Photo Credit: Catholic Relief Services, Madagascar

BASELINE REPORT

USAID/MADAGASCAR TSIRO BASELINE SURVEY

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ACRONYMS

CAPI	Computer Assisted Personal Interviews
CCP	Conservation and Communities Project
COFAV	Fandriana-Vondrozo Forest Corridor
COMATSA	Tsaratanana Forest Corridor
CSI	Coping Strategies Index
CWI	Comparative Wealth Index
DAP	Disclosure Analysis Plan
FIES	Food Insecurity Experience Scale
FTF	Feed the Future
FNM	Adult Female No Adult Male
GIS	Geographic Information Systems
HDDS	Household Dietary Diversity
ICC	Intra-Cluster Correlation Coefficient
INRM	Integrated Natural Resources Management
IR	Intermediate Results
IRB	Institutional Review Board
IWI	International Wealth Index
LSMS	Living Standards Measurement Survey
ODK	Open Data Kit
MDD-W	Minimum Dietary Diversity - Women
PII	Personally Identifiable Information
PPI	Poverty Probability Index
PPP	Purchasing Power Parity
PPS	Probability Proportional to Size
SA	Strategic Approach
SEED	Suitable Environment and Economic Development
SES	Socioeconomic Status
SI	Social Impact, Inc.
TSIRO	Thriving/Tangible and Sustainable Investments for Land Restoration and Economic Opportunity
USAID	United States Agency for International Development
WDDS	Women's Dietary Diversity Score

EXECUTIVE SUMMARY

INTRODUCTION

Madagascar is one of the world's highest-priority countries for biodiversity conservation.[1] There are more plant and animal species in Madagascar than on the entire African continent, and more than eighty percent of Madagascar's species are found nowhere else on earth.[2] Because of its exceptional natural resources and high rate of endemism, the loss of one hectare of forest in Madagascar can have a larger effect on biodiversity than forest lost practically anywhere else on earth.

The USAID/Madagascar Mission's Sustainable Environment and Economic Development (SEED) Office is planning three activities under the Conservation and Communities Project (CCP). CCP aims to help conserve biodiversity, promote resilient livelihoods that provide alternatives to unsustainable natural resource management practices, and take concrete actions to secure effective local ownership and management of natural resources.

USAID/Madagascar contracted the Integrated Natural Resource Management (INRM) mechanism to conduct a baseline household survey and environmental monitoring as a benchmark for the Mission's activities under the Health, Ecosystems and Agriculture for Resilient, Thriving Societies (HEARTH) program. This document reports findings from the baseline household survey for the Thriving/Tangible and Sustainable Investments for Land Restoration and Economic Opportunity (TSIRO) Alliance, one of the three CCP activities.

TSIRO ALLIANCE

The TSIRO Alliance is a five-year activity that aims to conserve ecosystems and improve the well-being and prosperity of 2,000 small- and medium-hold farmers and their communities in two forest areas: the Tsaratanana Forest Corridor (COMATSA) and the Fandriana-Vondrozo Forest Corridor (COFAV). The activity is implemented by Catholic Relief Services (CRS), along with four private sector partners and two technical partners.

The TSIRO Alliance intends to support farmers in up to 30 communes and plant more than 1.5 million trees in agroforestry systems that incorporate food and spice crops such as cacao, vanilla, cinnamon, and wild pepper. TSIRO focuses on four major threats to biodiversity and human wellbeing: (i) deforestation, (ii) unsustainable farming practices, (iii) insufficient access to resources for farmers and farmer groups, and (iv) underdeveloped supply chains. This approach is expected to reduce soil erosion; provide stable, diversified incomes for farmers, which may allow households to invest more in their family's health and education; and enhance the biodiversity of the area.

The USAID/Madagascar TSIRO Baseline Survey was designed to provide baseline estimates that will inform activity implementation and serve as a benchmark for future assessments. All aspects of the baseline survey were designed by INRM with support from USAID/Madagascar, the TSIRO Alliance, and CAETIC Développement.

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[1] *Ecosystem Profile: Madagascar and Indian Ocean Islands.* Final Version, December 2014.
[2] World Wildlife Fund. https://www.worldwildlife.org/places/madagascar

BASELINE DESIGN AND METHODOLOGY

Purpose of the survey

The purpose of the USAID/Madagascar TSIRO Baseline Survey is to provide the U.S. Government interagency partners, United States Agency for International Development (USAID), USAID/Madagascar, and the TSIRO implementing partners with baseline estimates across a range of indicators relevant to the TSIRO Alliance's design and strategic approaches.

Geographic focus

The geographic focus of the TSIRO Baseline Survey is the COMATSA and the COFAV corridors. Located in the northwest and southeast of Madagascar, respectively, the COMATSA and COFAV corridors are the TSIRO activity's implementation areas. Both landscapes are under serious threat, with poverty, malnutrition, and a lack of access to resources contributing to their degradation. These forests are among the country's most highly threatened and impacted formations. Despite these challenges, these landscapes remain promising areas for sustainable agricultural production.

Sampling design

The TSIRO Baseline Survey is not intended to be representative of all households in the intervention districts, as the TSIRO Alliance is working with targeted farmer groups. Instead, the survey focuses on collecting data that reflect the characteristics of participant households. The TSIRO Baseline Survey was conducted among a random sample of 755 households representative of the entire population of households participating in the TSIRO Alliance's activities at the start of implementation. The survey used a stratified, multi-stage cluster sampling design. In the first stage, fokontany were selected using probability proportional to size (PPS); in the second stage, participating households were selected randomly.

Survey content

The TSIRO Baseline Survey Instrument includes the following survey modules:

- Module 1: Household roster and demographics
- Module 2: Food security, resilience, and health
- Module 3: Agricultural technologies and agricultural productivity
- Module 4: Credit access and group participation
- Module 5: Natural Resources
- Module 6: Energy use
- Module 7: Gender and empowerment
- Module 8: Consumption and poverty

The survey instrument was developed from existing USAID and other relevant guidance to ensure that the questionnaire was based on verified tools and drew from the 2015 Baseline Study of Food for Peace Development Food Assistance Projects in Madagascar survey instrument and the 2020 USAID Madagascar Conservation and Communities Project Baseline Household Survey instrument. Upon completing the first draft of this survey instrument, USAID/Madagascar, the TSIRO Alliance, and CAETIC provided detailed feedback to contextualize the questions for the TSIRO implementation area.

Fieldwork

With guidance and oversight from INRM, CAETIC hosted a seven-day training workshop followed by a three-day comprehensive pilot test of the tool for all enumerators. Survey data collection was then conducted from August 16th - September 12th, 2021, using tablets and SurveyCTO. Data quality assurance during fieldwork included co-enumeration and accompaniments by supervisors and back-checks conducted by both CAETIC and INRM. Additionally, each team organized a daily debriefing to discuss the work progress, to review any challenges faced, clarify questions related to the survey protocol, and solve any problems encountered.

RESULTS

Demographics and background characteristics

Across the TSIRO Alliance implementation area, the average participating household had between five and six members. The mean number of adults per household was 2.7, with a roughly equal share of male and female adults. Across all households, just 11.5% were headed by a woman. Household heads most commonly reported having a primary school education, with more than 53% of respondents indicating this was their highest education level achieved. 78.5% of household heads in the sample were literate. Virtually all household heads worked in the last 12 months.

Livelihoods

Nearly 50% of participating households in the TSIRO implementation area fell below the USD $1.90 per day poverty line. The share of households that fell below this threshold was significantly higher in the COFAV region (50.5%) than in the COMATSA region (36.4%). The prevalence of poverty also significantly differed by whether the household head was literate, with 45% of households with a literate household head living in poverty compared to 66.3% of those with a non-literate household head.

The most common borrowing source among TSIRO participants was a friend or relative (36.2%), followed by group-based micro-finance (20.6%), and non-governmental organizations (4.1%). Fewer than 3% of households in the sample borrowed from a formal lender, while less than 1% borrowed from an informal lender.

Agriculture

The average household in the TSIRO Baseline Survey holds three plots of land that totaled to an average of 3.02 hectares. The average household grows 4.3 different types of crops, with 78.3% of households growing at least one of the four activity crops (cacao, vanilla, black pepper, or cinnamon). The most commonly grown crops were rice (95.4%), cassava (72.8%), vanilla (66.0%), and fruits (62.6%). Among the four TSIRO activity crops (cacao, vanilla, black pepper, and cinnamon), the share of households growing each ranged from 13.9% for cacao to 66.0% for vanilla. The share of households growing cacao and vanilla were significantly larger in the COMATSA region than in the COFAV region.

The average cacao-producing household planted just 0.1 hectares of cacao in the last year, while harvesting 0.75 hectares.[3] The average cacao yield was 2.5 tons per hectare.[4] Black pepper was produced in the smallest quantity among the four activity crops, with 0.04 hectares planted in the last year, 0.13 hectares cultivated during this period, and an average yield of 0.56 tons per hectare. Among households that grew cinnamon in the last year, the average household planted 0.15 hectares while harvesting 0.17 hectares. The average cinnamon yield was 1.52 tons per hectare. Vanilla was produced in the largest quantity among the targeted crops, with 0.19 hectares planted in the last year, 0.39 hectares cultivated, for an average yield of 0.3 tons per hectare.

The average cacao-producing household sold 1.89 tons[5] in the last year and reported earning USD $1,420.97 from cacao sales. Among households that grew black pepper in the last year, the average household sold 0.01 tons and reported earning USD $13.23 from those sales. The average cinnamon-producing household sold 0.06 tons in the last year and reported USD $44.35 in revenue from those sales. Finally, among households that grew vanilla in the last year, the average household sold just 0.01 tons and earned USD $134.98 in revenue from vanilla sales.

The share of households selling cacao directly to a company or to a local buyer/trader was significantly higher in the COMATSA region than in the COFAV region, while the share selling cacao to another source was significantly higher in the COFAV region than COMATSA. The share of households selling vanilla to a local market was significantly higher in the COMATSA region than in the COFAV region.

The most commonly used agricultural management practices were techniques for weed management (94.9%), followed by the use of post-harvest processing techniques (79.4%), and use of water management (71.2%). The share of households using improved seeds, planting materials, or seedlings, as well as those using soiling fertilization and water management were significantly higher in the COFAV region than in the COMATSA region. Conversely, the share of households using vaccination or deworming and techniques to feed animals through locally available foods was significantly higher in the COMATSA region than in the COFAV region.

38.4% of households hold non-titled, privately-owned land with formal documents, 37.5% hold land with no documents, while 27.4% of households hold certified land. The share of households that hold certified land was significantly higher in the COFAV region than in the COMATSA region, while the share that hold titled land, and non-titled privately-owned land with formal or simple documents was significantly higher in the COMATSA region. Importantly, just three percent of participating households indicated owning land that overlaps a protected or *transfert de gestion*, with no significant differences by region.

Food security and health

In the full sample, 71.1% of households were classified as moderately or severely food insecure, with 62.5% classified as moderate, 8.6% categorized as severe, and 28.9% of households experiencing little to no food

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[3] As cacao is a tree crop with long harvesting cycles, farmers typically harvest trees that were planted several years prior.

[4] Zero cacao-producing households reported engaging in post-harvest processing, so cacao yield estimates are assumed to be wet cacao. Wet cacao typically weighs around three times more than cacao that has been dried via post-harvest processing.

[5] This estimate uses the weight of wet cacao and the area harvested, rather than cultivated. No households reported post-harvest processing for their cacao production.

insecurity. 72.9% of participating households in the COFAV region experienced moderate or severe food insecurity, compared to just 30.7% in the COMATSA region.

The share of women consuming a diet of minimum diversity was 19.9% for the full sample, with a significantly higher percentage of women in the COMATSA region consuming a diverse diet (55.8%) than those in the COFAV region (17.9%). The average female respondent consumed 3.3 out of 10 food groups in the 24-hours preceding the survey. The average number of food groups consumed was significantly higher among participating households in the COMATSA region than those in the COFAV region, at 4.4 and 3.3, respectively.

The coping strategies index (CSI) measures the extent to which households use different consumption coping strategies when faced with limited food access. Participating households in the COFAV region scored significantly higher on the CSI (34.6) than those in the COMATSA region (6.3), suggesting that beneficiaries in the COFAV region turn to consumption coping strategies with more frequency and severity than those in the COMATSA region.

The average household in the sample spent approximately USD $20 on health expenditures in the last three months, with significantly higher expenditures in the COMATSA region (USD $51.01) than in the COFAV region (USD $18.04). Respondents estimated traveling nearly five kilometers for health services, on average. This distance was significantly higher in the COFAV region than in the COMATSA region.

Natural resources and energy use

Almost 86% of beneficiary households believe that there are current threats to their community's ecosystem. The most commonly chosen responses were slash-and-burn agriculture (76.8%), illegal logging (52.8%), climate change impacts (40.1%), and unsustainable farming practices (23.9%).

Nonetheless, 61% of TSIRO households plan to clear land for cultivation or livestock in the next 12 months, with no significant difference across regions. Overall, 49.0% of participating households reported that they collect forest products. The resources that were most widely considered to be important were firewood (85.7%), medicinal plants (49.9%), wild fruits (33.1%), honey (18.6%), and mushrooms (17.3%).

78.9% of TSIRO households reported being directly affected by the loss of an ecosystem service in the last 12 months. Households that were directly affected by such a loss were asked to indicate the way that this loss most affected them. The vast majority of households reported that their economic well-being was most affected (86.3%), followed by their medical health (12.8%), and emotional, psychological, or spiritual well-being (0.6%).

The most commonly used fuel sources were firewood (92.5%), kerosene (44.0%), and charcoal and coal (12.0%). The average beneficiary household used 284.4 kilograms of firewood in the last 30 days, with those in the COFAV region using a significantly higher amount than those in the COMATSA region.

Gender and empowerment

The share of female respondents stating that their husband or partner makes decisions about their money was significantly higher among beneficiaries in the COFAV region (8.6%) compared to those in the COMATSA region (1.6%). Similarly, the share of participating women in the COFAV region stating that

someone else decides how to spend their money was significantly higher than in the COMATSA region, at 10.4% and 0%, respectively.

When asked who makes decisions about the female respondent's healthcare, 46.0% of women stated that their husband/partner makes this decision alone, while 37.4% reported that they make this decision jointly, and 16.4% stated that they make the decision alone. The share of women who reported making decisions about their healthcare alone or jointly was significantly higher in the COMATSA region than the COFAV region, while the share that reported that their husband/partner makes these decisions was significantly higher in the COFAV region.

Women were asked if they believe it is justified for a husband to hit or beat his wife under five different circumstances.[6] The share of women indicating that this form of gender-based violence is justified ranged from 11.6-26.8%, with the highest percentage of women reporting that hitting or beating is acceptable if the wife neglects the children, followed by going out without telling her husband. The share of women that agreed with this statement for arguing with the husband, refusing to have sex with him, or burning food ranged from 11-13%. None of these items significantly differed by region.

CONCLUSIONS

The results of this survey demonstrate the significant and multifaceted needs of the target communities, highlighting the potential benefits of an integrated approach. Respondents report high levels of belief in the importance of conserving their environment and reliance on their forest resources, yet they also face immediate needs with high levels of poverty and food insecurity and low levels of dietary diversity and access to finance from formal institutions. Moreover, they report already facing loss of ecosystem services with negative effects on their livelihoods, yet more than half of TSIRO households also report planning to clear more land in the next year.

We find significant differences across a range of outcome areas between participants in the COFAV and COMATSA regions. Beneficiary households in the COMATSA region tended to be significantly better off than those in the COFAV region, with higher rates of education, literacy, food security, and dietary diversity and lower rates of poverty.

Access to credit through formal institutions is very low among TSIRO participants and instead appears to be largely based on personal connections or micro-finance groups. Households most commonly borrowed cash or in-kind from a friend, relative, or group-based micro-finance organization, while fewer than 3% borrowed from a formal lender. Among households that did borrow in the last year, the majority of respondents indicated making borrowing decisions jointly.

Participating households on average cultivated 4.3 crops and held approximately 3 hectares of land. The most commonly grown crops were rice, cassava, vanilla, and fruits. Among the four TSIRO activity crops, the share of households growing each ranged from 13.9% for cacao to 66.0% for vanilla. Households in the COMATSA region were significantly more likely to grow cacao, while those in the COFAV region were significantly more likely to grow black pepper and cinnamon.

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[6] Although enumerators requested to interview women alone for these sensitive questions, we found no statistically or practically significant differences in responses between women who were successfully interviewed alone and those who responded to these questions with someone else in the room. Therefore, we include all female respondents in our results.

Cacao farmers in COMATSA were significantly more likely to sell their cacao directly to companies. However, we did not find any significant differences in yield or sales between regions for any of the targeted crops. Average earnings from cacao were substantially higher than from all other targeted crops.

More than a third of all TSIRO households had no documents for their land, while a quarter held certified land. Participating households in the COFAV region were significantly more likely to hold titled and certified land, while those in the COMATSA region were significantly more likely to hold non-titled land with formal or simple documents.

Food security and dietary diversity were low among participating households and were significantly lower in COFAV. More than 70% of all beneficiary households were classified as moderately or food insecure, and just 20% of women of reproductive age consumed a minimally acceptable diet in the 24-hours prior to data collection. Participating households in the COFAV region experienced a higher frequency and severity of coping behaviors related food consumption than those in the COMATSA region. Use of seven of the 14 coping strategies significantly differed by region, with a higher share of households in the COFAV region than the COMATSA region using each in all seven cases, further highlighting the differing food security situations in the two implementation regions.

Almost half of households surveyed report collecting forest products. Among those collecting firewood, approximately 85% noted that it was important or very important to their livelihood, yet almost 40% overall, and more than 70% in COMATSA, reported difficulty in accessing over the last year.

At the time of data collection, 86% of TSIRO households believed that there were current threats to their community's ecosystem. The threats that households most commonly reported were slash-and-burn agriculture, illegal logging, climate change impacts, and unsustainable farming practices. Despite this recognition of ecosystem threats, the majority of households reported that they intend to clear land for cultivation or livestock in the next year, a result that was consistent across regions. The most common reasons given for clearing land in the future were to increase the size of the household's land, to grow more crops to consume, and to grow more crops to sell.

Nearly 80% of participating households reported being directly affected by the loss of an ecosystem service in the last 12 months. The vast majority of households reported that their economic well-being was most affected (86.3%), followed by their medical health (12.8%), and emotional, psychological, or spiritual well-being (0.6%).

The most commonly used fuel sources among activity participants were firewood, kerosene, and charcoal and coal. Whereas households in the COMATSA region were significantly more likely to use firewood and kerosene, those in the COFAV region were significantly more likely to use charcoal and coal. The average household traveled two kilometers to collect firewood in the last 30 days, while needing to travel just 0.2 kilometers for charcoal and coal.

Rates of acceptance of gender-based violence was relatively high among beneficiaries in both regions. When asked whether they believe it is justified for a husband to hit or beat his wife under different circumstances, the share of women indicating that this form of gender-based violence is justified

ranged from 11.6-26.8%, with the highest percentage of women reporting that hitting or beating is acceptable if the wife neglects the children, followed by going out without telling her husband.

1.   INTRODUCTION

Madagascar is one of the world's highest-priority countries for biodiversity conservation.[7] There are more plant and animal species in Madagascar than on the entire African continent, and more than eighty percent of Madagascar's species are found nowhere else on earth.[8] Because of its exceptional natural resources and high rate of endemism, the loss of one hectare of forest in Madagascar can have a larger effect on biodiversity than forest lost practically anywhere else on earth.

