploratory analysis of estimates for households that received actual paper copies of customary land certificates for their fields,

6 Breaking it down by chiefdom for the headperson data, 18 of the villages who received certificates by the launch of the follow-up survey are in the Maguya chiefdom, with seven land tenure villages remaining in Maguya. There are 18 land tenure villages in Mkanda with certificates, with nine remaining, zero in Mnukwa, with 25 remaining, and finally two in Mshawa, with 40 remaining.

7 Some chiefs refused to present customary land certificates to households from Malawi, and required households to show their National Registration Card (NRC) prior to receiving their customary land certificate.

versus those that participated in the certification process but did not receive a physical land certificate. This regression output and write-up can be found in Annex 2. Given the selection bias and discrepancy in M&E, headperson and household data regarding certificate distribution, these results should be treated with caution.

Detecting long term effects

There is strong reason to expect that TGCC effects in the long run may differ from those in the short run. It may take time for households to trust that the guarantees of land tenure will be honored. Households that adopt agroforestry may subsequently abandon it. We recommend a third round of data collection in 2–3 years that revisits the same households who took part in the baseline and follow-up surveys in order to investigate the longer term effects of the TGCC program. A third round of data collection will provide additional evidence about the impact of the land registration and governance intervention on field investments, agricultural productivity and livelihoods, as well as the impact of strengthening perceived tenure security on agroforestry seedling survival. This will promote a better understanding of the TGCC program's full policy potential and value for money, and inform other stakeholders' decisions to take the program to scale in Zambia and other African countries with similar customary land systems.

Following the completion of the follow-up data collection, the TGCC program expanded the Land Tenure intervention to cover control households. This will reduce the rigor of the evaluation design, depending on how the certificates are distributed in control areas. The optimal scenario for the long term study is for TGCC to distribute certificates across *all* control villages. This would create a lagged design where the control areas still serve as a valid comparison, however, inferences about the treatment impact would be based on the *maturity* of the treatment. We would still expect to see better outcomes in the treatment areas compared to the control, although the treatment effect would most likely be dampened.

More problematic would be if the Land Tenure intervention was implemented in only one or two chiefdoms instead of uniformly across all of them. This would result in selection bias and the inability to distinguish whether changes in villages with certificates are driven by receiving land certificates or by something inherently different about the chiefdom. For example, chiefs who opted to expand the treatment in their chiefdom may be more invested in protecting their land from investors, or they may have better governance than chiefs who did not expand the program. In the latter case, the study will need to compensate with additional statistical corrections.

PROGRAMMING & POLICY RECOMMENDATIONS

Overall, the impact evaluation findings provide a basis for the following policy recommendations:

Scaling-up the Land Tenure intervention

As the Government of Zambia prepares to revise the Land Act with anticipated technical support from USAID, the results from the evaluation support the scale-up of TGCC in Zambia and program piloting in other customary land systems in Africa. Supplemental research analysis focused on the intervention's positive effect on field investment indicators at the field level, which provides evidence that a policy of customary land formalization may support a viable pathway for smallholder-led agricultural transformation. A land policy to support smallholders through customary land certification may address Zambia's central development challenge of achieving greater agricultural productivity and balanced, inclusive economic growth (Huntington et al., 2018).

Reconsidering the benefits of Agroforestry extension

Findings about the impact of the Agroforestry extension intervention are important, as donors and the government continue to promote climate-smart agricultural practices while seeing relatively little increase in uptake. Although the TGCC agroforestry extension program did promote an increase in agroforestry adoption, seedling survival rates are on average less than 40% and declined over time. The qualitative data highlights a number of challenges to keeping seedlings alive, including water shortages, the need for significant labor investments during the harvest season and constant threats from fire, pests and livestock.

Given these contextual and environmental challenges to keeping seedlings alive, agroforestry may not be the best climate-smart agricultural investment to offer. Households may be more responsive to a program that promotes reforestation or growing community woodlots, as many respondents mentioned the need for trees for fuelwood and climate resilience. Other CSA possibilities with greater benefits to farmers include minimal tillage and crop rotation. Minimal tillage requires greater labor than traditional tillage, but can be done in the farming offseason where labor is less constrained. Crop rotation requires no additional labor, but does require a change in farming inputs that may need to be provided.

Adjust agroforestry extension to address low seedling survival

If programs choose to continue with agroforestry, several issues should be addressed. First, seedling survival will continue to be low if traditional village rules regarding grazing and setting fires are not addressed. Future programs should incorporate improved land management rules in communities with the aim of increasing seeding survival rates. One potential rule in the Zambian context is to prohibit livestock from grazing on fields at any point in the harvest cycle. Other areas for improvement include addressing inequalities regarding seedling distribution and who works in the nursery.

Another possible option for future agroforestry programs is to incorporate incentives to motivate better survival rates. In another RCT of an agroforestry program in Eastern Province, Jack et al. (2016) found that paying cash incentives to farmers who kept at least 70% of their trees alive after one year increased the seedling survival rate in the short term, as well as increasing program participation and the number of trees planted. The same study also found that weekly monitoring visits from program officers improved seedling survival, which, though costly, could be incorporated into future programs.

In Zambia, given a long history of radio broadcasts and agroforestry activities, improving farmer's knowledge of agroforestry might not need to remain an intervention focus. The ecological benefits of agroforestry are widely known, even at baseline and across control groups, and the evaluation findings do not support the claim that lack of knowledge is a barrier to uptake. To help inform the design of future programs, baseline data can be used to assess farmers' knowledge of agroforestry or other CSA practices in areas with a long history of development interventions.

Increase participation in programs by increasing the number of sensitization visits

Some households wanted to participate in the Agroforestry intervention, but were reportedly refused. Other households signed up expecting a different type of intervention, or were not clear about who in their household was allowed to attend trainings.

To allow for greater participation and reduce confusion, future programs could increase the number of sensitization visits they make to each village and permit households to join the program until the end of the final sensitization visit. Additional sensitization will spread information about the program and give households extra time to decide if they would like to participate. The meeting should clearly lay out the

expected time commitments, number of household members who are permitted to join and/or attend trainings and the types of inputs the households would receive, all things which generated confusion during the Agroforestry intervention and may explain some of the negative effects discussed in the sections below.

Increase village land committee (VLC) training on systems for updating customary land certificates

The follow-up survey shows that many VLC members did not understand the system that the Chipata District Land Alliance (CDLA) put in place for updating customary land certificates or applying for new ones. This is worrisome for the sustainability of the land certification program. Future iterations of the program would do well to increase training on these steps, and perhaps place greater emphasis on recruiting VLC members who are literate. This of course, has its own tradeoffs that would need to be weighed carefully before choosing a path forward. In-line with recommendations from TGCC, it may be more effective and sustainable to create VLCs that operate at the sub-chiefdom level as opposed to the village level. This would decrease the number of people who would need to be trained in these systems.

Increased and continued sensitization about land certification process

Several years into the program, there is still some skepticism about the true purpose of the land registration and governance program. Households are leery the program could lead to taxation, or even land grabbing, and still more households, particularly women, were confused about the certification process. Additional sensitization by CDLA and the VLCs will help alleviate these concerns and increase household buy-in for registration.

Focus group discussions reveal that households do not know how to use their certificates to resolve a conflict in the future, or how to ask for the certificates to be updated. An additional village-wide meeting conducted by CDLA after the distribution of certificates would help to explain these processes and increase the sustainability of the certificates.

Involve the entire village in the boundary demarcation process

Qualitative findings showed a clear link between high levels of household participation in the boundary demarcation process and fewer conflicts over boundaries. We recommend that every effort be made to include the entire village in the demarcation process, including women. This is in-line with the best practices during boundary demarcation recommended by other organizations that specialize in interventions to protect customary lands and natural resources.

Improve dispute data collection and organization

For future parcel mapping and dispute objections and correction efforts, TGCC should improve its dispute data collection and organization methods. This will allow the program to better track where, when and how disputes were identified and resolved over time. As part of this process it will be important to have dispute attributes tied to each parcel such as the date the dispute was identified, the type of dispute, if (and when) the dispute was resolved, as well as what method was used to resolve the dispute. Assuming this data is tracked by parcel, this would allow for analysis of disputes by village or help identify patterns in the types of parcels or types of disputes that occur. Additionally, it will be important to ensure that this data collection effort is streamlined to minimize any additional workload for the TGCC program. Overall, this level of dispute analysis will identify lessons learned as well as help pinpoint how future programming efforts in Zambia or elsewhere could be modified to more efficiently identify and resolve land parcel disputes.

2.0 BACKGROUND AND CONTEXT

DEVELOPMENT CHALLENGE

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 that address poverty reduction, agricultural livelihoods, natural resource management and gender disparities, among other issues. To motivate the evaluation, this section provides 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 sub-Saharan Africa—including insecure resource tenure—and examines research on programs and policies in tenure security and agricultural investment.[8]

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% 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).

8 For an in-depth discussion of the research motivation and supporting literature, please refer to Persha and Huntington (2016) and Persha et al. (2016).

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 decisions about local land management and allocations. While villages do often have some small amount of community land, these community resources are not farmland—they may be forested land, woodlots or community grazing areas.

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, and insufficient access to arable land is a recognized driver of continued impoverishment in rural areas (Jayne et al., 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 et al., 2009).

AGROFORESTRY

Agricultural production supports the livelihood of over 70% of Zambia's population, including 78% 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% of rural Zambians live in extreme poverty, and stunting and malnutrition impact rural communities at much higher rates than their urban counterparts. Individual land holdings are, on average, small and a quarter of the rural population nationwide farms on only one hectare of land. The primary crop grown is corn, and for most farmers it is the only crop they grow, which increases vulnerability 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. 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. Indeed, 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 et al., 2001; Mbow et al., 2014; 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 et al., 2014).

However, 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). Indeed, uptake of CSA practices, in particular agroforestry, remains very limited in Zambia, notwithstanding favorable Zambian agricultural policy encouraging CSA and agroforestry promotion among a number of organizations. Statistics analyzed from the 2012 Rural Agricultural Livelihoods Survey from Chipata District show agroforestry species were planted on 6% of fields (N=84) and in 8% of households (n=31) surveyed.[9]

Several barriers to widespread agroforestry adoption persist. Prior research has tended to emphasize identifying the biophysical properties of agroforestry systems rather than examining cultural, demographic and socioeconomic factors that might impede wider adoption (Ajayi, 2007; Sirrine et al., 2010). 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. Wealth-based and gendered aspects of agroforestry uptake are also reported in a number of studies across the sub-Saharan region (Kiptot et al., 2014; Phiri et al., 2004). For example, 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 their 2003 meta-analysis of barriers to agroforestry adoption across 32 empirical case studies, Pattanayak et al. (2003) identified tenure security and extension support as two of the most important determinates of increased agroforestry uptake (finding tenure security significant in 72% and extension support significant in 90% of cases that included these factors in their analyses) (Pattanayak et al., 2003). Compared with annual crops, trees require longer periods to produce mature crops—five to fifteen years for Musangu trees and three to five years for the *Gliricidia* trees that are the focus of the TGCC 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. Uncertainty over land security has implications for undertaking investments with future payoffs and may limit incentives that rely on a long time horizon. The lack of security may serve as a disincentive for farmers to engage in agroforestry, given 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 et al., 2014).

9 If missing responses are included at the field level, the Rural Agricultural Livelihoods Survey data shows agroforestry planted on only 5% of fields.

Secure land tenure alone is widely hypothesized to be a necessary condition for individuals to undertake productivity-enhancing investments on their land. Numerous studies have suggested positive impacts of greater land tenure security on agricultural outcomes and investment in rural land (Deininger et al., 2011; Deininger and Chamorro, 2004; Feder et al., 1988; Holden et al., 2009; Jacoby et al., 2002; Rozelle and Swinnen, 2004). Across a longer timeframe, investment in agroforestry is hypothesized to increase famer's agricultural productivity as the mature trees improve the quality of the soil and reduce the need for chemical fertilizer. Consequently, increased agricultural productivity improves household wealth through higher yields.

In Zambia and other countries where most rural residents depend on land for their livelihoods, insecure tenure and conflicts that can result from uncertainty over ownership or boundaries undermines household productivity. Although empirical evidence demonstrating a strong link between strengthened land rights and reduced land conflict is relatively scarce, some studies do indicate that land registration programs can have the ability to reduce boundary disputes and litigation arising from such conflicts. A basic premise of stronger and more secure land tenure is that the enforcement of these rights lessens the risk of being forcibly displaced and allows for a level of long-term security and a sense of permanence that encourages land-related investment (Besley, 1995). Increased tenure security is also thought to reduce the need for smallholders to expend resources to defend their land claims, which can be particularly important for women and other vulnerable groups whose rights may not be sufficiently protected under traditional practices (Joireman, 2008).

In sub-Saharan Africa, many questions remain around the efficacy of interventions designed to strengthen perceptions of tenure security and subsequently promote longer-term sustainable land use investments. Some studies have found very strong evidence of positive impacts (Deininger et al., 2011; Deininger and Jin, 2006). However, to date no clear consensus has emerged from empirical studies across varying sub-Saharan African contexts on whether and how stronger land tenure security incentivizes farmer decision-making and pursuit of different land investment strategies on their farms (Lawry et al., 2014; Place, 2009). More recent literature has paid particular attention to the role of customary land titles (Goldstein et al., 2018; Place and Otsuka, 2001; Smith, 2004).

The TGCC IE was designed to address these evidence and knowledge gaps and to inform future programs and policy formulation by measuring the direct and joint impacts of the TGCC land registration and governance and agroforestry extension interventions on three main types of outcomes. These categories are:

- Changes in household perceptions of tenure security over their smallholdings;
- Planned and actual agricultural investment resulting from perceived tenure security, including improved adoption of agroforestry and related CSA activities; and
- 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 overarching question that underlies and motivates this evaluation 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 also advances understanding of the following secondary questions.

1. Do chief—and village—level tenure strengthening activities around participatory village mapping and clarified land allocation processes reduce land disputes within villages?[10]
2. To what extent do improvements in village land management, allocation and adjudication processes contribute to more positive perceptions 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, and 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 agroforestry extension resources additionally impact a farmer's decision to engage in agro-forestry?

10 Note that there is a discrepancy from the original design report and pre-analysis plan in this question. As 'sustainable land use planning' was planned but not actually included in the TGCC intervention plan. We have removed that reference from this secondary research question.

3.0 TGCC OVERVIEW

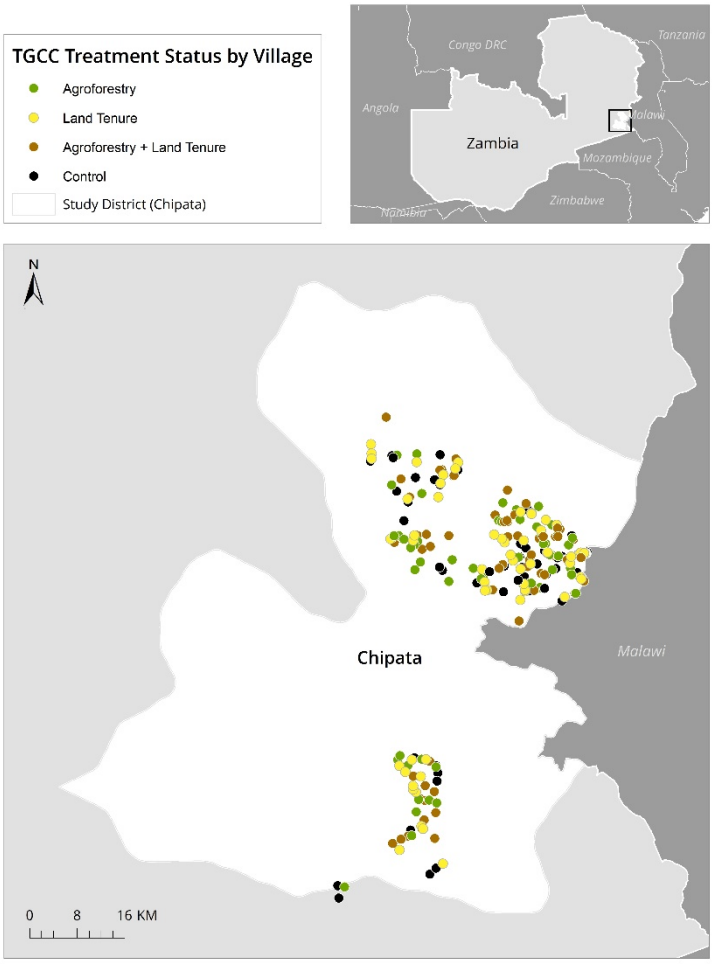
This section describes the TGCC interventions under evaluation. We use M&E data collected by the evaluation team and implementing partner, as well as key informant interview data, to detail the planned versus actual activities for each intervention and discuss obstacles to implementation. Note that the M&E data reported by the implementing partner extends through February 2018, in contrast to evaluation data sources collected July–August 2017. The key informants include Village Land Committee (VLC) members for villages in the Land Tenure intervention and yield group leaders or lead farmers for the Agroforestry intervention.

The evaluation focused on two interventions:

- **Land Tenure**—A village-level land registration and governance intervention consisting of participatory mapping, village headperson land administration support and provision of land information and dispute resolution training, including the facilitation of informal customary land use certificates for households. This intervention was implemented by Chipata District Land Alliance (CDLA), a community based organization.[11]
- **Agroforestry**—Agroforestry extension in villages to facilitate tree planting adoption and survivorship on smallholder farms, implemented by the NGO COMACO.

Both interventions took place in Chipata District in Eastern Province from late summer 2014 through the end of 2016.[12] The villages participating in this evaluation and their treatment status are shown in Figure 3-1.

FIGURE 3-1: TGCC TREATMENT STATUS BY VILLAGE



11 District Land Alliances (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.

12 The Land Tenure program finished by 2016, but the distribution of certificates continued through early 2018.

TENURE SECURITY STRENGTHENING INTERVENTION

The land-tenure intervention was implemented by the CDLA in four chiefdoms: Mnukwa, Mkanda, Mshawa and Maguya. The intervention aimed to strengthen customary tenure through a set of activities that took place at the chiefdom, village and household levels. 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 aimed 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:

The primary activities under the land tenure intervention consisted of establishing Village Land Committees (VLCs), conducting participatory mapping and facilitating the issuance of informal customary land certificates. In particular, the Land Tenure intervention included:

- Holding community workshops to establish VLCs;
- Providing training to VLCs about land management, conflict resolution, customary land certificates and the customary land registration process;
- Conducting participatory mapping through the development of a common village map that can be used as a tool by the headperson when allocating land;
- Providing households with information on land law and rights (CDLA and VLCs), as well as information about customary land certificates; and,
- Facilitating the process for households to obtain informal customary land use certificates (CDLA and VLCs). The certification process included:
  - Demarcation of land through boundary walks;
  - Adjudication and support for land dispute resolution;
  - Facilitating an objections and corrections process for field and village boundary review;
  - 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.

VLCs are responsible for a variety of land related activities, detailed in Table 3-1 below. The most common activities conducted by VLCs during the intervention include the resolution of household and village level conflicts and clarifying household and village level boundaries. The resolution of conflicts

between households in the village was ranked as a primary VLC activity by key informants in the Land Tenure villages. M&E data from CDLA shows that VLCs report resolving 574 conflicts (or an average of 5 per Land Tenure village) between September 2015 and February 2018, roughly 30% of all conflicts that VLCs report occurring.

Several governance activities—originally planned to be conducted through the VLCs—were less common or were eliminated from intervention activities. Less common activities included holding village meetings and informing the community about their land rights; key informants reported that these occur in slightly more than a third of treatment villages.[13] Only 20% of villages opened the VLC meetings up to the entire community. Moreover, creating and enforcing village rules about land use were not currently widespread and are not planned for expansion in the future. Only eight VLC KIIs (7%) report allocating land as an activity they have ever or are currently doing, though M&E data from CDLA reports that 287 new parcels of land have been allocated between September 2015 and February 2018. Land use planning activities, documenting land use rules and regulations and the use of a paralegal to support adjudication and land dispute resolution were not included in the intervention.

TABLE 3-1: OCCURRENCE OF GOVERNANCE ACTIVITIES BY VLCS

	Ever did Activity	Currently doing Activity	Will do Activity in Future
	LT + (Ag+LT)	LT + (Ag+LT)	LT + (Ag+LT)
Resolve HH conflicts	71% (81)	58% (54)	38% (42)
Clarify HH boundaries	47% (54)	31% (34)	28% (31)
Resolve village conflicts	46% (52)	36% (40)	28% (31)
Clarify village boundaries	42% (48)	38% (41)	21% (23)
Hold meetings about land management issues	36% (40)	32% (35)	27% (30)
Inform members of the village about land rights	33% (37)	25% (27)	34% (37)
Create rules about land management	16% (18)	8% (9)	12% (13)
Enforce village rules about land management	10% (11)	5% (5)	15% (16)
Allocate land	7% (8)	7% (8)	17% (19)
Award land certificates	7% (8)	8% (9)	14% (15)
Update land certificates	2% (2)	1% (1)	6% (7)

PARTICIPATION

According to key informants, the Land Tenure intervention was widely supported by chiefs, headpersons and the village as a whole. Almost 90% (N=73) of key informants responded that their chief "strongly supports" the land registration and governance program, and only one key informant said the chief was unsupportive. There was no notable difference between chiefdoms.

Participation by households was high in villages where the program was offered. Those who did not participate most frequently did so because they were out of the village or unavailable during the process. Only six key informants cited households not wanting a certificate as a reason that households did not participate. Focus group discussions indicate that households who did not want a certificate likely did

13 M&E data from CDLA report an average of 24 meetings per treatment village between September 2015 and February 2018, with 27,462 non-unique participants overall.

not want them because of a fear of being taxed or belief that the customary system is strong enough to protect their land without additional documentation.

IMPLEMENTATION HETEROGENEITY

There were some important differences in how the CDLA program was implemented across chiefdoms, particularly in Maguya. Households in the Maguya chiefdom were not originally offered the option to register a parcel as "family land"; instead, all land had to be registered as household land. Households in Maguya were also originally only permitted to register one person as a joint landholder. CDLA returned to these households and gave them the option to register multiple joint landholders and register land as family land, however, few households opted to make these changes. Also different in Maguya chiefdom, villages boundary walks took place without input from neighboring villages. This was modified in other chiefdoms to include these stakeholders. In another deviation, households in Mshawa chiefdom received the intervention several months later than the other chiefdoms due to a change in chiefdom leadership. Randomization occurred *within* versus across chiefdoms and these differences do not threaten the validity of the overall treatment impacts, however, they do have important implications for the interpretation of what constitutes the 'treatment' under investigation.

There are also village level differences in the establishment and composition of the VLCs. According to the program design, VLC members were meant to be elected. However, key informant interviews indicated that in approximately 60% of villages VLC members were appointed by the village as a whole, whereas 20% of villages elected VLC members. Data from focus groups with the implementing partners indicates that villages were first asked to elect members, but if no one volunteered, people would be appointed. 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 appoint women and inform them that the role was mandatory. These recruiting methods led to VLCs that are, on average, 46% women with 86% of villages (N=110) having at least one female member.[14]

SUSTAINABILITY

The M&E findings suggest possible sustainability problems for the land certificates as CDLA hands over the process of awarding and updating these certificates to the VLCs. Most key informants do not report the VLCs being involved in the awarding or the updating of customary land certificates, either in the past, present or future. While awarding the certificates falls to the chief during the period of the intervention, future awards and the updating of certificates are meant to be done by the VLC. Only 15 key informants believe that awarding land certificates would be an activity in the future, and seven stated that VLCs would play a role in updating land certificates in the future. Correspondingly, there appears to be a lack of familiarity with the DHIS2 reporting system that CDLA uses for updating existing or issuing new land certificates. Only 35% (N=30) of VLC members from the KII sample know how to use the DHIS2 reporting system.[15] Given the current state of land policy and administration in Zambia, maintaining the TGCC's Land Tenure outputs, outcomes and achievements will require a broader and more systematic policy and programming approach.

14 CDLA did not focus on youth while recruiting VLC members, but 36% of VLC members are under the age of 35, and 79% (N=100) of KII respondents report at least 1 youth member on their VLC.

15 It is possible that other members of the VLC than the member selected for the KII interview know how to the DHIS2 reporting system, as M&E data from CDLA shows that an average of 70% of villages have submitted monthly reports using the DHIS2 system.

AGROFORESTRY EXTENSION INTERVENTION

The Agroforestry intervention was implemented by COMACO in five chiefdoms: Mnukwa, Mkanda, Mshawa, Maguya, and Saili. The fifth chiefdom, Saili, was not a part of the randomized control trial for the evaluation.[16] Thus, the results for Saili are not analyzed and described in this follow-up report that focuses on the RCT.

The Agroforestry intervention included activities at the village level, as well as basic interactions with chiefs. Through the intervention, an extension agent provided support related to planting and establishment of Musangu (*Faidherbia albida*) trees and/or *Gliricidia (Gliricidia Sepium)* on cropland. Activities consisted of establishing Farmer Groups in treatment villages, establishing nurseries, distributing seedlings, and providing training and agricultural extension support services about agroforestry to farmer groups. Specific activities included:

- Conducting awareness meetings with chiefs and headpersons;
- Forming village-level Farmer Groups open to any household in the village;
- Facilitating the use of Lead Farmers to disseminate information;
- Leading trainings on agroforestry with Farmer Groups;
- Distributing high-quality *Gliricidia* and Musangu 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 promote the protection of seedlings during establishment;
- Providing additional resources to remove constraints to investment, such as groundnut seeds[17] or wells,[18] as necessary; and,
- Collecting monitoring data on seed/seedling planting, survival, and threats to tree survival through TGCC mobile data collection units.

There were limits to the number of household members who could officially participate in Farmers Groups due to limitations in the amount of inputs provided to each Group. For each one lima[19] of land a household owns, one member was able to join. Although not required, this member was typically the household head. Household members who were not official members were welcome to attend meetings and trainings, and frequently, a household head would send 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.