Unfortunately, widespread poverty in Madagascar drives an array of threats to the country's diverse ecosystems.[9] As population growth leads to increased demand for land and natural resources, people with limited economic opportunities turn to harmful practices such as slash-and-burn agriculture, fuelwood collection, and illegal wildlife harvesting.[10] This overexploitation of natural resources can exacerbate poverty and jeopardize the effectiveness of Madagascar's governing institutions. Without effective governance to protect and maintain natural resources, local populations increasingly disregard environmentally sound livelihood practices that can have long-term, lasting benefits.[11] Instead, people tend to exploit natural resources to meet their basic needs.

Additionally, predicted climate changes threaten the wellbeing of the Malagasy people and the long-term persistence of Madagascar's biodiversity. Rainfall patterns in some areas of the country will intensify, leading to increased flooding and erosion, while rainfall in other areas will decrease and become less predictable.[12] Given its geographic location, Madagascar is also frequently subject to powerful cyclones that damage ecosystems and infrastructure, particularly on the coasts, and climate change is likely to increase both the frequency and severity of these storms.

The USAID/Madagascar Mission is planning three activities that address the above issues, each of which will operate under the Sustainable Environment and Economic Development (SEED) Office's Conservation and Communities Project (CCP). CCP aims to help conserve biodiversity, promote resilient livelihoods that provide alternatives to unsustainable natural resource management practices, and take concrete actions to secure effective local ownership and management of natural resources.

USAID's results framework for CCP includes the following intermediate results (IRs):

> **IR1:** Targeted ecosystems sustainably managed through improved community-based natural resource management and better protected area management.

> **IR2:** Human well-being improved near selected areas of high biodiversity value through economic development and social support programs that help protect biodiversity.

> **IR3:** Decentralized natural resource governance enhanced through more effective environmental policy, land tenure security, and civil society engagement.

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[7] *Ecosystem Profile: Madagascar and Indian Ocean Islands.* Final Version, December 2014.

[8] World Wildlife Fund. https://www.worldwildlife.org/places/madagascar

[9] République de Madagascar / United Nations Development Programme. Rapport National sur le développement humain – Madagascar 2018.

[10] United Nations Population Fund. Madagascar: Country Implementation Profile. 2012

[11] World Bank. Madagascar Country Environmental Analysis. 2013

[12] David Eckstein, Vera Künzel, Laura Schäfer, Maik Winges. Global Climate Risk Index 2020: Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2018 and 1999 to 2018. German Watch, 2020.

USAID/Madagascar contracted the Integrated Natural Resource Management (INRM) mechanism to conduct a baseline household survey and environmental monitoring as a benchmark for the Mission's activities under the Health, Ecosystems and Agriculture for Resilient, Thriving Societies (HEARTH) program. This document reports findings from the baseline household survey for the Thriving/Tangible and Sustainable Investments for Land Restoration and Economic Opportunity (TSIRO) Alliance, one of the three CCP activities.

2.   TSIRO ALLIANCE

The TSIRO Alliance is a five-year activity that aims to conserve ecosystems and improve the well-being and prosperity of 2,000 small- and medium-hold farmers and their communities in two forest areas: the Tsaratanana Forest Corridor (COMATSA) and the Fandriana-Vondrozo Forest Corridor (COFAV). The activity is implemented by Catholic Relief Services (CRS), along with four private sector partners and two technical partners.[13],[14]

The TSIRO Alliance intends to support farmers in up to 30 communes and plant more than 1.5 million trees in agroforestry systems that incorporate food and spice crops such as cacao, vanilla, cinnamon, and wild pepper. TSIRO focuses on four major threats to biodiversity and human wellbeing: (i) deforestation, (ii) unsustainable farming practices, (iii) insufficient access to resources for farmers and farmer groups, and (iv) underdeveloped supply chains. This approach is expected to reduce soil erosion; provide stable, diversified incomes for farmers, which may allow households to invest more in their family's health and education; and enhance the biodiversity of the area.

These activities are guided by the following strategic approaches (SAs):

SA1: By 2025, 70% of targeted farmers use improved/sustainable agroforestry and agriculture techniques for cacao and spice production to protect/expand habitat for biodiversity (reduce pressures on environment, particularly protected areas).

SA2: By 2025, 60% of targeted farmers and 80% of farmer groups have improved financial & organizational management capacities for collective action (to participate in value chain).

SA3: By 2025, 60% of targeted male and female farmers and their households have diversified and sufficient income streams (through increased production and sale of cocoa and spices) to support education, health, sustainable energy, and other basic needs (including shift away from destructive practices).

SA4: By 2025, there is a 30% increase in consumer participation in awareness and educational platforms and a 20% increase of private sector (chocolate and spices related) awareness on environmental and biodiversity benefits linked to responsible cacao and spice production (and purchases).

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[13] The TSIRO Alliance private sector partners are (i) Fine Chocolate Industry Association (FCIA), (ii) Madecasse-Beyond Good, (iii) Shanala, and (iv) Guittard Chocolate & Akesson's.
[14] The TSIRO Alliance technical partners are (i) Heriloom Cacao Preservation Fund (HCP), and (ii) Centre ValBio (CVB).

The USAID/Madagascar TSIRO Baseline Survey was designed to provide baseline estimates that will inform activity implementation surrounding each SA outlined above and serve as a benchmark for future assessments. All aspects of the baseline survey were designed by INRM with support from USAID/Madagascar, the TSIRO Alliance, and CAETIC.

3. BASELINE DESIGN AND METHODOLOGY

3.1 PURPOSE OF THE SURVEY

The purpose of the USAID/Madagascar TSIRO Baseline Survey is to provide the U.S. Government interagency partners, United States Agency for International Development (USAID), USAID/Madagascar, and the TSIRO implementing partners with baseline estimates across a range of indicators relevant to the TSIRO Alliance's design and strategic approaches.

3.2 PREPARATORY ACTIVITIES AND STAKEHOLDER PARTICIPATION

In preparation for the TSIRO Baseline Survey, INRM staff met with USAID/Washington, USAID/Madagascar, and the TSIRO implementing partners to discuss the best approach for evaluating the TSIRO Alliance, including the possibility of an impact evaluation. Based on these conversations, INRM and USAID decided to conduct a baseline survey of program participants, rather than an impact evaluation. Additionally, INRM held discussions with the TSIRO implementing partners to discuss the content, sample size, timing, and location of the baseline survey.

Another key preparatory task included the identification of an in-country partner to conduct data collection activities, for which INRM managed a free and open competition. The request for proposals was released on April 9, 2021, with proposals submitted by May 3, 2021. INRM's selection committee reviewed all technical and cost proposals received by the stated deadline. The members of the selection committee also independently reviewed and scored all technical proposals based on a pre-defined scoring criterion. The committee determined CAETIC to be the most technically sound and agreed to subcontract the firm for this evaluation.

3.3 TIMING OF DATA COLLECTION

Data for the TSIRO Baseline Survey were collected with the following considerations for timing: (i) the implementing partner's timeline for the rollout of the TSIRO Alliance activities, and (ii) the COVID-19 pandemic and associated travel restrictions and safety considerations. These issues were carefully weighed with USAID/Madagascar and the TSIRO Alliance, with all parties agreeing that the TSIRO Baseline Survey would take place between August and September of 2021. In discussions with the implementing partners, it was emphasized that collecting baseline data during this time frame was critical to the project's timeline and any significant delays in the baseline evaluation could jeopardize the start of implementation.

3.4 GEOGRAPHIC FOCUS

The geographic focus of the TSIRO Baseline Survey is the Tsaratanana Forest Corridor (COMATSA) and the Fandriana-Vondrozo Forest Corridor (COFAV). Located in the northwest and southeast of Madagascar, respectively, the COMATSA and COFAV corridors are the TSIRO activity's implementation areas (Figure 1). Both landscapes are under serious threat, with poverty, malnutrition, and a lack of access

to resources contributing to their degradation. In the COFAV corridor, it is estimated that forest loss was more than one percent per year between 2000 and 2012.[15] These forests are among the country's most highly threatened and impacted formations.[16] About 150 of COFAV's plant and animal species are considered endangered,[17] while the same is true of 36 species in the COMATSA landscape.[18] Despite these challenges, these landscapes remain promising areas for sustainable agricultural production.

FIGURE 1: MAP OF TSIRO INTERVENTION AREAS IN MADAGASCAR, COMATSA (LEFT) AND COFAV (RIGHT)[19]
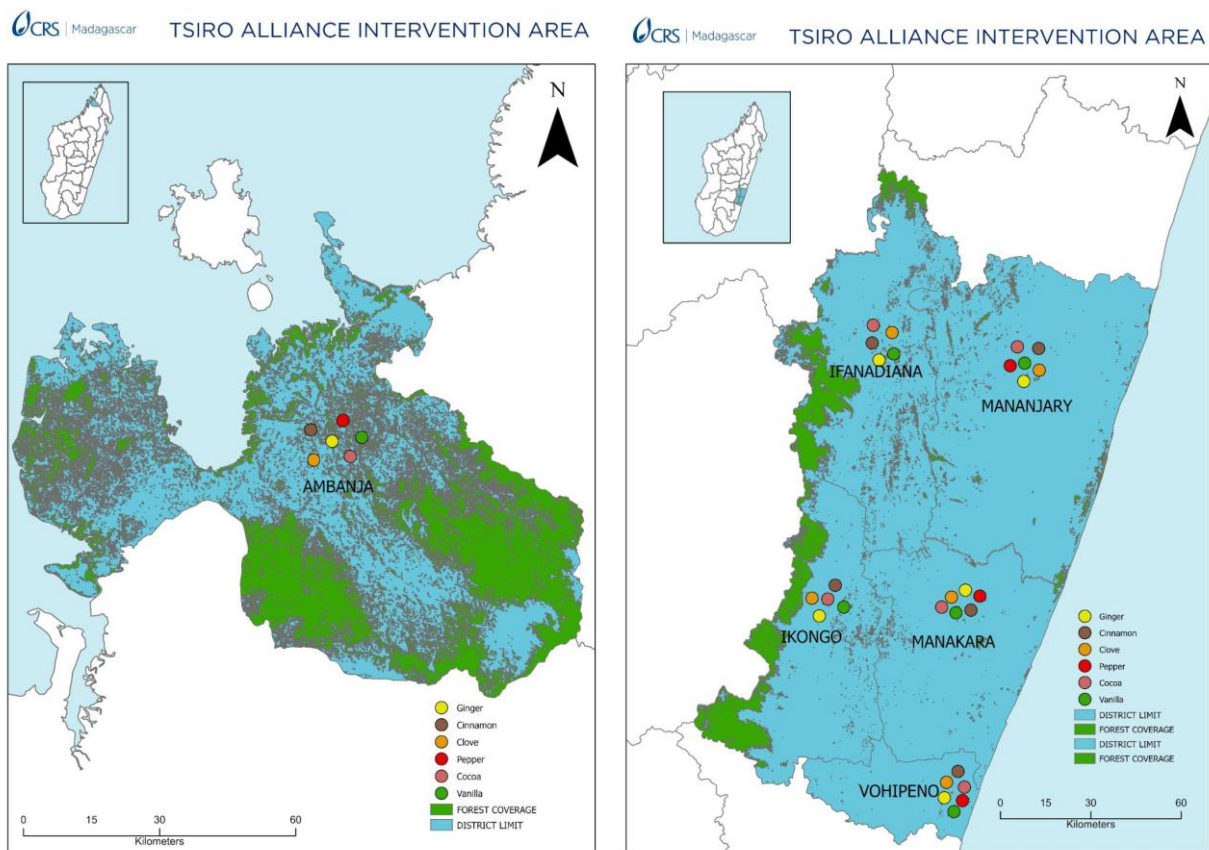
3.5   STUDY POPULATION

The TSIRO Baseline Survey is not intended to be representative of all households in the intervention Districts, as the TSIRO Alliance is working with targeted farmer groups. Instead, the survey focuses on collecting data that reflect the characteristics of participant households, based on lists of targeted or participating farmer groups and farmers provided to INRM by the TSIRO Alliance. All indicators are

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[15] Ramiadantsoa et al. Large-Scale Habitat Corridors for Biodiversity Conservation: A Forest Corridor in Madagascar. PLOS ONE 10(7): e0132126. Doi:10137/journal.pone 0132126

[16] Schatz, 2000

[17] Conservation International. Carbon Emissions Reduction Project in the Ambositra-Vondrozo Forest Corridor: climate, community, and biodiversity standards project design document. 2014.

[18] Rabearivony, J. et al. *Roles of a forest corridor between Marojejy, Anjanaharibe-Sud and Tsaratanana protected areas, northern Madagascar, in maintaining endemic and threatened Malagasy taxa.* Madagascar Conservation and Development, volume 10, Issue 2, August 2015.

[19] Source: TSIRO Alliance Technical Application

presented at the household level and respondents within the household were selected for their ability to respond for the household, rather than as an individual.

3.6   SAMPLING DESIGN

The TSIRO Baseline Survey was conducted among a representative, random sample of the entire population of households participating in the TSIRO Alliance's activities at the start of implementation.[20] The survey used a stratified, multi-stage cluster sampling design. In the first stage, fokontany[21] were selected using probability proportional to size (PPS); in the second stage, participating households were selected randomly.

Sampling was conducted based on a sample frame compiled by the TSIRO Alliance which includes 2,865 farmers from 152 different fokontany. Two aspects of the sample frame required additional consideration in sampling. First, less than 3 percent of the sample frame lived in the Northern intervention area (COMATSA). Based on the total sample size of 750 households, as described in Section 3.7, this would equate to only 23 respondents from COMATSA in the sample. Because of the importance of measuring the TSIRO Alliance's progress in both intervention areas, USAID decided to sample all identified farmers in the Northern area (a total of 85 households), rather than a proportional number. The Evaluation Team uses weighting to ensure representativeness across the full sample to account for this disproportionate sampling. Second, there was a high degree of variability in the number of farmers from each fokontany, ranging from one to 198. Moreover, 60 percent of the fokontany included fewer than 15 farmers (the originally anticipated number of farmers to be sampled in each fokontany), with almost a third of fokontany having only one or two farmers. Having multiple fokontany with only a small number of farmers presents logistical challenges for data collection, as it is significantly more efficient to collect data from more farmers per each sampled fokontany.

Based on these factors, the sampling was conducted as follows: the sample frame was stratified by forest corridor (COMATSA and COFAV) to create a total of two strata. As noted above, all farmers in the sample frame from COMATSA (85 households across 13 fokontany) were selected, and the remainder (665) were sampled from COFAV. A total of 50 fokontany are included in the sample, with 13 coming from COMATSA.[22] The remaining 37 fokontany within COFAV were sampled at the first stage using PPS, with replacement, based on the expected number of participating households in each fokontany. That is, fokontany with more farmers in the sample frame had a higher probability of being sampled, and fokontany could be sampled more than once. At the second stage, a maximum of 11 households were sampled randomly from each selected fokontany, and some fokontany were selected multiple times. In addition to the randomly sampled households, we also randomly sampled a list of 5 replacement households in each fokontany which were designated as ordered replacements, in the event that one of the originally sampled households would be unable to be interviewed for any reason. The full list of the number of sampled households by region and fokontany are provided in Appendix C.

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[20] Note that, at the time of the survey design, the TSIRO Alliance anticipated that their initial list of activity participants would not encompass all eventual beneficiaries. The Alliance expected that a large number of new, but presently unknown, farmers would eventually become beneficiaries. Therefore, the baseline survey was designed to be representative of the initial list of known participants.

[21] Administrative divisions in Madagascar consist of provinces, regions, communes, and at the lowest level, fokontany.

[22] The original sample design which was agreed upon with USAID and the data collection partner, prior to receiving the sample frame, called for a total sample size of 750 households, with 15 households from each of 50 fokontany. Due to resource constraints, the number of fokontany could not be significantly increased, even if the sample size remained the same.

3.7 SAMPLE SIZE

The aim of the TSIRO Baseline Survey is to produce estimates of indicators, including their standard errors and confidence intervals, and to enable a statistical test of differences to detect changes in indicators over time. This sub-section describes the sample size calculations required to ensure adequate power for estimating changes in indicators of proportions or means.

3.7.1 Method for calculating sample size

To estimate the required sample size, we considered two targeted indicators for which prior data is available: the Household Dietary Diversity Scale (HDDS) and per capita consumption expenditures. Based on TSIRO activity documents outlining that the project intends to achieve a 20 percent increase in HDDS, INRM used mean and standard deviation estimates of HDDS reported in the 2015 Baseline Study of Food for Peace Development Food Assistance Projects in Madagascar as the basis for sample size calculations. Sample size calculations were conducted in Stata using the 'Power' command under a clustered approach. However, INRM discussed with USAID/Madagascar that a 20 percent increase in HDDS may be an unrealistic target and recommended that the target change be reduced to below 15 percent.

3.7.2 Computing the initial sample size of the survey

Table 3 presents the calculation of the initial sample size for HDDS and expenditures, using the input parameters given in the table and formula below.

TABLE 1: CALCULATION OF INITIAL SAMPLE SIZE

Indicator	Sample size	ICC	Baseline mean	Percent change	Minimum detectable change	Minimum endline mean
HDDS	750	.075	4.0	9.3	0.37	4.37
HDDS	750	.15	4.0	11.5	0.46	4.46
Expenditures	750	.075	1.36	14.7	0.20	1.56
Expenditures	750	.15	1.36	18.4	0.25	1.61

Table 3 lists two separate sample size calculations that were conducted for the HDDS and expenditures. The table shows that depending on the level of clustering (or ICC, which we could not verify in the data), a sample of 750 households is sufficient to measure between a 9.3 and 11.5 percent change in HDDS (equivalent to 0.37 and 0.46 food groups) and between a 14.7 to 18.4 percent change in expenditures (equivalent to $0.20 and $0.25). Based on this analysis, USAID/Madagascar and INRM agreed to collect a sample size of 750 to ensure adequate power to detect reasonable changes over time.[23]

3.8 SURVEY CONTENT

The TSIRO Baseline Survey Instrument includes the following survey modules:

- Module 1: Household roster and demographics
- Module 2: Food security, resilience, and health
- Module 3: Agricultural technologies and agricultural productivity
- Module 4: Credit access and group participation

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[23] Based on the revised sampling approach which includes a varying number of respondents per cluster, the sample should be sufficient to measure a change of approximately 11.5-14 percent in HDDS and between 18-22 percent in expenditures.

- Module 5: Natural Resources
- Module 6: Energy use
- Module 7: Gender and empowerment
- Module 8: Consumption and poverty[24]

The survey instrument was developed from existing USAID, Feed the Future (FTF), and other relevant guidance to ensure that the questionnaire was based on verified tools.[25] INRM accessed USAID and FTF survey instrument templates and cross-validated questions against two sources: the 2015 Baseline Study of Food for Peace Development Food Assistance Projects in Madagascar survey instrument and the 2020 USAID Madagascar Conservation and Communities Project Baseline Household Survey instrument. Upon completing the first draft of this survey instrument, USAID/Madagascar, the TSIRO Alliance, and CAETIC provided detailed feedback to contextualize the questions for the TSIRO implementation area.

Additionally, based on discussions with USAID and the TSIRO Alliance, INRM used an alternative approach to measuring household poverty status. The standard LSMS/FTF modules used to measure household consumption and expenditures typically take between 60 and 90 minutes to administer and can be burdensome for both respondents and enumerators. Alternative approaches to measuring households' poverty status have been developed and extensively used in recent decades. Using prior data from Madagascar provided by USAID, INRM used machine learning tools to identify a subset of questions that predict poverty with a high degree of accuracy. INRM's approach closely matches the Poverty Probability Index (PPI), which has been applied in many countries, including Madagascar. Importantly, this approach relies on existing survey data with a full consumption expenditure or poverty module in order to conduct the analysis and identify the subset of questions to be used. For the PPI in Madagascar, this was done using data from the 2010 Periodic Household Survey conducted by INSTAT. INRM used the 2020 USAID Food for Peace Endline survey to conduct similar analysis and identify the updated subset of questions. More detail on INRM's approach and the selected subset of questions can be found in Appendix E.