According to the program design, every participating village should have participated in all four of the major program activities listed in Table 3-2 below. However, key informants indicate that—to the respondents' knowledge—not every activity was offered. In treatment communities, KIIs were most likely to report that households received agroforestry seedlings (82%, N=129), and least likely to report

16 Saili was added to serve as a separate "Agroforestry 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.

17 In year two, 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.

18 As a result of severe water shortages that threatened seedling survival, 47 communities were provided with a well as part of the agroforestry intervention.

19 A lima of land is the equivalent of one-quarter of a hectare

households worked in the nursery (54%, N=86). Forty-one percent (N=50) of key informants report their village participated in all four activities. This could suggest either some deviation in the planned agroforestry extension program, or that KII respondents do not accurately recall which activities took place. Nurseries, for example, were only established in 77 villages and shared between nearby villages, so work in the nursery may not have been shared equally by all participants.

TABLE 3-2: AGROFORESTRY ACTIVITIES

	Ag + (Ag+LT)
Attended trainings on agroforestry	79% (96)
Received agroforestry seedlings	85% (104)
Planted agroforestry seeds	79% (96)
Worked in a nursery	57% (69)
Village participated in all four of the activities	41% (50)

There are unexpected differences in the types of trees reportedly planted as part of the program, as noted below in Table 3-3. Overall, only 51 KIIs in the 107 treatment communities said that all three of the species of interest to TGCC were planted in their village as part of the Agroforestry intervention. Nearly all key informants in treatment villages said COMACO distributed Musangu seedlings, which are the most well-known agroforestry species in the region. A similarly high number report the planting of *Gliricidia* seedlings. However, key informants are less likely to say households planted pigeon peas as part of the Agroforestry intervention. Additional information from the implementing partner revealed that there were not enough pigeon peas available to distribute to each village.

TABLE 3-3: TREE PLANTING ACTIVITIES IN AGROFORESTRY VILLAGES

	Ag + (Ag+LT) (N=122)
Households planted Musangu trees	93% (113)
Households planted *Gliricidia* trees	91% (111)
Households planted pigeon peas	32% (39)
Households planted all 3 COMACO species	31% (38)

SUSTAINABILITY

There are several implementation issues that suggest sustainability problems for the agroforestry extension intervention. We examine these in significant detail in Section 6.0 (Agroforestry findings section). First, a number of seedling nurseries are no longer operational, as illustrated in Table 3–4. Approximately 42% of villages reported having an operating nursery, and an additional 18% used to have a nursery, but it is no longer operational. Second, a large amount of household labor is required in the nursery during the growing season. Amongst treatment villages that have had or currently have nurseries, 73% of KIIs (N=71) reported that households are required to work in the nurseries to receive seedlings. Households work an average of 70 hours per growing season in the nursery. Third, according to key informants, most households expected other programming or inputs from COMACO beyond agroforestry, including improved crop seeds (70% (85)), guaranteed market access for crops (37% (N=45)), higher prices for crops (34% (N=42) and fuel-efficient cook stoves (41%(N=50). Without the follow-on benefits, household may not have sufficient incentives to continue the labor and time investment necessary to ensure seedling survival.

TABLE 3-4: NURSERIES

	Ag + (Ag+LT)
Have a nursery	42% (53)
Do not have a nursery	40% (50)
Had a nursery, but is no longer operational	18% (22)

4.0 EVALUATION METHODS

EVALUATION DESIGN

FACTORIAL DESIGN

The evaluation utilizes a factorial design to test the impacts of the TGCC intervention. To assess the individual and joint effect of each of the Land Tenure and Agroforestry interventions, the evaluation design is a four-arm village-level RCT. Figure 4-1 illustrates the four treatment arms of the IE, consisting of the different interventions or combination of interventions that treatment villages received (pure control, 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 villages receiving the Agroforestry or Land Tenure condition versus control villages provides the average program impact on each of these interventions. The comparison of the average outcomes in the group receiving *both* the Land Tenure and Agroforestry treatment provides evidence about the additional effect of land tenure certification in promoting agroforestry uptake and CSA. To ensure that the four treatment groups are similar enough to provide a valid counterfactual for comparison, balance tests were conducted in the Baseline Report and the Pre-Analysis Plan,[20] and do not reveal any meaningful differences between the treatment and control groups that would threaten the validity of the study.

In Saili chiefdom, no chiefdom level land tenure activities were completed, nor did any village receive 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. Note that the results for Saili are not analyzed and described in this first follow-up report, which focuses on the RCT.[21]

OUTCOME FAMILIES, HYPOTHESES, AND INDICATORS

Following from the evaluation questions, program theory and hypotheses, we developed a set of five 'outcome families' with thematic groupings of hypothesized program effects: Tenure Security, Land Governance, Uptake of Agroforestry Practices, Investment in Agriculture and the long-term effects of Agricultural Productivity and Livelihoods. We test a series of hypotheses that link the expected effect of the program to outcomes in each family. To understand how and why the program may have led to changes, we developed and pre-specified a set of primary and secondary indicators. Data on these indicators measure and track changes at the household level across baseline and follow-up data collection. The hypotheses and primary and key secondary household indicators for each outcome family are listed below in Table 4-1. Please refer to Annex 6 for a full list of all evaluation indicators, and to the Pre-Analysis Plan for additional details about each of the evaluation indicators.

20 Please refer to Annex 6 for links to all TGCC Impact Evaluation reports and supplemental documentation.

21 The main objective of studying the impact of the agroforestry program in Saili will be 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."

TABLE 4-1: HYPOTHESES AND PRIMARY HOUSEHOLD INDICATORS

Outcome Family	Hypothesis	Primary Indicators
Tenure Security	**H1:** Households receiving the TGCC intervention have different levels of village-wide incidence of land conflicts. **H2:** Households in villages receiving the TGCC intervention perceive different levels of tenure security.	TS-1: Overall PCA index of HH perception of tenure security TS-2: Long-term PCA index of HH perception of tenure security TS-3: Short-term PCA index of HH perception of tenure security TS-4: PCA index of HHs perceived expropriation risk from internal actors TS-5: PCA index of HHs perceived expropriation risk from external actors TS-6: Experienced at least one dispute on field
Land Governance	**H3:** Households receiving the TGCC intervention perceive different levels of transparency regarding the land allocation process and accountability of land allocation decision makers. **H4:** Households in villages receiving the TGCC intervention have different levels of satisfaction regarding the resolution of land disputes.	G-1: Overall land governance indicator (Index) G-3: Household perception of land leaders (Index)
Uptake of Agroforestry Practices	**H5:** Households in villages receiving the TGCC intervention have greater uptake of agroforestry. H6: Households in villages receiving the TGCC intervention have greater rates of agroforestry seedling survival.	A-1: Household engages in agro-forestry A-2: Extent of field(s) planted with agroforestry trees or shrubs A-3: Agroforestry seedling survival rates
Field Investment	**H7:** Households in villages receiving the TGCC intervention have greater uptake of climate-smart agriculture (excluding agroforestry). **H8:** Households in villages receiving the TGCC intervention have greater uptake of short and long term field investments.	TS-2: Length of fallowing period
Long term: Agricultural Productivity and Livelihoods	**H9:** Households in villages receiving the TGCC intervention have higher agricultural productivity and crop yields. **H10:** Households in villages receiving the TGCC intervention have different livelihood and welfare outcomes.	AP-1: Household reported experiencing improved crop growth AP-2: Household reported experiencing improved crop yields L-1: Asset-based wealth index: Assets (counts), Livestock (counts), land area owned, roof construction/material

SAMPLING DETAILS AND DATA COLLECTION

DATA COLLECTION

ENDLINE DATA COLLECTION

Follow-up data collection took place between June 2017 and August 2017. The household, headperson, and key informant surveys were collected through a cloud-based mobile data collection effort. Data was entered directly into Android phones using a mobile data collection platform, SurveyCTO. Rural Net Associates (Rural Net), a Lusaka-based data collection firm, conducted the follow-up data collection in close collaboration with Evaluation, Research and Communication (ERC). Rural Net also conducted the TGCC baseline data collection in 2014. The research team did not experience unexpected circumstances in the field during data collection.

Enumerator training took place from June 5 through June 16, 2017, including a pilot exercise in Chongwe, a rural community just outside of Lusaka. The ERC Project Manager and an ERC analyst led a four-day training of the trainers for seven Supervisors and seven Deputy Supervisors, as well as the Field Manager and Deputy Field Manager. Training focused on the five TGCC instruments (household, headperson, Yield Group Leader key informant, Village Land Committee key informant and Focus Group Discussion), SurveyCTO, electronic data collection, supervisor responsibilities, as well as information about sampling, tracking and spotchecks. Training contained lectures, role plays and group exercises. All team members were fluent in English and Chinyanja, and the majority had at least some post-secondary education. Roughly half were female.[22]

Training of the full enumerator team took place over five days, and was led by the Field Manager and Deputy Field Manager with ERC support. Fifty-seven enumerators were trained on best practices for interviewing, the ethics of research with human subjects and the household survey instrument. Survey instruments were practiced in Chinyanja. The training provided two days for enumerators to practice the survey in small groups, share their questions and advice and practice using SurveyCTO, the survey platform selected for this project. Feedback from this training allowed ERC to improve the instruments and further adapt them to the local context before data collection.

The four-person qualitative team received an additional day of training by ERC. Qualitative enumerators were trained on best practices for qualitative data collection, the ethics of research with human subjects, the FGD instrument and objectives, respondent selection and recruiting and qualitative data management. A majority (~75%) of the qualitative enumerators were female in an attempt to ensure that women's FGDs would be led by a female enumerator. The qualitative team also received a second day of training to serve as auditors. Auditor training consisted of reviewing protocols for audits as well as practicing each of the three versions of the audit survey. A pilot was conducted in Chongwe on June 16, 2017 to give all team members direct experience using SurveyCTO and practicing the household survey. The data collected from this pilot also led to several minor improvements in the survey instrument.

22 In total, the survey team consisted of one Field Manager, one Deputy Field Manager, seven Supervisors, seven Deputy Supervisors, 35 enumerators, four qualitative enumerators/auditors and one mobilizer, who traveled ahead of the team to make survey appointments in villages. The team was subdivided into seven teams consisting of one supervisor, one deputy supervisor and five enumerators. Each small team was responsible for surveying one village per day (15 household surveys, 1 headman survey, 1 VLC KII and 1 YGL KII). Supervisors conducted the headman survey, Deputy Supervisors conducted the VLC and YGL KII surveys, and enumerators conducted the household survey.

In line with the requirements for human subjects' protection, approval was received from the Clark University Institutional Review Board in May 2016 and from the ERES Institutional Review Board in Lusaka in June 2017. Written 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. They were also informed that their responses would be shared through public posting and publication in a way that protected their identities. Participants who agreed to participate in the research signed or stamped their fingerprint on a paper consent form. In addition, consent was recorded in the electronic survey device.

DATA QUALITY

The TGCC follow-up data collection effort utilized the following quality control measures: observation of enumerators by supervisors and the Field Manager and Deputy Field Manager; site presence by the Field Manager and Deputy Field Manager; daily quality control checks by ERC staff; and auditing of respondents. Each enumerator was observed, or "spotchecked," by their Supervisor and the Field Manager a minimum of two times each week, and the Supervisor or Field Manager was present for the entire interview. This observation exercise had an accompanying checklist through which the Supervisor or Field Manager scored the enumerator on a scale from 1–5 on their surveying technique, including the informed consent process, probing ability and relationship with the respondent. The checklist was designed by ERC, and the scores could be used for positive incentives (bonuses) or for reprimanding (verbal warning, or in extreme cases, dismissal), as the firm saw fit. Feedback from the Field Manager and Supervisors was continuously used to improve enumerator performance and discourage data falsification.

In addition to the spotchecks, 15% of surveys were audited by the audit team. These audits were stratified by enumerator, and each enumerator had surveys audited every week. The audit data was compared to the original data by the ERC team and the number of discrepancies were recorded. If a large number of discrepancies were found, additional training was offered to the enumerator. If necessary, additional targeted audits were used to investigate unusual patterns that could indicate data falsification.

Finally, the most thorough checks were back-checks conducted by the ERC evaluation team. These checks were conducted on 100% of all household, spotchecks, and leader surveys using SurveyCTO, and results were compiled and shared with the survey firm. The back-checks compared survey responses by each enumerator to search for patterns indicating data falsification or systematic errors that should be corrected, including short survey times, missing responses, a low average number of "other, specify" responses or multiple selections, low average number of rows completed on each roster and any other significant irregularities by day, village, survey team or enumerator.

SAMPLE CHARACTERISTICS

At follow-up, household and headman surveys were conducted as panel surveys, and as many baseline respondents as possible were re-interviewed at follow-up.[23] If the original respondent could not be interviewed, they were replaced with another adult member of the household. If the entire household could not be tracked, another household in the village was selected.[24]

ATTRITION

Due to the time between baseline data collection and follow-up data collection (three years), the survey team encountered some difficulty tracking all baseline respondents. Whenever possible, mobilizers and supervisors were instructed to first try to replace missing respondents from someone within the household, and then to replace the respondent using the randomized protocol. In some villages, the small village population made it impossible to replace attrited households. Before a household was considered untrackable, the survey team conducted three visits.

In total, 514 households were added to the follow-up data collection. These households were selected randomly to either replace households who were interviewed at baseline but could not be tracked, or in cases where fewer than fifteen households were interviewed from that village at baseline, to supplement the sample size. These respondents were not included in the panel analysis, but were included in descriptive statistics for the follow-up survey.

Altogether, 3,522 households were interviewed at baseline, and 3,403 households were interviewed for the follow-up survey. The panel dataset consists of 2,937 households that were surveyed at baseline and then again for the follow-up. The study had an attrition rate of 15% for the sample that includes Saili and 13% for the randomized sample. Table A7-1 in Annex 7 shows that attrition appears to be random, and there is no selection bias due to attrition. The primary causes of attrition are households leaving the study area. Because our indicators of interest are closely tied to geography, the survey firm did not follow households who moved outside of the study area, though they did attempt to follow households who moved to another community that was a part of the sample.

HOUSEHOLD SURVEY

TGCC treatment impacts discussed in this report are based on the panel dataset of 2,937 households. Table 4-2 shows the breakdown of panel household observations by chiefdom and treatment group.

TABLE 4-2: HOUSEHOLD PANEL OBSERVATIONS

	Mnukwa	Mkanda	Mshawa	Maguya	Saili	Overall
Agroforestry	132	142	164	147	0	585
Land Tenure	125	111	223	147	0	606
Agroforestry & Land Tenure	121	112	259	154	0	646
Control	141	121	208	110	0	580
Agroforestry Control	0	0	0	0	520	520
Total	519	486	854	558	520	2,937

23 Please refer to Annex 6 TGCC Baseline Report for detailed sampling information on baseline data collection.

24 In Agroforestry, Agroforestry Control, and Land+Agroforestry villages, households who participated in the agroforestry intervention were given preference for replacement. In all other villages, replacement households were selected at random using SurveyCTO.

The dataset for the follow-up household survey includes 3,391 respondents and 293 village observations. Table 4-3 shows the breakdown of household observations for the follow-up survey by chiefdom and treatment group.

TABLE 4-3: FOLLOW-UP HOUSEHOLD OBSERVATIONS

	Mnukwa	Mkanda	Mshawa	Maguya	Saili	Overall
Agroforestry	178	162	166	168	0	674
Land Tenure	168	131	271	178	0	720
Agroforestry & Land Tenure	146	125	271	199	0	741
Control	175	150	220	142	0	674
Agroforestry Control	0	0	0	0	582	582
Total	667	568	887	687	582	3,391

For the full household panel sample, the average respondent age is 45 years old (sd=16). Sixty-six percent of respondents are monogamously married (N=1,595), and 5% are polygamous (N=121). An additional 17% are widowed (N=404). Nearly a fifth of the sample has no formal education (19%, N=526), but 40% (N=1,120) have reached at least grade seven. Households own an average of two hectares of land.

Fifty-six percent (N=1,593) of respondents identify as members of the patrilineal N'goni tribe, and another third identify as members of the matrilineal Chewa tribe (35%, N=994), the two major tribes in Eastern province. Respondents who identify as Chewa are most common in Mkanda chiefdom. Ninety-three percent (N=2,610) of respondents are Christian. Sixty percent (N=1,702) were born in the village where they currently live, and those who were not born in the village have lived there for an average of 22 years (sd=15).

HEADPERSON SURVEY

TABLE 4-4: HEADMAN OBSERVATIONS

	Mnukwa	Mkanda	Mshawa	Maguya	Saili	Overall
Agroforestry	13	12	19	11	0	55
Land Tenure	12	13	20	11	0	56
Agroforestry & Land Tenure	13	14	22	14	0	63
Control	15	14	19	10	0	58
Agroforestry Control	0	0	0	0	39	39
Total	53	53	80	46	39	271

Table 4-4 shows headman observations by chiefdom and treatment group. In total, 271 headmen were interviewed and 90% (N=243) of respondents are men. Mirroring the household sample, the most common tribes are N'goni (67%, N=183) and Chewa (30%, N=82). Chewa respondents are most

common in Mkanda chiefdom (N=49). Women are more likely to serve as the headperson in Mkanda chiefdom, where Chewas, a matrilineal tribe, are dominate.

The headperson is, on average, older than household survey respondents, with an average age of 57 (sd=14). Eighty-seven percent (N=238) of headperson respondents have attended some formal schooling, and 44% (N=121) have reached grade seven or higher, a higher rate than for the average household. Eighty-nine percent (N=243) are married, and 11% are polygamous (N=29). Two-thirds of headmen were born in the village they currently lead (67%, N=184), and those who were not born in the village have lived there for 33 years on average (sd=18).

Though all the villages in the sample have a relatively small population (approximately 200 people), there is a great deal of variance in population size (from 10 to 850). On average, villages contain 41 households (sd=48); the smallest village has only two households, while the largest has 300. Sixty-eight percent (N=186) of villages have mobile phone service within the village, and 53% of villages have a borehole (N=146). Seven percent (N=19) have a primary school in the village, two villages have a secondary school (<1%), and six villages (2%) have a health clinic.

KEY INFORMANT INTERVIEWS

Key informant respondents were selected with assistance from the headperson. In villages without VLCs, key informants include a village member who was knowledgeable about land issues, often the Induna. In villages without agroforestry Yield Group Leaders (YGL), the YGL key informant interview was conducted with the COMACO lead farmer in agroforestry villages, or a village member who was knowledgeable about agriculture in villages without the COMACO program. Table 4-5 shows key informant observations by chiefdom and treatment group.

TABLE 4-5: KEY INFORMANT OBSERVATIONS

	Mnukwa		Mkanda		Mshawa		Maguya		Saili		Overall	
	YGL	VLC	YGL	VLC	YGL	VLC	YGL	VLC	YGL	VLC	YGL	VLC
Agroforestry	14	13	20	19	14	15	11	11	0	0	59	58
Land Tenure	12	14	20	21	10	12	14	14	0	0	56	61
Agroforestry & Land Tenure	12	14	25	26	14	11	15	15	0	0	66	66
Control	19	16	20	20	17	13	10	9	0	0	66	58
Agroforestry Control	0	0	0	0	0	0	0	0	40	38	40	38
Total	57	57	85	86	55	51	50	49	40	38	287	281

FOCUS GROUP DISCUSSIONS

In addition to the four quantitative surveys, the evaluation conducted 62 focus group discussions in 27 purposefully selected villages across all five treatment arms, shown in Table 4-6. This sampling plan is described in detail in the Pre-Analysis Plan (see Annex 6). Respondents were selected to capture a variety of experiences within the Agroforestry and Land Tenure treatment arms, including women, youth and individuals within treatment villages who did not participate in the interventions ("non-participants"). Focus group participants were recruited by enumerators with assistance from the headperson, taking care to avoid selection bias. When possible, respondents were selected to be

homogenous in age, gender and socioeconomic status, however, given the small sizes of the villages, the majority of village residents would often participate in the discussions.

TABLE 4-6: 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 (Saili)	2	4
TOTAL	27	62

ANALYTICAL APPROACH

The benefit of an RCT is that individuals offered the treatment are, on average, no different from those held as controls. Any difference between the two groups must be caused by the treatment, assuming correct implementation and a sufficient sample size to ensure baseline balance. However, the individuals who actually take-up or adhere to the treatment are not random. Those who expect to benefit most, or are most well-informed, or have more trust in institutions may be the ones who take up treatment. Comparing that group to the control group would be invalid. Thus, the evaluation examines the effect of being offered treatment, which is randomly allocated, rather than the effect of taking up treatment, which is not. From a policy perspective, Intent to Treat (ITT) is more relevant than Treatment on the Treated (TOT), since when a program is implemented in an area, not all potential participants will take part in the program.

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. In this follow-up report, the analysis tests the impact of TGCC on the primary and secondary household indicators described in Table 4.1 above. Our estimation compares the following three groups:

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

Group 2—The Agroforestry + Land Tenure arm to the Agroforestry intervention. This estimation of the joint effect of strengthening land tenure in areas receiving the agroforestry extension represents the primary objective of the IE. It enables the research to determine whether or not improving perceived tenure security increases farmer investment in sustainable agroforestry and uptake of other CSA practices.

Group 3—The Agroforestry + Land Tenure arm to the Land Tenure intervention. 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.

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 are tested for heterogeneous treatment effects across a number of household subgroups. The study may not be well-powered enough to detect every treatment effect; however, the results that are significant show that the program had differential effects. This represents a secondary versus primary analysis, and is applied across the regression analysis for Groups 1–3 described above.

Our primary household subgroups of interest include:

- 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 (land-constrained vs. others); and,
- Age of household head at baseline (youth (under 35 vs. others) and elders (above 55 vs. others).

The main effect of the land tenure treatment is estimated with the following specification for household panel outcomes:

$$[1a] \quad Yij=\beta 0+\beta 1 TijAGRO+\beta 2\ TijTENURE+\beta 3\ TijTENURE*AGRO\ +Yij0+uij$$

where *Yij* is the outcome measure of household *i* in village *j*. *Tij* is the treatment dummy for each of the three treatment arms of interest. *Yij0* is the baseline vectors for the outcome measure and *uij* are robust standard errors clustered at the village level, using Huber-White sandwiched standard errors (Lin et al., 2013).

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

$$[1b] \quad Yij=\beta 0+\beta 1 TijAGRO+\beta 2\ TijTENURE+\beta 3\ TijTENURE*AGRO+Yij0+Hetij+\beta 4 TijAGRO*Hetij+\beta 5 TijTENURE*Hetij+\beta 6\ Tij(TENURE*AGRO)*Hetij+\ uij$$

Please refer to Annex 6 (Pre-Analysis Plan) for more details on the empirical approach.

MULTIPLE TESTING

A 'false discovery rate' adjustment was used, to correct p-values[25] from each test for the fact that several tests were run within each outcome family (Benjamini and Hochberg, 2000). Given the number of tests that were run, some portion of the significant results obtained may be simply due to chance. Put differently, the more tests that are run, the higher the likelihood that some of them will come back significant, but some of these are likely to be false positives. Results that maintain their significance even after the p-values were adjusted via the 'false discovery rate' correction are considered highly robust.

Given the number of outcomes tested in the evaluation, there may be false positives in our results. Thus, we report both uncorrected p-values and corrected p-values using the Benjamini and Hochberg (1995) False Discovery Rate Correction. Our main report findings and summary sections rely on the uncorrected values, because we are analyzing a number of closely related interdependent outcomes and,

25 The p-value is the level of significance within a statistical hypothesis test that represents the probability of the occurrence of a given event.

therefore, the standard corrections for the false discovery rate are likely too conservative (Gelman et al., 2012).[26] The corrected values and summary write-up are included in Annex 5. The statistical significance of the primary outcome indicators does not change when the p-values are corrected.

EXPLORATORY, DESCRIPTIVE AND QUALITATIVE ANALYSIS

Additionally, we support this primary analysis with descriptive statistics based on the panel results, as well as full follow-up survey sample results for the section that discusses the agroforestry results. We also include a secondary "within-treatment" analysis for subgroups to assess whether there were differential effects within the treatment groups to gauge the tendency for elite capture. Finally, we incorporate additional qualitative findings from key informant interviews and focus group discussions to further ground the analysis. These findings are integrated throughout the body of the report.

As a supplemental analysis for the Land Tenure intervention, we also examine treatment effects for households that received physical land certificates versus households who only completed the *process* of land registration at the time of the follow-up survey. As described in the introduction, these results are not experimental; they are exploratory and should be treated with caution. The distribution of land certificates was not random, and has the potential to introduce selection bias, since chiefs who were quicker to distribute the certificates may be more supportive of the Land Tenure intervention and more likely to uphold the rights granted by the certificate. Correspondingly, for the Agroforestry intervention, we also estimate the impact of the program on those individuals in the treatment arms who actually participated in the agroforestry extension intervention. Since not all household chose to participate, there was not comprehensive uptake across villages. Summary write-ups for these results are included in Annex 3 and should be treated as investigative and not measures of a causal program impact.

26 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.

5.0 OUTCOME FAMILY I, TENURE SECURITY

Hypothesis 1: *Households in villages receiving the TGCC intervention perceive different levels of tenure security.*

Hypothesis 2: *Households in villages receiving the TGCC intervention have different levels of village-wide incidence of land conflicts.*

SUMMARY OF KEY FINDINGS

- There is strong empirical evidence that the TGCC land registration and governance intervention had a positive impact on perceived tenure security for primary and secondary indicators.
- According to the regression results, there is no quantitative evidence that the Land Tenure intervention had an impact on the prevalence of land disputes.
- We find positive Land Tenure subgroup treatment impacts for female- and elder-headed households.
- For the overall household panel sample, there is no evidence of marginal improvements to perceived land tenure security for the joint Agroforestry + Land Tenure treatment group. However, we do find evidence of marginal improvements for the joint Agroforestry + Land Tenure treatment group among female-headed households.
- There is some evidence of a negative or dampening treatment effect on perceived land tenure security for households receiving the Agroforestry intervention.
- According to the exploratory analysis for the "within-treatment" effects, we do not find evidence of elite capture or uneven program impacts for marginalized groups. Women and other vulnerable subgroups experience similar positive treatment impacts to their counterparts within the treatment area.

Tables 5-1 through 5-3 illustrate the statistically significant regression findings for the household and subgroup panel samples. The coefficient on the treatment estimate is included in the table; a (P) designates a primary indicator and an (S) designates a secondary indicator. For indexes, we report the standard deviation above the control mean and for binary indicators, we report the marginal effect on the probability the household reports the chance of encroachment across all of their fields for a particular source of dispossession is "impossible." A discussion of the magnitude of effects is included below in the Results section. The level of statistical significance is indicated by the color of the table cell where: $p < 0.1$; $p < 0.05$; $p < 0.01$.

RESULTS

Tables 5-1 through 5-3 below display the overall and subgroup treatment effects for primary and secondary indicators. These tables, along with Figures 5-1 and 5-2, show that *all* primary household indicators of perceived tenure security are statistically significant for households receiving the land registration and governance intervention. For all Figures in the report, positive (or negative) impacts are represented by the vertical confidence bars that do not overlap with an effect size of '0'; the magnitude of effects is indicated by a greater distance from the '0' effect size line.

TABLE 5-1: TENURE SECURITY OVERALL SUMMARY TABLE (BY TREATMENT GROUP)

	AG	LT	AG+LT
Overall PCA index of HH perception of tenure security (P)		0.16	0.11
Long-term PCA index of HH perception of tenure security (P)		0.15	0.10
Short-term PCA index of HH perception of tenure security (P)		0.15	0.10
PCA index of HHs perceived expropriation risk from internal actors (P)		0.15	0.11
PCA index of HHs perceived expropriation risk from external actors (P)		0.15	0.09
Experienced at least one dispute on field (P)			
HHs perceived expropriation risk from other HHs (S)		6%	
HHs perceived expropriation risk from elites (S)			
HHs perceived expropriation risk from neighboring villages (S)		6%	
HHs perceived reallocation risk from chief (S)			
HHs perceived reallocation risk from headperson (S)		5%	
HHs perceived expropriation risk from extended family (S)			

TABLE 5-2: TENURE SECURITY SUBGROUPS SUMMARY TABLE (LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
Overall PCA index of HH perception of tenure security (P)	0.21				0.25
Long-term PCA index of HH perception of tenure security (P)	0.18				0.25
Short-term PCA index of HH perception of tenure security (P)	0.21				0.25
PCA index of HHs perceived internal actor expropriation risk (P)	0.21				0.26
PCA index of HHs perceived external actor expropriation risk (P)	0.16				0.22
Experienced at least one dispute on field (P)					
HHs perceived expropriation risk from other HHs (S)	10%				10%
HHs perceived expropriation risk from elites (S)					
HHs perceived expropriation risk from neighboring villages (S)					14%
HHs perceived reallocation risk from chief (S)					10%
HHs perceived reallocation risk from headperson (S)	12%				10%
HHs perceived expropriation risk from extended family (S)					11%

TABLE 5-3: TENURE SECURITY SUBGROUPS SUMMARY TABLE (AGROFORESTRY + LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
Overall PCA index of HH perception of tenure security (P)	0.19				
Long-term PCA index of HH perception of tenure security (P)	0.19				
Short-term PCA index of HH perception of tenure security (P)	0.19				
PCA index of HHs perceived internal actor expropriation risk (P)	0.19				
PCA index of HHs perceived external actor expropriation risk (P)	0.18				
Experienced at least one dispute on field (P)					
HHs perceived expropriation risk from other HHs (S)					
HHs perceived expropriation risk from elites (S)					
HHs perceived expropriation risk from neighboring villages (S)					
HHs perceived reallocation risk from chief (S)					
HHs perceived reallocation risk from headperson (S)					
HHs perceived expropriation risk from extended family (S)					

FIGURE 5-1: TREATMENT EFFECT ON TENURE SECURITY—PCA

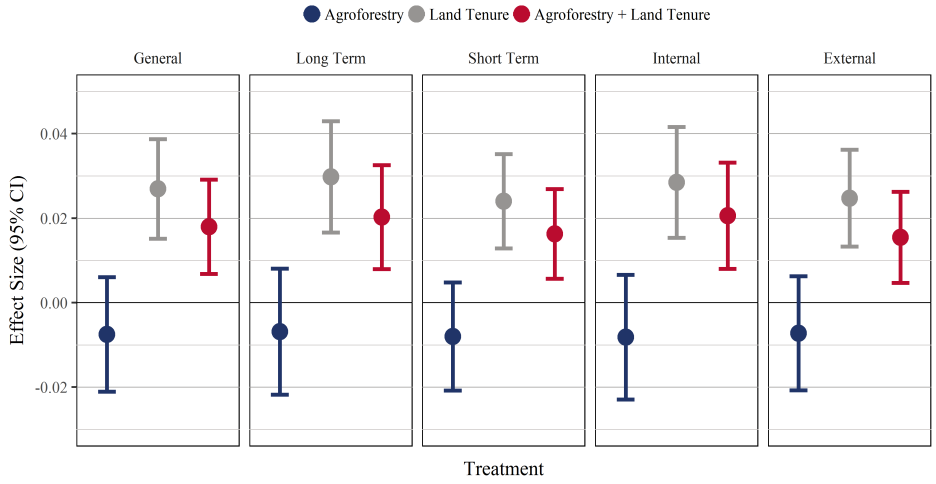
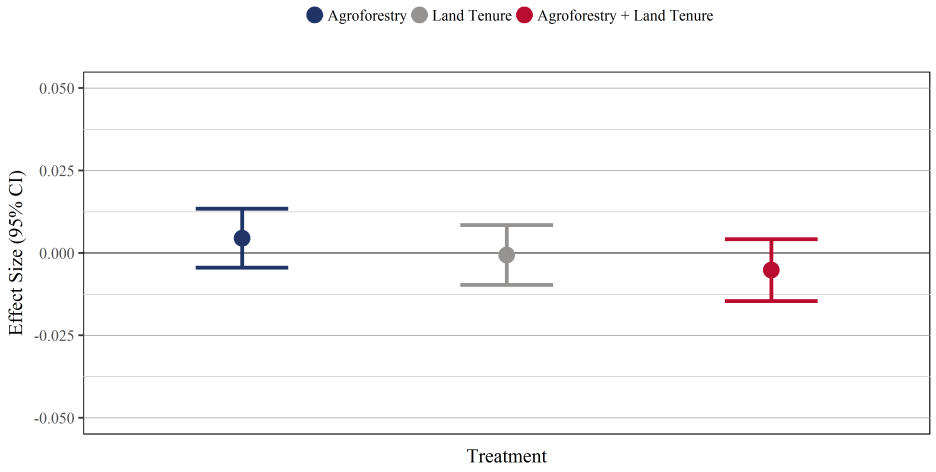


FIGURE 5-2: TREATMENT EFFECT ON TENURE SECURITY—DISPUTES



The results for this outcome family provide strong evidence that the TGCC Land Tenure intervention had a positive impact on perceived tenure security. In contrast, the regression findings do not indicate a Land Tenure impact on the prevalence of land disputes. The number of disputes reported by both headmen and households did decrease, from an average of 2.42 conflicts per village to 1.54 conflicts per village at the time of the follow-up survey. However, this decrease in conflicts occurs across both treatment and control groups, and the treatment results are not statistically different from the control group. It is unlikely that this decrease across all groups is caused by spillover from villages that received the land tenure treatment, as a similar decrease in conflict is found in the Saili chiefdom which did not receive the land tenure treatment.

The regression results indicate a positive and statistically significant treatment impact on perceived tenure security for all indexes, with the overall index having the largest effect at 0.16 ($p < 0.01$) standard deviations above the control mean. Treatment households perceive that their fields are more secure from reallocation or unauthorized appropriation from both internal (0.15 ($p < 0.01$)) and external (0.14 ($p < 0.01$)) threats in the next three years (0.15 (p <0 .01)) and beyond four years (0.15 ($p < 0.01$)).

Looking across the binary measures for the six sources of dispossession, we find that the land registration and governance intervention raised the probability households think encroachment or unauthorized appropriation is "impossible" by 5 to 6 percentage points for headman, neighboring villages and other households within their home village. However, we do not find a marginal impact for the treatment for chiefs, elites or family members. Moreover, there is no evidence that the intervention had any short-term impact on the already low prevalence of reported land disputes in the study area.

In addition, we find a number of positive treatment impacts for elder- and female-headed households. The magnitude of these impacts is greater than those of the overall household sample. Mirroring the average household results, female- and elder-headed households in the treatment perceive that their fields are more secure from reallocation or unauthorized appropriation overall (0.21 ($p < 0.05$); 0.25 ($p < 0.01$)) from both internal (0.21 ($p < 0.05$); 0.26 ($p < 0.01$)) and external (0.16 ($p < 0.05$); 0.22 ($p < 0.01$)) threats in the next three years (0.20 ($p < 0.05$); 0.25 ($p < 0.01$)) and beyond four years (0.18 ($p < 0.01$); 0.25 ($p < 0.01$)), respectively.

For the sources of dispossession, we again find significant and more substantial treatment effects for female and elderly-headed households. The intervention raised the probability that female- and elder-headed households think encroachment or unauthorized appropriation is "impossible" by 9 to 12 percentage points for headman (12% ($p < 0.05$); 9% ($p < 0.05$)) and other households within their home village (10% ($p < 0.10$), 10% ($p < 0.10$)). Moreover, for elder-headed households, we also find a positive program effect for neighboring villages (14% ($p < 0.01$)), as well as for sources of dispossession where there is no average household effect, including chief (10% ($p < 0.05$)), and family (11% ($p < 0.05$)). These are the largest treatment impacts related to the Tenure Security Outcome Family that we find in the analysis. There is no evidence of differential effects between treatment and control groups for poor, youth or land-constrained respondents.

Thus, although we see strong treatment impacts for the aggregate-, female- and elder-headed households across *all* primary indicators the impact of TGCC is not consistent across sources of dispossession and is null for elite appropriation.

The planting of agroforestry trees is not linked to greater perceived secure tenure for the full household sample. There is no evidence of marginal improvements to perceived land tenure security for

households in the Agroforestry + Land Tenure treatment group for the aggregate household sample. Furthermore, the regression analysis indicates a potential dampening effect on perceived tenure security for elder-headed households involved in the agroforestry extension program. Despite the strong Land Tenure effects across primary and secondary indicators for elder-headed household respondents, there is no evidence of a positive treatment effect in the Agroforestry + Land Tenure group for this subgroup.

Finally, our exploratory analysis of a within treatment differential does not reveal any differences between the average treatment effect and the results for female-headed and other vulnerable subgroups that received the Land Tenure treatment. Put differently, female and vulnerable group effects are not statistically different from the average treatment effect. This provides some positive evidence of equity benefits for the program participants receiving the Land Tenure intervention.

DISCUSSION

The regression analysis provides strong evidence that the TGCC Land Tenure intervention had a positive impact on perceived tenure security. In this section, we explore the pathways or mechanisms linking the TGCC intervention to the positive impacts identified above. This section investigates household and key informant descriptive and qualitative data to understand *why* we see treatment effects.

BENEFITS FROM CUSTOMARY LAND CERTIFICATES, NOW AND IN THE FUTURE

As described above in Section 3, the TGCC Land Tenure intervention focused on boundary demarcation, land governance and customary land documentation through informal customary land registration. Table 5-4 below displays the benefits of customary land certificates (CLC) that are expected by respondents. Roughly 80% of treatment households believe that having a customary land certificate will make it less likely for their land to be taken, both now and in the future. The rate is similar between male- and female-headed households. Qualitative findings illuminate why households feel that customary land certificates make it less likely that land will be taken. Focus group discussions (FGD) reveal that households believe that having well-known and clearly defined boundaries through the demarcation process in combination with paper "evidence" of their ownership are the primary drivers of the increased sense of tenure security. The children are the primary recipients of these benefits and will be protected from other family members grabbing land after the death of their father. This series of FGD quotes illustrate this sense of security.

> "When [the land] was merely referred to as "land of our parents," I did [not] have the sense of personal ownership of the land. The land belonged to us as a family. But now, what I have is much more. It is my land. The certificate has my name and that of my wife and children. When I die, the certificate will be issued in the name of my children. I feel that the future of my children is much more secure. No one will take the land away from them" (Mkanda).
> "My brothers and sisters no longer have a say over my land as they did when we called it the land of our parents. My wife and children have much more security over my land, because their names are on the certificate. I have secured their future by having a certificate for my land" (Mkanda).

Households also believe that the certificates will stop the headman or chief from reallocating unproductive land, which is increasingly in demand as the population grows. A male FGD participant in Mnukwa chiefdom described the benefit this way: "…after the field has been mapped the headman cannot add another person because the boundary has been measured already and the land is now [the

owners'], unlike the way it was without certificates… If a person was given 20 hectares, then he had to cultivate the entire 20 hectares, but if he failed and only managed 3 or 4 it used to be like a punishment to people. If the certificates come, then maybe this year [if] things won't go well such that I won't manage to cultivate the whole field, they cannot add someone else."

Focus group discussions also highlight citizens' hope that certificates can protect households from powerful elites by providing them some amount of power, as long as the government and customary leaders respect their certificate. "To add on what is agreed by maybe the headman, or the chairman, or maybe the chief, there are people who come from town, from town they come to see the chairman or the headman, those people come with money how can we find a place to cultivate here? so when those people come, they have their own money, so they will use their money 'If you give us such an amount we will give you that area'…They come in through the headman, the chief and the chairman, so they come to provoke this one [current land owner] and he has no power, where will he get that?... What needs to protect the person is the certificate and then the government should defend this person even the headman and the chief should support that person who has the certificate, so this is what is needed" (Mnukwa).

TABLE 5-4: EXPECTED BENEFITS OF CUSTOMARY LAND CERTIFICATES

	LT (N=208)		Ag+LT (N=230)	
Benefit	**Now**	**Future**	**Now**	**Future**
Land is less likely to be taken from the household	81% (168)	81% (168)	83% (190)	80% (183)
Land is less likely to be taken from the village	40% (83)	33% (69)	37% (84)	37% (86)
Fewer disputes about boundaries	45% (93)	50% (105)	47% (108)	52% (119)
Fewer disputes about inheritance	42% (87)	52% (108)	39% (89)	54% (125)
Fewer disputes about land allocation	25% (51)	27% (57)	17% (39)	28% (64)
Gain access to credit	3% (6)	3% (7)	2% (4)	3% (7)
Gain ability to buy or sell land	2% (4)	2% (4)	1% (3)	1% (2)
More control over agricultural decision making	13% (27)	14% (29)	10% (24)	10% (22)
There are no benefits	9% (18)	1% (2)	9% (20)	3% (6)

The qualitative analysis indicates that a subset of households report that they have already experienced benefits from the land governance and registration intervention, citing a decrease in disputes about boundaries, inheritance, and land allocation. In contrast to the regression results, the qualitative data highlight households' belief that CLCs have served to reduce disputes about boundaries. Qualitative findings also show that the demarcation process itself strengthened perceptions of tenure security by making boundaries clear and well-known throughout the village. A FGD participant in Mnukwa commented "There were land disputes before Land Alliance came because the field boundaries were not clear but now they are clear, there is no one who can say 'you have taken part of my field.' No. Now you have to be in agreement for someone to use part of your field."

FGDs indicate that conflicts were less likely to occur in villages with widespread participation in the demarcation process, as opposed to just a few households, or only men.[27] According to a woman in Mshawa describing the demarcation process— "they had chosen 10 people, we were the ones who were going round the fields... I was the only woman the rest were men, they were many…women stayed behind they [men] told us to stay behind and cook relish."

27Note that female participation was a part of the original design of the boundary walk for the Land Tenure intervention.

The descriptive statistics show that households believe that CLCs have reduced disputes about inheritance (40%, N=176), and even more believe they will do so in the future (53%, N=233).

A male FGD participant in Mshawa elaborated on the certificate's benefit for women after the death of their husband. "Now I know, once I get my certificate, even my wife and children will be secure after I am dead. Because what happens is that the woman is told to go back to her parent's village and the relatives get the land for themselves… If on the certificate you are there registered, you will have the right because there is nowhere they can take you, the evidence is the certificate."

However, qualitative findings are mixed about whether this protection will extend to women without children. In most cases, it appears that customary land certificates protect women's land rights through their children. Women are the stewards of the land until their children are grown, then the land passes to the adult children, who in turn provide for their mother. If a woman without children is widowed or divorced, in most patrilineal tribes she must still return to her village and get land from her parents or brothers. As one woman from Mshawa chiefdom described in a FGD, "Us as women cannot be involved in land issues, it is the men's duty to do so. The men are the ones who are supposed to sign for the land because they own the land, it is them who brought us here. We left our villages and came here, can we say that we have land? We have no land."

Across all treatment and control areas, the majority of households without documentation for their land would like some form of documentation to reduce the likelihood of losing their land (84%, N=830), and to strengthen the ability of their children to inherit the land (69%, N=688). Very few households in either treatment group believe that CLCs will lead to access to credit, either now or in the future.[28] Just over a quarter (25%, N=63) of households in the Land Tenure group without land certificates believe that CLCs will protect their field investments. Table 5-5, below, shows the most common benefits associated with a CLC.

TABLE 5-5: WHY WOULD HOUSEHOLDS WANT A CUSTOMARY LAND CERTIFICATE?

	LT	Ag+LT	Control
Reduce likelihood of losing my land	77% (202)	71% (217)	75% (411)
Protects investments I have made on my land	25% (63)	29% (86)	16% (85)
Strengthens the ability for my children to inherit the land	63% (163)	62% (189)	62% (336)
Helps me to obtain access to credit	3% (7)	4% (13)	2% (13)

Of the households who do not have CLC in the Land Tenure group, nearly all of them (87%, N=501) would like to have documentation, and would pay an average of 75 ZMW ($7.50) for documentation, as shown in Table 5-6. Interestingly, households in the treatment area who do not have certificates are willing to pay 5% less of what households in control areas are willing to pay. This could represent the strong demand in control communities for certification. An alternative explanation is that since treatment communities have been told by CDLA they will receive certificates for free, they are willing to pay less. Another explanation is that treatment communities believe it may be a possibility that they

28 CDLA programming specifically stated that customary land certificates could not be used as collateral.

will be required to pay to receive certificates that have not been distributed and subsequently choose a more affordable amount.

TABLE 5-6: DEMAND FOR CUSTOMARY LAND CERTIFICATES

	LT + (Ag+LT)	Control
Percentage of households without documentation who would like documentation	87% (501)	89% (490)
Average amount households would pay to receive documentation for their fields (in kwacha)	76 (204)	80 (230)

Overall, the results for village key informants (KI) regarding benefits from the land certification process mirror those found in the household sample. This is illustrated in Table 5-7. Consistent with the household results, the main benefits cited by KI in Land Tenure villages is that land is less likely to be taken from households, along with decreases in disputes about inheritance boundaries. One exception is that key informants highlight that the TGCC Land Tenure intervention also provided greater protection for community land. No KI respondents reported increased access to credit or the ability to purchase and sell land; the number of KI respondents that expect to see these benefits in the future are similarly low. As the CDLA program specifically told participants that certificates could not be used for these purposes, it is promising that these limitations are well-understood.

TABLE 5-7: KII BENEFIT FROM LAND CERTIFICATION PROCESS

Benefit	Present	Future
	LT + (Ag+LT)	LT+ (Ag+LT)
Fewer disputes about inheritance	62% (52)	71% (60)
Land is less likely to be taken from households	59% (62)	78% (66)
Fewer disputes about boundaries	57% (48)	62% (52)
Land is less likely to be taken from the village	52% (44)	60% (51)
Fewer disputes about land allocation	27% (23)	36% (30)
Households gain access to credit	0 (0%)	0 (0%)
Households gain ability to buy or sell land	0 (0%)	5% (4)
Households have more control over agricultural decision making	6% (5)	12% (10)
Women have more equal access to land	14% (11)	15% (12)
Youth have more equal access to land	11% (9)	13% (11)
Poor households have more equal access to land	6% (5)	10% (8)
No benefits	7% (6)	2% (2)

NEGATIVE EFFECTS OF CUSTOMARY LAND CERTIFICATES, NOW AND IN THE FUTURE

In general, the number of households and village key informants who expect any negative impacts as a result of their CLC is low, shown below in Table 5-8. The biggest negative impact reported by households and KI is fear of paying taxes or fees in the future. As a female FGD participant said, "We might just hear in the future that you should be paying every month since you already signed on the certificates." Some households also believe that CLCs have made land harder to acquire, and will continue to do so in the future. There are a handful of households who believe that CLCs have increased disputes about inheritance (4%, N=16). Similarly, only a few key informants believe that CLCs

have increased conflicts, increased corruption or increased the likelihood of land being taken from households of the community.

The qualitative findings reveal that the initial skepticism some felt about the program, primarily that the certification process was a way for the government to grab their land, is decreasing. A Mkanda FGD respondent stated "That is why you can see that even those who were reluctant to have their fields demarcated by CDLA, are now changing their minds and now also requesting for their fields to be demarcated. Those fears and misconceptions they earlier had on this program, are now slowly dissipating." Still, ongoing and additional sensitization by CDLA about the program would be beneficial.

There are also a fair number of FGD participants that point out that regardless of the land certificates, their tenure security is derived from customary systems in the chiefdom. They feel secure in their land tenure because the chief gave them their land, not because of the certificates. As a youth from Mshawa commented "Our headman and chief will always protect our interests when it comes to securing our fields."

TABLE 5-8: NEGATIVE IMPACTS OF CUSTOMARY LAND CERTIFICATES

	LT + (Ag+LT) (N=493)	LT + (Ag+LT) (N=493)
Households	**Present**	**Future**
There are no negative effects	90% (396)	87% (379)
Key informants	**LT + (Ag+LT)**	**LT + (Ag+LT)**
	Present	**Future**
There are no negative effects	86% (73)	69% (59)

6.0 OUTCOME FAMILY II, LAND GOVERNANCE

Hypothesis 3: *Households in villages receiving the TGCC intervention perceive different levels of transparency regarding the land allocation process and accountability of land allocation decision makers.*

Hypothesis 4: *Households in villages receiving the TGCC intervention have different levels of satisfaction regarding the resolution of land disputes.*

SUMMARY OF KEY FINDINGS

- There is no quantitative evidence of aggregate household or subgroup impacts for the primary governance outcomes analyzed in the regression analysis.
- For secondary outcomes for the overall household sample, we see a 4% higher perception of leaders as trustworthy in villages receiving the Land Tenure treatment. There is a 5% greater participation in land related meetings in villages receiving the Agroforestry treatment.
- For secondary subgroup outcomes, the findings are mixed. We find some positive results in the Land Tenure group. In particular, there are some positive treatment effects for elderly-headed households; they are more likely to believe that leaders are trustworthy, accountable, make transparent decisions and protect natural resources, in comparison to their control counterparts. Moreover, poor households are 10% less likely to report that households have been disadvantaged by land allocation decisions. However, in the Agroforestry and Agroforestry + Land Tenure groups, we find *negative* treatment impacts across all subgroups. There is scattered evidence that treatment subgroups perceive equity or accountability problems with local leaders and additional disadvantages for vulnerable groups related to land management and allocation.
- For the within-treatment analysis, we find some evidence of positive subgroup benefits for primary indicators compared to the average treatment effect. These results—in combination with the Tenure Security Outcome Family findings—lend further support to an argument that the program was not subject to elite capture.

Tables 6-1 through 6-4 illustrate the statistically significant regression findings for the household and subgroup panel samples. The coefficient on the treatment estimate is included in the table; a (P) designates a primary indicator and an (S) designates a secondary indicator. For indexes, we report the standard deviation above the control mean and for binary indicators, we report the marginal effect on the probability the household reports that they 'agree' or 'strongly agree' with a question. A discussion of the magnitude of effects is included below in the Results section. The level of statistical significance is indicated by the color of the table cell where: $p < 0.1$; $p < 0.05$; $p < 0.01$.

RESULTS

Although the Land Tenure intervention was inherently a governance program, there is no evidence of an impact on *primary* governance outcomes for the household sample. Tables 6-1 through 6-4 below display the overall and subgroup treatment effects for primary and secondary indicators. These tables, along with Figure 6-1, show that the primary household indicators of governance outcomes are not statistically significant for households and subgroups receiving the land registration and governance intervention. For all Figures in the report, positive (or negative) impacts are represented by the vertical confidence bars that do not overlap with an effect size of '0'; the magnitude of effects is indicated by a greater distance from the '0' effect size line.