3.9   HUMAN SUBJECTS RESEARCH PROTECTION

INRM followed a number of procedures to ensure that the survey work adhered to ethical research standards, including the following provisions:

IRB approval. Social Impact's Institutional Review Board (IRB) reviewed and approved the survey protocol and final instrument for the TSIRO Baseline Survey.

Training in protection of human subjects. All field supervisors and interviewers received training in protection of human subjects.

Confidentiality protections. Respect for the confidentiality of respondent information was maintained throughout the survey process. Interviewers were prohibited from interviewing anyone they know or discussing identified respondent's information with anyone other than the field team member or field supervisor. All data transmitted to the INRM servers was encrypted and accessible only by INRM staff. Datasets for internal USAID use will retain only personally identifiable information (PII) that are essential

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[24] Note that the consumption and poverty module is a short module similar to the Poverty Probability Index. See Appendix C for more details.
[25] Other tools used for instrument design include the Living Standards Measurement Study (LSMS) and Demographic and Health Surveys (DHS).

to analysis; these data will not be shared publicly. All PII and other information that would allow deduction of respondent identities will be stripped from data sets before being made public. All staff working with survey data both in-country and at INRM offices signed confidentiality statements before working with the survey.

4. FIELDWORK

4.1 TRAINING

CAETIC hosted a seven-day training workshop between August 2 - August 9, 2021, at its training center in Ambatolampy Tsimahafotsy. The training initially consisted of 4 supervisors and 18 enumerators that were chosen based on their technical skills, knowledge of the study area, and their mastery of local dialects. However, after the withdrawal of two candidates, 16 enumerators ultimately completed the training. The training, conducted with guidance and oversight from INRM, covered the following material: introduction to the survey, conducting the interview, questionnaire content, fieldwork procedures, entering and managing data on the tablet, and completing survey modules. Hands-on training and practice sessions covered the use of all technical equipment required for survey implementation, including tablet computers with apps for data entry.

Near the end of the training, the programmed survey instrument was pre-tested. The pretest was conducted among the training participants, with each individual taking turns simulating the role of interviewer and respondent. The pretest focused on the survey instrument—whether the flow between survey modules worked well, whether all questions were comprehended, and whether the full range of appropriate responses were available. Simultaneously, the pretest was structured to identify any problems with using the tablet, such as skip patterns and navigation between survey modules.

All issues with the survey instrument and program were communicated to the INRM team, who ensured that all necessary corrections were made, documented, and tested. When the program revisions passed final testing, the revised program was downloaded from INRM's servers and loaded on all tablets by CAETIC's supervisory staff. The pretest also consisted of testing data transmission, extraction, and the generation of field check table reports by INRM. INRM's project manager closely monitored the effectiveness of these systems, procedures, and activities, and worked to ensure that any issues were resolved.

At the conclusion of training, a household pilot survey was carried out near Andasibe National Park, located approximately 140 km from Antananarivo, an area purported to have similar characteristics to the TSIRO Baseline Survey population. The pilot survey took place from August 10th – August 12th, 2021. 26 individuals took part to the pilot survey, including: 16 enumerators, 4 field supervisors, 4 CAETIC staff, including the field manager, as well as the INRM senior survey coordinator and data quality specialist. A total of 39 pilot surveys were completed (2-3 surveys per enumerator), and six backchecks were conducted (1-2 per supervisor).

4.3   DATA COLLECTION

Enumerators and field supervisors from CAETIC were deployed to the field from August 16th - September 12th, 2021. Upon arrival in each commune, CAETIC conducted courtesy visits with the mayor before beginning interviews in the selected fokontany. Representatives from the TSIRO Alliance were also contacted at the beginning of field work to ensure that they were aware of the expected dates of data collection in each commune.

Upon arrival at each fokontany, CAETIC conducted a courtesy visit to the local chief to explain the purpose of the survey. This was also an opportunity to inquire information related to the survey such as the name of hamlets in the fokontany, lodging for field teams, and any local considerations to keep in mind. The support given by the local authorities (fokontany chiefs, elders, and those responsible for local security) was essential to identifying the correct respondents listed in the sample.

Household interviews were carried out using tablets and SurveyCTO. Each enumerator and field supervisor were provided with a tablet and three power banks in addition to the materials for the survey. The CAPI approach was critical to ensuring data consistency and accuracy. At the beginning of each day of fieldwork, the field supervisor provided each enumerator with a list of households to be surveyed that day.

TABLE 2: SURVEYS COMPLETED BY DISTRICT

District	Completed	Partially completed	Total
Ambanja	76	1	77
Ifanadiana	50	0	50
Ikongo	98	12	110
Mananjary	454	64	518
Total	**678**	**77**	**755**

Across the four districts included in the survey, a total of 755 interviews were fully or partially completed. 678 households fully completed the survey, and 77 households partially completed the survey. Households that completed at least 50% of survey modules but did not complete the full survey were considered partially complete and did not require replacement. The data for partially completed households was analyzed for all completed modules and treated as missing for all modules that the household did not respond to. Additionally, there were 132 households that required replacements for a variety of reasons. Two households declined to participate in the survey, 30 households from the sampling list were discovered to be duplicates, 17 households indicated that the household head was deceased, seven households no longer lived at the original address, and 76 households were unable to be located or could not be interviewed for other reasons.

TABLE 3: HOUSEHOLD REPLACEMENT BY DISTRICT

District	Refused	Duplicates	Died	Address changed	Missing	Unknown	Total
Ambanja	0	4	0	0	4	0	8
Ifanadiana	1	3	0	1	0	0	5
Ikongo	1	4	4	0	15	9	33
Mananjary	0	19	13	6	25	23	86
Total	**2**	**30**	**17**	**7**	**44**	**32**	**132**

Throughout data collection, field supervisors performed quality control in the form of accompaniment, co-enumeration, and back-checks. 68 of the surveyed received an accompaniment, while 21 households were co-enumerated by the interviewer and supervisor, and 82 of the surveyed households were contacted for a short back-check survey to verify key responses. Additionally, each team organized a daily debriefing to discuss the work progress, to review any challenges faced, clarify questions related to the survey protocol, and solve any problems encountered.

5. RESULTS

The TSIRO Baseline Survey findings are organized into six categories: (1) demographics and background characteristics; (2) livelihoods; (3) agriculture; (4) food security and health; (5) natural resources and energy use; and (6) gender and empowerment. In each of the following sub-sections, we present results from key indicators within each category, as well as statistical tests of differences across the region and other disaggregations.

5.1 DEMOGRAPHICS & BACKGROUND CHARACTERISTICS

This section presents an overview of the demographics and background characteristics of the sample. This section is based on responses to the Household Roster module of the survey, which collected information on each individual member of the household, including their age, education, literacy, and work status.

5.1.1 Household Size and Composition

Table 4 presents summary statistics on the size and composition of households in the TSIRO Baseline Survey sample. Across the full TSIRO Alliance implementation area, the average participating household had between five and six members. The mean number of adults per household was 2.7, with a roughly equal share of male and female adults. There was approximately one female of reproductive age (ages 15-49), and fewer than one child under the age of five within each household. Household size was significantly larger among beneficiaries in the COFAV region than in the COMATSA region, which appears to largely be driven by a higher number of females of reproductive age and children over the age of five. Across all households, just 11.5% were headed by a woman.

TABLE 4: HOUSEHOLD SIZE AND COMPOSITION BY REGION

	Overall		COFAV		COMATSA		
	N	Mean	N	Mean	N	Mean	Signif
Household size	755	5.62	678	5.66	77	4.96	*
Number of adults (>18)	755	2.74	678	2.74	77	2.74	
Number of adult males (>18)	755	1.40	678	1.39	77	1.44	
Number of adult females (>18)	755	1.34	678	1.34	77	1.30	
Number of females of reproductive age (15-49)	755	1.26	678	1.27	77	1.08	***
Number of youth (15-29)	755	1.56	678	1.56	77	1.38	
Number of children over five years of age	755	2.39	678	2.42	77	1.71	***
Number of children under five years of age	755	0.67	678	0.67	77	0.64	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

5.1.2 Gendered Household Type

Figure 2 presents the share of households that fall within each gendered household type in the sample. Nearly 90% of households in the TSIRO Alliance population consisted of male and female adults, nearly 7% had an adult female but no adult male, and 3.5% were comprised of an adult male and no adult female. None of the sampled households consisted of children and no adults. There were no significant differences in gendered household type across the COFAV and COMATSA regions (see **table D2** in Appendix D for detailed results by region).

FIGURE 2: GENDERED HOUSEHOLD TYPE BY REGION

Differences found to be statistically significant are indicated by level: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

5.1.3 Education & Employment

Figure 3 displays the highest education level achieved by household heads in the sample. Household heads most commonly reported having a primary school education, with more than 53% of respondents indicating this was their highest education level achieved. The share of household heads whose highest education level was preschool, primary, or higher education/university was significantly higher in the

COFAV region, while the proportion reaching secondary first cycle was significantly higher in the COMATSA region. 78.5% of household heads in the sample were literate, with no significant difference across region. (See **table D3** in Appendix D for detailed results on the education and literacy of household heads).

FIGURE 3: EDUCATION OF HOUSEHOLD HEAD BY REGION

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Table 5 reports on the employment status and payment structure of household heads. Virtually all beneficiary household heads worked in the last 12 months. Although a similar share of respondents worked across the COFAV and COMATSA regions, the payment structure significantly differed by region. Whereas half of the respondents in the COFAV region were not paid for their work in the last year, more than 90% of those in the COMATSA region were not paid.

TABLE 5: EMPLOYMENT OF HOUSEHOLD HEAD BY REGION

	Overall		COFAV		COMATSA		
	N	Percentage	N	Percentage	N	Percentage	Signif.
Employment							
Worked in last 12-months	748	98.65	671	98.65	77	98.70	
Paid in cash only	734	28.25	658	29.39	76	6.58	***
Paid in cash and in-kind	734	16.46	658	17.32	76	0.00	***
Paid in-kind only	734	3.28	658	3.45	76	0.00	***
Not paid	734	52.01	658	49.83	76	93.42	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.2   LIVELIHOODS

This section presents an overview of the livelihoods of participating households in the TSIRO implementation area. This section is based on responses to the Poverty module and Credit & Groups module of the survey. As described in section 3.8, the Poverty module consists of 10 weighted survey questions, identified through a rigorous machine learning approach, that can accurately predict the likelihood that a household lives in poverty in Madagascar. The Credit & Groups module collected

information on households' access to and use of credit, groups, and organizations that exist in the community, as well as activities and social assistance that have benefited each household in the past.

5.2.1   Prevalence of Poverty

Using machine learning methods, we analyzed up-to-date information from the 2020 Food for Peace Endline Survey in Madagascar to predict poverty in relation to current poverty national and international poverty lines. As standard consumption/expenditure survey modules can take more than an hour to complete per household, our approach identified a subset of 10 survey questions that can accurately predict poverty in Madagascar. Using the 10 selected variables, our model accurately predicts the poverty status of 83% of households in the 2020 Food for Peace Endline sample. Technical details behind this methodology and the set of selected questions are discussed further in Appendix E.

FIGURE 4: PREVALENCE OF POVERTY AT THE $1.90/DAY POVERTY LINE
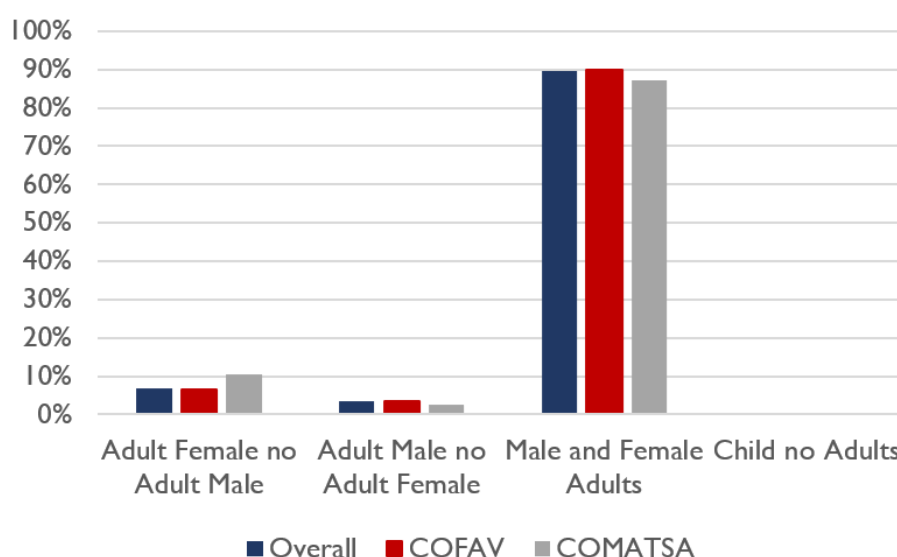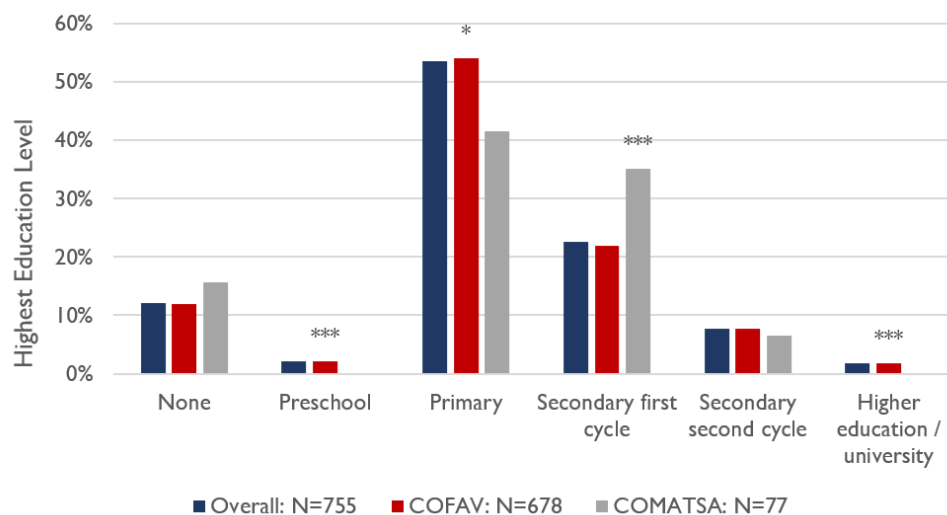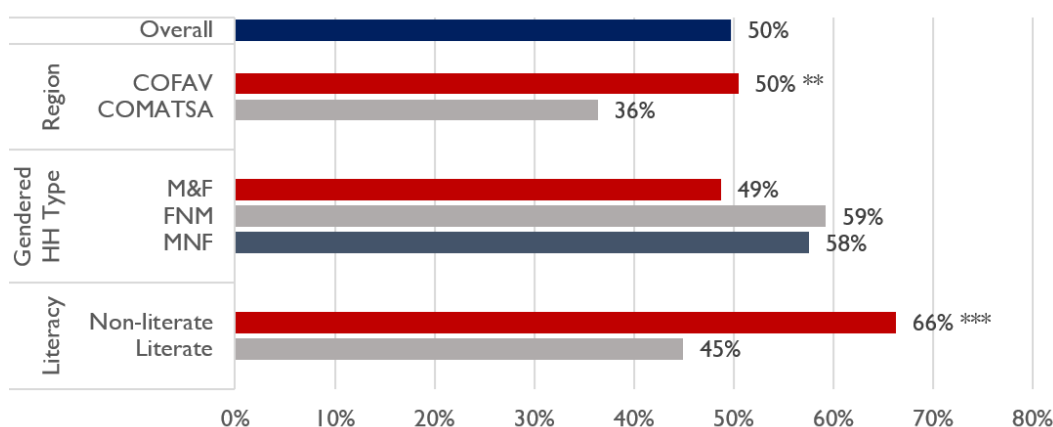

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.
Gendered household types are male and female adults (M&F), adult females and no adult males (FNM), adult male and no adult female (MNF)

Nearly 50% of participating households in the TSIRO implementation area fell below the USD $1.90 per day poverty line (**figure 4**). The share of households that fell below this threshold was significantly higher among beneficiaries in the COFAV region (50.5%) than those in the COMATSA region (36.4%). The prevalence of poverty also significantly differed by whether the household head was literate, with 45% of households with a literate household head living in poverty compared to 66.3% of those with a non-literate household head. Interestingly, there were no significant differences in the prevalence of poverty between different gendered household types (see **table D4** in Appendix D for detailed estimates).

As the TSIRO Baseline Survey sample is not intended to be representative of all households in the implementation areas, we used the 2010 INSTAT Periodic Household Survey[26] to estimate the prevalence of poverty among all households in the COMATSA and COFAV regions (more commonly known as Diana and Vatovavy Fitovinany, respectively). Importantly, INSTAT reports poverty according to the MGA 468,800 per person per year poverty line, which is not directly comparable to that of the USD $1.90 per person per day poverty line used by USAID. Therefore, we followed FTF guidance to estimate the

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[26] This is the most recent nationally representative data that is publicly available for Madagascar.

prevalence of poverty according to the USD $1.90 per person per day poverty line by converting the raw consumption estimates from the 2010 INSTAT data into USD at 2011 purchasing power parity (PPP).

Following this approach, we estimate that the national prevalence of poverty in Madagascar was 67.8% in 2011, with 77.5% of all households in Vatovavy Fitovinany falling below the USD $1.90 poverty line and just 39.4% of households in Diana falling below this threshold. Acknowledging that rates of poverty have likely meaningfully changed since 2010, the estimated prevalence of poverty among TSIRO participants in COFAV appear to be much lower than that of all households in the Vatovavy Fitovinany region in 2010 (50.5% compared to 77.5%). However, the estimated prevalence of poverty among TSIRO participants in COMATSA appears comparable to that of all households in the Diana region in 2010 (36.4% compared to 39.4%).

5.2.2 Dwelling Characteristics

Figure 5 presents the dwelling characteristics of households in the sample. The most common roofing material was thatch/palm/leaves (65.4%), followed by sheet (28.3%), and motte grass (5.7%). Fewer than one percent of households had wooden boards or another type of material, while no households had tile as their roofing material. Households in the COFAV area were significantly more likely to have thatch/palm/leaf or motte grass roofs, while those in the COMATSA region were significantly more likely to have sheet roofs. 47.7% of households had thatch/palm/leaves walls, compared to 19.3% with mud, 15.5% with other wall material, and 10.4% with wooden boards as walls (see **table D5** in Appendix D for regional disaggregations). A significantly higher share of TSIRO households in the COFAV region had thatch/palm/leave, mud, and brick and mortar walls, while those in the COMATSA region were significantly more likely to have cement or other wall material.

Beneficiary households' main lighting sources were somewhat evenly split between oil lamps (38.0%), solar panels (29.6%), and energy provided by the ADAPS association (28.5%). Oil lamps and ADAPS were significantly more common in the COFAV region, while solar panels were significantly more common in the COMATSA region (70.1%). The most frequently reported source for cooking energy was firewood with 91.9% of households, followed by charcoal (8.1%), and gas (0.1%). Whereas a significantly higher share of households used firewood in the COFAV region than the COMATSA region, the share using charcoal as their main source of cooking energy was significantly higher in the COFAV region.

FIGURE 5: DWELLING CHARACTERISTICS
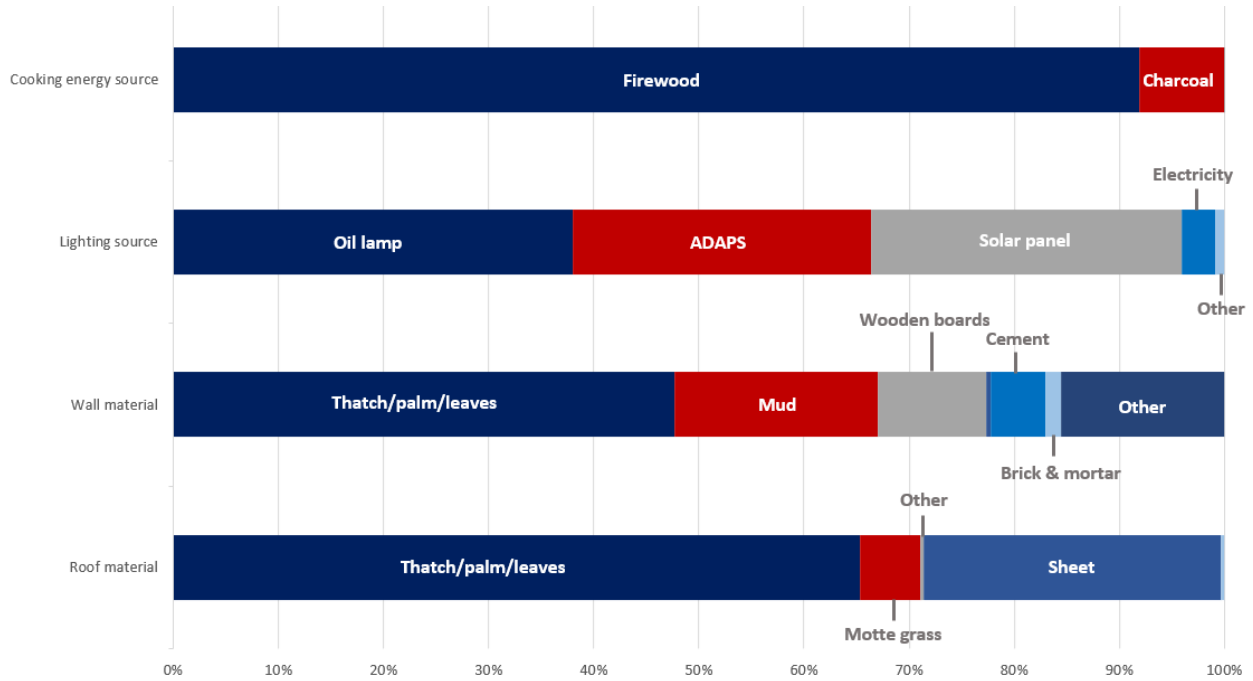
5.2.3 Access to Credit

Respondents were asked whether anyone in their household borrowed cash, in-kind, or a combination of cash and in-kind in the last year from six different sources. **Figure 6** reports on the share of TSIRO households that borrowed from each source, regardless of whether this was cash or in-kind. The most common borrowing source among beneficiaries in the TSIRO implementation area was a friend or relative (36.2%), followed by group-based micro-finance (20.6%), and non-governmental organizations (4.1%). Fewer than 3% of households in the sample borrowed from a formal lender, while less than 1% borrowed from an informal lender.

The share of participant households that borrowed from a friend or relative was significantly higher in the COFAV region (37.3%) than in the COMATSA region (15.6%). Conversely, the share of households that borrowed via group-based micro-finance and from a formal lender was significantly higher in the COMATSA region. Although less than 20% of households in the COFAV region borrowed from a group-based micro-finance organization, more than 44% did so in the COMATSA region. Similarly, less than 2% of participating households in the COFAV region borrowed from a formal lender, 18.2% borrowed from this source in the COMATSA region. **Table D6** in Appendix D provides detailed estimates disaggregated by region.

FIGURE 6: BORROWING BY REGION
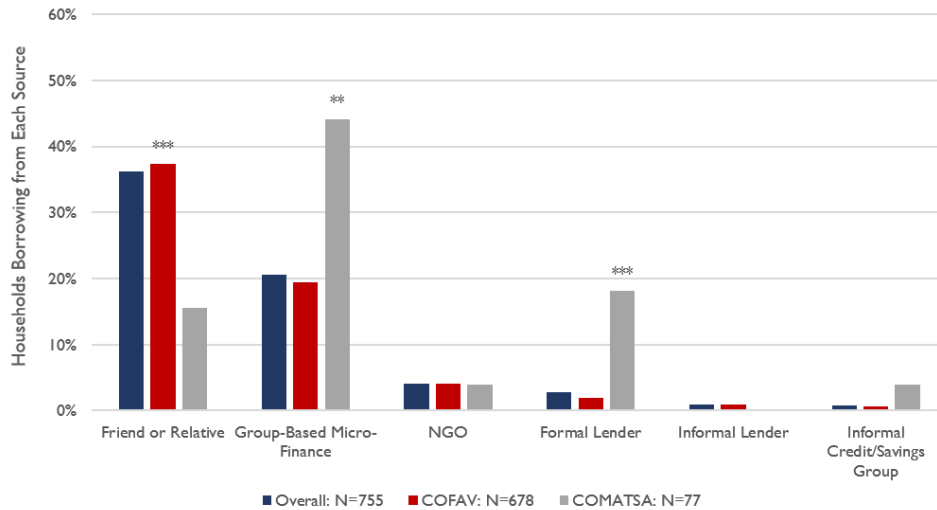
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Among households that did borrow from a given source in the last year, respondents were asked who made the decision to borrow and who makes the decision about how the money/items borrowed will be used. **Table 6** reports the share of respondents that indicated that they made these decisions alone, jointly, or that someone else made the decision.[27] We also report statistical tests of differences by respondent gender.

63.1% of respondents that borrowed from a friend or relative indicated that they made the decision to borrow jointly, while 29.6% indicated making this decision alone and 7.3% responded that someone else made this decision. Female respondents were significantly more likely to make the decision to borrow from a friend or relative alone, while male respondents were significantly more likely to report making this decision jointly. Among households that borrowed from group-based micro-finance, 56.4% of respondents made the decision to borrow jointly, while 34.9% made this decision alone and 8.7% responded that someone else made this decision. Borrowing decisions did not significantly differ by respondent gender for group-based micro-finance.

Among households that borrowed from a friend or relative, 63.2% of respondents indicated that they jointly made the decision about how to use the borrowed money/items, compared to 29.6% of respondents that indicated making this decision alone and 7.3% that responded that someone else made this decision. Female respondents were significantly more likely to report making the decision over how to use this money alone, while male respondents were significantly more likely to report doing so jointly. Trends were similar for households that borrowed from group-based micro-finance, with 65.3% of respondents indicating that they made the decision about how to use the borrowed money/items jointly and 28% that indicated making this decision alone. Similarly, women were significantly more likely to report

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[27] Note that we only present these statistics for the borrowing sources that have a large-enough sample size to report point estimates and disaggregations.

making this decision alone, while male respondents were significantly more likely to report making this decision jointly.

TABLE 6: BORROWING AND USE DECISIONS BY GENDER

	Overall		Male		Female		Signif.
	N	Percentage	N	Percentage	N	Percentage	
Decision to borrow from each source							
Friend or relative							
Self	261	29.57	169	23.63	92	40.33	**
Jointly	261	63.11	169	68.20	92	53.89	*
Other	261	7.32	169	8.17	92	5.78	
Group-based micro-finance							
Self	152	34.85	79	27.83	73	42.35	
Jointly	152	56.42	79	62.14	73	50.32	
Other	152	8.72	79	10.02	73	7.34	
Decision about how to use loan from each source							
Friend or relative							
Self	261	26.65	169	18.56	92	41.33	***
Jointly	261	63.15	169	70.21	92	50.35	*
Other	261	10.20	169	11.23	92	8.32	
Group-based micro-finance							
Self	152	28.02	79	13.51	73	43.50	**
Jointly	152	65.28	79	78.93	73	50.72	**
Other	152	6.70	79	7.57	73	5.78	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.2.4 Group Membership

Households were asked to indicate whether 10 separate groups or associations existed in their community and whether or not they participated in each. **Figure 7** reports on the share of households that indicated that each group was present in their community as well as whether they are members of each group. The red bar in this figure displays the share of households reporting that each group exists in their community. Among those who did report having each group in their community, the blue bar displays the share of households that report being a member of each group. For example, the top bar indicates that 81.83% of all households reported that a women's group is present in their community (shown in red), while 68.64% of households that have such a community reported being a member of this group (shown in blue).

The groups that were most prevalent in the TSIRO implementation areas were women's groups, local government, agricultural producer's groups, and credit/micro-finance groups. 81.8% of households reported that a women's group was present in their community, with no significant difference across regions. Among households that do have a women's group in their community, 68.6% are members of this group. 77.6% of households indicated the presence of local government in their community, with a significantly larger share indicating this in the COMATSA region (97.4%) than in the COFAV region (76.6%). Just 14% of households with local government in their communities indicated that they are members of this group. Nearly 60% of households indicated that there was an agricultural producer's group in their community. A significantly larger share of households in the COMATSA region reported the presence of a producer's group than in the COFAV region, at 77% and 59%, respectively. Among the households that do have an agricultural producer's group in their community, 85.2% were members of their local group. 45.7% of households reported that a credit/micro-finance group was present in their community, with a significantly larger share indicating this in the COMATSA region (89.3%) than in the

COFAV region (43.4%). Among households that do have a credit/micro-finance group in their community, 54.2% are members of this group, with no significant differences in membership by region.

FIGURE 7: GROUP EXISTENCE AND MEMBERSHIP
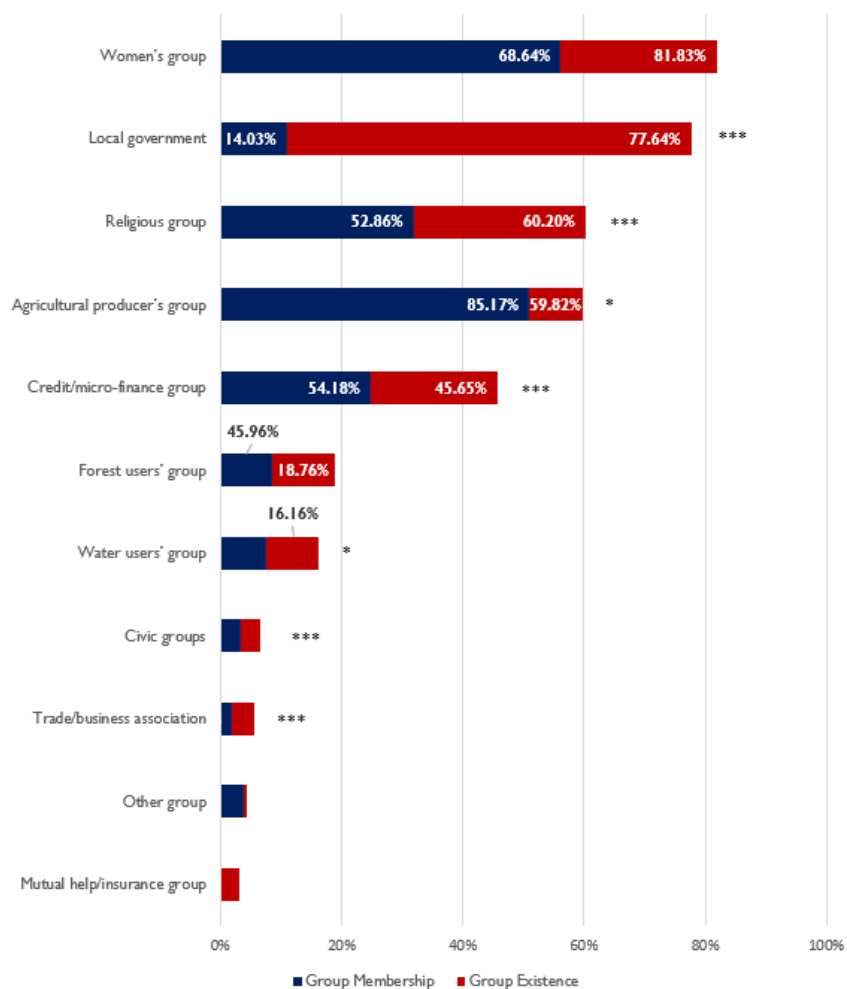
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Figure 8 disaggregates the shares of households that are members of each group by male and female respondents.[28] Across all groups, the only significant differences in membership by respondent gender were among credit/micro-finance groups and religious groups. Female respondents were significantly more likely to be members of both groups than male respondents. Whereas 46.9% of male respondents reported being members of their local credit/micro-finance group, 65.3% of female respondents indicated the same. Similarly, 64.1% of female respondents were members of their local religious groups, compared to 47.1% for male respondents.

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[28] Note that the Credit & Groups module of the TSIRO Baseline Survey did not require a specific gender of the respondent, and therefore we do not have a representative sample of male and female respondents to this module.

FIGURE 8: GROUP MEMBERSHIP BY GENDER
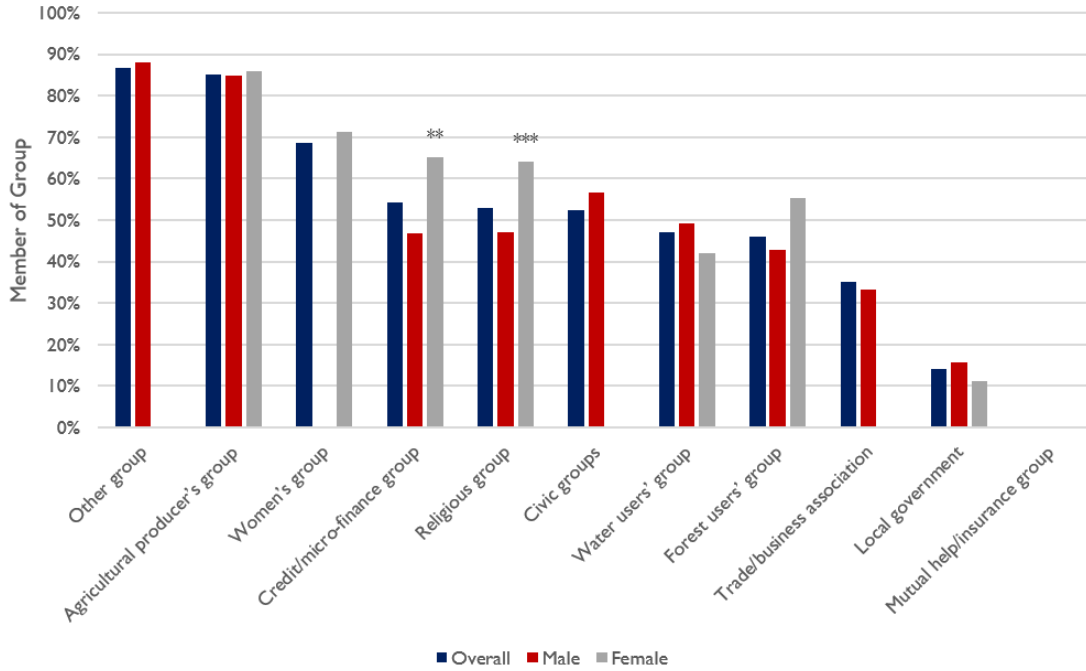
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.2.5   Social Assistance Participation

Beneficiary households were asked about their social assistance participation across a range of activities. **Figure 9** reports the share of households that indicated participating in or receiving social assistance across each activity. The most common form of social assistance participation was activities funded by the government, NGOs, or other organizations in the last five years (43.4%), followed by agriculture/livestock trainings (38.6%), and projects funded by USAID over the last five years (38.5%). A significantly higher share of households in the COFAV region reported participation in USAID-funded projects than those in the COMATSA region, at 39.5% and 18.4%, respectively. Conversely, whereas 29.4% of households in the full TSIRO implementation area indicated participation in agroforestry, forest conservation, or natural resource management trainings/activities, a significantly higher share of households in the COMATSA region participated (46.8%) than in the COFAV region (28.5%).

FIGURE 9: SOCIAL ASSISTANCE PARTICIPATION BY REGION
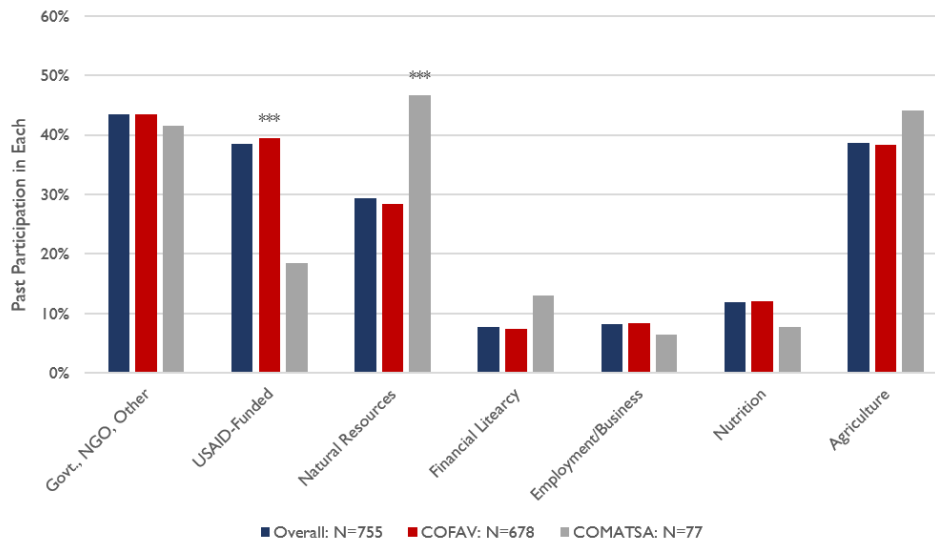
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.3   AGRICULTURE

This section summarizes the agricultural production and land tenure of households in the TSIRO Baseline Survey sample. This section is based on responses to the Agriculture module of the survey, which asks households about their agricultural production, use of improved management practices, and land ownership and tenure status.

5.3.1   Agricultural Plots and Crops Grown

Table 7 displays the total number of plots held by each household, as well as the total area of all plots held. The average household in the TSIRO Baseline Survey holds three plots of land, with no significant difference across the COFAV and COMATSA regions. On average, the total area of these plots is 3.02 hectares.

TABLE 7: NUMBER OF PLOTS AND TOTAL AREA BY REGION

	Overall		COFAV		COMATSA		
	N	**Mean**	**N**	**Mean**	**N**	**Mean**	**Signif**
Number of plots	754	3.01	677	2.99	77	3.42	
Total area of plots (hectares)	755	3.02	678	2.98	77	3.83	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Households were asked to list all of the crops that they planted, cultivated, or harvested in the last 12 months (results are shown in **Figure 10**). The average TSIRO household grows 4.3 different types of crops, with 78.3% of households growing at least one of the four activity crops (cacao, vanilla, black pepper, or cinnamon). The most commonly grown crops were rice (95.4%), cassava (72.8%), vanilla (66.0%), and fruits (62.6%). Among the four TSIRO activity crops (cacao, vanilla, black pepper, and cinnamon), the share of households growing each ranged from 13.9% for cacao to 66.0% for vanilla. The share of participant households growing cacao and vanilla were significantly larger in the COMATSA region than in the COFAV

region. In particular, fewer than 9.5% of beneficiary households in the COFAV region grew cacao, compared to 98.7% of beneficiary households in the COMATSA region. Conversely, a significantly higher share of such households in the COMATSA region grew black pepper, cinnamon, cassava, groundnuts, potatoes or sweet potatoes, and fruits than those in the COFAV region.