TABLE 6-1: GOVERNANCE OVERALL SUMMARY TABLE (BY TREATMENT GROUP)

	AG	LT	AG+LT
Overall PCA index of governance (P)			
PCA index of HH perception of land leaders (P)			
HH perception of land allocation, 0 = worse, 4 = better (S)			
HH believes leaders are trustworthy (S)		4%	
HH believes leaders protect natural resources (S)			
HH believes decisions are fair (S)			
HH believes decisions are transparent (S)			
HH believes rules are clear (S)			
HH believes leaders are accountable (S)			
PCA index of equity in land allocation across vulnerable groups (S)	-.16		
HH participation in land management-related meetings (S)	0.05		
HH feels women disadvantaged in land allocation decisions (S)	-7%		
HH feels the elderly disadvantaged in land decisions (S)	-6%		
HH feels the poor disadvantaged in land decisions (S)	-5%		
HH feels minority tribe members disadvantaged in land decisions (S)	-6%		
HH feels vulnerable groups disadvantaged in land decisions (S)	-9%		

TABLE 6-2: GOVERNANCE SUBGROUPS SUMMARY TABLE (LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
Overall PCA index of governance (P)					
PCA index of HH perception of land leaders (P)					
HH perception of land allocation, 0 = worse, 4 = better (S)					
HH believes leaders are trustworthy (S)					6%
HH believes leaders protect natural resources (S)					5%
HH believes decisions are fair (S)					
HH believes decisions are transparent (S)					7%
HH believes rules are clear (S)					
HH believes leaders are accountable (S)					7%
PCA index of equity in land allocation across vulnerable groups (S)					
HH participation in land management-related meetings (S)					
HH feels women disadvantaged in land decisions (S)					
HH feels elderly disadvantaged in land decisions (S)					
HH feels poor disadvantaged in land decisions (S)					
HH feels minority tribe members disadvantaged in land decisions (S)					
HH feels vulnerable groups disadvantaged in land decisions (S)		10%			

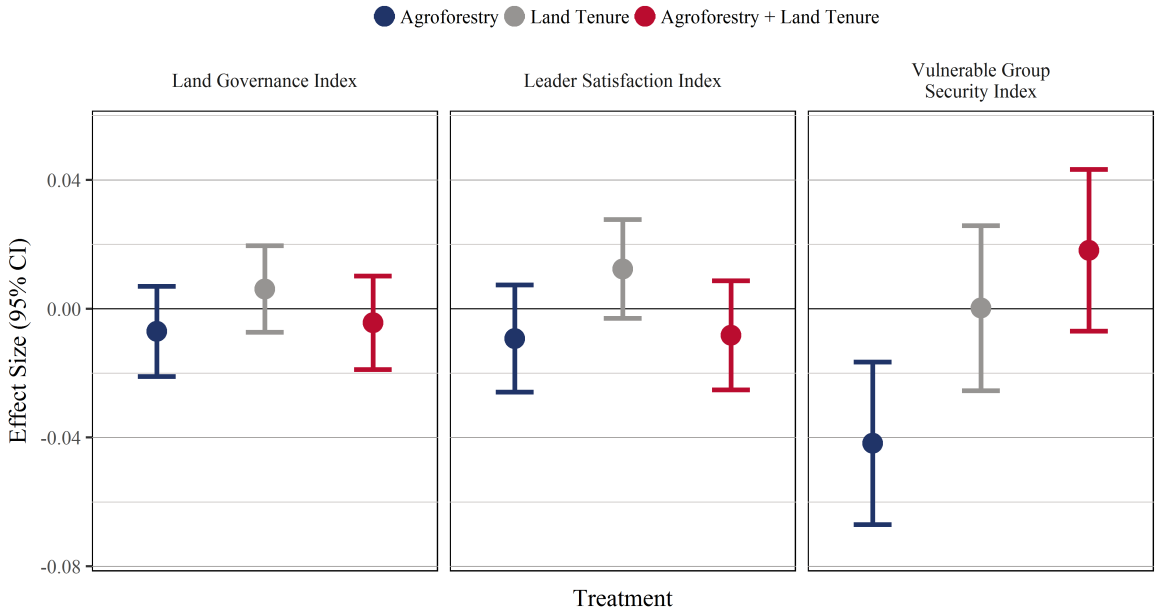
TABLE 6-3: GOVERNANCE SUBGROUPS SUMMARY TABLE (AGROFORESTRY HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
Overall PCA index of governance (P)					
PCA index of HH perception of land leaders (P)					
HH perception of land allocation, 0 = worse, 4 = better (S)					
HH believes leaders are trustworthy (S)	-6%				
HH believes leaders protect natural resources (S)	-6%				
HH believes decisions are fair (S)	-12%			-8%	
HH believes decisions are transparent (S)					
HH believes rules are clear (S)					
HH believes leaders are accountable (S)					
PCA index of equity in land allocation across vulnerable groups (S)					-0.22
HH participation in land management-related meetings (S)	8%			7%	
HH feels women disadvantaged in land decisions (S)	-10%				
HH feels elderly disadvantaged in land decisions (S)					-8%
HH feels poor disadvantaged in land decisions (S)	-7%				-12%
HH feels minority tribe members disadvantaged in land decisions (S)					
HH feels vulnerable groups disadvantaged in land decisions (S)					-10%

TABLE 6-4: GOVERNANCE SUBGROUPS SUMMARY TABLE (AGROFORESTRY + LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
Overall PCA index of governance (P)					
PCA index of HH perception of land leaders (P)					
HH perception of land allocation, 0 = worse, 4 = better (S)		-0.26			
HH believes leaders are trustworthy (S)			-16%		
HH believes leaders protect natural resources (S)					
HH believes decisions are fair (S)				-13%	
HH believes decisions are transparent (S)					
HH believes rules are clear (S)					
HH believes leaders are accountable (S)			-12%		
PCA index of equity in land allocation across vulnerable groups (S)					
HH participation in land management-related meetings (S)					
HH feels women disadvantaged in land decisions (S)					
HH feels elderly disadvantaged in land decisions (S)					
HH feels poor disadvantaged in land decisions (S)	-8%			7%	
HH feels minority tribe members disadvantaged in land decisions (S)					
HH feels vulnerable groups disadvantaged in land decisions (S)					

FIGURE 6-1: TREATMENT EFFECT ON LAND GOVERNANCE—PCA INDECES



The analysis of secondary indicators presents a more complicated and mixed story. We find some positive results for the Land Tenure group, but negative or unexpected results for households in villages receiving the Agroforestry treatment. The analysis of secondary indicators shows that households receiving the Land Tenure treatment are 4% ($p<0.05$) more likely to rate their leaders as trustworthy above the control mean. We find a slight increase in participation in community land meetings for households receiving the Agroforestry treatment (5% ($p<0.10$)); this includes an 8% ($p<0.05$) increase for female-headed households and a 7% ($p<0.05$) increase for youth-headed households.

However, the analysis highlights several negative results for equity indicators among participants receiving the Agroforestry condition. Among the secondary indicators, we find negative impacts for households in the Agroforestry intervention for an index (-0.16 ($p<0.05$)) and questions that ask respondents to assess whether vulnerable groups (women (7% ($p<0.05$)), elderly (6% ($p<0.05$)), poor (5% ($p<0.05$)) and minority tribes (6% ($p<0.05$)) have been disadvantaged in decisions about land reallocation. Respondents in the Agroforestry group are 9% ($p<0.01$) more likely to say that any vulnerable group is disadvantaged in land decisions, compared to the control mean.

For our analysis of subgroup effects for secondary indicators, we find evidence of positive effects in the Land Tenure group. There are some positive treatment effects for elderly-headed households; they are more likely to believe that leaders are trustworthy (6% ($p<0.05$)), accountable (7% ($p<0.10$)), make transparent decisions (7% ($p<0.10$)) and protect natural resources (5% ($p<0.05$)), in comparison to their control counterparts. Moreover, poor households are 10% ($p<0.10$) less likely to report that households have been disadvantaged by land allocation decisions.

However, in the Agroforestry group, we find *negative* treatment impacts across all subgroups. There is scattered evidence that treatment subgroups perceive equity or accountability problems with local leaders and additional disadvantages for vulnerable groups related to land management and allocation. In the Agroforestry group, female-headed households are less likely to report that leaders are trustworthy

(6% ($p<0.05$)), protect natural resource (6% $p<0.10$)), and make fair decisions (12% ($p<0.01$)). They are more likely to report that women (10% ($p<0.05$)) and the poor (7% ($p<0.10$)) are more likely to be disadvantaged in land decisions. Youth-headed households are more likely to say that land decision making is not fair (8% ($p<0.10$)), and elderly-headed households are more likely to say that vulnerable groups overall (10% ($p<0.10$)) have been disadvantaged in land decisions, as well as elderly (8% ($p<0.10$)) and poor (12% ($p<0.01$)).

Similarly, in the Agroforestry + Land Tenure group, we find that poor households are less likely to say that land was allocated fairly (-0.26 ($p<0.05$)) and women are (8% ($p<0.10$)) more likely to report that the poor are disadvantaged in land related decisions. Land constrained households are less likely to report that leaders are trustworthy (16% ($p<0.05$)) and accountable (12% ($p<0.10$)). Youth are more likely to say that decision making is fair (13% ($p<0.01$)) and the poor are disadvantaged in land related decision making (7% ($p<0.10$)).

The within-treatment analysis shows no significant difference between the average treatment effect and the subgroups for primary indicators. This exploratory evidence suggests that certain subgroups within the treatment—such as men or those that are relatively well-off—did not experience differential governance impacts. However, the within-treatment analysis for *secondary* indicators highlights positive impacts, along with further evidence of problematic results for households receiving the agroforestry extension program. On the positive side, we find several examples where subgroup impacts are higher (or more positive) than the average household effect. In particular, poor respondents receiving the land registration and governance program are more likely to participate in land meetings compared to their treatment counterparts. An, youth in the Agroforestry group are more likely to report greater equity in land allocation. On the negative side, we find significant lower results of decision-making fairness for female-headed households, youth and poor households, as well as a perception of additional disadvantages for vulnerable groups for female-headed households and elders. Finally, for the Agroforestry + Land Tenure treatment group, land constrained households are less likely to participate in land related meetings compared to the average treatment respondent and poor households are less likely to feel like land decisions are fair, transparent and accountable.

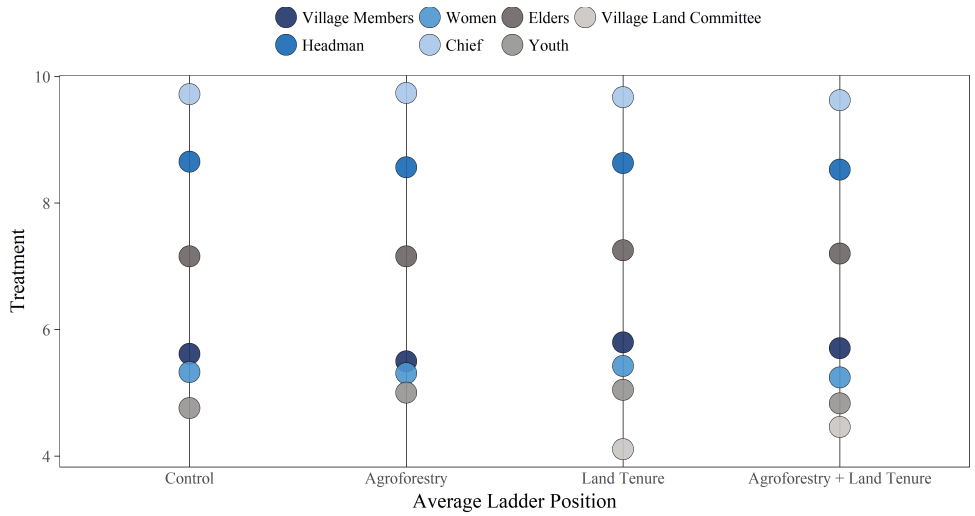
DISCUSSION

As demonstrated in Section 5, the land registration and governance program had a strong and positive impact on tenure security, however, the regression results presented in this section indicate that this effect may not have occurred through the expected theory of change and governance indicators tested by the evaluation. The Land Tenure intervention was comprised of several governance activities—as defined by the implementing partner and USAID—including establishing Village Land Committees (VLCs), conducting participatory mapping, and facilitating the issuance of customary land certificates. VLCs also provided households with information on land law and rights (CDLA and VLCs), as well as information about customary land certificates.

One explanation for the strong tenure results but underwhelming governance results could be that the tenure results are being primarily driven by the land registration and boundary demarcation activities—and that the governance components have little effect. Another explanation may be that, although an extensive survey module was included, the governance indicators measured by the evaluation do not capture the types of governance changes that are occurring in village land administration due to the program. Another explanation may be the strong baseline state of governance in the study area.

In terms of descriptive findings, survey respondents were asked to rank a variety of community actors on a "ladder of power," which indicates how much power various people have over land management decisions in the community. This is shown in see Figure 6-2. Unsurprisingly, the chief has the most decision-making power, followed by the headperson and village elders. This is consistent across all households in the Land Tenure, Agroforestry and Agroforestry + Land Tenure group, and there is no substantive difference between these rankings for traditional authorities between treatment and control areas. Similarly, the treatment versus control rankings for the village as a whole, women and youth are essentially equivalent across treatment and control villages. Households in villages receiving the land registration and governance treatment rank the VLC as having the least amount of decision-making power for all groups.

FIGURE 6-2: LADDER OF POWER



7.0 OUTCOME FAMILY III, UPTAKE OF AGROFORESTRY PRACTICES & SEEDLING SURVIVAL

Hypothesis 5: *Households in villages receiving the TGCC intervention have greater uptake of agroforestry.*

Hypothesis 6: *Households in villages receiving the TGCC intervention have greater rates of agroforestry seedling survival.*

SUMMARY OF KEY FINDINGS

- The regression results show that the Agroforestry treatment was successful in motivating greater uptake of agroforestry.
- There is no quantitative evidence from the aggregate household findings to support the primary hypothesis that strengthening tenure security leads to greater agroforestry uptake.
- All subgroups show significant uptake in agroforestry and increased agroforestry planting across fields for treatment villages receiving agroforestry extension. Descriptively, we see a small upward trend for subgroups in the Agroforestry + Land Tenure group of marginal benefits to linking agroforestry extension with land registration and governance.
- Within treatment areas, the seedling and tree survival rates are low. For the long term, it will be valuable to track whether there is a relationship between tree survival and tenure security perceptions.

Tables 7-1 through 7-3 illustrate the statistically significant regression findings for the household and subgroup panel samples. The coefficient on the treatment estimate is included in the table; a (P) designates a primary indicator. For agroforestry extent, we report the percent of agroforestry coverage above the control mean, and for the binary indicator of agroforestry adoption, we report the marginal effect on the probability the household reports that they engaged in agroforestry. A discussion of the magnitude of effects is included below in the Results section. The level of statistical significance is indicated by the color of the table cell where: $p < 0.1$; $p < 0.05$; $p < 0.01$.

TABLE 7-1: AGROFORESTRY UPTAKE SUMMARY TABLE (BY TREATMENT GROUP)

	AG	LT	AG+LT
% of field(s) planted with agroforestry trees or shrubs (S)	14%		15%
Field is planted with agroforestry trees or shrubs (Y/N) (S)	30%		30%

TABLE 7-2: AGROFORESTRY UPTAKE SUBGROUPS SUMMARY TABLE (AGROFORESTRY HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
% of field(s) planted with agroforestry trees or shrubs (S)	14%	13%	15%	13%	16%
Field is planted with agroforestry trees or shrubs (Y/N) (S)	28%	20%	22%	28%	32%

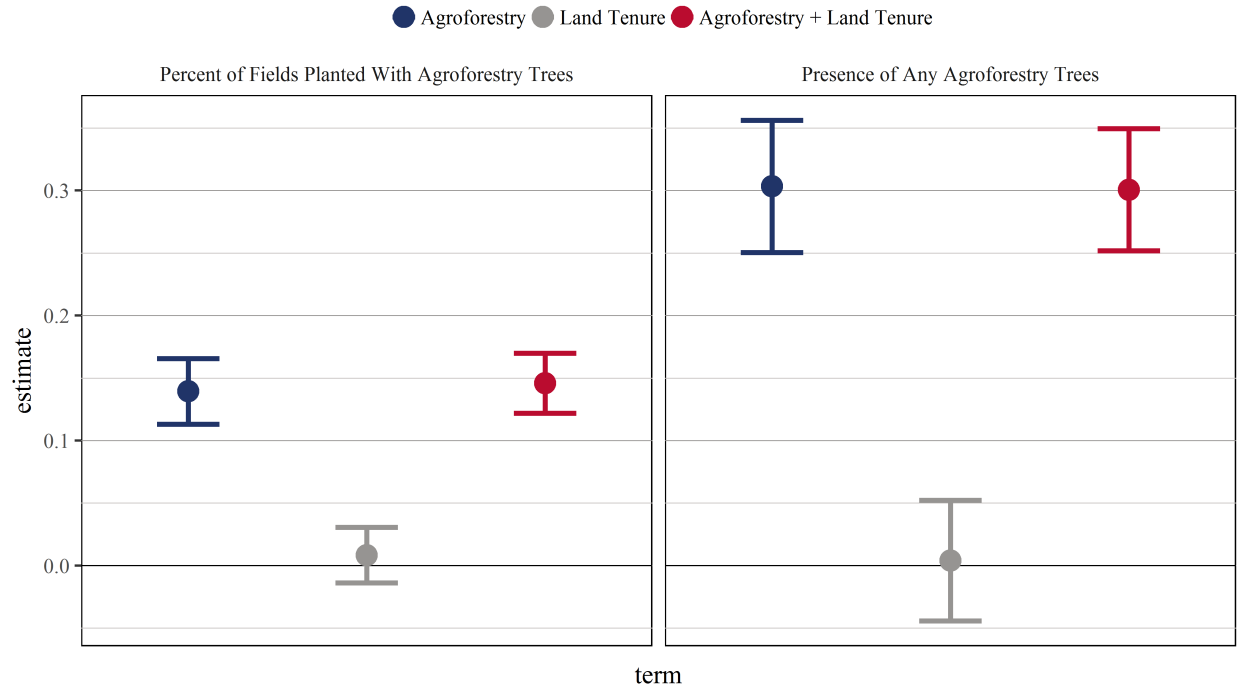
TABLE 7-3: AGROFORESTRY UPTAKE SUBGROUPS SUMMARY TABLE (AGROFORESTRY + LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
% of field(s) planted with agroforestry trees or shrubs (S)	18%	14%	10%	14%	16%
Field is planted with agroforestry trees or shrubs (Y/N) (S)	33%	25%	19%	26%	35%

RESULTS

The findings in this section speak to the fundamental research question driving the study—whether stronger property rights affect a farmer's decision to practice climate-smart agriculture, including agroforestry. The results show a positive aggregate Agroforestry treatment impact for agroforestry adoption (14% (p<0.01)) and the extent of agroforestry planted (30% (p<0.01)), illustrated in Figure 7-1. Correspondingly, all subgroups show significant uptake in agroforestry and increased agroforestry planting across fields—female (14% (p<0.01), 28% (p<0.01)), youth (13% (p<0.01), 28% (p<0.01)), and elder-headed (16% (p<0.01), 32% (p<0.01)) households, as well as poor (13% (p<0.01), 20%(p<0.01)) and land constrained households (15% (p<0.01), 22% (p<0.01)).

FIGURE 7-1: TREATMENT EFFECT ON AGROFORESTRY UPTAKE



For the overall household sample, there is no evidence to support a link between perceived tenure security and agroforestry uptake. Specifically, there is no evidence of marginal improvements in households that received the Agroforestry + Land Tenure treatment versus those that only received the Agroforestry treatment. This finding is consistent across the primary household panel analysis, as well as for the exploratory analysis where we focus on the results for only those households that actively participated in the COMACO training.

In contrast, the subgroup findings for female-headed and poor households indicate a slight uptick (5%) from linking land tenure and agroforestry, although not statistically significant. This lends some qualitative support to the argument that, at least for more marginalized groups, stronger property rights may affect a farmer's decision to practice climate-smart agriculture (CSA) including agroforestry. Finally, there is no strong/systematic evidence of within treatment differences between subgroups and the aggregate treatment estimates. This bodes well for equity in the distribution of program benefits and absence of elite capture.

Within treatment areas, the seedling and tree survival rates are low. Figure 7-2 shows the survival rates of each village in the sample. Figure 7-3 displays seedling survival rates across all tree species from 2014–2016 for treatment and control households. These low survival rates do not appear to correlate with the geographical location of the village, or with the location of wells or water points. It is important to highlight that the entire Chipata district experienced droughts during the 2014–2015 and 2015–2016 growing seasons.

FIGURE 7-2: SEEDLING SURVIVORSHIP BY VILLAGE

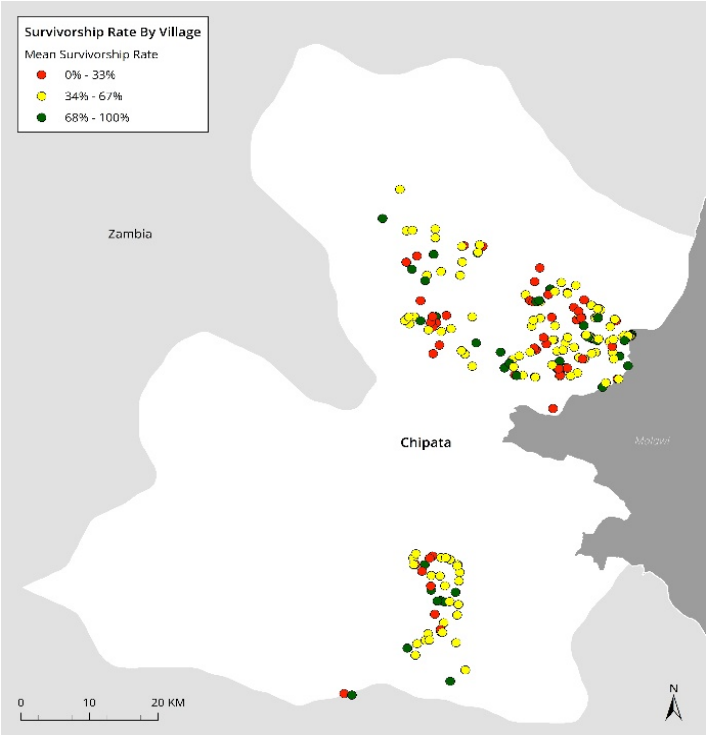
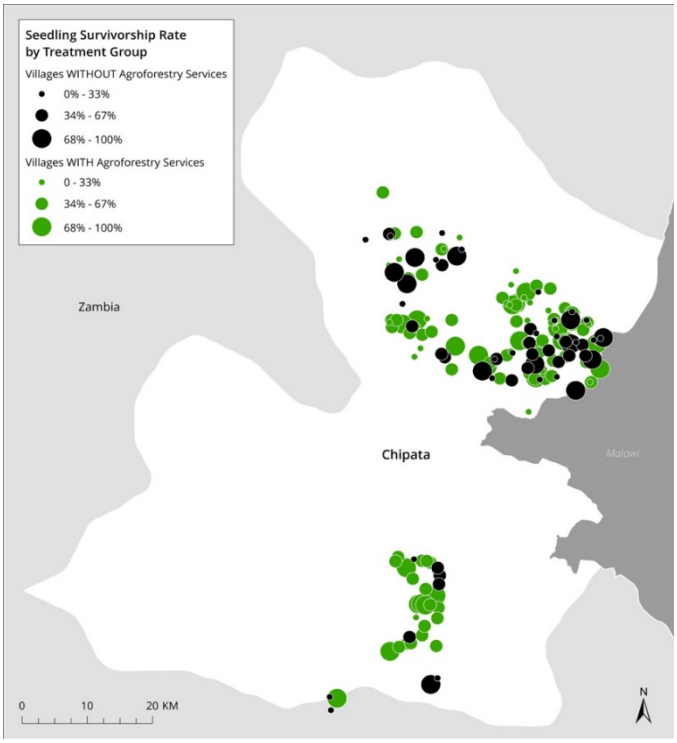


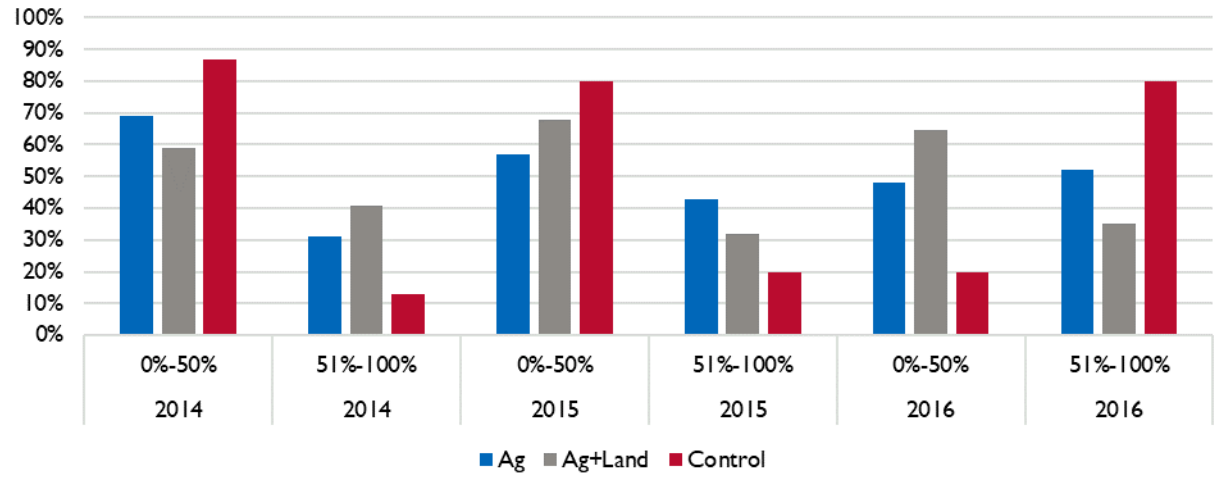
FIGURE 7-3: SEEDLING SURVIVAL RATES BY TREATMENT GROUP



Across all years of the intervention, the majority of households who engaged in agroforestry report that less than 50% of their Musangu seedlings on their fields survived, as shown in Figure 7-4. However, treatment households have slightly higher survival rates than control households. Since the overall sample size of control households who planted seedlings is low, the percentages may be misleading. In 2014, the first year of the COMACO program, about a quarter of fields planted with Musangu in treatment communities (24%, N=25) have between 76–100% of seedlings alive today. Six fields in treatment communities have a zero percent survival rate, compared to one in control communities.