FIGURE 10: CROPS GROWN BY REGION

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.3.2   Production and Sales of Targeted Crops

Among households that grew each of the four activity crops in the last year, **figure 11** displays the yield (tons per hectare harvested) for each. Additionally, **Table D13** provides detailed estimates on the total area planted, cultivated, and harvested for each crop (see Appendix D). The average cacao-producing household planted just 0.1 hectares of cacao in the last year, while harvesting 0.75 hectares.[29] The average cacao yield was 2.5 tons per hectare. Black pepper was produced in the smallest quantity among the four activity crops, with 0.04 hectares planted in the last year, 0.13 hectares cultivated during this period, and an average yield of 0.56 tons per hectare. Zero cacao-producing households reported engaging in post-harvest processing, so cacao yield estimates are assumed to be wet cacao. Wet cacao typically weighs around three times more than cacao that has been dried via post-harvest processing.

Among households that grew cinnamon in the last year, the average household planted 0.15 hectares while harvesting 0.17 hectares. The average cinnamon yield was 1.52 tons per hectare. Vanilla was produced in the largest quantity among the targeted crops, with 0.19 hectares planted in the last year, 0.39 hectares cultivated, for an average yield of 0.3 tons per hectare.

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[29] As cacao is a tree crop with long harvesting cycles, farmers typically harvest trees that were planted several years prior.

FIGURE 11: PRODUCTION AND YIELD OF TARGETED CROPS
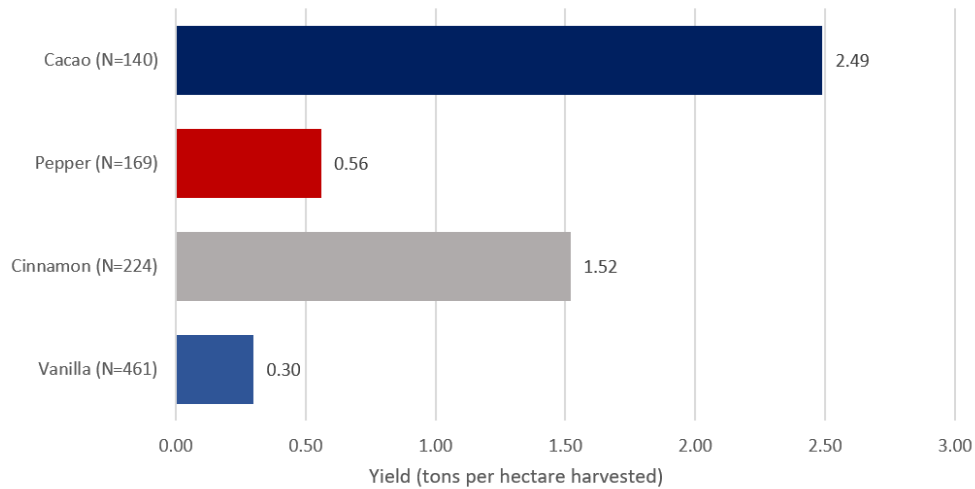
Due to small sample sizes within each subgroup, statistical test of differences are not reported in this figure

Figure 12 displays the value of sales from each in the last year (the total amount of each targeted crop sold is presented in **Table D14** in Appendix D). The average cacao-producing household sold 1.89 tons in the last year and reported earning USD $1,420.97 from cacao sales. Among households that grew black pepper in the last year, the average household sold 0.01 tons and reported earning USD $13.23 from those sales. The average cinnamon-producing household sold 0.06 tons in the last year and reported USD $44.35 in revenue from those sales. Due to small sample sizes in the COMATSA region, significance tests of differences across regions are not reported for black pepper or cinnamon. Finally, among households that grew vanilla in the last year, the average household sold just 0.01 tons and earned USD $134.98 in revenue from vanilla sales. There were no significant differences in the amount or value of vanilla sales across regions.

FIGURE 12: SALES OF TARGETED CROPS
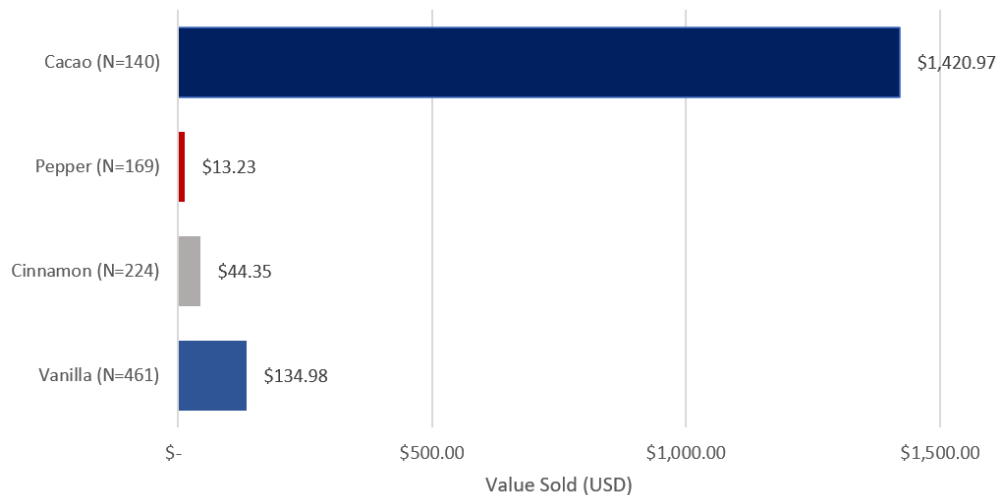
Due to small sample sizes within each subgroup, statistical test of differences is not reported in this figure

Figure 13 expands on the sales of targeted crops by reporting the share of crop-producing households that sold (i) directly to a company, (ii) to a local buyer/trader, (iii) to a local market, or (iv) to another source. The share of households selling cacao directly to a company or to a local buyer/trader was significantly higher in the COMATSA region than in the COFAV region, while the share selling cacao to another source was significantly higher in the COFAV region than COMATSA. The share of households selling vanilla to a local market was significantly higher in the COMATSA region than in the COFAV region. See **table D14** for regional disaggregates.

FIGURE 13: SALES CHANNEL FOR TARGETED CROPS
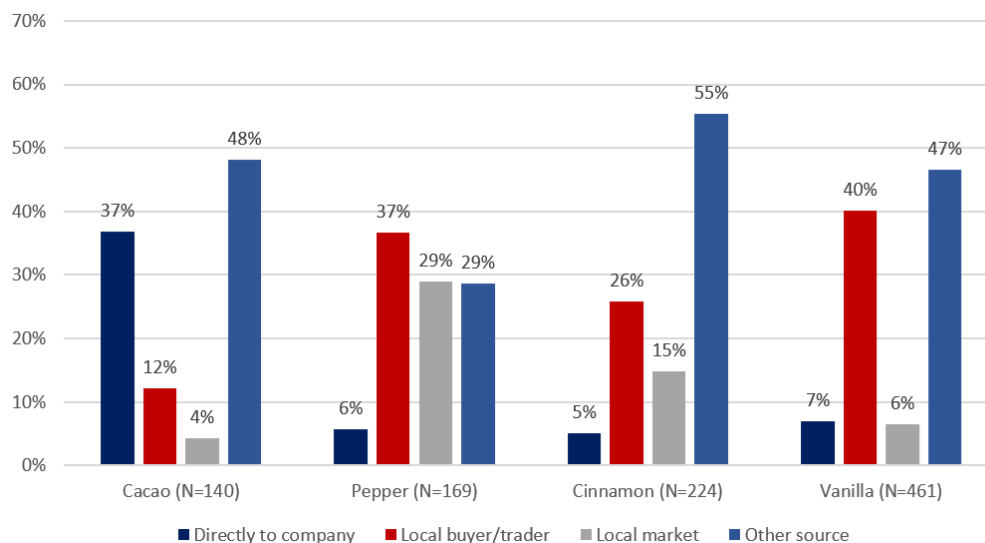
Due to small sample sizes within many subgroups, statistical test of differences is not reported in this figure

5.3.3   Improved Management Practices

Figure 14 reports the share of households that used improved management practices. The most commonly used practices were techniques for weed management (94.9%), followed by the use of post-harvest processing techniques (79.4%), and use of water management (71.2%). The share of households using improved seeds, planting materials, or seedlings, as well as those using soiling fertilization and water management were significantly higher in the COFAV region than in the COMATSA region. Conversely, the share of households using vaccination or deworming and techniques to feed animals through locally available foods was significantly higher in the COMATSA region than in the COFAV region.

FIGURE 14: USE OF IMPROVED MANAGEMENT PRACTICES BY REGION
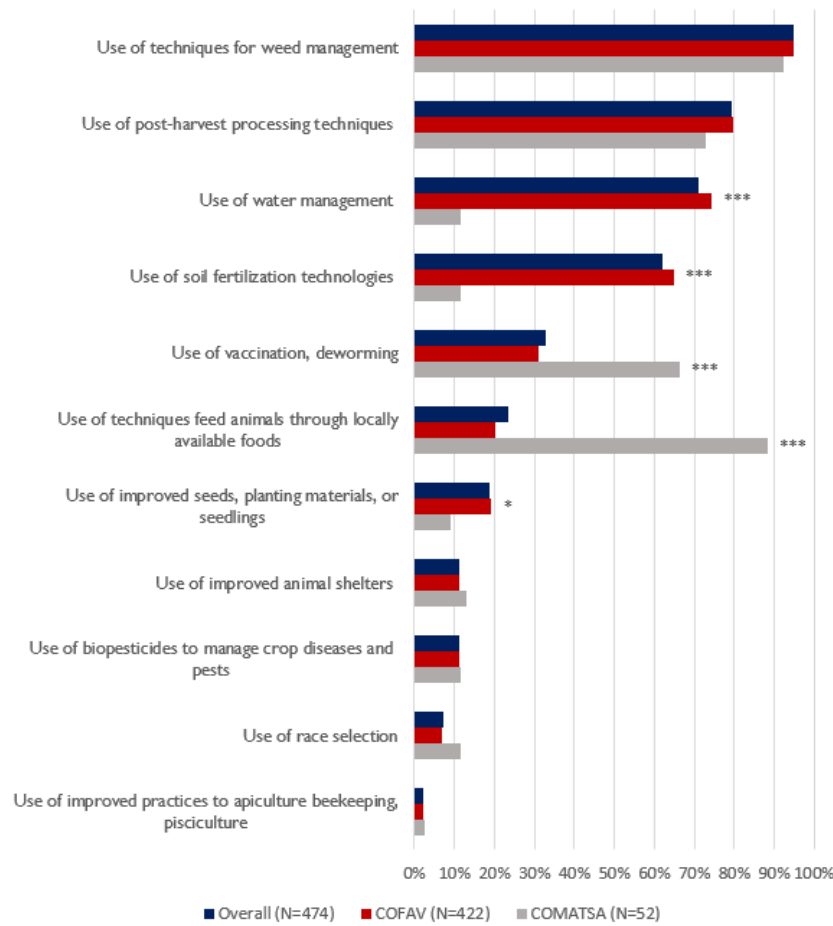
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Figure 15 presents the share of households using improved natural resource management practices. The most commonly used practices were techniques to protect soil from bush fires (58.1%), integrating agroforestry with cash crop production (53.6%), water management techniques (53.4%), and soil fertility management techniques (52.7%). The share of households using soil fertility management techniques, techniques to protect soil from bush fires, and water management techniques was significantly higher in the COFAV region than in the COMATSA region. The share of households using watershed management techniques was significantly higher in the COMATSA region.

FIGURE 15: USE OF IMPROVED NATURAL RESOURCES MANAGEMENT PRACTICES BY REGION
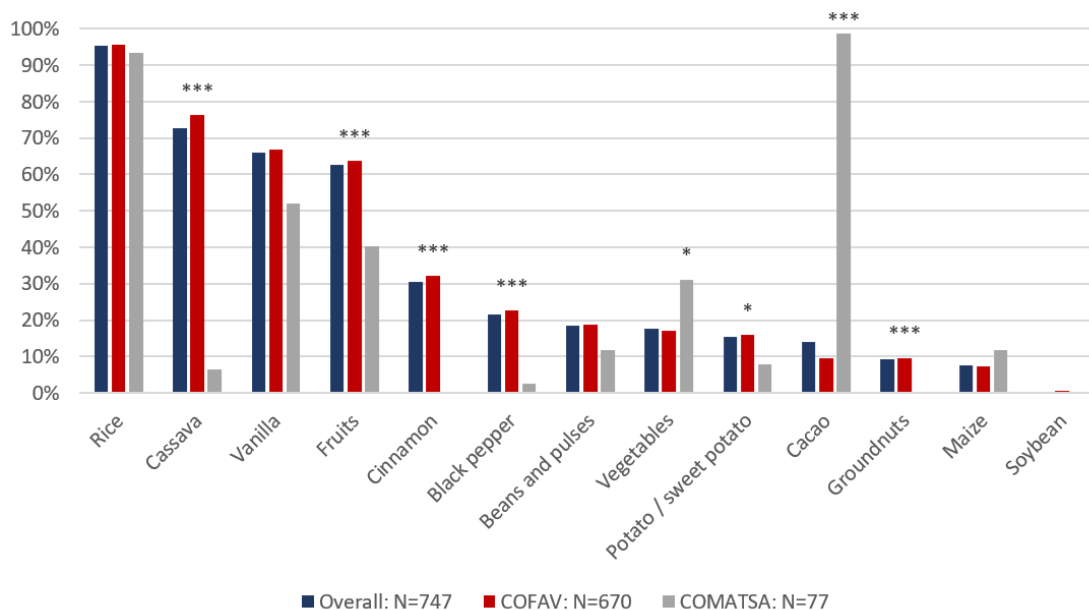

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.3.4 Livestock Production

Figure 16 displays the share of households raising targeted livestock in the last 12 months. 79.4% of all households raised livestock in the last year. Among households that did raise livestock, the most commonly raised livestock were chickens (92.4%), followed by ducks (21.9%), geese (4.6%), and goats (0.7%). Although households in the COFAV and COMATSA regions were equally likely to have raised livestock overall, the composition of animals raised varied significantly by region. A significantly higher share of households in the COFAV region raised chickens and geese, while a significantly higher share of households in the COMATSA region raised ducks and goats.

FIGURE 16: LIVESTOCK PRODUCTION BY REGION

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.3.5   Land Ownership and Tenure Status

Finally, **Table 8** presents the share of households whose land falls under different ownership arrangements. 38.4% of households hold non-titled, privately-owned land with formal documents, 37.5% hold land with no documents, while 27.4% of households hold certified land. The share of households that hold certified land was significantly higher in the COFAV region than in the COMATSA region, while the share that hold titled land, and non-titled privately-owned land with formal or simple documents was significantly higher in the COMATSA region. Importantly, just three percent of participating households indicated owning land that overlaps a protected area or *transfert de gestion*, with no significant differences by region.

TABLE 8: LAND OWNERSHIP ARRANGEMENT BY REGION

	Overall		COFAV		COMATSA		
	N	Percentage	N	Percentage	N	Percentage	Signif.
Percentage of households with ownership arrangement:							
State owned	755	0.92	678	0.97	77	0.00	
Titled	755	6.13	678	5.63	77	15.58	*
Certified	755	27.44	678	28.19	77	12.99	*
Non-titled privately-owned with formal documents	755	38.44	678	37.60	77	54.55	*
Non-titled privately-owned with simple documents	755	8.96	678	8.08	77	25.97	***
No documents	755	37.54	678	37.67	77	35.06	
Other	755	2.02	678	1.85	77	5.19	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.4   FOOD SECURITY AND HEALTH

5.4.1   Food Insecurity Experience Scale

The experience of food insecurity is characterized by uncertainty and anxiety regarding food access and changes in the quality of the diet (i.e., less balanced and more monotonous diets). As food insecurity becomes severe, the quantity of food consumed by the household decreases as the portion sizes are

reduced and meals are skipped. When food insecurity is most severe, individuals are forced to go without eating.

For the TSIRO Baseline Survey, the prevalence of moderate and severe food insecurity indicator is based on the FIES, which measures the percentage of individuals that experienced food insecurity at moderate or severe levels during the 12 months preceding the survey. FIES is a scale established by the United Nations' Food and Agriculture Organization that is used to estimate the probability that each household or individual belongs to a specific category of food insecurity severity. The difficulty in accessing food due to lack of money or other resources is measured from answers to a set of eight questions covering a range of severity of food insecurity in the 12 months preceding the survey. Respondents are assigned a probability of being in one of three categories—little to no food insecurity, moderate food insecurity, and severe food security. The moderate and severe food insecurity category is the cumulative probability of being in two categories of moderate and severe food insecurity.

In the full sample, 71.1% of households were classified as moderately or severely food insecure, with 62.5% classified as moderate, 8.6% categorized as severe, and 28.9% of households experiencing little to no food insecurity (**figure 17**). 72.9% of households in the COFAV region experienced moderate or severe food insecurity, compared to just 30.7% in the COMATSA region. The share of households experiencing food insecurity was largely similar across gendered household types, with 65.3% of FNM households categorized as moderately or severely food insecure and 71.3% meeting this criterion among M&F households.

FIGURE 17: FOOD INSECURITY EXPERIENCE SCALE
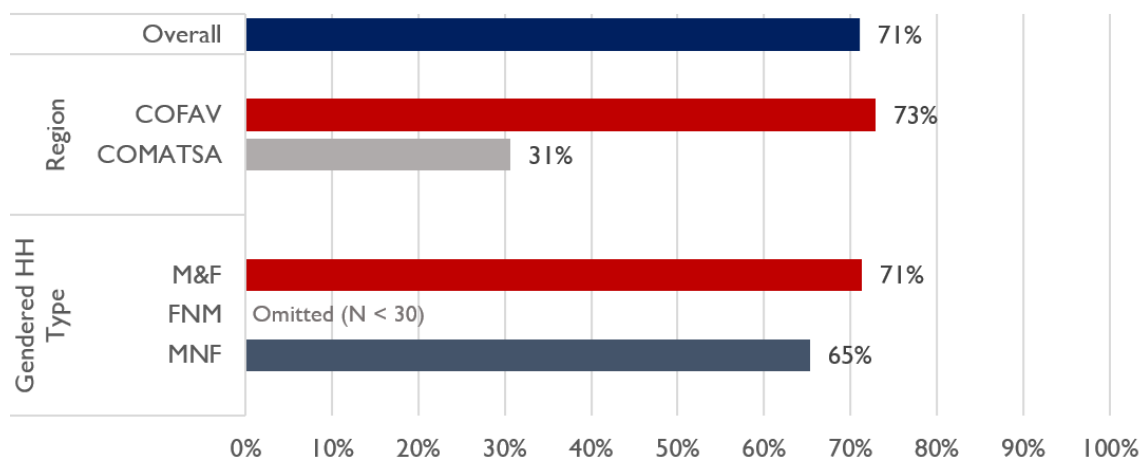
Gendered household types are male and female adults (M&F), adult females and no adult males (FNM), adult male and no adult female (MNF)

5.4.2   Women's Dietary Diversity

The primary indicator used to measure women's dietary diversity in the TSIRO Alliance intervention area is minimum dietary diversity–women (MDD-W), which is the proportion of women of reproductive age who are consuming a minimum dietary diversity. MDD-W is a new version of the Women's Dietary Diversity Score (WDDS) indicator. The MDD-W was developed based on results of recent research to

improve the utility of the WDDS. MDD-W is considered more useful for reporting and describing progress toward improved nutrition for women than WDDS.

MDD-W captures the proportion of women of reproductive age in the project implementation areas who are consuming a minimum dietary diversity. A woman of reproductive age is considered to be consuming a minimum dietary diversity if she consumed at least 5 of 10 specific food groups in the previous 24 hours.