Survival rates for Musangu trees planted in 2015, the second year of the program, are slightly lower than they were for the first year of the program. In the second year of the program, COMACO discontinued extension services and only provided seeds which may explain the lower survival rate. Only 17% (N=14) of fields planted by treatment households have a survival rate above 75%. Still, this is higher than control households, where only one household has a survival rate that high. It is also important to note that the 2014–2015 and 2015–2016 growing seasons were years with historically bad rainfalls and low crop yields.

FIGURE 7-4: MUSANGU SURVIVORSHIP BY YEAR

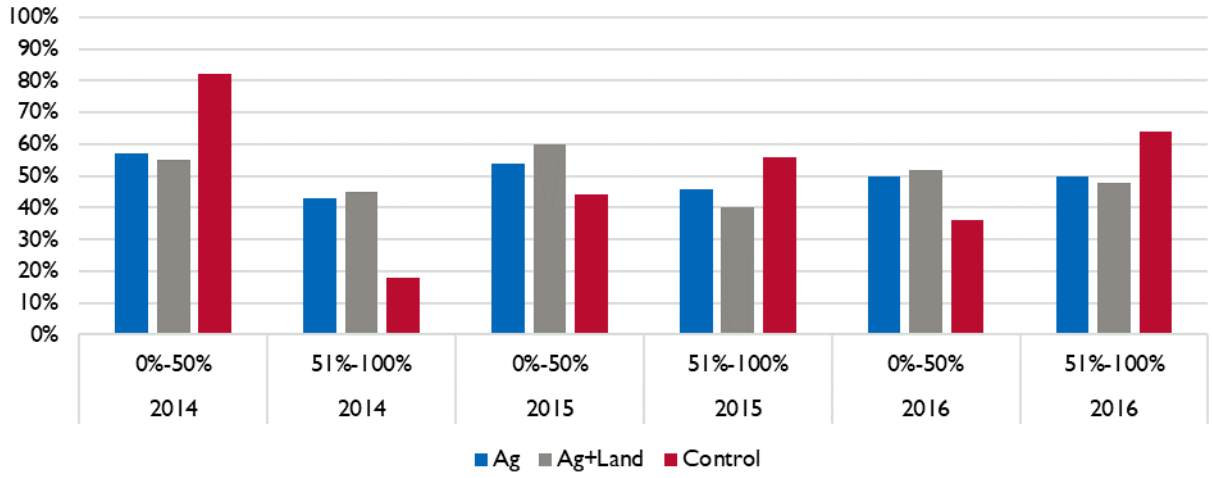


In 2016, after COMACO ended agroforestry support in treatment villages, survival rates for Musangu trees fell below the survival rates of trees in control villages. Only four treatment household fields report a survival rate higher than 75%, which is equal to the number of fields as in the control group. Table 7-4 shows the average household survival rate for Musangu trees in 2014–2016 by treatment group.

TABLE 7-4: MUSANGU TREE SURVIVAL RATES

Musangu Trees	Ag	Ag+LT	Control
Percentage of trees planted in 2014 that are alive now			
0%	11% (4)	3% (2)	1
1–25 %	34% (12)	29% (20)	1
26–50%	26% (9)	26% (18)	5
51–75%	9% (3)	19% (13)	0
76–100%	20% (7)	23% (16)	2
Percentage of trees planted in 2015 that are alive now			
0%	13% (4)	12% (6)	2
1–25%	34% (11)	25% (13)	3
26–50%	13% (4)	29% (15)	4
51–75%	22% (7)	13% (7)	2
76–100%	19% (6)	15% (8)	1
Percentage of trees planted in 2016 that are alive now			
0%		2	0
1–25%	5	5	2
26–50%	4	4	0
51–75%	8	5	4
76–100%	3	1	4

FIGURE 7-5: *GLIRICIDIA* SURVIVORSHIP BY YEAR



Survival rates for *Gliricidia* trees are slightly more optimistic, though the majority of households still report survival rates under 50%, as shown in Figure 7-5. Of the seedlings planted in 2014, 32% (N=48) of fields planted by treatment households have more than 75% are alive today, compared to zero control household fields. The figures are similar for seedlings in fields that treatment households planted in 2015 (33%, N=35) and 2016 (28%, N=20). The number of fields with a survival rate higher than 75% planted by control households increased from eight in 2015 to nine fields in 2016. Table 7-5 shows the average household survival rate for *Gliricidia* trees in 2014–2016 by treatment group.

TABLE 7-5: *GLIRICIDIA* TREE SURVIVAL RATES

Gliricidia Trees	Ag	Ag+LT	Control
Percentage of trees planted in 2014 that are alive now			
0%	11% (9)	14% (10)	5
1–25%	22% (18)	21% (15)	2
26–50%	20% (17)	17% (12)	2
51–75%	14% (12)	10% (7)	1
76–100%	28% (23)	35% (25)	0
Percentage of trees planted in 2015 that are alive now			
0%	11% (7)	12% (7)	3
1–25%	26% (16)	23% (13)	3
26–50%	15% (9)	18% (10)	6
51–75%	13% (8)	16% (9)	9
76–100%	31% (19)	28% (16)	8
Percentage of trees planted in 2016 that are alive now			
0%	3% (1)	9% (4)	2
1–25%	23% (7)	22% (10)	3
26–50%	19% (6)	13% (6)	2
51–75%	16% (5)	27% (12)	5
76–100%	29% (9)	24% (11)	9

Overall, seedling survival for Musangu and *Gliricidia* was the lowest in 2016. This suggests that the support provided by COMACO during the agroforestry program was critical to the survival of seedlings, and withdrawing this support has had negative impacts on seedling survival rates.

DISCUSSION

This section explores the factors driving program participation, expected benefits and the main challenges to agroforestry, in order to better understand uptake and seedling survival.

PARTICIPATION

In communities where the agroforestry extension was offered 57% (N=711) of households had at least one household member participate in the program. The benefits of agroforestry are well-known to households in Chipata district. Focus group participants easily articulated the benefits, even if they did not participate in the agroforestry extension intervention.

An Agroforestry participant in Mnukwa chiefdom described the benefits this way: "Growing agroforestry in our fields will help us save tremendously on the purchases of fertilizers. At least we will have money to spend on other necessities, like our children's education… It will also help us maintain the fertility in our fields, rather than depending on these fertilizers that even end up destroying the fertility of the soils in our fields."

A female FGD participant in Maguya chiefdom described how she expects to benefit from agroforestry. "Growing little food has troubled us here in this village. If you don't have fertilizer and at home you have a big family including grandchildren and the field is not productive so to hear that there are trees that can make soil fertile… so when fertility returns to the soil, people can grow enough food for their

families. That is why we want agroforestry trees. Most of us can't afford to buy fertilizer. So we want fertility to return to the soil so that we can reduce hunger in our homes"

Table 7-6 illustrates the many reasons households chose to participate in the Agroforestry intervention. The primary reason households participate is to reap the agricultural benefits from agroforestry (78%, N=554), such as improving soil fertility and reducing the need for fertilizer. Other common reasons included wanting to learn new farming techniques (36%, N=261) and wanting advice about agroforestry (37%, N=263). Other draws to the program were receiving free inputs (8%, N=58), and wanting fuelwood (2%, N=14).

TABLE 7-6: WHY PARTICIPATE IN COMACO PROGRAM

Reasons for participating	Ag	Ag+LT
Want to higher soil fertility and other benefits from agroforestry	77% (250)	78% (304)
Want to learn about new farming techniques	37% (120)	36% (141)
Want advice about agroforestry	31% (101)	42% (162)
Want free inputs	6% (20)	10% (38)
Want fuelwood	1% (3)	3% (11)
My friend/neighbor/relative urged me to participate	1% (2)	1% (5)
The headman urged me to participate	1% (2)	2% (6)
Want a guaranteed buyer/better price for my crops	1% (4)	1% (2)
Want to benefit from fuel-efficient cookstoves	1% (3)	1% (2)
Want fodder for livestock	0% (0)	0% (0)

Table 7-7 illustrates the reasons that households did not participate in the agroforestry extension program. The biggest reason for nonparticipation was inability to attend the meetings (40%, N=141). This suggests that modifications to recruitment protocols, such as greater outreach before signups began, or allowing for multiple rounds of program signups as news of the program permeates the villages, might engender higher participation rates.

Other reasons households did not participate include an overall lack of interest (7%, N=29), a desire to see if other households were successful before trying agroforestry (7%, N=26), and because agroforestry requires too much labor for the household (6%, N=21). Not being allowed to plant trees is almost never a reason households do not participate (1%, N=5), suggesting that for most households, there are no rules prohibiting them from planting trees.

In the FGDs, a lack of incentive to counteract the high labor and time costs is a consistent theme for households who chose not to participate. They would prefer a program that provided inputs that materialized in the short term, such as seeds, to the long-term benefits associated with agroforestry. This is especially true in areas that currently have virgin land or relatively fertile soil. The two quotes below illustrate this sentiment:

"The reason why I did not take part is that doesn't this project go with other additional crops such as beans and cowpeas? So you find that you as a farmer can't start with planting trees without first planting crops because as a farmer you first need a seed that will lift you out of your problems" (Mshawa, Agroforestry non-respondent).

"How can a program be only about trees! It takes a lot of years before you can cut a 'beam' out of it?...We would be glad if this program will go with seeds that we plant in the fields. These same seeds

will also be planted in the same field but now if we have only planted trees, what benefit will we achieve if there is no seed to plant in it? Then poverty will continue but trees and seeds ought to go together so that we can also sell" (Mshawa, male Agroforestry non-participant).

TABLE 7-7: WHY NOT PARTICIPATE

Reasons for not participating	Ag (N=174)	Ag+LT (N=177)
Wanted to participate but failed to attend the meetings	40% (69)	41% (72)
Not interested in trying a new farming method	7% (13)	7% (13)
Wanted to see if other households had success before trying	5% (9)	7% (12)
Required too much labor	6% (10)	6% (11)
No benefits to agroforestry	5% (9)	3% (5)
Not allowed to plant trees on my land	1% (2)	2% (3)

AGROFORESTRY UPTAKE

Households in Agroforestry treatment villages (54%, N=771) are more likely to have engaged in agroforestry than control households (24%, N=163). Agroforestry + Land treatment households have the highest participation rate (56%, N=412). Agroforestry households have a participation rate of 53% (N=359).

The most common tree species planted are the Musangu tree and *Gliricidia*, each planted by roughly 40% of all households in the treatment group.[29] It can be grown amidst any crop, but COMACO encouraged farmers to plant their fields where Musangu seedlings were being grown with low-growing crops such as groundnuts, to ensure that the seedlings would get enough sunlight. Households were provided with 25 Musangu seedlings. Just over a third of households (35%, N=205) receiving the Agroforestry treatment and (41%, N=263) of households receiving the Agroforestry + Land Tenure treatment planted Musangu trees. Uptake for the control group is substantially lower (14%, N=79).

Gliricidia is also grown from a seedling and intercropped. Households struggled to keep the seedlings alive in the nursery, as *Gliricidia* is particularly sensitive to water shortages. This may explain the slightly lower rates of *Gliricidia* adoption, though households who participated in the extension program received both species. Households in the treatment group were provided with 100 *Gliricidia* seedlings and have a rate of adoption slightly under 40% (39%, N=552)) The rate for control villages is significantly lower (15%, N=102). Female headed households in treatment communities are slightly less likely to have planted *Gliricidia* trees than male headed households (FHH: 23%, MHH: 28%, significant at the 1% level). Based on Monitoring and Evaluation (M&E) conversations with the COMACO team, female-headed households were more likely to struggle to transport their seedlings from the nursery to their fields, and the large number of *Gliricidia* seedlings (100 *Gliricidia* vs. 25 Musangu) may have been too much of an obstacle for female-headed households.

29 Musangu trees are grown from seedlings. It is intercropped with the field's main crop, and is best suited to being planted in a 5–by–5 meter grid.

The third species of tree provided by the program was pigeon peas, though the provision of these seeds was not uniform. The original design called for 500g of pigeon pea seeds to be distributed to households, which would be planted directly in their fields. Pigeon peas grow into a bush that produces an edible fruit (the pigeon pea), and are highly desirable for consumption. Despite their desirability, less than 5% of treatment households planted pigeon peas (4%, N=48).[30]

TABLE 7-8: HH TREE SPECIES PLANTED

Species	Ag (N=585)	Ag+LT (N=646)	Control (N=580)
Musangu	35% (205)	41% (263)	14% (79)
Gliricidia	40% (236)	38% (243)	15% (88)
Pigeon Peas	5% (31)	3% (17)	1% (5)

EXPECTED BENEFITS FROM AGROFORESTRY UPTAKE

Households have a clear understanding of the expected benefits for agroforestry trees. The most common expected benefit cited by treatment groups both now and in the future is improved soil fertility (18%, N=82 for Musangu; 26%, N=136 for *Gliricidia*). The number of households who expect to see that benefit in the future is double the number of households who currently see the benefit (35%, N=164 for Musangu; 48%, N=231 for *Gliricidia*), which seems to indicate households understand that the benefits of agroforestry accrue in the future.

Similarly, improved crop growth around trees is another benefit cited for both species, particularly in the future. Ten percent of households say they expect to see improved crop growth in the future for Musangu trees (N=48), as do 13% of households for *Gliricidia* (N=60). This is a lower percentage than we would expect, since higher yields and/or improved crop growth should be the ultimate benefit to households.

A benefit emphasized in focus group discussions is the increased availability of fuel wood. It appears that at least some households view their agroforestry trees as an opportunity for a woodlot as opposed to caring for their trees to improve their field's agricultural productivity. This is further supported by the number of households who do not believe that there are any yield-related benefits to the trees. The household statistics are less striking than the qualitative analysis, but are worth noting—5% (N=22) of households believe their Musangu trees will increase the availability of fuelwood in the future. This is highest in the Agroforestry group (5%, N=11). The percent of households who believe that *Gliricidia* trees will increase the availability of fuelwood in the future is slightly higher (6%, N=31).

As Table 7-9 below illustrates, agroforestry adoption is not associated with greater perceived tenure security. Almost no households believe that planting agroforestry trees reduce the fear of their land being taken, or raise the value of their land for collateral, either now or in the future. This coincides with the regression results presented in Section 5 that show no significant difference between the Land Tenure and Agroforestry + Land Tenure findings for perceived tenure security.

TABLE 7-9: MUSANGU AND *GLIRICIDIA* TREE BENEFITS

Benefits	Present	Future	Present	Future
Musangu trees	**Ag (N=205)**		**Ag+LT (N=263)**	

30 COMACO did not distributed pigeon peas in all villages due to a lack of seeds.

No benefits	23% (47)	8% (16)	35% (91)	11% (29)
Improved soil fertility	18% (36)	31% (63)	18% (46)	38% (101)
Improved crop growth around trees	9% (19)	9% (18)	4% (10)	11% (30)
Higher overall crop yield	3% (7)	9% (18)	3% (9)	13% (33)
Increased fuel wood availability	<1% (1)	5% (11)	2% (4)	4% (11)
Reduced labor time on weeding	0% (0)	0% (0)	0% (0)	<1% (1)
Reduced weeds	0% (0)	1% (2)	0% (0)	2% (4)
Reduced fear of land being taken	0% (0)	<1% (1)	0% (0)	<1% (1)
Raised value of the land for collateral	0% (0)	0% (0)	0% (0)	0% (0)
***Gliricidia* trees**	**Ag (N=236)**		**Ag+LT (N=243)**	
Improved soil fertility	32% (75)	49% (115)	25% (61)	48% (116)
No benefits	38% (90)	15% (35)	40% (98)	15% (37)
Improved crop growth around trees	9% (21)	11% (27)	9% (21)	14% (33)
Higher overall crop yield	6% (14)	18% (42)	7% (16)	19% (45)
Increased fuel wood availability	1% (3)	7% (16)	2% (5)	6% (15)
Reduced labor time on weeding	0% (0)	<1% (2)	1% (3)	3% (7)
Reduced weeds	<1% (1)	1% (3)	<1% (1)	4% (9)
Reduced fear of land being taken	<1% (1)	<1% (1)	<1% (1)	1% (2)
Raised value of the land for collateral	0% (0)	0% (0)	0% (0)	0% (0)

Taken together, these findings suggest that the program helped households understand the major ecological benefits of agroforestry trees, as well as the fact that these benefits will likely manifest in the future as opposed to the present.

Despite understanding the benefits, households seem skeptical that the benefits will actually materialize for them, either now or in the next 3–5 years. At present, between 30–40% of treatment households see no benefits to their agroforestry trees (29%, N=138 for Musangu; 39%, N=188 for *Gliricidia*), though as expected, this number drops substantially when households are asked about benefits they expect in the next 3–5 years (10%, N=45 for Musangu; 15%, N=72 for *Gliricidia*). Still, the number of people who do not expect any benefits from their agroforestry trees seems high, considering the amount of time and labor households put into their trees, and raises the question of why these households are engaging in agroforestry at all. There is nothing definitive in the data to answer this question, but focus group responses do allude to households joining the program from a sense of obligation.

CHALLENGES TO SURVIVAL

Table 7-10 shows the types of challenges to agroforestry tree survival that households encountered. The most common challenges to agroforestry seedling survival, for both *Gliricidia* and Musangu, include a lack of water for seedlings, fires burning trees, pests killing the trees and animals grazing in the field.[31]

31 The greatest challenge facing households planting pigeon peas is not lack of water, but animals grazing in the field, followed by pests killing or damaging the plants. Lack of water is the third most common challenge.

Given the drought conditions during implementation, lack of water for seedlings was the number one challenge for both Musangu and *Gliricidia* seedlings, identified by 20% (N=95) of treatment households for Musangu trees, and 27% (N=130) of treatment households for *Gliricidia* trees. Fourteen percent of treatment households (N=113) say that their nursery never had enough water, and 12% (N=97) say their nursery only had enough water part of the year.[32] COMACO attempted to address this challenge by installing wells in villages with significant water scarcity, however, it does not appear that the wells improved seedling survival in subsequent years.

FGDs tell a similar story. A participant in the agroforestry extension from Mnukwa chiefdom commented "The challenge we are facing is lack of water. Even if they brought more seed for us to plant, once the rains stop, we work in vain. So we don't know how you are going to help us, once you help us with water, aah we will have trees all over here."

Traditional land management practices also present a challenge to the survival of agroforestry trees. In particular, animals grazing trees, which occurs when animals are allowed to graze anywhere in the fields after crops have been harvested, was cited as a challenge to growing Musangu by 6% of treatment households (N=27). Another traditional practice, setting fires to fields to clear crops after harvest or to harvest mice to eat, resulted in 8% of treatment households (N=38) reporting that their Musangu seedlings were burned by fires.

Pests killing and damaging trees was also a challenge for households growing both Musangu and *Gliricidia*, especially in the control areas. The fact that treatment communities were slightly less likely to have their trees killed by pests may speak to the success of COMACO's training about how to protect their trees.

Finally, it is worth noting that lack of knowledge was not a prevalent challenge for households. Additional agroforestry trainings in the future would likely have limited impact on uptake or survivorship.

32 Thirty-one percent (N=456) of household respondents did not know if their nurseries had water during the year.

TABLE 7-10: AGROFORESTRY CHALLENGES

	Musangu			*Gliricidia*		
	Ag	Ag+LT	Control	Ag	Ag+LT	Control
Lack of water	19% (38)	22% (57)	22% (17)	28% (67)	26% (63)	24% (21)
Pests killed/damaged trees	10% (20)	13% (34)	21% (27)	18% (43)	18% (44)	20% (17)
Animals grazed trees	6% (12)	6% (15)	5% (4)	10% (24)	9% (22)	10% (9)
Fires burned the trees	3% (6)	12% (32)	9% (7)	12% (29)	9% (21)	13% (11)
Trees were chopped down by mistake	4% (8)	5% (12)	13% (10)	6% (13)	5% (11)	6% (5)
Lack of knowledge	4% (9)	2% (6)	6% (5)	6% (15)	3% (8)	8% (7)
Difficulty transporting seedlings to field	0% (0)	1% (2)	0% (0)	3% (6)	3% (7)	2% (2)
Not enough labor to care for trees	<1% (1)	2% (5)	1% (1)	1% (2)	2% (5)	0% (0)
Could not access seeds	<1% (1)	<1% (1)	1% (1)	3% (6)	1% (3)	1% (1)
Did not see benefits so stopped caring for trees	0% (0)	0% (0)	0% (0)	0% (0)	1% (2)	1% (1)

VILLAGE LAND MANAGEMENT PRACTICES

Land management rules in a village play an important role in the success or failure of agroforestry. Based on the key informant YGL responses, the agroforestry program had a limited effect on the existence or adoption of village rules related to land management. The descriptive results do not indicate a substantive difference in rule adoption or the types of rules between treatment and control communities.

Rules about setting fires and grazing livestock are particularly important, since seedlings are susceptible to being grazed or trampled by livestock or burned by fires, as discussed above. Half of villages have a rule that forbids lighting fires in fields at any point in the year (53%, N=146). The other half of villages either have no rule about lighting fires, or allow fires after the crops are harvested. Figure 7-6 shows seedling survival in villages that have a rule that forbids fires on fields at any time in the year. The results show a potential association between the presence of rules and higher survival rates for agroforestry trees.

Grazing rules are another possible means for increasing seedling survival. Traditionally, animals are allowed to graze in fields after crops are harvested, which leaves seedlings vulnerable to being grazed or trampled by cattle, goats and other livestock. We examined the seedling survival rates for villages that forbid livestock grazing on fields, or allow it only if the livestock are accompanied (68%, N=187), and compared to villages that either have no rule about grazing or allow livestock to graze unaccompanied on fields (32%, N=86). Figure 7-7 shows the results of the comparison. There does not appear to be as strong of an association between grazing rules and seedling survival, compared to the rules about starting fires. One reason that grazing rules may not have the same effect on survival as fires is that even if supervised, it is not always possible to control livestock, and seedlings may still be grazed or trampled even if the rule is being obeyed. Another possible explanation is a lower rate of adherence to rules about grazing than rules about fire, as reported by households. Five percent of households in treatment

areas (N=46) say that households do not follow rules about grazing, compared to 10% of households in treatment area (N=99) who say households do not follow rules about fires.

Focus group discussions further highlight the importance of good grazing practices. A participant from Mnukwa described the challenge this way: "We will first need to have proper prevention plan from livestock. Sometimes we are not around, we may be attending a funeral at a neighboring village, so if we do not secure these trees from livestock then there is nothing that will happen. The chief need to teach the headmen how to look after livestock and the headmen should in turn teach their subjects, because if these livestock are left like this destroying plants… we need strict rules on livestock, if not it will continue to be a serious problem."

FIGURE 7-6: SURVIVORSHIP RATE & FIRE RULES BY VILLAGE

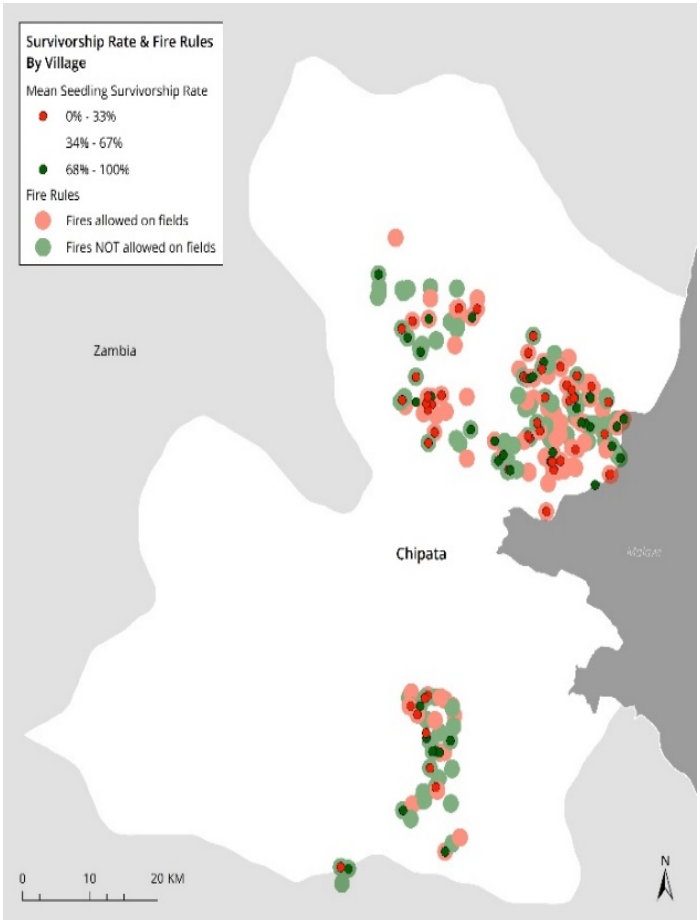
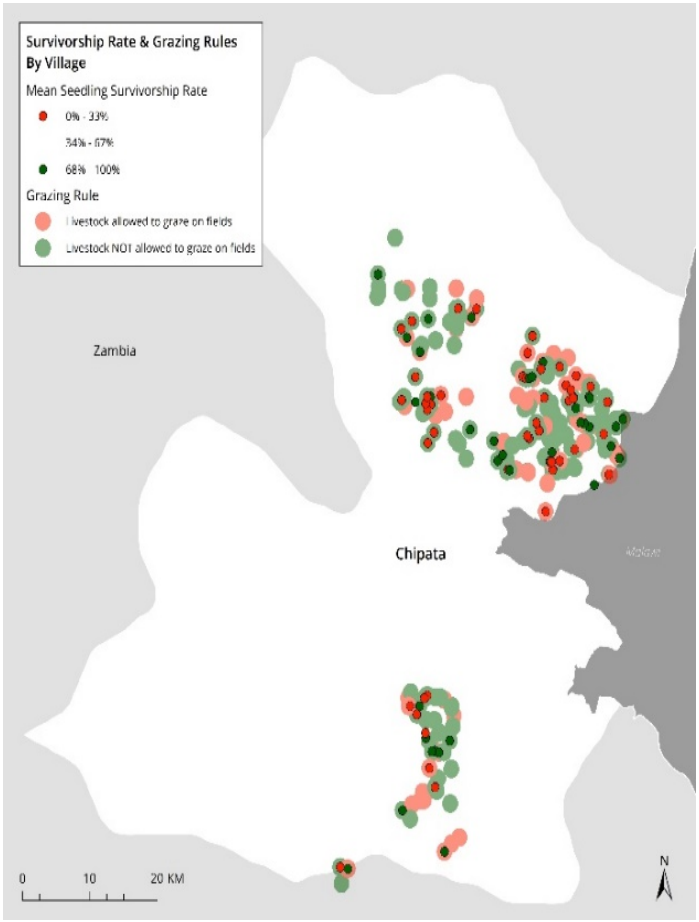


FIGURE 7-7: SURVIVORSHIP RATE & GRAZING RULES BY VILLAGE



8.0 OUTCOME FAMILY IV, FIELD INVESTMENT

Hypothesis 7: *Households in villages receiving the TGCC intervention have greater uptake of climate-smart agriculture (excluding agroforestry).*

Hypothesis 8: *Households in villages receiving the TGCC intervention have greater uptake of short and long term field investments.*

SUMMARY OF KEY FINDINGS

- For the household level panel analysis, there is no evidence of greater labor or cost intensive field investments for households in the Land Tenure treatment group.
- Across the three treatment groups, we find evidence of negative investment impacts for all subgroups except female-headed households.
- For the within-treatment analysis, we generally find that the average treatment impacts are equivalent to the subgroup impacts, although there is evidence that youth in treatment areas are less likely to fallow or engage in labor or cost intensive field investments.

Tables 8-1 through 8-4 illustrate the statistically significant regression findings for the household and subgroup panel samples. The coefficient on the treatment estimate is included in the table; a (P) designates a primary indicator and an (S) designates a secondary indicator. For binary indicators, we report the marginal effect on the probability the household reports that they have undertaken the field investment in question. A discussion of the magnitude of effects is included below in the Results section. The level of statistical significance is indicated by the color of the table cell where: $p < 0.1$; $p < 0.05$; $p < 0.01$.

TABLE 8-1: FIELD INVESTMENT OVERALL SUMMARY TABLE (BY TREATMENT GROUP)

	AG	LT	AG+LT
HH engages in fallowing (Y/N) (S)	-4%		
Minimum number of seasons HH left a field fallow (P)			
HH practiced zero tillage on field (S)			
HH applied manure or compost on field (S)			
HH used fertilizer on field (S)			
HH constructed planting basins in field (S)			
HH used crop rotation on field (S)			

TABLE 8-2: FIELD INVESTMENT SUBGROUPS SUMMARY TABLE

(LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
HH engages in fallowing (Y/N) (S)					
Minimum number of seasons HH left a field fallow (P)					
HH practiced zero tillage on field (S)					-7%
HH applied manure or compost on field (S)			-21%		
HH used fertilizer on field (S)					
HH constructed planting basins in field (S)			-15%		
HH used crop rotation on field (S)					

TABLE 8-3: FIELD INVESTMENT SUBGROUPS SUMMARY TABLE (AGROFORESTRY HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
HH engages in fallowing (Y/N) (S)		-6%			
Minimum number of seasons HH left a field fallow (P)					
HH practiced zero tillage on field (S)					
HH applied manure or compost on field (S)					
HH used fertilizer on field (S)			14%		
HH constructed planting basins in field (S)					
HH used crop rotation on field (S)					

TABLE 8-4: FIELD INVESTMENT SUBGROUPS SUMMARY TABLE (AGROFORESTRY + LAND TENURE HOUSEHOLDS ONLY)

	FHH	POOR	LC	YOUTH	ELDERLY
HH engages in fallowing (Y/N) (S)				-6%	
Minimum number of seasons HH left a field fallow (P)					
HH practiced zero tillage on field (S)					-8%
HH applied manure or compost on field (S)					
HH used fertilizer on field (S)					
HH constructed planting basins in field (S)					
HH used crop rotation on field (S)					

RESULTS

There is no evidence of improved long term or labor/cost intensive field investments (planting basins, rotating crops fallowing and fertilizer application) for primary or secondary indicators measured at the household level for the Land Tenure intervention. However, supplemental research conducted at the field level does uncover some empirical support to the hypothesis that greater perceived tenure security is associated with increased field investments (See Huntington et al., 2018).

Although land constrained households are more likely to apply chemical fertilizer, the subgroup results show several negative heterogeneous treatment impacts for youth- and elder-headed households, as well as poor and land constrained. There are no differential impacts for female-headed households. For Land Tenure, the results show that elderly households are 7% ($p<0.05$) less likely to practice zero tillage methods and that land constrained households are less likely to engage in manuring or composting (21% ($p<0.05$)), or planning basins (15% ($p<0.05$)). Poor households in the Agroforestry treatment are 6% ($p<0.05$) less likely to fallow. In the Agroforestry + Land Tenure group, we find that youth are less likely to leave their fields fallow (6% ($p<0.10$)) and elder-headed households are 8% ($p<0.05$) less likely to use zero tillage than their control counterparts.

Given that negative investment results were unexpected, we checked the subgroup balance on investment indicators at baseline and found several cases of imbalance that might contribute to the explanation of these results.

In terms of the within-treatment analysis, the findings do not reveal systematic evidence of a difference between the average treatment effects and subgroup results for female-headed, elderly, poor or land constrained households. The exception to this is the results for youth. Compared to the average treatment effect for 'non-youth,' youth are less likely to have fallowed in the past 3 years, or to have invested in CSA in the Agroforestry + Land Tenure condition.

9.0 OUTCOME FAMILY V, LONG TERM OUTCOMES: AGRICULTURAL PRODUCTIVITY & LIVELIHOODS

Hypothesis 9: *Households in villages receiving the TGCC intervention have higher agricultural productivity and crop yields.*

Hypothesis 10: *Households in villages receiving the TGCC intervention have different livelihood and welfare outcomes.*

SUMMARY OF KEY FINDINGS

- There is no evidence of treatment impacts on outcomes that may take several years to materialize, including changes in agricultural productivity, land transactions or livelihoods.

TABLE 9-1: AGRICULTURAL PRODUCTIVITY AND LIVELIHOODS* (HOUSEHOLDS OVERALL)

	Ag	LT	Ag+LT
HH reported experiencing improved crop growth as a result of agroforestry (P)			
HH reported experiencing higher overall crop yield as a result of agroforestry (S)			
Asset-based wealth index (P)			
HHs obtained formal loan from bank or microcredit institution (S)			
HH engages in land rental activity as landlord (S)			

RESULTS

As Table 9-1 shows above, there is no evidence of a treatment impact for our long term primary indicators. This is not surprising given the short time period between program completion and follow-up data collection. The evaluation team recommends another round of data collection in 2–3 years to investigate the impact of TGCC on these development priorities.

ANNEX 1. GEOSPATIAL CONTEXT

OVERVIEW

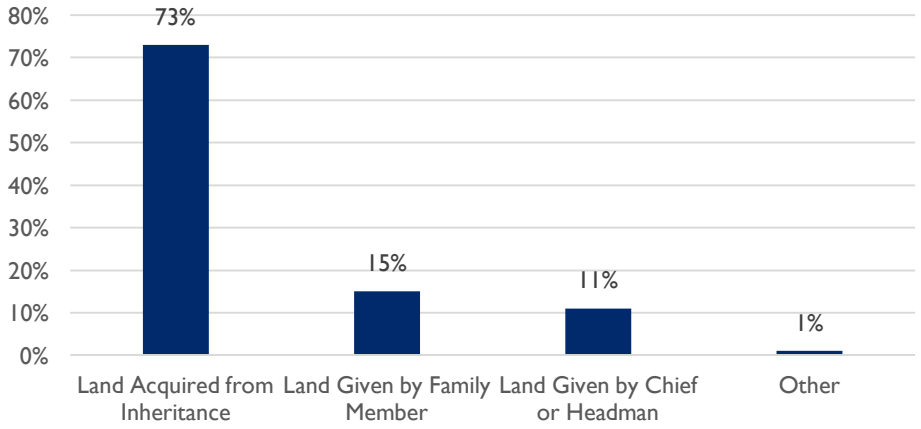
CDLA provided geospatial data on parcel boundaries across the four treatment chiefdoms as well as claimant details pertaining to each parcel. An examination of claimant details and spatial relationships in land treatment areas provides contextual information to enable better interpretation of the evaluation findings and help identify how program implementation and context variation should be accounted for. It is important to note that this data is only available for villages in the Land and Ag+Land treatment groups.

Another important distinction between CDLA's geospatial parcel data and ERC's non-spatial field data is how they are 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.

CERTIFICATE REGISTRATION

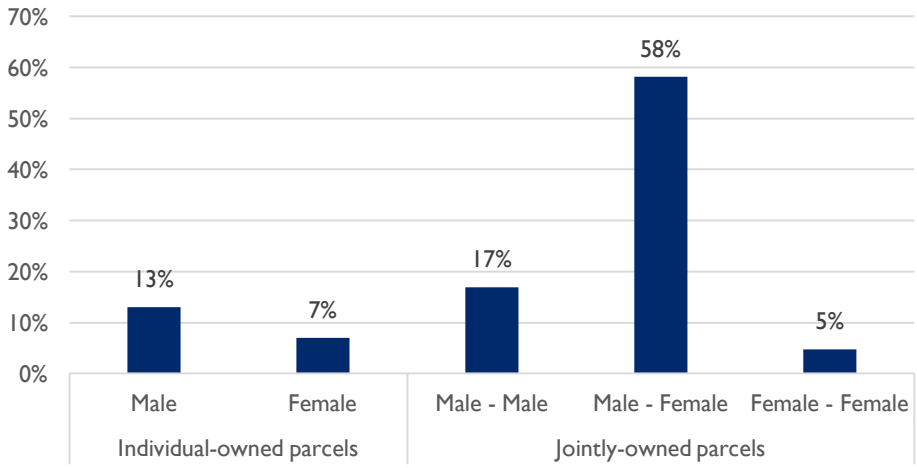
According to CDLA's certificate registration details, there are 5,911 land parcels that are registered across the four treatment chiefdoms and that match the treatment villages in this analysis, shown in Figure A1-1 below. The majority of these parcels (87%, N=4,799) are held by a household with the remaining (13%, N=732) are held by extended family. The majority of landholders' claims to the land are based on inheritance (73%, N=4,354) followed by land given by a family member (15%, N=863) and land given by the chief or headman (11%, N=697).

FIGURE A1-1: PARCEL CLAIMANT BASIS



The total number of landholders per parcel ranges from one to 11. The most common number of landholders per parcel is two (67%, N=3,949), followed by one (20%, N=1,186) and then three landholders (8%, N=487). Overall, most land parcels were registered jointly (80%, N=4,725). Of the individually-owned parcels, men (65%, N=771) are almost twice as likely to own the land parcel than women (35%, N=415), shown in Figure A1-2.

FIGURE A1-2: PARCEL CLAIMANT TYPE BY GENDER



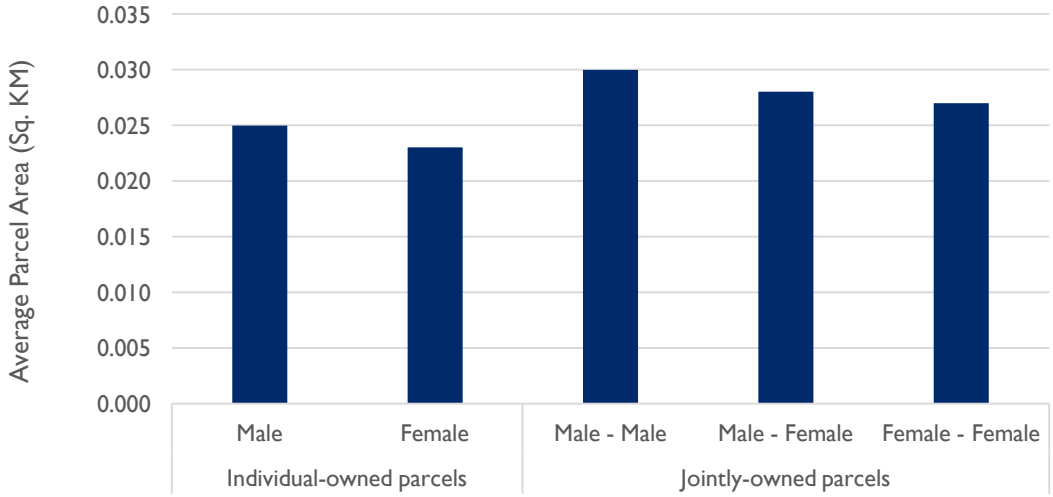
Since inheritance is the most common basis for claims to land, it's important to assess the gender division in parcel ownership to understand any potential differentiation in inheritance rights across women and men. Across jointly owned parcels, 73% (N=3,439) are male-female owned, 21% (N=1,002) are male-male owned and 6% (N=284) are female-female owned. It is expected that male-female is the most common type of joint ownership, specifically between spouses, which the certificate registration details confirm. Across jointly-owned male-female parcels, 48% (N=1,641) are indeed between spouses, followed by 32% (N=1,081) between parent and child and 8% (N=282) between siblings. Parent-child joint ownership is the most common type of joint ownership for both male-male parcels (53%, N=528) and female-female parcels (55%, N=156).

PARCEL CHARACTERISTICS

PARCEL TOTAL AREA

The average parcel size across all treatment groups is .028 sq. km with a minimum parcel size of 0.007 sq. km and a maximum of 0.16 sq. km. Figure A1-3 shows individually owned parcels have a slightly smaller mean size (0.025 sq. km) than the overall average and jointly owned parcels are in line with this mean size (0.028 sq. km). For Individually owned parcels, male-owned parcels have a greater average size than females (0.025 sq. km vs 0.023 sq. km). For jointly owned parcels, male-male landholders overall have the greatest average parcel size (0.03 square kilometers) compared to male-female (0.028 sq. km) and female-female (0.027 sq. km).

FIGURE A1-3: AVERAGE PARCEL AREA BY GENDER



Across the male-male and male-female owned parcels, siblings have the greatest average parcel sizes (0.036 sq. km and 0.036 sq. km, respectively). Female-female sibling landholders also have the largest parcel sizes (0.03 sq. km) out of all the female-female groups. For male-female spouse owned parcels, the average parcel size is 0.029 sq. km. Parcel size across parent-child owned parcels is largest among the male-male group (0.03 sq. km) followed by the male-female group (0.028 sq. km) and lastly the female-female group (0.025 sq. km). These larger than average parcel sizes for siblings may be an indication that larger, more desirable land parcels are inherited and shared within a family while smaller parcels may be used for other purposes such as sharing with spouses or other distant relatives.

PARCEL DISTANCE TO VILLAGE CENTER

The mean distance from land parcels to the center of the village is 1.1 km with a minimum distance of 0.15 km and a max distance of 4.9 km. Village centers were calculated using the mean center of household GPS coordinates. Individually owned parcels are slightly farther from the village center (1.2 km) than the overall average and jointly owned parcels are just below the average distance (1 km). For individually owned parcels, male-owned parcels are the same mean distance to the village center as female-owned parcels (1.2 km). For jointly owned parcels, all gender subgroups also have the same mean distance of 1 km from the village center. These parcel distance calculations indicate that there is no substantial differences across gender in parcel distance from the center of the village.

PARCEL DISTANCE TO WELL OR BOREHOLE

The average distance to wells or boreholes is 1.27 km with a minimum distance of 0.02 km and a maximum distance of 6.5 km. Parcels in the Ag+Land treatment group (N=3,296) have an average distance of 1.38 km to the nearest well or borehole, which is farther than villages in the Land treatment group (1.14 km, N=2,547).

The average distances from a parcel to a well or borehole across parcels that are jointly owned (1.26 km) and individually owned (1.28 km) are almost equal. The mean distance of individually owned male parcels to a well or borehole (1.29 km) is slightly greater compared to individually owed female parcels (1.21 km). Of the jointly owned parcels, male-male owned parcels have the farthest average distance from wells (1.32 km) compared to male-female owned parcels (1.27 km) and female-female owned parcels (1.26 km).

Across male-female owned parcels, spouses have parcels that are the farthest away from wells or boreholes (1.35 km) compared to siblings (1.19 km) and parent and child owned parcels (1.13 km). Female-female sibling owned parcels have an average closer parcel distance to wells (1.19 km) than female-female parent and child owned parcels (1.24 km).

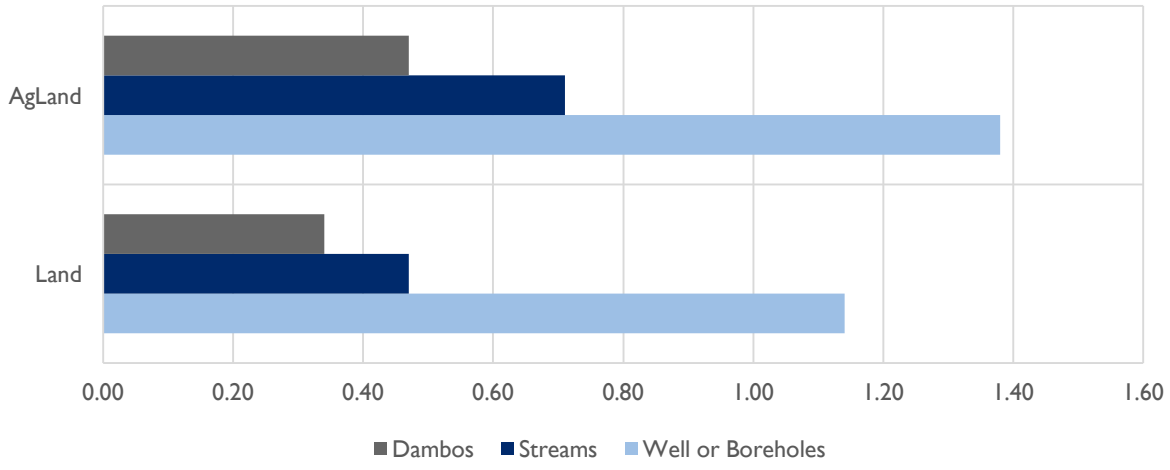
PARCEL DISTANCE TO STREAMS AND DAMBOS

The average distance from a parcel to a stream is 0.61 km with a minimum distance of 0 km and a maximum distance of 3.7 km. Parcels in the Ag+Land treatment group are farther on average (0.71 km) from streams than parcels in the Land treatment group (0.47 km). Parcels that are individually owned are farther away on average (0.74 km) from streams than jointly owned parcels (0.57 km). Similar to the distances to wells or boreholes, female-female jointly owned parcels are closer to streams (0.49 km) than male-male (0.58 km) or male-female (0.57) jointly owned parcels. Of the female-female owned parcels, siblings have parcels that are farther away (0.55 km) compared to parent and child landholders (0.45 km).

The average distance from a parcel to a dambo is 1.1 km with a minimum distance of 0.04 km and a maximum distance of 15 km. This average distance is consistent across parcels in both the Ag+Land and Land treatment groups though there are large standard deviations within chiefdoms across the Ag+Land treatment group, particularly in Maguya (1.9 km) and Mnukwa (1.5 km).

The averages across all resources including wells or boreholes, streams and dambos is shown in Figure A1-4. Overall, parcels in the Ag+Land treatment group shows slightly farther distances away from local resources.

FIGURE A1-4: AVERAGE DISTANCE (KM) FROM PARCEL TO RESOURCES BY TREATMENT GROUP



VILLAGE CHARACTERISTICS

VILLAGE AREA AND NUMBER OF PARCELS

The average village size across all villages is 2.5 sq. km. Villages in the Ag+Land treatment group are overall slightly larger (2.7 sq. km, N=62) than villages in the land treatment group (2.4 sq. km, N=53). The variation in total village land area across chiefdoms varies substantially by treatment groups (see Table A1-1 and Figure A1-5). In Mshawa, villages in the Ag+Land treatment group (3.2 sq. km, N=23) are about double the total average size of villages in the Land treatment group (1.5 sq. km, N=19). Conversely, villages in the Ag+Land treatment group in Mkanda are half the size (0.8 sq. km, N=14) of those in the Land treatment group (1.3 sq. km, N=12). In Mnukwa, the average size of villages in the Land treatment group have a very high standard deviation (7 sq. km), as shown in Table A-1. The mean number of parcels by village is 51 with the Ag+Land group averaging a slightly greater number of parcels (53) compared to the Land group (48).

FIGURE A1-5: VILLAGE BOUNDARIES BY TREATMENT GROUP ACROSS CHIEFDOMS

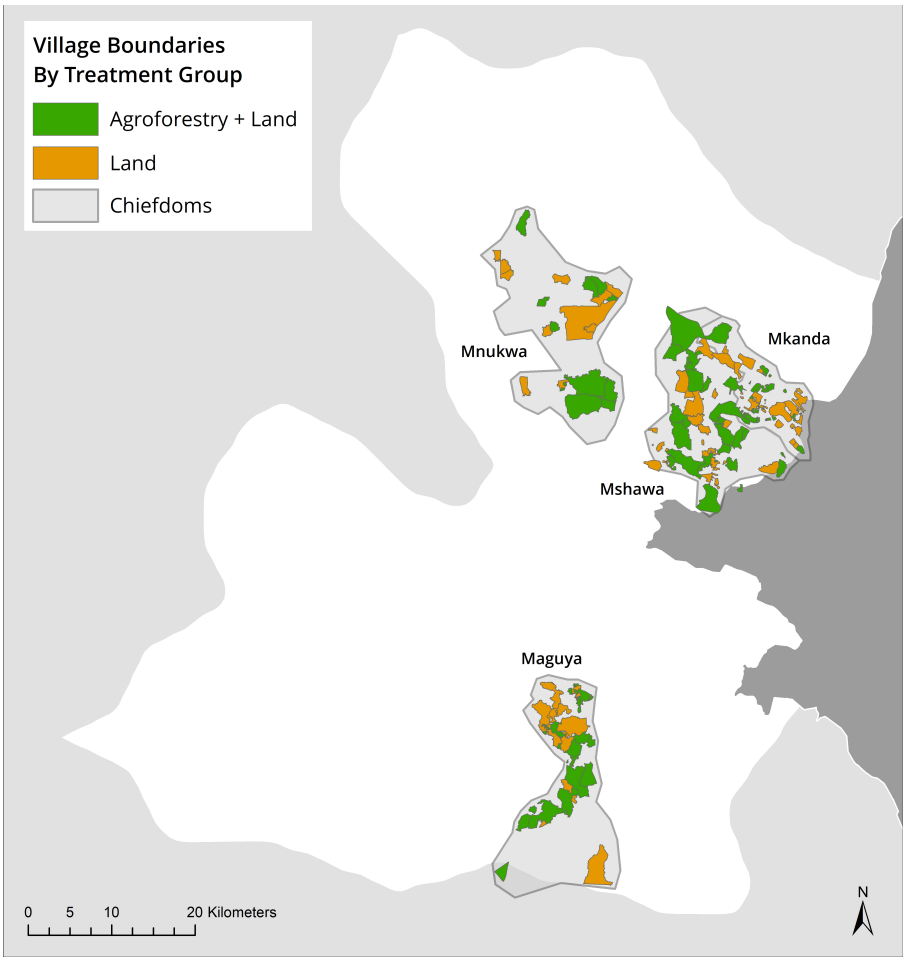


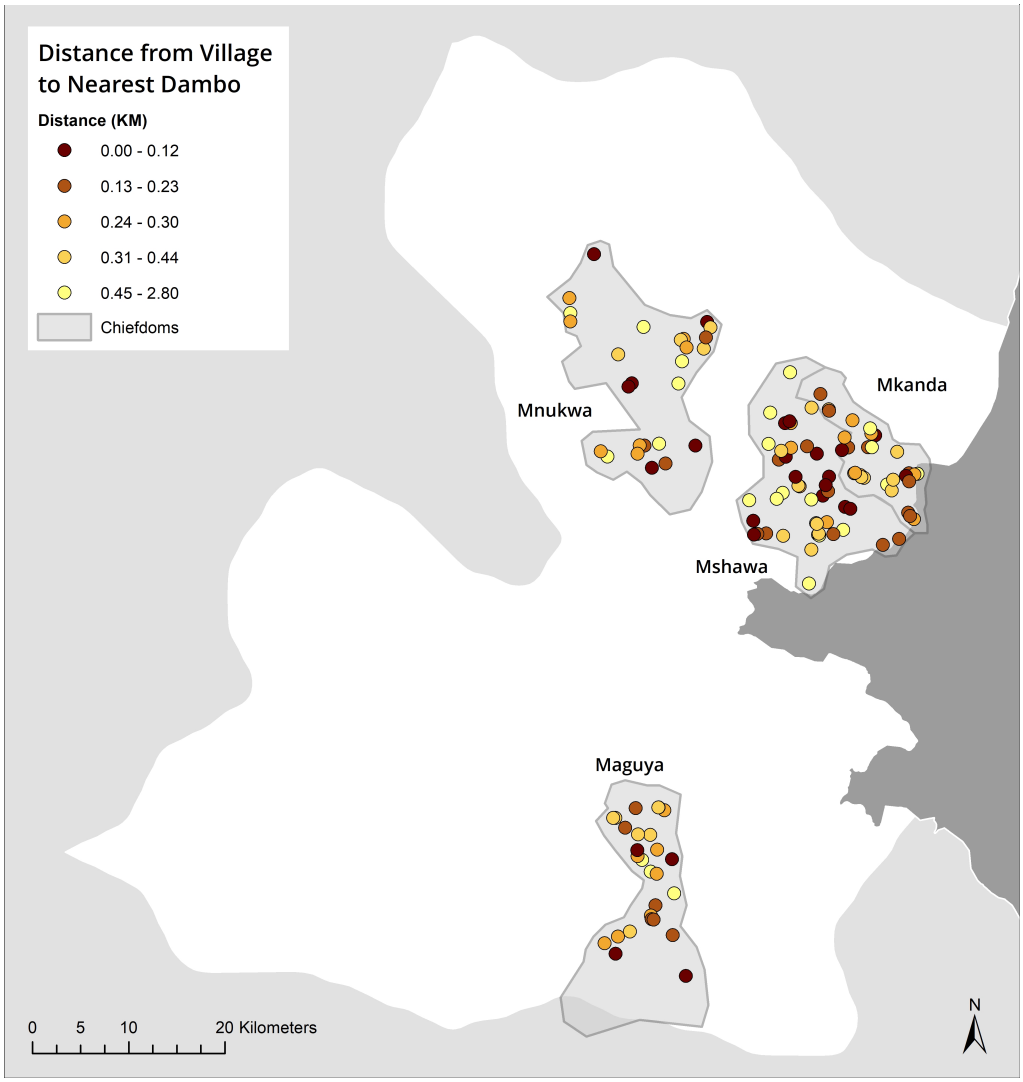
TABLE A1-1: MEAN VILLAGE SIZE BY TREATMENT GROUP

	Ag+Land			Land		
	Area	Std.	N	Area	Std.	N
Maguya	2.8	2.0	13	2.9	2.5	11
Mkanda	0.8	1.2	14	1.3	1.2	12
Mnukwa	3.9	3.9	12	4.5	7.0	11
Mshawa	3.2	2.7	23	1.5	1.1	19

DAMBOS

The average distance from village centers to dambos is 0.36 km with a minimum distance of 0 km and a maximum distance of 2.8 km. Both villages in the Land and Ag+Land treatment group are also equal to the overall average distance so there is little variation across these two treatment groups (see Figure A1-6).