The 10 food groups are listed below:

- Grains, roots, and tubers
- Legumes and beans
- Nuts and seeds
- Dairy products
- Eggs
- Flesh foods including organ meat and miscellaneous small animal protein
- Vitamin A-rich dark green leafy vegetables
- Other vitamin A-rich vegetables and fruits
- Other fruits
- Other vegetables

FIGURE 18: MINIMUM DIETARY DIVERSITY-WOMEN BY REGION
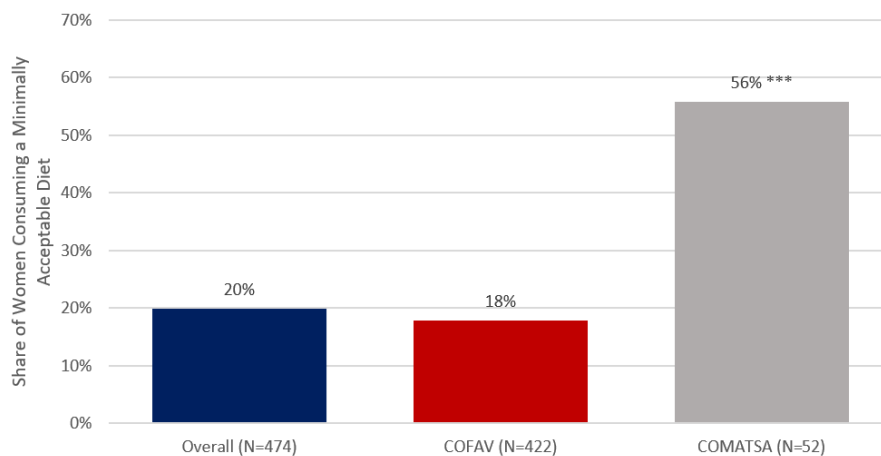
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Figure 18 shows that the share of women consuming a diet of minimum diversity was 19.9% for the full sample, with a significantly higher percentage of women in the COMATSA region consuming a diverse diet (55.8%) than those in the COFAV region (17.9%). The average female respondent consumed 3.3 out of 10 food groups in the 24-hours preceding the survey. The average number of food groups consumed was significantly higher in the COMATSA region than in the COFAV region, at 4.4 and 3.3, respectively.

Of the 10 food groups included in the MDD-W, **figure 19** shows that the most commonly consumed was grains, white roots, and tubers (97.2%), followed by dark green and leafy vegetables (69.7%), other vegetables (45.2%), and meat, poultry, and fish (40.1%). The share of households consuming dairy, meat,

poultry, and fish, and other vegetables was significantly higher in the COMATSA region than in the COFAV region, while a significantly higher share of households in the COFAV region consumed dark green and leafy vegetables than those in the COMATSA region. Interestingly, only one household reported consuming wild meat in the last 24-hours.

FIGURE 19: FOOD GROUPS CONSUMED BY REGION
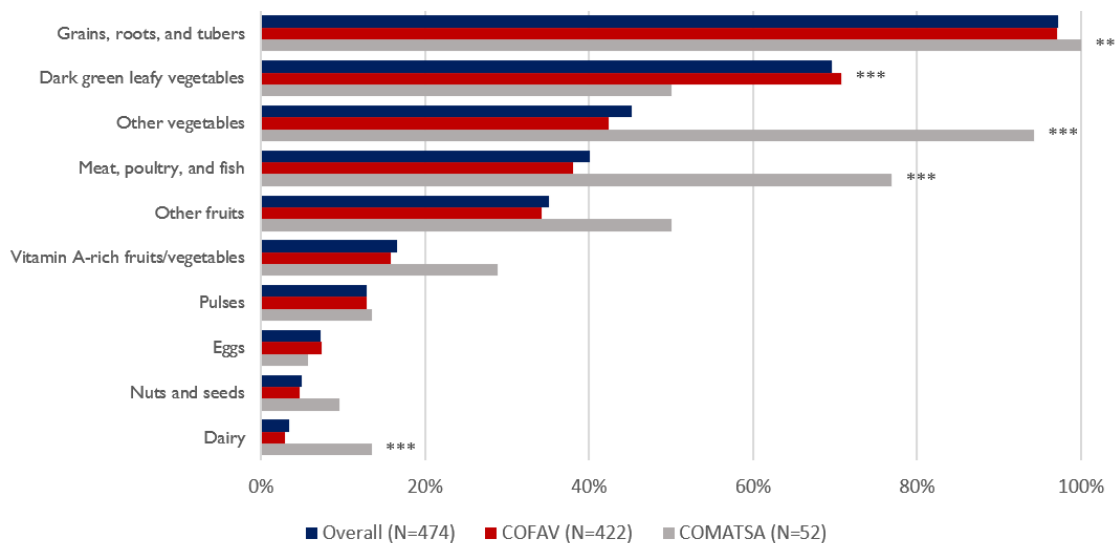
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.4.3   Coping Strategies Index

The CSI measures the extent that households use different consumption coping strategies when faced with limited food access. The CSI is a proxy of a household's resilience to negative food security shocks as well as their absorptive capacity to such shocks.

To measure CSI, households are asked if they have used any of the consumption coping strategies below over a 30-day recall period as a result of food access challenges. During analysis, the frequency was recoded into the following frequency weights: Never = 0; Seldom = 0.5; Sometimes = 1.5; Often = 3.5 and Daily = 7. The score for each strategy frequency is multiplied by the weight given to each strategy to get a weighted score for a single strategy. The weighted scores for each strategy are then added together to get a household coping strategy index. Higher scores are associated with an increased frequency and severity of coping behaviors.

The average CSI score was 33.2, with a significant difference across regions (**table D22**). Households in the COFAV region scored significantly higher on the CSI (34.6) than those in the COMATSA region (6.3), suggesting that beneficiaries in the COFAV region turn to consumption coping strategies with more frequency and severity than those in the COMATSA region.

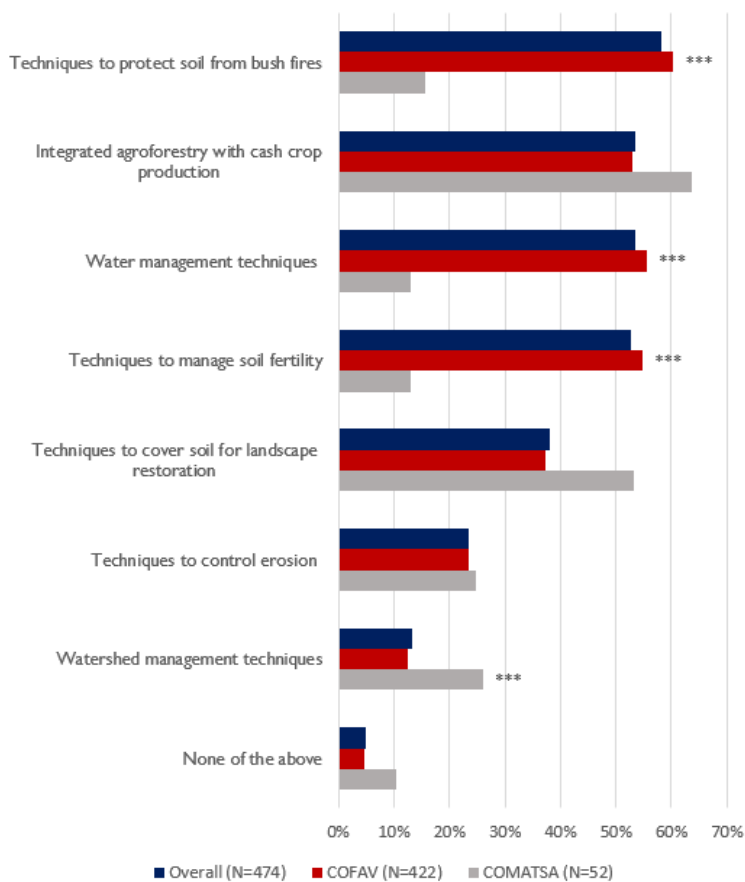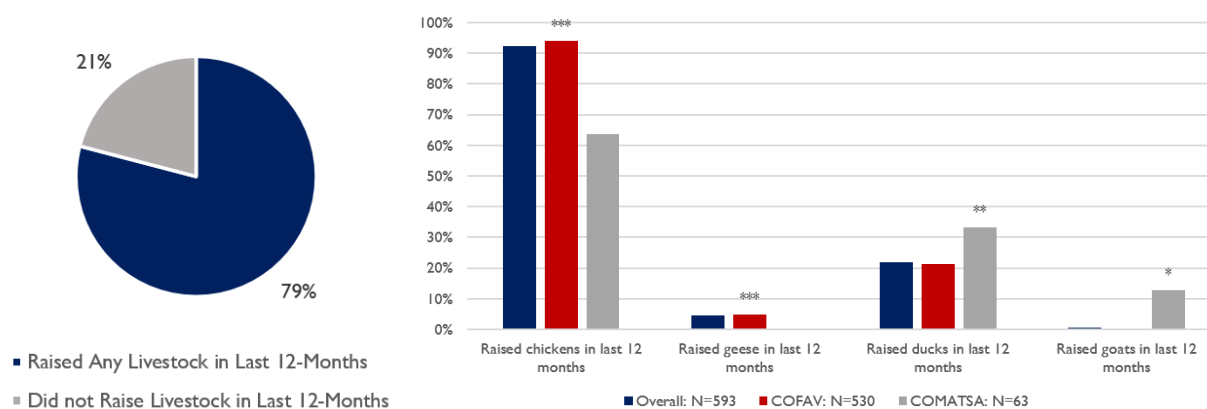## FIGURE 20: COPING STRATEGIES BY REGION
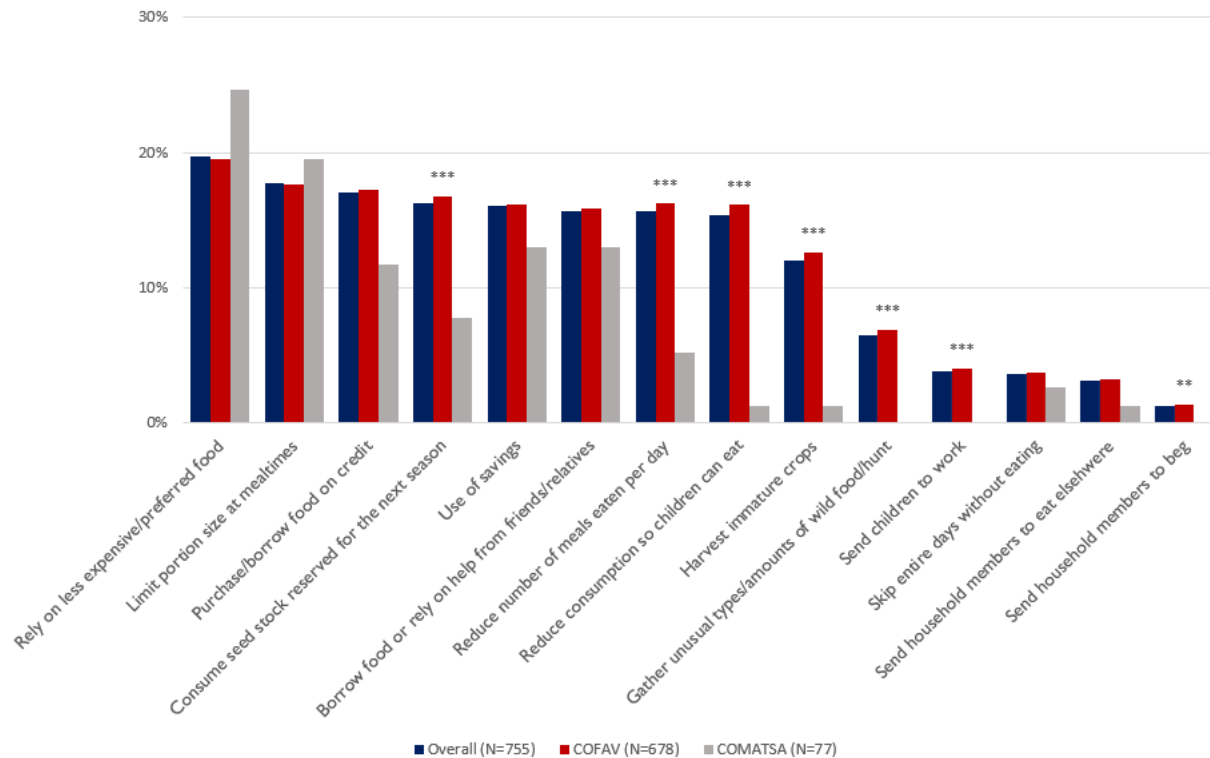
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

As shown in **figure 20**, the most commonly used coping strategies were relying on less expensive or less preferred food (19.8%), limiting portion size at mealtimes (17.7%), purchasing or borrowing food on credit (17.0%), consuming seed stock reserved for the next season (16.3%), and use of savings for food (16.0%). Use of seven of the 14 coping strategies significantly differed by region, with a higher share of households in the COFAV region than the COMATSA using each in all seven cases.

5.4.4   Exposure to Shocks

Households were asked whether they experienced a number of shocks in the last 12-months. As shown in **table 9**, the most commonly experienced shocks were illness (47.6%), large rises in food prices (32.0%), large decreases in the sale price of crops (23.8%), and droughts (22.5%). The share of households experiencing droughts, crop diseases/pests, livestock diseases/deaths, job loss or non-payment, large increases in food prices, break-up of household, theft, or fire damage was significantly higher in the COFAV region than in the COMATSA region. Experiencing a death in the household was the only shock that was more prevalent in the COMATSA region than in the COFAV region.

TABLE 9: SHOCK EXPOSURE BY REGION

	Overall		COFAV		COMATSA		Signif.
	N	Estimate	N	Estimate	N	Estimate	
Share of households experiencing each type of shock in the last 12-months							
Drought	755	22.50	678	23.40	77	5.19	***
Flood/water logging	755	4.93	678	4.78	77	7.79	
Strong winds or storms	755	1.60	678	1.62	77	1.30	
Crop disease or pests	755	13.17	678	13.79	77	1.30	***
Livestock disease or deaths	755	11.18	678	11.63	77	2.60	***
Loss of job/non-payment	755	4.19	678	4.41	77	0.00	***
Large fall in sale price of crops	755	23.78	678	23.67	77	25.97	
Large rise in prices of food	755	31.96	678	32.81	77	15.58	***
Death in household	755	18.54	678	17.94	77	29.87	*
Break-up of household	755	2.30	678	2.41	77	0.00	***
Illness	755	47.55	678	47.05	77	57.14	
Theft	755	14.86	678	15.23	77	7.79	*
House damaged due to fire	755	0.77	678	0.81	77	0.00	*
End of regular assistance, aid or remittances	755	0.00	678	0.00	77	0.00	-
Other	755	18.19	678	18.39	77	14.29	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.4.5 Access to Health Services

The average household in the sample spent approximately USD $20 on health expenditures in the last three months, with significantly higher expenditures in the COMATSA region (USD $51.01) than in the COFAV region (USD $18.04) (see **figure 21**). Respondents estimated traveling nearly five kilometers for health services, on average. This distance was significantly higher in the COFAV region than in the COMATSA region. In the last three months, households had an average of 1.8 outpatient health consultations, of which 1.3 were with a community health center, 0.2 were with a government hospital or other source, and less than 0.05 were with traditional healers or community health agents. Whereas the mean number of visits to a government hospital was significantly higher in the COMATSA region than in the COFAV region, a large number of visits to other health sources took place in the COFAV region.

FIGURE 21: HEALTH EXPENDITURES (LEFT) AND DISTANCE TRAVELED FOR HEALTH SERVICES (RIGHT) BY REGION
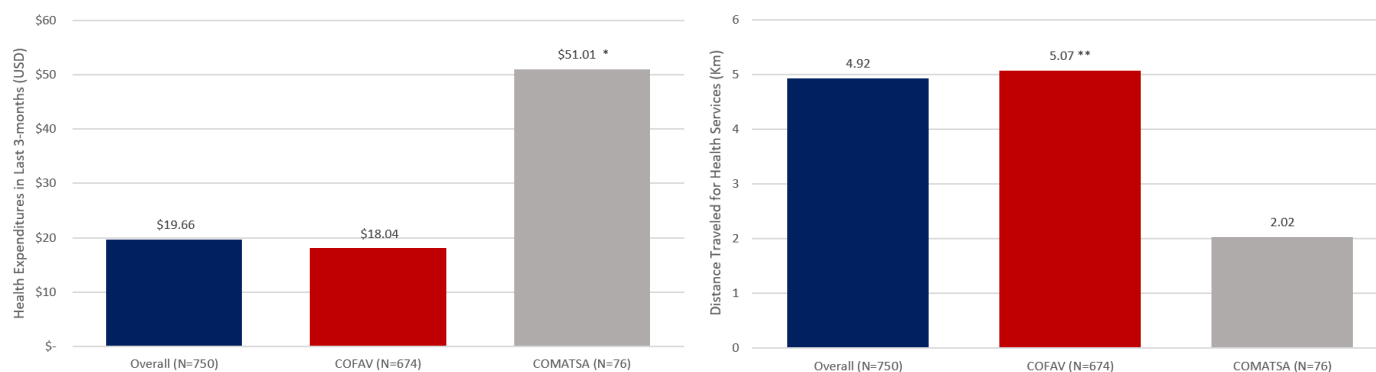
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.5   NATURAL RESOURCES AND ENERGY USE

This section presents an overview of the conservation attitudes, natural resources management, and energy use of households in the TSIRO Baseline Survey sample. This section is based on responses to the Natural Resources and Energy Use modules of the survey.

5.5.1   Conservation Attitudes

As displayed in **table D25**, 85.9% of households believe that there are current threats to their community's ecosystem (see Appendix D). Households that share this belief were then provided with a list of specific ecosystem threats and asked to identify which they believed posed the largest threats to the ecosystem in their community (**figure 22**). The most commonly chosen responses were slash-and-burn agriculture (76.8%), illegal logging (52.8%), climate change impacts (40.1%), and unsustainable farming practices (23.9%). A significantly higher share of households in the COFAV region believed slash-and-burn agriculture, unsustainable farming practices, and other unsustainable resource use were larger threats than those in the COMATSA region. Conversely, a significantly higher share of households in the COMATSA region identified illegal logging, illegal fishing by use of beach seine nets, and climate change impacts than those in the COFAV region.

FIGURE 22: ECOSYSTEM THREATS BY REGION
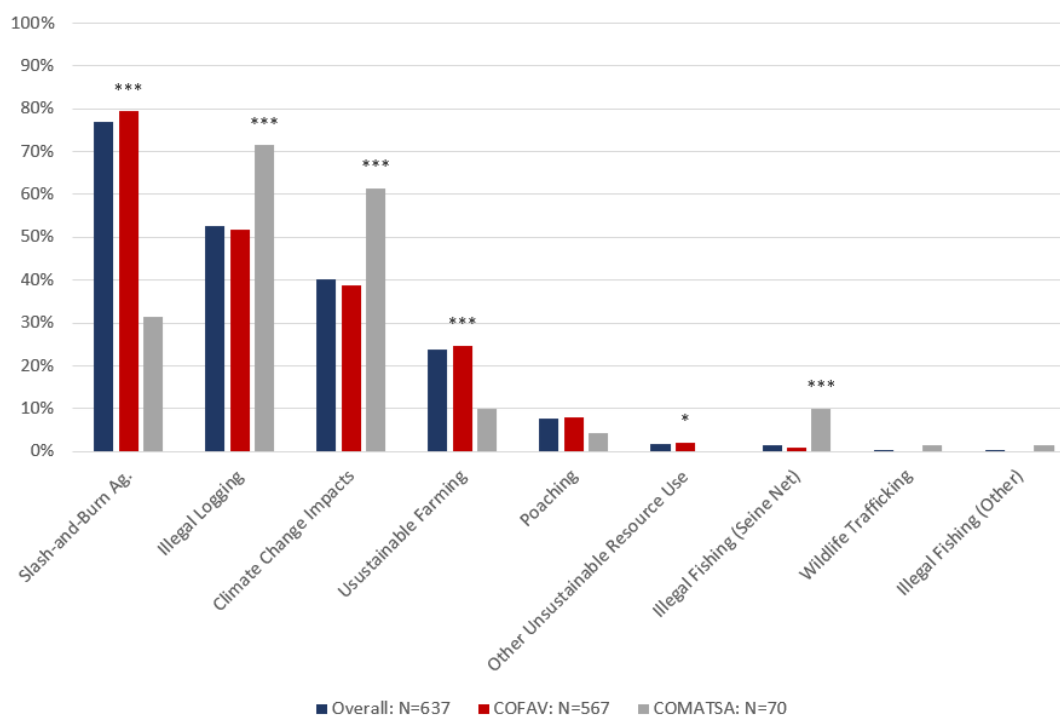
Differences found to be statistically significant are indicated by level: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Households were asked to identify how strongly they agreed or disagreed that it is important to protect ecosystem services for a number of environmentally generated benefits. In **figure 23**, we present the share of households that indicated 'agree' or 'strongly agree' for each statement. A high share of

households agreed with each of the eight statements, with 82.2% being the lowest share of households indicating 'agree' or 'strongly agree.' Attitudes were not significantly different across regions, with the exception of pollinating plants and crops to produce food, which was supported by a significantly higher share of households in the COFAV region than in the COMATSA region.