FIGURE A1-6: DISTANCE FROM VILLAGE TO NEAREST DAMBO



ANNEX 2. WITH CERTIFICATE VERSUS WITHOUT CERTIFICATE

AGGREGATE

All tenure security indicators that were significant for the aggregate population remain significant for households who report having a customary land certificate. Several of these indicators increase from a 5% level of significance to a 1% level of significance, particularly for the Ag+Land group. This is not surprising, as we would expect households who hold a physical customary land certificate (CLC) to perceive their tenure security to be higher than households with certificates, even if those households had undergone the certification process. The significance of the field investment indicators related to long-term investments also increases in significance from 10% to 1% for the Ag+Land group.

When the sample is restricted to only households who have received CLCs, a number of governance indicators gain significance. For the tenure security group, these include an index of overall governance, an index of leader satisfaction and indicators about household's perception of their leaders, including that they are trustworthy, protect natural resources and make fair decisions. For both the tenure security group and the Ag+Land group, having a certificate increases the significance of indicators about leader's decisions being transparent and rules being clear. Interestingly, having a certificate also increases the significance of minority tribes being disadvantaged for Ag+Land households.

FHH

We also see an increase in significance for tenure security indicators for female-headed households who report having land certificates in the Land Tenure and Ag+Land treatments. Female-headed households are more likely to say their land is safe from encroachment in both the long and short term. An indicator for the threat of encroachment by neighboring villages also becomes significant for female-headed households.

Like the results for aggregate households, when the sample of female-headed households is restricted to those who have received CLCs, a number of governance indicators gain significance for the Land Tenure group, but not the Ag+Land group. Female-headed households with certificates are more likely to participate in community meetings, more likely to say that village rules are clear, decisions are transparent and leaders are trustworthy. Three index variables that capture overall governance, leader satisfaction and the risk of allocation also become significant.

Indicators for long-term field investments and an asset index that measures livelihoods also gained significance amongst female-headed households in the land tenure group. This suggests that once certificates are distributed for the entire sample, we may expect to see some positive benefits from the land tenure program across a few of these long-term indicators, at least for female-headed households.

YOUTH

Possession of certificates appears to have a large effect on the perceived tenure security for youths in the Land Tenure group compared to youths without a certificate. Every single tenure security indicator is significant, and many at the 1% level. In the Ag+Land group, youth are more likely to believe their fields are safe from encroachment from other households in the village, from family members, from elites and from the chief. Youth in the Land Tenure group are also more likely to invest in climate-smart agricultural practices.

Youth with certificates do not show the same increase in significance in indicators associated with good governance that we see with other groups, with a few exceptions. Youth in Land Tenure households with certificates are more likely to say their leaders are trustworthy than those without certificates, and in the Ag+Land group, youth with certificates are more likely to say decisions are transparent, though both are only significant at the 10% level.

Five indicators related to the treatment of vulnerable populations, including women, youth and the elderly, all gain significance for the Land Tenure group. In the Ag+Land group, an index related to the treatment of marginalized groups gains significance; thoseother indicators remain the same as for the aggregate group.

ELDERLY

The significance of land tenure indicators for elderly households with land certificates remains the same as they are for the aggregate population, as do most of the governance and agroforestry indicators. However, as with female-headed households and households overall, governance indicators gain significance for households in the Land Tenure group. These include indicators for overall governance, trustworthiness of leaders, clarity of rules about land management and participation in land meetings. Elderly households with land certificates in both the land tenure and Ag+Land group are more likely to invest in long-term climate-smart agriculture technologies, and in the Ag+Land elderly households are more likely to participate in climate-smart agriculture overall.

POOR

Poor households with land certificates are similar to the overall sample across all land tenure indicators, as well as many governance indicators. Poor households with certificates in the Land Tenure group are more likely than the sample as a whole to say that land management decisions are transparent.

There are some differences in indicators related to vulnerable groups in the community. Land Tenure elderly households with certificates are more likely to say that households of a different tribe than the headman were disadvantaged, and more likely to say that vulnerable groups in general as disadvantaged—but less likely to say that elderly are disadvantaged. In the Ag+Land group, households with certificates are more likely to believe that vulnerable groups are disadvantaged overall, as determined by a PCA index.

LAND CONSTRAINED

Land constrained households in the Land Tenure group experience the same increase in significance across all the tenure security indicators that the aggregate sample, female-headed households youth and elderly households. Land constrained households in the Land Tenure group are also more likely participate in land management meetings. There are also differences on perceptions of treatment of

vulnerable groups. In the Land Tenure group, elderly households are more likely to say women are disadvantaged, and in the Ag+Land group believe that vulnerable groups in general are more disadvantaged.

ANNEX 3. AGROFORESTRY - Follow-up sample

Note that this Annex provides statistics for the full follow-up sample versus the household panel sample.

Within treatment areas, the seedling and tree survival rates are low. Figure A3-1 shows seedling survival rates across all tree species from 2014–2016 for treatment and control households. Figure A3-2 displays the survival rates of each village in the sample. These low survival rates do not appear to correlate with the geographical location of the village, or with the location of wells or water points. It is important to highlight that the entire Chipata district experienced droughts during the 2014–2015 and 2015–2016 growing seasons.

FIGURE A3-1: SEEDLING SURVIVAL RATES BY TREATMENT GROUP

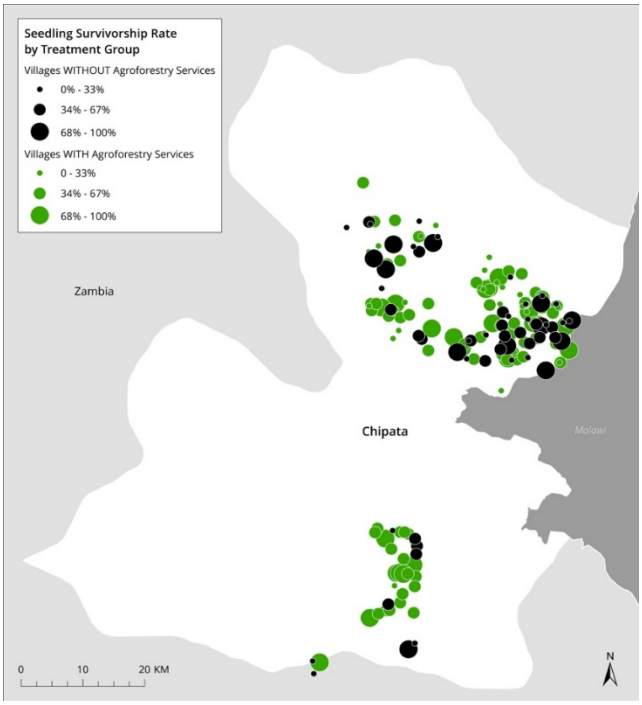
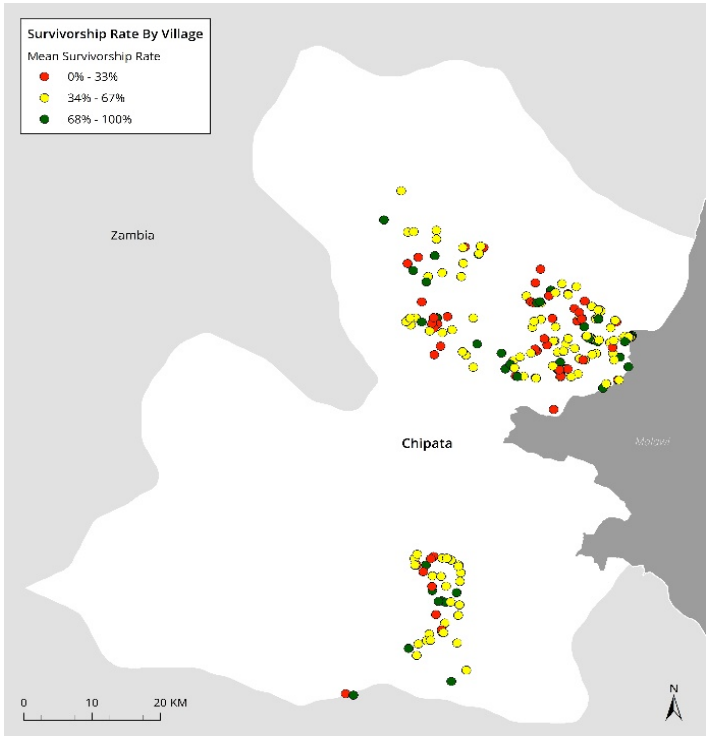


FIGURE A3-2: SEEDLING SURVIVORSHIP BY VILLAGE

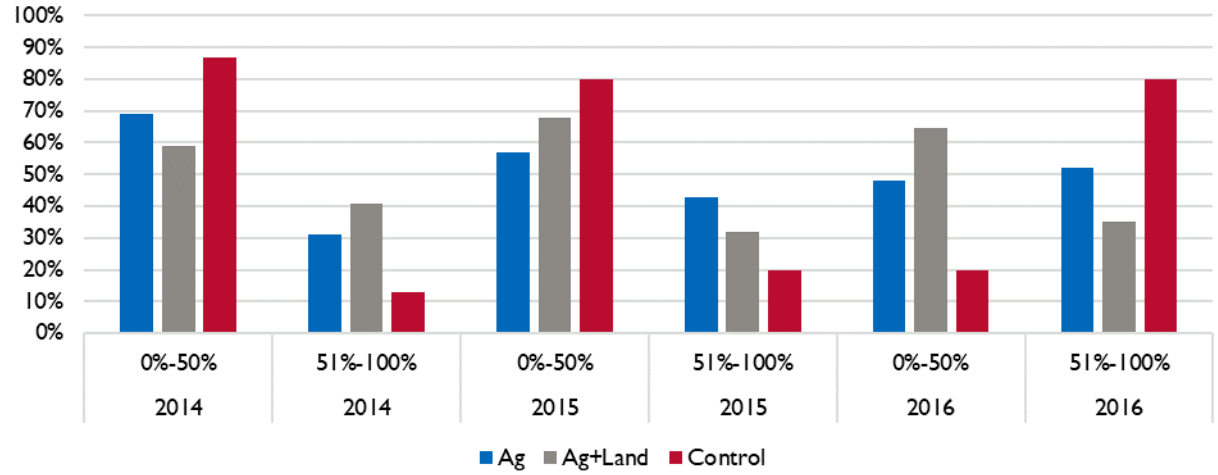


Across all years of the intervention, the majority of households who engaged in agroforestry report that less than 50% of their Musangu seedlings survived, as shown in Figure A3-3. However, treatment households have slightly higher survival rates than control households. Since the overall sample size of control households who planted seedlings is low, the percentages may be misleading. In 2014, the first year of the COMACO program, just under a quarter of households in treatment communities (23%,

N=59) report that between 76–100% of seedlings are alive today. This is slightly higher than households in control communities (18%, N=24). Nine percent (N=23) of households in treatment communities have a zero percent survival rate, compared to 16% (N=21) of control communities.

Survival rates for Musangu trees planted in 2015, the second year of the program, are slightly lower than they were for the first year of the program. In the second year of the program, COMACO discontinued extension services and only provided seeds, which may explain the lower survival rate. Only 19% (N=37) of treatment households have a survival rate above 75%. Still, this is higher than control households, where only three households have a survival rate that high. It is also important to note that the 2014–2015 and 2015–2016 growing seasons were years with historically bad rainfalls and low crop yields.

FIGURE A3-3: MUSANGU SURVIVORSHIP BY YEAR

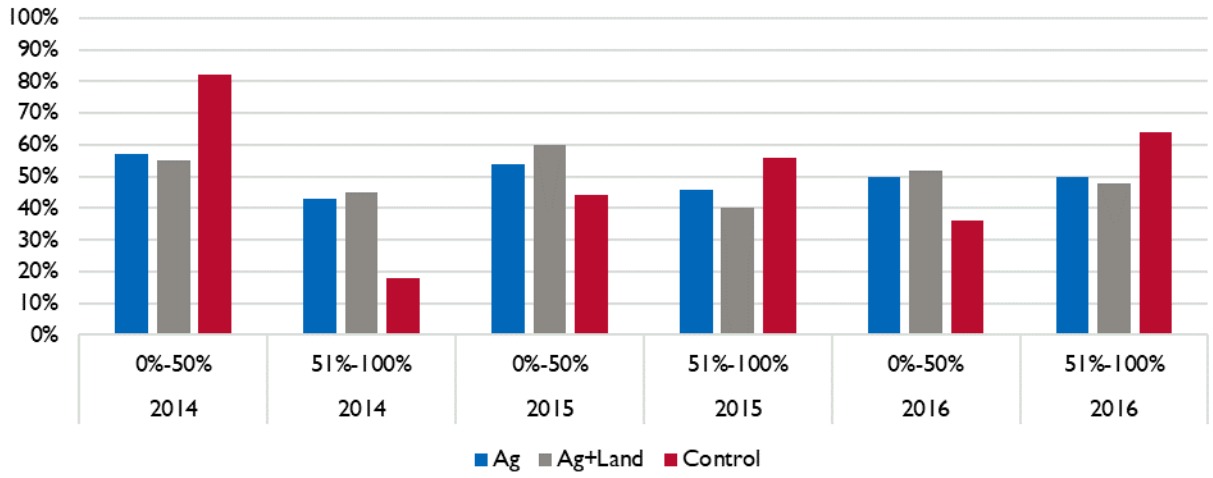


In 2016, after COMACO ended agroforestry support in treatment villages, survival rates for Musangu trees fell below the survival rates of trees in control villages. Only 8% of treatment households report a survival rate higher than 75%, (N=6), the same number of households as in the control group (30%, N=6). Table A3-1 shows the average household survival rate for Musangu trees in 2014–2016 by treatment group.

TABLE A3-1: MUSANGU TREE SURVIVAL RATES

Musangu Trees	Ag	Ag+LT	Control
Percentage of trees planted in 2014 that are alive now			
0%	9% (8)	10% (15)	26% (6)
1–25%	37% (35)	24% (38)	22% (5)
26–50%	18% (17)	23% (36)	30% (7)
51–75%	11% (10)	14% (22)	0% (0)
76–100%	19% (18)	26% (41)	17% (4)
Percentage of trees planted in 2015 that are alive now			
0%	8% (7)	10% (11)	23% (6)
1–25%	35% (29)	25% (28)	31% (8)
26–50%	14% (12)	26% (29)	15% (4)
51–75%	18% (15)	14% (15)	15% (4)
76–100%	20% (17)	18% (20)	12% (3)
Percentage of trees planted in 2016 that are alive now			
0%	3% (1)	22% (9)	10% (2)
1–25%	31% (11)	22% (9)	25% (11)
26–50%	20% (7)	15% (6)	0% (0)
51–75%	31% (11)	24% (10)	30% (6)
76–100%	11% (4)	5% (2)	30% (6)

FIGURE A3-4: *GLIRICIDIA* SURVIVORSHIP BY YEAR



Survival rates for *Gliricidia* trees are slightly more optimistic, though the majority of households still report survival rates under 50%, as shown in Figure A3-4. Of the seedlings planted in 2014, 27% (N=65) of treatment households say that more than 75% of them are alive today, compared to only two of control households. The figures are nearly identical for seedlings that treatment households planted in 2015 (26%, N=50) and 2016 (26%, N=31). The survival rate of control households increased to 28% (N=12) in 2015, and to 40% (N=17) in 2016, surpassing the survival rate of the treatment households. Table A3-2 shows the average household survival rate for *Gliricidia* trees in 2014–2016 by treatment group.

TABLE A3-2: *GLIRICIDIA* TREE SURVIVAL RATES

Gliricidia Trees	Ag	Ag+LT	Control
Percentage of trees planted in 2014 that are alive now			
0%	12% (14)	12% (15)	36% (5)
1–25%	23% (27)	20% (26)	14% (2)
26–50%	19% (22)	21% (27)	21% (3)
51–75%	17% (20)	15% (19)	14% (2)
76–100%	26% (30)	28% (35)	14% (2)
Percentage of trees planted in 2015 that are alive now			
0%	9% (9)	11% (10)	19% (8)
1–25%	26% (26)	23% (21)	9% (4)
26–50%	17% (17)	18% (17)	21% (9)
51–75%	17% (17)	16% (14)	21% (9)
76–100%	28% (28)	24% (22)	28% (12)
Percentage of trees planted in 2016 that are alive now			
0%	4% (2)	13% (9)	12% (5)
1–25%	20% (10)	20% (14)	7% (3)
26–50%	16% (8)	10% (7)	19% (8)
51–75%	22% (11)	23% (16)	17% (7)
76–100%	31% (15)	23% (16)	40% (17)

Overall, seedling survival for Musangu and *Gliricidia* was the lowest in 2016. This suggests that the support provided by COMACO during the agroforestry program was critical to the survival of seedlings, and withdrawing this support has had negative impacts on seedling survival rates.

DISCUSSION

This section explores the factors driving program participation, expected benefits and the main challenges to agroforestry, in order to better understand uptake and seedling survival.

PARTICIPATION

In communities where the agroforestry extension was offered, roughly a third of households had at least one household member participate in the program. Male-headed households are 7% more likely than female-headed households to have had a member participate. The benefits of agroforestry are well-known to households in Chipata district. Focus group participants easily articulated the benefits, even if they did not participate in the agroforestry extension intervention.

An Agroforestry participant in Mnukwa chiefdom described the benefits this way: "Growing agroforestry in our fields will help us save tremendously on the purchases of fertilizers. At least we will have money to spend on other necessities, like our children's education… It will also help us maintain the fertility in our fields, rather than depending on these fertilizers that even end up destroying the fertility of the soils in our fields."

A female FGD participant in Maguya chiefdom described how she expects to benefit from agroforestry. "Growing little food has troubled us here in this village. If you don't have fertilizer and at home you have a big family including grandchildren and the field is not productive so to hear that there are trees that can make soil fertile… so when fertility returns to the soil, people can grow enough food for their

families. That is why we want agroforestry trees. Most of us can't afford to buy fertilizer. So we want fertility to return to the soil so that we can reduce hunger in our homes."

Table A3-3 illustrates the many reasons households chose to participate in the Agroforestry intervention. The primary reason households participate is to reap the agricultural benefits from agroforestry (76%, N=1,117), such as improving soil fertility and reducing the need for fertilizer. Other common reasons included wanting to learn new farming techniques (37%, N=547) and wanting advice about agroforestry (36%, N=529). Other draws to the program were receiving free inputs (9%, N=132), and being encouraged by the headman to participate (3%, N=9). A small number of households also participated in the program because they wanted fuelwood (2%, N=27).

TABLE A3-3: WHY PARTICIPATE IN COMACO PROGRAM

Reasons for participating	Ag	Ag+LT
Want to higher soil fertility and other benefits from agroforestry	77% (288)	76% (349)
Want free inputs	7% (25)	10% (44)
Want advice about agroforestry	33% (125)	40% (181)
Want to learn about new farming techniques	37% (136)	36% (165)
My friend/neighbor/relative urged me to participate	<1% (2)	2% (7)
The headman urged me to participate	5% (2)	2% (9)
Want a guaranteed buyer/better price for my crops	1% (4)	1% (4)
Want fuelwood	<1% (2)	3% (12)
Want fodder for livestock	0% (0)	0% (0)
Want to benefit from fuel-efficient cookstoves	1% (3)	<1% (2)

Table A3-4 illustrates the reasons that households did not participate in the agroforestry extension program. The biggest reason for nonparticipation was inability to attend the initial meeting (34%, N=428). This suggests that modifications to recruitment protocols, such as greater outreach before signups began, or allowing for multiple rounds of program signups as news of the program permeates the villages, might engender higher participation rates.

According to FGDs, there was some confusion about the recruitment process. As one respondent described, "When COMACO first came, it appears as though they came to a group (of participants) that had already been formed. Yes. And the required number had already been met. It is not as though we did not want to participate; it is just that the required number for the group had already been met. Otherwise, we also wanted to participate in agroforestry."

A FGD participant from Maguya chiefdom who did not participate in the agroforestry extension program echoed this observation. "I thought that maybe this organization only comes only for those who are in the COMACO program—that is the reason why we didn't take part but we have a heart to join."

Other reasons households did not participate include an overall lack of interest (5%, N=62), a desire to see if other households were successful before trying agroforestry (4%, N=56), and because agroforestry requires too much labor for the household (3%, N=43). Not being allowed to plant trees is almost never a reason households do not participate (1%, N=15), suggesting that for most households, there are no rules prohibiting them from planting trees.

In the FGDs, a lack of incentive to counteract the high labor and time costs is a consistent theme for households who chose not to participate. They would prefer a program that provided inputs that materialized in the short term, such as seeds, to the long-term benefits associated with agroforestry. This is especially true in areas that currently have virgin land or relatively fertile soil. The two quotes below illustrate this sentiment:

"The reason why I did not take part is that doesn't this project go with other additional crops such as beans and cowpeas? So you find that you as a farmer can't start with planting trees without first planting crops because as a farmer you first need a seed that will lift you out of your problems" (Mshawa, Agroforestry non-respondent).

"How can a program be only about trees! It takes a lot of years before you can cut a 'beam' out of it?...We would be glad if this program will go with seeds that we plant in the fields. These same seeds will also be planted in the same field but now if we have only planted trees, what benefit will we achieve if there is no seed to plant in it? Then poverty will continue but trees and seeds ought to go together so that we can also sell" (Mshawa, male Agroforestry non-participant).

TABLE A3-4: WHY NOT PARTICIPATE

Reasons for not participating	Ag	Ag+LT
Wanted to participate but failed to attend the meetings	40% (80)	33% (79)
Not interested in trying a new farming method	7% (14)	5% (11)
Wanted to see if other households had success before trying	6% (12)	6% (13)
Required too much labor	6% (12)	5% (10)
No benefits to agroforestry	3% (6)	3% (7)
Not allowed to plant trees on my land	<1% (1)	1% (4)

AGROFORESTRY UPTAKE

Households in Agroforestry treatment villages (54%, N=782) are more likely to have engaged in agroforestry than control households (24%, N=156). Agroforestry + Land treatment households have the highest participation rate (56%, N=425). Agroforestry households have a participation rate of 52% (N=357).

The most common tree species planted by households in the treatment group is the Musangu tree, as shown Table A3-5. It can be grown amidst any crop, but COMACO encouraged farmers to plant their fields where Musangu seedlings were being grown with low-growing crops such as groundnuts, to ensure that the seedlings would get enough sunlight. Households were provided with 25 Musangu seedlings. A third of households (33%, N=227) receiving the Agroforestry treatment and (42%, N=315) of households receiving the Agroforestry + Land Tenure treatment planted Musangu trees. Uptake for the control group is substantially lower (14%, N=93).

The second most common species of agroforestry tree is *Gliricidia*. *Gliricidia* is also grown from a seedling and intercropped. Households struggled to keep the seedlings alive in the nursery, as *Gliricidia* is particularly sensitive to water shortages. This may explain the slightly lower rates of *Gliricidia* adoption, though households who participated in the extension program received both species. Households in the

treatment group were provided with 100 *Gliricidia* seedlings and have a rate of adoption slightly under 40% (288+270). The rate for control villages is significantly lower (14%, N=93). Female headed households in treatment communities are slightly less likely to have planted *Gliricidia* trees than male headed households (FHH: 35%, MHH: 40%). Based on Monitoring and Evaluation (M&E) conversations with the COMACO team, female-headed households were more likely to struggle to transport their seedlings from the nursery to their fields, and the large number of *Gliricidia* seedlings (100 *Gliricidia* vs 25 Musangu) may have been too much of an obstacle for female-headed households.

The third species of tree provided by the program was pigeon peas, though the provision of these seeds does not appear to have been uniform. The original design called for 500g of pigeon pea seeds to be distributed to households, which would be planted directly in their fields. Pigeon peas grow into a bush that produces an edible fruit (the pigeon pea), and are highly desirable for consumption. Despite their desirability, less than 5% of treatment households planted pigeon peas.[33]

TABLE A3-5: HH TREE SPECIES PLANTED

Species	Ag (N=680)	Ag+LT (N=759)	Control (N=582)
Musangu	33% (227)	42% (315)	14% (93)
Gliricidia	40% (270)	38% (288)	14% (93)
Pigeon Peas	5% (34)	3% (19)	1% (6)

EXPECTED BENEFITS FROM AGROFORESTRY UPTAKE

Households have a clear understanding of the expected benefits for agroforestry trees. The most common expected benefit cited by treatment groups both now and in the future is improved soil fertility (36%, N=339 for Musangu; 38%, N=364 for *Gliricidia*). The number of households who expect to see that benefit in the future is double the number of households who currently see the benefit (67%, N=636 for Musangu; 66%, N=608 for *Gliricidia)*, which seems to indicate households understand that the benefits of agroforestry accrue in the future.