FIGURE 23: IMPORTANCE OF ECOSYSTEM SERVICES BY REGION

"Agree" or "strongly agree that it is important to protect ecosystem services in order to:

■ Overall: N=755　■ COFAV: N=678　■ COMATSA: N=77

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.5.2 Tree Access, Planting, and Clearing

When asked whether their household has access to trees for production from a list of sources, 6.6% of respondents indicated that their household has access to trees through a tree nursery owned by the household, 10.6% have such access through membership to a tree nursery, 27.3% have access to trees via a woodlot, 37.4% have access through other means, while 31.9% did not have access to trees (**table 10**). A significantly higher share of households in the COFAV region reported access to trees through owning a tree nursery, membership to a tree nursery, and access to a woodlot than households in the COMATSA region. A significantly higher share of households in the COMATSA region reported not having access to trees.

52.1% of households reported planting trees in the last three years, with notably more households planting trees in the COMATSA region (70.1%) than in the COFAV region (51.1%). Among households that did

plant trees in the last three years, respondents were asked why they chose to plant trees. The most common reasons given for planting trees were to obtain timber for use by the household (59.8%), reforestation or restoration (51.2%), soil improvement or erosion control (27.3%), shade for agriculture (24.7%), and firewood for use by the household (23.9%). A significantly higher share of households in the COFAV region reported planting trees for firewood for use by the household, to grow spices/fruits to sell, growing spices/fruits to eat, as well as for timber to sell and use by the household. Conversely, a significantly higher share of households in the COMATSA region reported planting trees for reforestation/restoration, soil improvement or erosion control, and shade for agriculture than those it the COFAV region.

TABLE 10: TREE ACCESS AND PLANTING BY REGION

	Overall		COFAV		COMATSA		
	N	**Percentage**	**N**	**Percentage**	**N**	**Percentage**	**Signif.**
Access to trees							
Own a tree nursery	755	6.57	678	6.91	77	0.00	***
Member of a tree nursery	755	10.59	678	11.14	77	0.00	**
Access to woodlot	755	27.30	678	28.52	77	3.90	***
Other access to trees	755	37.38	678	37.64	77	32.47	
None of the above	755	31.87	678	30.22	77	63.64	***
Tree planting							
Planted trees in last 3 years	755	52.06	678	51.11	77	70.13	*
Reasons for planting trees							
Reforestation/restoration	392	51.17	338	49.66	54	72.22	***
Firewood for own use	392	23.90	338	25.48	54	1.85	***
Firewood for sale	392	1.77	338	1.90	54	0.00	*
Charcoal for sale	392	0.25	338	0.13	54	1.85	
Spices/fruits for sale	392	9.23	338	9.89	54	0.00	***
Spices/fruits to eat	392	19.02	338	19.99	54	5.56	***
Timber for sale	392	6.98	338	7.48	54	0.00	***
Timber for own use	392	59.79	338	62.61	54	20.37	***
Soil improvement/erosion control	392	27.27	338	26.18	54	42.59	*
Shade for agriculture	392	24.74	338	22.40	54	57.41	***
Other	392	0.45	338	0.48	54	0.00	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Among all households in the sample, 29.4% reported clearing land for cultivation or livestock in the last three years, with households in the COFAV region significantly more likely to have cleared land than households in the COMATSA region (**table 11**). Among households that did clear land in the last three years, 90.9% reported clearing fallow agricultural land, while 5.7% indicated clearing forest, and just 3.4% reported clearing other land. Statistical tests of differences across regions are not reported for the type of land cleared due to small sample sizes in the COMATSA region. When asked where they cleared land in the last three years, 93.8% reported doing so in fallow land, while 3.2% reported clearing land in a transfert de gestion.

TABLE 11: LAND CLEARING IN LAST THREE YEARS BY REGION

|	Overall		COFAV		COMATSA		
	N	Percentage	N	Percentage	N	Percentage	Signif.
Land clearing							
Cleared land for cultivation/livestock	755	29.37	678	30.16	77	14.29	**
Type of land cleared							
Forest	200	5.73	189	5.42	11	^	-
Fallow agricultural land	200	90.91	189	91.14	11	^	-
Other	200	3.35	189	3.44	11	^	-
Where land was cleared							
Protected area	200	0.00	189	0.00	11	^	-
Sacred forest	200	0.00	189	0.00	11	^	-
Transfer de gestion	200	3.18	189	2.81	11	^	-
Fallow land	200	93.78	189	94.07	11	^	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

Figure 24 shows that 61% of households plan to clear land for cultivation or livestock in the next 12 months, with no significant difference across regions. Unsurprisingly, households that reported clearing land in the last three years were significantly more likely to have plans to clear land in the next 12-months. There was no significant relationship between households that planted trees in the last three years and those that plan to clear land in the next year. Surprisingly, households that believe there are current threats to their community's ecosystem were significantly more likely plan to clear trees in the next year, while being affected by the loss of an ecosystem service is not significantly associated with this intention. Non-poor households were significantly more likely to indicate that they plan clear land in the next year than those that fall below the USD $1.90/day poverty line. This result is largely in line with the academic literature, which suggests that at low levels of economic development, income increases lead to higher levels of environmental degradation.[30,31]

Among those that plan to clear land in the next year, just 5.6% intend to do so in a protected area, transfert de gestion, or sacred forest (see **table D29** for more details). A notably higher share of households in the COMATSA region intend to clear forest in a protected area, transfert de gestion, or sacred forest in the next year (15%) than those in the COFAV region (5.2%).

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[30] Yasin, I., et al. (2020). "The impact of financial development, political institutions, and urbanization on environmental degradation: evidence from 59 less-developed economies". Environment, Development and Sustainability. doi:10.1007/s10668-020-00885-w

[31] Importantly, the relationship between economic growth and environmental degradation reverses beyond certain income thresholds, at which point income increases lead to higher levels of environmental protection.

FIGURE 24: LAND CLEARING INTENTIONS IN NEXT 12-MONTHS BY REGION
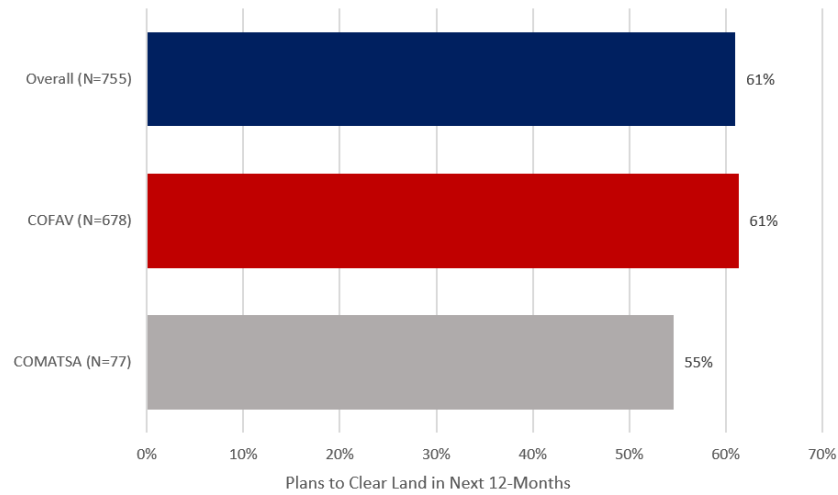
Plans to Clear Land in Next 12-Months

- Overall (N=755): 61%
- COFAV (N=678): 61%
- COMATSA (N=77): 55%

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

As shown in **figure 25**, when asked why they intend to clear land in the next 12 months, the most common reasons given were to increase the size of the household's land (78.1%), to grow more crops to consume (45.6%), and to grow more crops to sell (39.6%). A significantly higher share of households in the COFAV region intend to clear land in order to grow more crops to consume and to grow different types of crops than those in the COMATSA region. Conversely, a substantially higher share of households in the COMATSA region intend to clear land because their existing or past land is no longer productive.

FIGURE 25: LAND CLEARING REASONS IN NEXT 12-MONTHS BY REGION
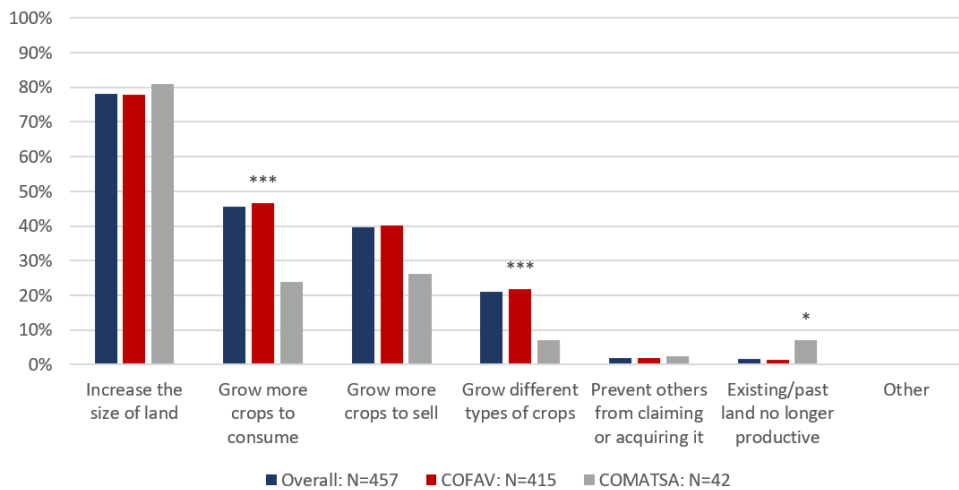
Overall: N=457   COFAV: N=415   COMATSA: N=42

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.5.3 Use of Forest Resources

Overall, 49.0% of households reported that they collect forest products. Among those that do collect forest products, households were asked how important a number of forest resources are to their livelihood. **Figure 26** reports the share of households that answered 'important' or 'very important' for

each resource. The resources that were most widely considered to be important were firewood (85.7%), medicinal plants (49.9%), wild fruits (33.1%), honey (18.6%), and mushrooms (17.3%). A significantly higher share of households in the COFAV region considered mushrooms important than those in the COMATSA region, while the share of households that considered wild fruits, bushmeat, medicinal plants, charcoal, and fish important was significantly higher in the COMATSA region.
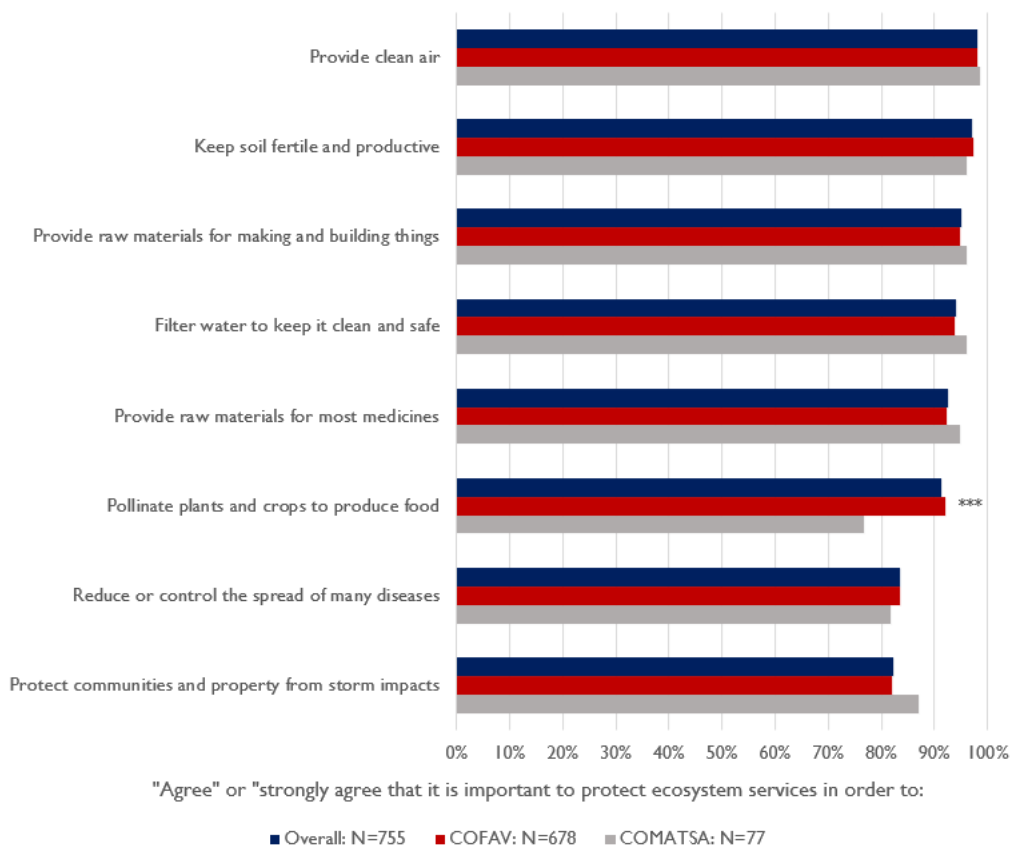
FIGURE 26: IMPORTANCE OF FOREST RESOURCES BY REGION
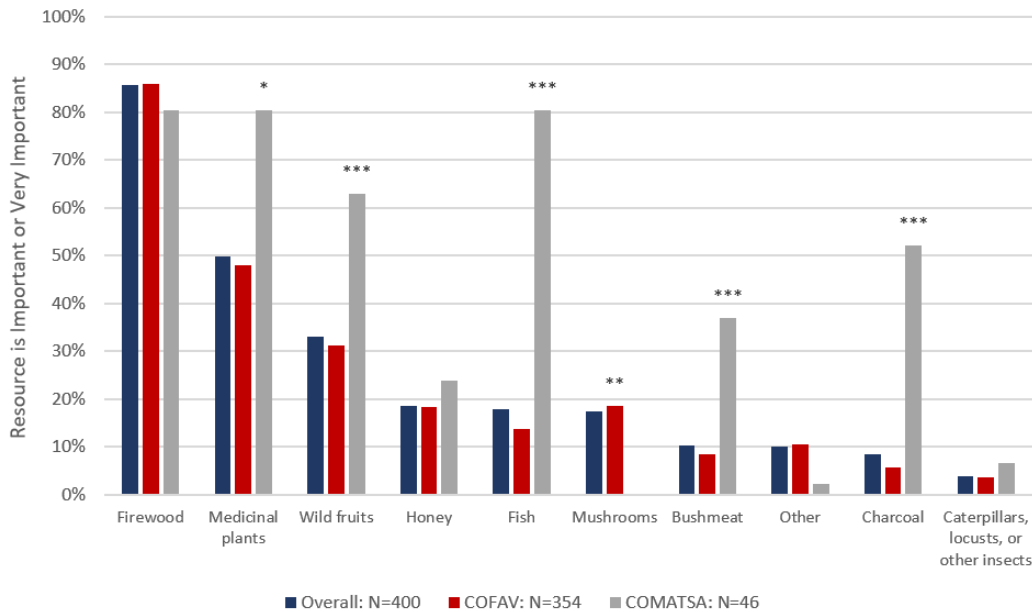
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

For each of the forest resources discussed above, households were asked whether they had difficulty accessing the resource, and whether their use of that resource increased, decreased, or stayed the same over the last year (**figures 27 and 28**). Households most commonly reported having difficulty accessing firewood (38.2%), followed by honey (20.7%), mushrooms (14.3%), and wild fruits (13.4%). The share of households reporting difficulty accessing mushrooms was significantly higher in the COFAV region than in the COMATSA region, while the share reporting difficulty accessing caterpillars, locusts, or other insects, wild fruits, bushmeat, medicinal plants, firewood, charcoal, and fish was considerably higher in the COMATSA region than in the COFAV region.

FIGURE 27: DIFFICULTY ACCESSING FOREST RESOURCES IN LAST YEAR BY REGION

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

FIGURE 28: USE OF FOREST RESOURCES IN LAST YEAR
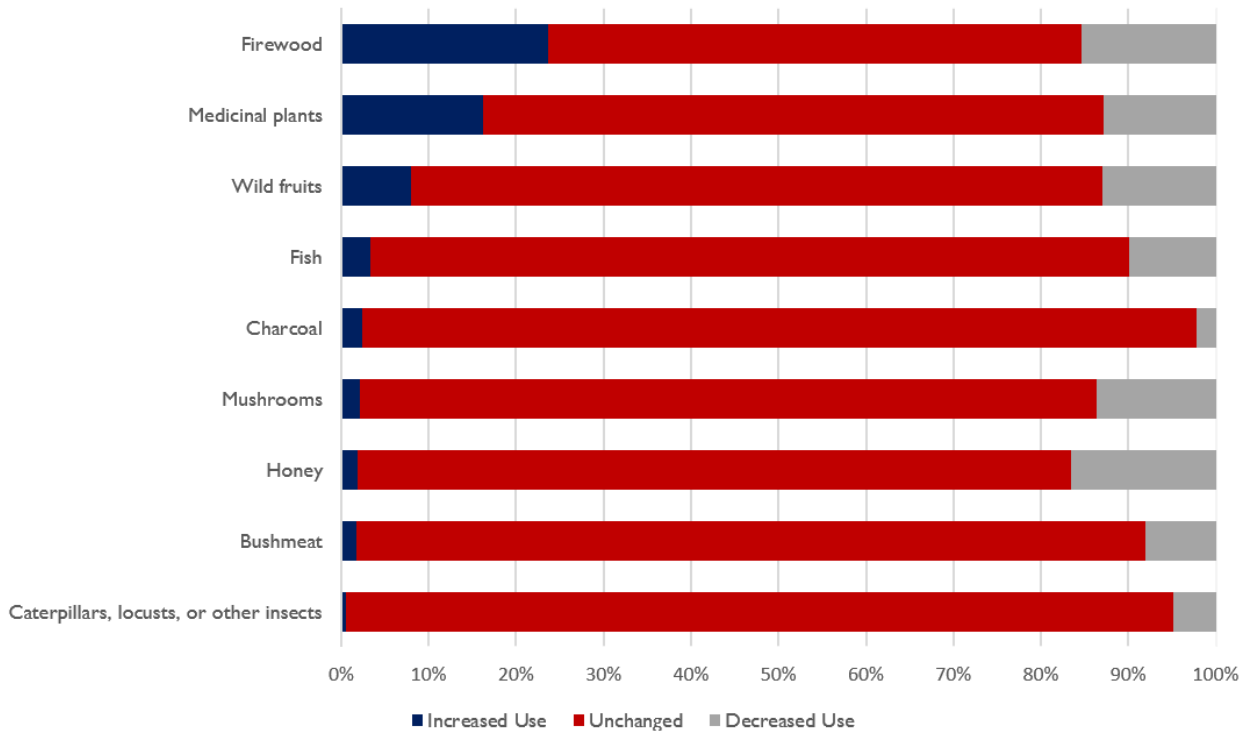
Figure 29 displays that 78.9% of households reported being directly affected by the loss of an ecosystem service in the last 12 months. Households that were directly affected by such a loss were asked to indicate the way that this loss most affected them. The vast majority of households reported that their economic

well-being was most affected (86.3%), followed by their medical health (12.8%), and emotional, psychological, or spiritual well-being (0.6%). None of these responses varied significantly by region.