Similarly, improved crop growth around trees is another benefit cited for both species, particularly in the future. Between 17% and 21% of households say they expect to see improved crop growth in the future for Musangu trees, as do 15–19% of households for *Gliricidia*. This is a lower percentage than we would expect, since higher yields and/or improved crop growth should be the ultimate benefit to households. Also worth noting, no households believed that either agroforestry species would reduce their need for chemical fertilizer, although reducing chemical fertilizer use is a major objective of climate-smart agriculture and conservation farming.

A benefit emphasized in focus group discussions is the increased availability of fuel wood. It appears that at least some households view their agroforestry trees as an opportunity for a woodlot as opposed to caring for their trees to improve their field's agricultural productivity. This is further supported by the number of households who do not believe that there are any yield-related benefits to the trees. The household statistics are less striking than the qualitative analysis, but are worth noting—8% (N=71) of households believe their Musangu trees will increase the availability of fuelwood in the future. This is

33 COMACO did not distribute pigeon peas in all villages due to a lack of seeds.

highest in the Agroforestry group (9%, N=21). The percent of households who believe that *Gliricidia* trees will increase the availability of fuelwood in the future is slightly higher (10%, N=88).

As Table A3-6 below illustrates, agroforestry adoption is not associated with greater perceived tenure security. Almost no households believe that planting agroforestry trees reduce the fear of their land being taken, or raise the value of their land for collateral, either now or in the future. This coincides with the regression results presented in Section 5 that show no significant difference between the Land Tenure and Agroforestry + Land Tenure findings for perceived tenure security.

TABLE A3-6: MUSANGU AND GLIRICIDIA TREE BENEFITS

Benefits	Present	Future	Present	Future
Musangu trees	**Ag (N=227)**		**Ag+LT (N=315)**	
No benefits	38% (87)	14% (32)	44% (141)	15% (47)
Improved soil fertility	37% (83)	65% (148)	32% (102)	67% (212)
Improved crop growth around trees	11% (25)	18% (40)	8% (25)	21% (67)
Higher overall crop yield	7% (15)	22% (50)	6% (18)	23% (72)
Increased fuel wood availability	3% (7)	9% (21)	2% (6)	7% (21)
Reduced labor time on weeding	1% (2)	2% (5)	1% (2)	1% (4)
Reduced weeds	0% (0)	1% (2)	1% (3)	4% (11)
Reduced fear of land being taken	0% (0)	<1% (1)	0% (0)	<1% (1)
Reduced need for fertilizer	0% (0)	0% (0)	0% (0)	0% (0)
Raised value of the land for collateral	0% (0)	0% (0)	0% (0)	0% (0)
***Gliricidia* trees**	**Ag (N=270)**		**Ag+LT (N=288)**	
Improved soil fertility	42% (112)	65% (175)	38% (108)	63% (181)
No benefits	37% (100)	15% (40)	43% (124)	18% (51)
Improved crop growth around trees	12% (32)	17% (45)	13% (38)	19% (54)
Higher overall crop yield	9% (23)	24% (65)	9% (27)	25% (71)
Increased fuel wood availability	3% (7)	9% (25)	4% (11)	9% (27)
Reduced labor time on weeding	<1% (1)	2% (4)	1% (4)	5% (13)
Reduced weeds	<1% (1)	1% (4)	1% (2)	5% (5)
Reduced fear of land being taken	<1% (1)	1% (2)	<1% (1)	1% (2)
Raised value of the land for collateral	<1% (1)	0% (0)	0% (0)	0% (0)
Reduced need for fertilizer	0% (0)	0% (0)	0% (0)	0% (0)

Taken together, these findings suggest that the program helped households understand the major ecological benefits of agroforestry trees, as well as the fact that these benefits will likely manifest in the future as opposed to the present.

Despite understanding the benefits, households seem skeptical that the benefits will actually materialize for them, either now or in the next 3–5 years. At present, a quarter of treatment households see no benefits to their agroforestry trees (24%, N=228 for Musangu; 24%, N=224 for *Gliricidia*), though as expected, this number drops substantially when households are asked about benefits they expect in the next 3–5 years (8%, N=79 for Musangu; 9%, N=91 for *Gliricidia*). Still, the number of people who do not expect any benefits from their agroforestry trees seems high, considering the amount of time and labor households put into their trees, and raises the question of why these households are engaging in

agroforestry at all. There is nothing definitive in the data to answer this question, but focus group responses do allude to households joining the program from a sense of obligation.

CHALLENGES TO SURVIVAL

Table A3-7 shows the types of challenges to agroforestry tree survival that households encountered. The most common challenges to agroforestry seedling survival, for both *Gliricidia* and Musangu, include a lack of water for seedlings, fires burning trees, pests killing the trees and animals grazing in the field.[34]

Given the drought conditions during implementation, lack of water for seedlings was the number one challenge for both Musangu and *Gliricidia* seedlings, identified by 37% (N=201) of treatment households for Musangu trees, and 23% (N=209) of treatment households for *Gliricidia* trees. 14% of treatment households (N=114) say that their nursery never had enough water, and 12% (N=97) say their nursery only had enough water part of the year.[35] COMACO attempted to address this challenge by installing wells in villages with significant water scarcity, however, it does not appear that the wells improved seedling survival in subsequent years.

FGDs tell a similar story. A participant in the agroforestry extension from Mnukwa chiefdom commented: "The challenge we are facing is lack of water. Even if they brought more seed for us to plant, once the rains stop, we work in vain. So we don't know how you are going to help us, once you help us with water, aah we will have trees all over here."

Traditional land management practices also present a challenge to the survival of agroforestry trees. In particular, animals grazing trees, which occurs when animals are allowed to graze anywhere in the fields after crops have been harvested, was cited as a challenge to growing Musangu by 7% of treatment households (N=68). Another traditional practice, setting fires to fields to clear crops after harvest or to harvest mice to eat, resulted in 13% of treatment households (N=72) reporting that their Musangu seedlings were burned by fires.

Pests killing and damaging trees was also a challenge for households growing both Musangu and *Gliricidia* , especially in the control areas. The fact that treatment communities were slightly less likely to have their trees killed by pests may speak to the success of COMACO's training about how to protect their trees.

Finally, it is worth noting that lack of knowledge was not a prevalent challenge for households. Additional agroforestry trainings in the future would likely have limited impact on uptake or survivorship.

34 The greatest challenge facing households planting pigeon peas is not lack of water, but animals grazing in the field, followed by pests killing or damaging the plants. Lack of water is the third most common challenge.

35 Thirty-one percent (N=456) of household respondents did not know if their nurseries had water during the year.

TABLE A3-7: AGROFORESTRY CHALLENGES

	Musangu			*Gliricidia*		
	Ag	Ag+LT	Control	Ag	Ag+LT	Control
Lack of water	39% (89)	36% (112)	28% (26)	39% (104)	36% (105)	31% (30)
Pests killed/damaged trees	22% (51)	27% (85)	38% (35)	23% (62)	23% (65)	26% (25)
Animals grazed trees	15% (34)	11% (34)	8% (7)	15% (43)	10% (31)	12% (12)
Fires burned the trees	11% (24)	15% (48)	15% (14)	14% (38)	11% (33)	16% (16)
Trees were chopped down by mistake	6% (13)	8% (26)	12% (11)	6% (16)	5% (15)	6% (6)
Lack of knowledge	5% (11)	4% (11)	9% (8)	6% (15)	5% (15)	11% (11)
Difficulty transporting seedlings to field	1% (2)	1% (4)	0% (0)	3% (8)	3% (6)	2% (2)
Did not see benefits so stopped caring for trees	1% (2)	<1% (1)	2% (2)	0% (0)	1% (3)	1% (1)
Not enough labor to care for trees	1% (3)	2% (7)	2% (2)	1% (3)	2% (7)	0% (0)
Could not access seeds	<1% (2)	<1% (2)	1% (1)	2% (5)	1% (4)	1% (1)

VILLAGE LAND MANAGEMENT PRACTICES

Land management rules in a village play an important role in the success or failure of agroforestry. Based on the key informant YGL responses, the agroforestry program had a limited effect on the existence or adoption of village rules related to land management. The descriptive results do not indicate a substantive difference in rule adoption or the types of rules between treatment and control communities.

Rules about setting fires and grazing livestock are particularly important, since seedlings are susceptible to being grazed or trampled by livestock or burned by fires, as discussed above. Half of villages have a rule that forbids lighting fires in fields at any point in the year (53%, N=146). The other half of villages either have no rule about lighting fires, or allow fires after the crops are harvested. Figure A3-5 shows seedling survival in villages that have a rule that forbids fires on fields at any time in the year. The results show a potential association between the presence of rules and higher survival rates for agroforestry trees.

Grazing rules are another possible means for increasing seedling survival. Traditionally, animals are allowed to graze in fields after crops are harvested, which leaves seedlings vulnerable to being grazed or trampled by cattle, goats and other livestock. We examined the seedling survival rates for villages that forbid livestock grazing on fields, or allow it only if the livestock are accompanied (68%, N=187), and compared to villages that either have no rule about grazing or allow livestock to graze unaccompanied on fields (32%, N=86). Figure A3-6 shows the results of the comparison. There does not appear to be as strong of an association between grazing rules and seedling survival, compared to the rules about starting fires. One reason that grazing rules may not have the same effect on survival as fires is that even if supervised, it is not always possible to control livestock, and seedlings may still be grazed or trampled even if the rule is being obeyed. Another possible explanation is a lower rate of adherence to rules about grazing than rules about fire, as reported by households. Sixty-two percent of households

(N=2,123) say that households do not follow rules about grazing, compared to 57% of households (N=1,952) who say households do not follow rules about fires.

Focus group discussions further highlight the importance of good grazing practices. A participant from Mnukwa described the challenge this way: "We will first need to have proper prevention plan from livestock. Sometimes we are not around, we may be attending a funeral at a neighboring village, so if we do not secure these trees from livestock then there is nothing that will happen. The chief need to teach the headmen how to look after livestock and the headmen should in turn teach their subjects, because if these livestock are left like this destroying plants… we need strict rules on livestock, if not it will continue to be a serious problem."

FIGURE A3-5: SURVIVORSHIP RATE & FIRE RULES BY VILLAGE

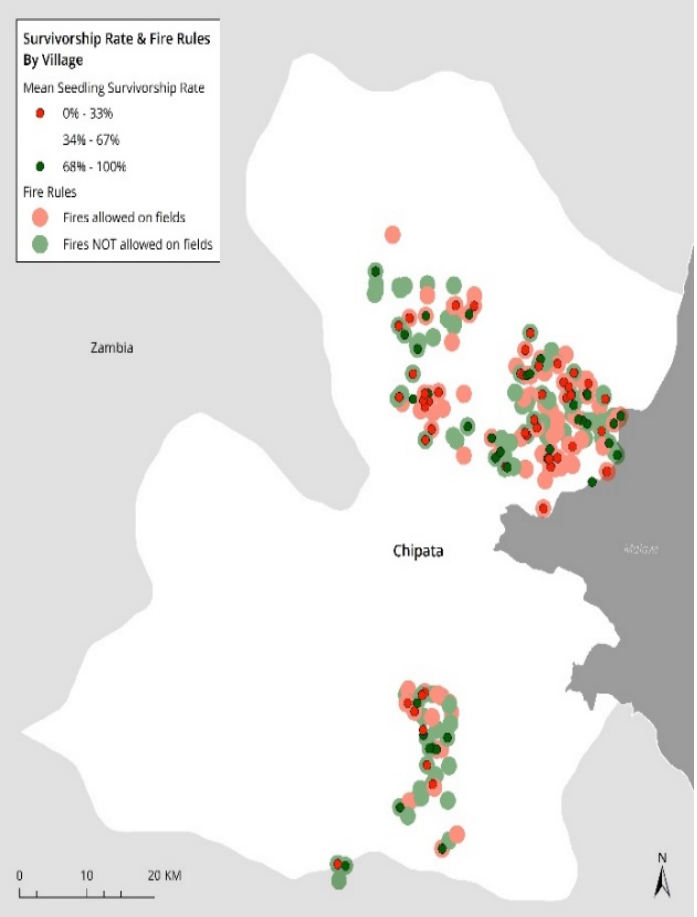
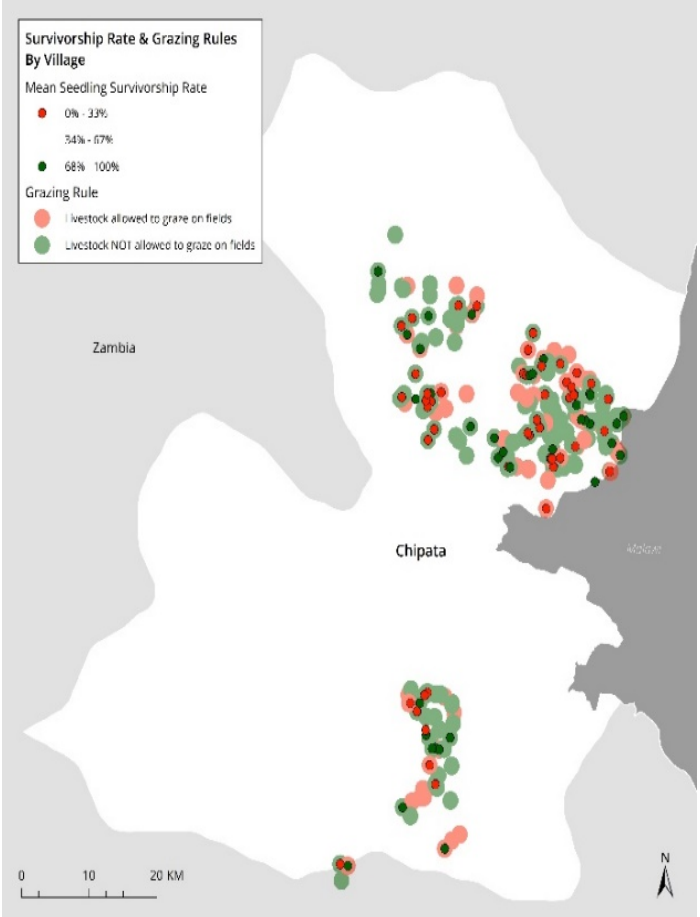


FIGURE A3-6: SURVIVORSHIP RATE & GRAZING RULES BY VILLAGE



ANNEX 4. MULTIPLE TEST CORRECTION

To examine the robustness of the impact estimates, a 'false discovery rate' adjustment was used, to correct p-values from each test for the fact that multiple tests were run within each outcome family and across subgroups (Benjamini and Hockberg, 2000). Given the number of tests that were run, some portion of the significant results obtained would be expected to be simply due to chance. Put differently, the more tests that are run, the higher the likelihood that some of them will come back significant, but some of these are likely to be false positives. Results that maintained their significance even after the p-values were adjusted via the 'false discovery rate' correction are considered highly robust.

Using multiple test correction on a subset of key indicators reveals that the three tenure security indexes for long term, short term and overall perceptions of tenure security are significant at the 5% level for households in the land tenure group.

ANNEX 5. SUPPLEMENTAL SUMMARY STATISTICS AND REGRESSION TABLES

For the supplemental summary statistics and regressions tables, please see the Annex 5 folder included in the zipped follow-up report package. The tables included in the Annex 5 folder are:

Household Panel Summary Statistics

Household Panel and Subgroup Regressions

ANNEX 6. SUPPLEMENTAL EVALUATION DOCUMENTATION

The following documentation and datasets for the TGCC Impact Evaluation (IE) in Zambia can found on LandLinks "https://land-links.org/evaluation/tenure-global-climate-change-tgcc-zambia/"

1. TGCC IE Design Report
2. TGCC IE Baseline Survey Instruments
3. TGCC IE Baseline Household Dataset
4. TGCC IE Baseline Headperson Dataset
5. TGCC IE Baseline Leader Geospatial Dataset
6. TGCC IE Baseline Household Codebook
7. TGCC IE Baseline Headperson Codebook
8. TGCC IE Baseline Analysis Report
9. TGCC IE Endline Pre-analysis Plan

The following documentation and datasets will be forthcoming through the same URL

1. TGCC IE Endline Household Dataset
2. TGCC IE Endline Headperson Dataset
3. TGCC IE Endline Yield Group Leader (YGL) Dataset
4. TGCC IE Endline Village Land Committee (VLC) Dataset
5. TGCC IE Endline Leader Geospatial Dataset
6. TGCC IE Endline Household Codebook
7. TGCC IE Endline Headperson Codebook
8. TGCC IE Endline Yield Group Leader (YGL) Codebook
9. TGCC IE Endline Village Land Committee (VLC) Codebook

ANNEX 7. ATTRITION TABLE

TABLE A7-1: MUSANGU TREE SURVIVAL RATES

Variable	Control Mean	Agro - Control	Land Tenure - Control	Agro X Land Tenure - Control	Saili - Control	P
tensec_index_hh_pca	0.22	0.02	-0.03	-0.04	-0.04	0.913
tensec_index_hh_long_pca	0.20	0.02	-0.01	-0.03	-0.02	0.977
tensec_index_hh_short_pca	0.23	0.01	-0.05	-0.04	-0.05	0.790
tensec_internal_pca	0.23	-0.03	-0.04	-0.08	-0.06	0.804
tensec_external_pca	0.18	0.06	-0.01	0.02	-0.01	0.828
dispute	0.24	0.01	-0.01	-0.00	0.00	0.937
landgov_overall_pca	0.14	0.05	-0.04	0.09	0.07	0.243
leadsatindex_pca	0.20	0.14	0.04	0.13	0.13	0.090
agroinv_csa	0.47	-0.01	-0.01	-0.02	-0.01	0.665
agroinv_aginvest_short	0.37	-0.01	-0.00	-0.00	0.02	0.244
agroinv_aginvest_long	0.45	-0.03	-0.03	-0.02	0.03	0.000
fallow_seasons_log_min	2.22	0.03	0.08	0.17	-0.20	0.310
agforben_4	0.13	-0.02	0.02	0.10	0.09	0.264
score_assetindex1	0.12	0.10	0.04	0.00	-0.30	0.000
attrit	0.13	0.05	0.03	0.03	0.05	0.200

ANNEX 8. DISCLOSURE OF ANY CONFLICTS OF INTEREST

There are no conflicts of interest in relation to the TGCC IE Zambia.

REFERENCES

Ajayi, O. C. (2007). User acceptability of sustainable soil fertility technologies: Lessons from farmers' knowledge, attitude and practice in Southern Africa. *Journal of Sustainable Agriculture*, *30*(3), 21–40. http://doi.org/10.1300/J064v30n03_04

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society. Series B* (Methodological), 289–300.

Benjamini, Y., & Hochberg, Y. (2000). On the adaptive control of the false discovery rate in multiple testing with independent statistics. *Journal of Educational and Behavioral Statistics, 25,* 60–83. http://doi.org/10.3102/10769986025001060.

Besley, T. (1995). Property rights and investment incentives: Theory and evidence from Ghana. *The Journal of Political Economy, 103*(5), 903–937.

Deininger, K., & Chamorro, J. S. (2004). Investment and equity effects of land regularisation: The case of Nicaragua. *Agricultural Economics,* (30), 101–116.

Deininger, K., & Jin, S. (2006). Tenure security and land-related investment: Evidence from Ethiopia. *European Economic Review*, *50*, 1245–1277. http://doi.org/10.1016/j.euroecorev.2005.02.001

Deininger, K., Ali, D. A., & Alemu, T. (2011). impacts of land certification on tenure security, investment, and land market participation: Evidence from Ethiopia. *Land Economics*, *87*(2), 312–334. Retrieved from http://le.uwpress.org/content/87/2/312.abstract

Deininger, K., Byerlee, D., Lindsay, J., Norton, A., Selod, H., & Stickler, M. (2011). *Rising global interest in farmland: Can it yield sustainable and equitable benefits?* (p. 264). The World Bank. http://doi.org/10.1596/978-0-8213-8591-3

Feder, G., Onchan, T., Chalamwong, Y., & Hongladarom, C. (1988). *Land policies and farm productivity in Thailand*. Baltimore, MD: Johns Hopkins University Press.

Franzel, S., Coe, R., Cooper, P., Place, F., & Scherr, S. J. (2001). Assessing the adoption potential of agroforestry practices in sub-Saharan Africa. *Agricultural Systems*, *69*, 37–62. http://doi.org/10.1016/S0308-521X(01)00017-8

Gelman, A., Hill, J. & Yajima, M. (2012). Why we (usually) don't have to worry about multiple comparisons. *Journal of Research on Educational Effectiveness*, 5, 189–211. http://doi.org/10.1080/19345747.2011.618213

Goldstein, M., et al. (2018). Land tenure security for men and women: Evidence from a randomized controlled trial in Uganda. *AEA RCT Registry*. April 22.

Holden, S. T., Deininger, K., & Ghebru, H. (2009). Impacts of low-cost land certification on investment and productivity. *American Journal of Agricultural Economics*, *91*(2), 359–373.

Huntington, H., Stickler, M., & Stevens, C. (2018). Customary land registration: A pathway to agricultural transformation and inclusive economic growth for rural Zambians? (Working paper).

Jack, B. K., Oliva, P., Bell, S., Severen, C., & Walker, E. (2016). *Technology adoption under uncertainty: Take up and subsequent investment in Zambia* (Working paper).

Jacoby, H. G., Li, G., & Rozelle, S. (2002). Hazards of expropriation: Tenure insecurity and investment in rural China . *American Economic Review, 92*(5), 1420–1447.

Jayne, T. S., Zulu, B., Kajoba, G., & Weber, M. T. (2009). *Access to land and poverty reduction in rural Zambia: Connecting the policy issues*. Retrieved from http://purl.umn.edu/55054

Joireman, S. F. (2008). The Mystery of capital formation in Sub-Saharan Africa: Women, property rights and customary law. *World Development, 36*(7), 1233–1246.

Kiptot, E., Franzel, S., & Degrande, A. (2014). Gender, agroforestry and food security in Africa. *Science Direct: Current Opinion in Environmental Sustainability*, *6*, 104–109. http://doi.org/10.1016/j.cosust.2013.10.019

Lawry, S., Samii, C., Hall, R., Leopold, A., Hornby, D., & Mtero, F. (2014). The impact of land property rights interventions on investment and agricultural productivity in developing countries. *Campbell Systematic Reviews*. https://doi.org/10.4073/csr.2014.1

Mbow, C., Van Noordwijk, M., Luedeling, E., Neufeldt, H., Minang, P. a, & Kowero, G. (2014). Agroforestry solutions to address food security and climate change challenges in Africa. *Science Direct: Current Opinion in Environmental Sustainability*, *6*, 61–67. http://doi.org/10.1016/j.cosust.2013.10.014

Mercer, D. E. (2004). Adoption of agroforestry innovations in the tropics: A review. *Agroforestry Systems*. http://doi.org/10.1023/B:AGFO.0000029007.85754.70

Pattanayak, S. K., Mercer, D. E., Sills, E., & Yang, J. (2003). Taking stock of agroforestry adoption studies. *Agroforestry Systems*, *57*, 173–186. http://doi.org/10.1200/JCO.2003.11.022

Persha, L., & Huntington, H. (2016). To what extent does tenure security shape agroforestry investment and impacts on agriculture and livelihoods in strong customary land systems? Evidence from early agroforestry adopters in Zambia's Eastern Province. In *2016 World Bank Conference on Land and Poverty*. Washington, D.C.

Phiri, D., Franzel, S., Mafongoya, P., Jere, I., Katanga, R., & Phiri, S. (2004). Who is using the new technology? The association of wealth status and gender with the planting of improved tree fallows in Eastern Province, Zambia. *Agricultural Systems*, *79*, 131–144. http://doi.org/10.1016/S0308-521X(03)00055-6

Place, F. (2009). Land Tenure and agricultural productivity in Africa: A comparative analysis of the economics literature and recent policy strategies and reforms. *World Development*, *37*, 1326–1336. http://doi.org/10.1016/j.worlddev.2008.08.020

Place, F., & Otsuka, K. (2001). Tenure, agricultural investment, and productivity in the customary tenure sector of Malawi. *Economic Development and Cultural Change*. http://doi.org/10.1086/321918

Rozelle, S., & Swinnen, J. F. M. (2004). Success and failure of reform: Insights from the transition of agriculture. *Journal of Economic Literature, 42*(2), 404–456.

Sirrine, D., Shennan, C., & Sirrine, J. R. (2010). Comparing agroforestry systems' ex ante adoption potential and ex post adoption: on-farm participatory research from southern Malawi. *Agroforestry Systems*. http://doi.org/10.1007/s10457-010-9304-0

Sitko, N. J., Chapoto, A., Kabwe, S., Tembo, S., Hichaambwa, M., Lubinda, R., … Nthani, D. (2011). *Technical compendium: Descriptive agricultural statistics and analysis for Zambia in support of the USAID Mission's Feed the Future strategic review* (Food Security Collaborative Working Paper No. 104016). Michigan State University, Department of Agricultural, Food, and Resource Economics.

Smith, R. E. (2004). Land tenure, fixed investment, and farm productivity: Evidence from Zambia's Southern Province. *World Development*, *32*, 1641–1661. http://doi.org/10.1016/j.worlddev.2004.05.006

Tetra Tech. (2014). *Zambia Tenure and Climate Change Scoping Report: Opportunities for land tenure and agroforestry intervention*.

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