FIGURE 29: LOSS OF ECOSYSTEM SERVICES BY REGION
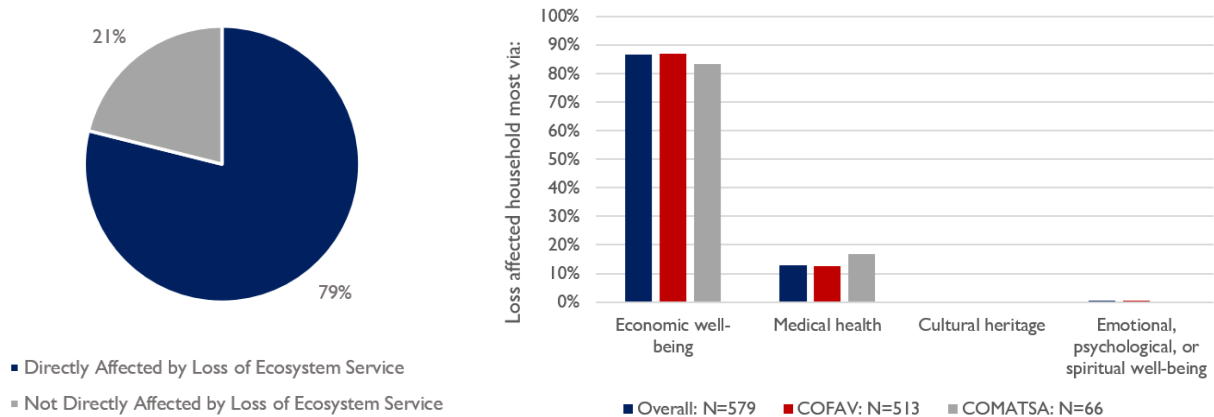
- Directly Affected by Loss of Ecosystem Service
- Not Directly Affected by Loss of Ecosystem Service

■ Overall: N=579   ■ COFAV: N=513   ■ COMATSA: N=66

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.4.3   Household Energy Use

To better understand household energy use, respondents were asked about their use of a number of fuel sources over the last 30 days. The most commonly used fuel sources were firewood (92.5%), kerosene (44.0%), and charcoal and coal (12.0%) (see **figure 30**). A significantly higher share of households in the COFAV region used firewood, candles, and kerosene in the last 30 days than those in the COMATSA region. Conversely, a considerably higher share of households in the COMATSA region reported using charcoal and coal and gasoline than those in the COFAV region.

FIGURE 30: FUEL SOURCES USED IN LAST 30-DAYS BY REGION
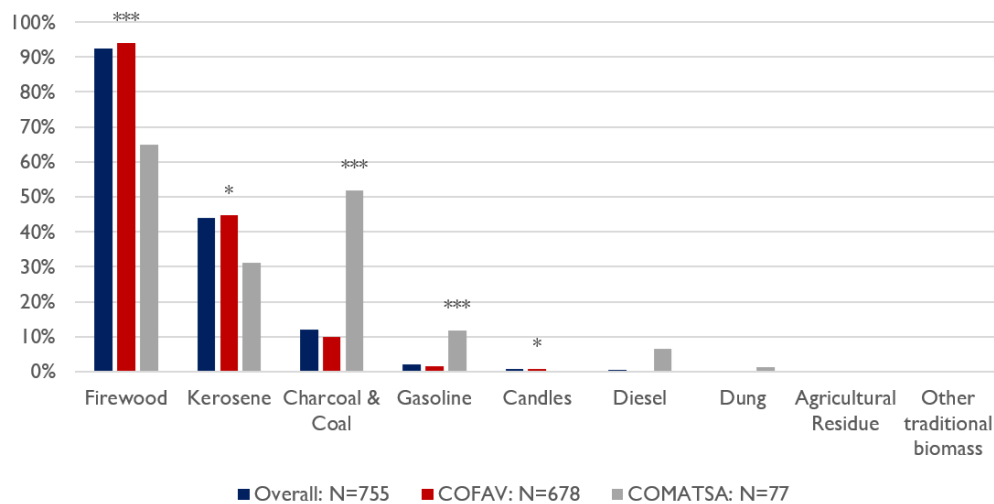
■ Overall: N=755   ■ COFAV: N=678   ■ COMATSA: N=77

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Respondents were asked to report the amount of each fuel source used during this time frame. **Table 12** reports the amount of each biomass fuel or candles used in kilograms, and the amount of each gaseous

or liquid fuel used in liters. As no households reported using agricultural residue or other traditional biomass, the quantity used for each is zero across all households. The average household used 284.4 kilograms of firewood in the last 30 days, with those in the COFAV region using a significantly higher amount (294.6 kilograms) than those in the COMATSA region (88.0 kilograms). The average household 8.0 kilograms of charcoal and coal in the last 30-days, with those in the COMATSA region using notably more (24.3 kilograms) than those in the COFAV region (7.1 kilograms). Households also reported using 6.8 liters of kerosene, 0.4 liters of gasoline, and 1.5 liters of diesel. There were no significant differences across the regions for the three gaseous and liquid fuels.

TABLE 12: QUANTITY OF FUEL SOURCES USED IN LAST 30-DAYS BY REGION

	Overall		COFAV		COMATSA		
	N	Mean	N	Mean	N	Mean	Signif
Biomass and candles							
Agricultural Residue (Kg)	755	0.00	678	0.00	77	0.00	-
Dung (Kg)	755	0.05	678	0.00	77	1.04	
Firewood (Kg)	755	284.38	678	294.62	77	87.97	***
Other traditional biomass (Kg)	755	0.00	678	0.00	77	0.00	-
Charcoal & Coal (Kg)	755	7.95	678	7.10	77	24.27	***
Candles (Kg)	755	0.00	678	0.00	77	0.00	
Gaseous and liquid fuels							
Kerosene (Liters)	755	6.83	678	7.10	77	1.57	
Gasoline (Liters)	755	0.38	678	0.13	77	5.19	
Diesel (Liters)	755	1.45	678	0.93	77	11.43	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Among households that did use each fuel source, **table 13** reports the distance traveled to collect each source.[32] The average household traveled two kilometers to collect firewood in the last 30 days, with households in the COFAV region traveling significantly further (2.1 kilometers) than in the COMATSA region (1.1 kilometers). Interestingly, the average household traveled just 0.2 kilometers to collect charcoal and coal in the last 30 days, a distance that did not substantially differ by region. On average, households traveled 2.7 kilometers for kerosene, which also did not significantly differ by region.

TABLE 13: DISTANCE TRAVELED TO COLLECT FUEL SOURCES BY REGION

	Overall		COFAV		COMATSA		
	N	Mean	N	Mean	N	Mean	Signif
Biomass and candles							
Firewood (Km)	697	2.02	647	2.06	50	1.08	***
Charcoal & Coal (Km)	98	0.20	58	0.21	40	0.15	
Gaseous and liquid fuels							
Kerosene (Km)	361	2.72	337	2.79	24	0.92	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

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[32] Note that due to small sample sizes for certain fuel sources, we only report on the sources that have sufficiently large samples for reliable point estimates.

Households that used firewood as a fuel source in the last 30 days were asked to estimate the percentage of their total use that went toward lighting, cooking, space heating, water heating, or other uses (results presented in **figure 31**). The energy source that consumed the largest share of total firewood use was cooking (92.5% of all firewood use), followed by water heating (5.6% of all firewood use), and space heating (2.2% percent of all firewood use). The share of firewood use that was dedicated to cooking was higher in the COMATSA region than in the COFAV region, at 99.0% and 92.2% of all firewood use, respectively. Conversely, the share of firewood use dedicated to water heating was notably higher in the COFAV region than in the COMATSA region, at 5.5% and 0.0% of all firewood use, respectively.

FIGURE 31: FIREWOOD USE IN LAST 30-DAYS BY REGION
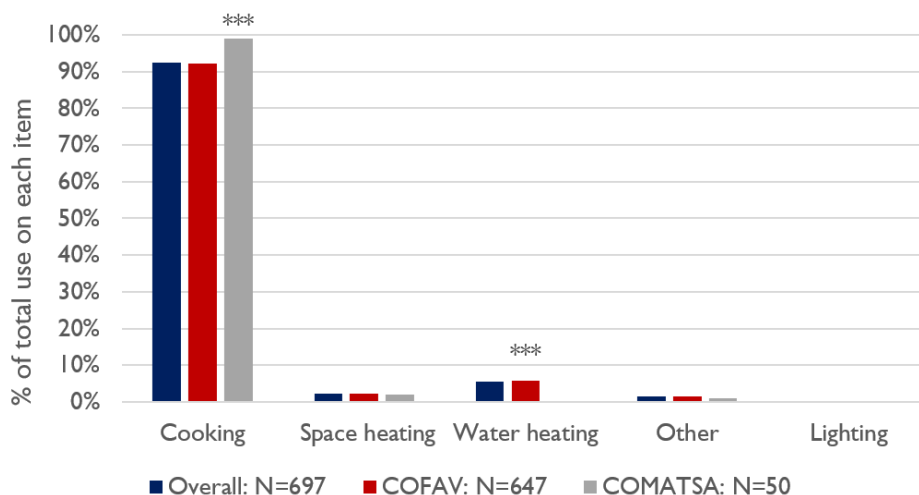
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

FIGURE 32: CHARCOAL AND COAL USE IN LAST 30-DAYS BY REGION
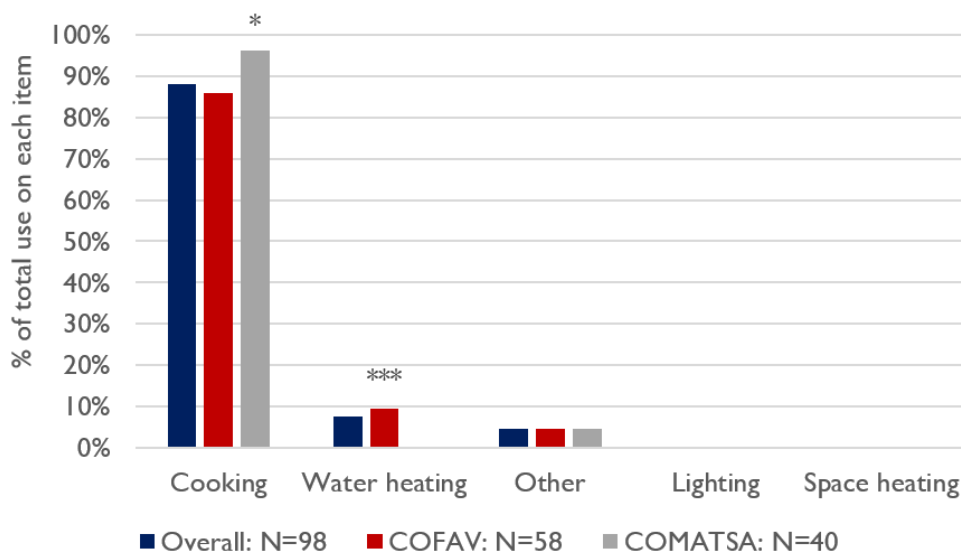
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Households that used charcoal and coal were also asked to estimate the share of their total use that went toward lighting, cooking, space heating, water heating, or other uses. As shown in **figure 32**, the energy source that used the largest share of total charcoal and coal use was cooking (88.1% of all charcoal and

coal use), followed by water heating (7.4% of all charcoal and coal use), and 'other' (4.5% of all charcoal and coal use). The share of total charcoal and coal use that was dedicated to cooking was significantly higher in the COMATSA region than in the COFAV region, while the share of total use that was dedicated to water heating was significantly higher in the COFAV region than in the COMATSA region.

5.6 GENDER AND EMPOWERMENT

This section presents an overview of the gender dynamics, decision-making, and attitudes of households in the TSIRO Baseline Survey sample. This section is based on responses to the Empowerment module of the survey.

5.6.1 Gendered Decision-Making

Women who were married or living with a partner were asked whether certain decisions are made by them alone, by their husband or partner, jointly with their husband or partner, or by someone else. When asked who makes decisions about money that is earned by the female respondent, 44.6% reported making these decisions jointly, 37.3% reporting making them alone, while fewer than 10% reported that their husband or partner makes those decisions alone or that someone else makes them. The share of respondents stating that their husband or partner makes decisions about their money was significantly higher in the COFAV region (8.6%) compared to the COMATSA region (1.6%). Similarly, the share of women in the COFAV region stating that someone else decides how to spend their money was significantly higher than in the COMATSA region, at 10.4% and 0%, respectively (see **figure 33**).

FIGURE 33: DECISION-MAKING ABOUT MONEY EARNED BY PRIMARY FEMALE DECISION-MAKER
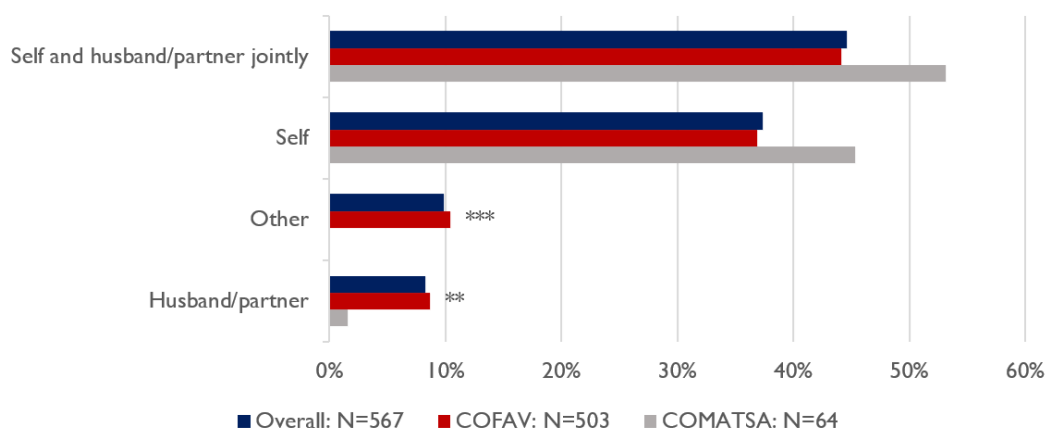
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

When asked how their income compares to their husband/partner, the majority of respondents (51.6%) said that they earn less than their husband/partner, followed by 22.0% who indicated that they earned about the same income as their husband/partner, and 13.2% who earn more than their husband/partner. 10.8% of women indicated that their husband did not earn an income. The share of respondents who reported earning more than their husbands was significantly higher in the COMATSA region (21.9%) than in the COFAV region (12.6%). Conversely, a significantly higher share of women in the COFAV region reported that their husbands earned no income.

FIGURE 34: FEMALE VS. MALE INCOME COMPARISON BY REGION
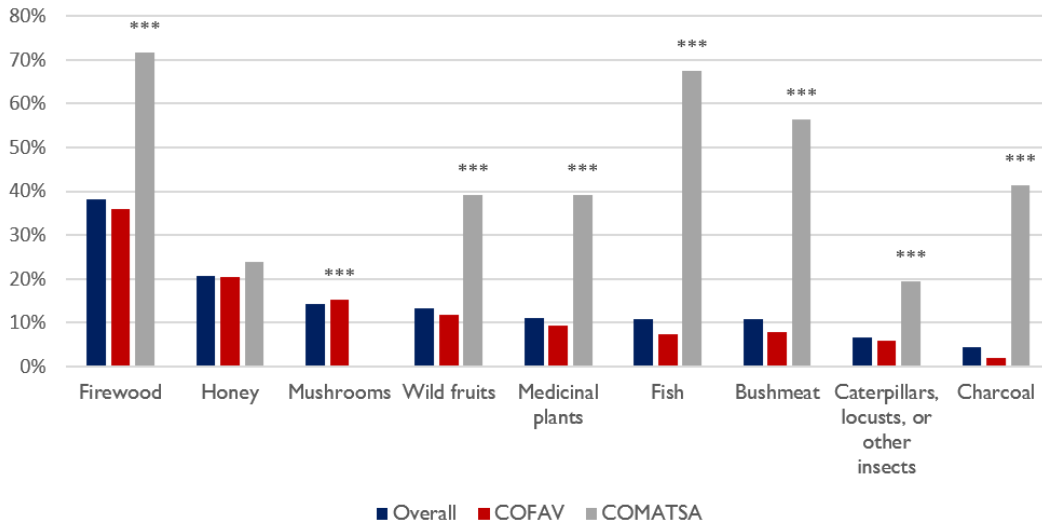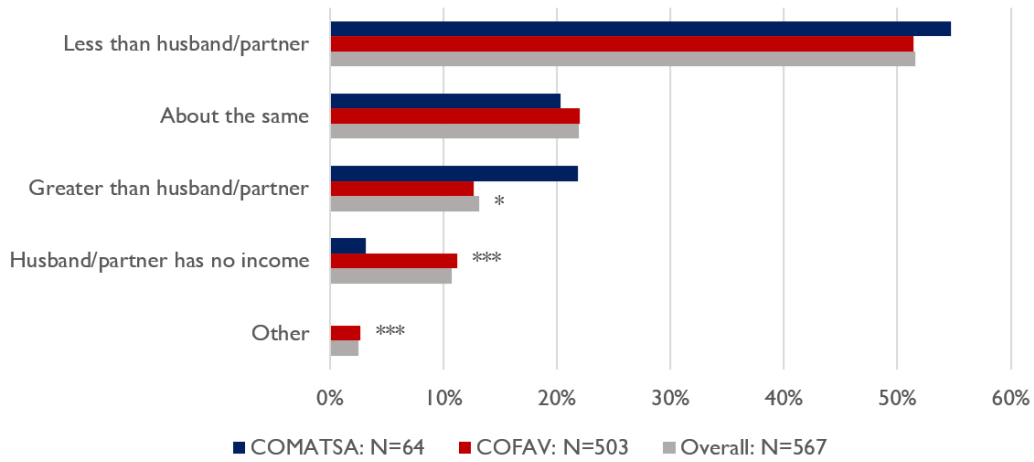

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

When asked who makes decisions about the female respondent's healthcare, 46.0% of women stated that their husband/partner makes this decision alone, while 37.4% reported that they make this decision jointly, and 16.4% stated that they make the decision alone. The share of women who reported making decisions about their healthcare alone or jointly was significantly higher in the COMATSA region than the COFAV region, while the share that reported that their husband/partner makes these decisions was significantly higher in the COFAV region. The most commonly reported way that decisions are made about major household purchases was jointly (63.1%), followed by the husband/partner alone (20.4%), and then by the female respondent alone (16.5%). The share of women stating that they make major household purchase decisions alone was significantly higher in the COFAV region than in the COMATSA region, while the share stating that they make these decisions jointly was significantly higher in the COMATSA region than in COFAV. When asked who makes decisions about visiting family or relatives, 18.9% indicated making these decisions alone, with a significantly higher share reporting this in the COMATSA region (31.3%) than in the COFAV region (18.2%). 22.6% of respondents indicated that their husband/partner makes decisions about visiting relatives alone, with a significantly higher share stating this in the COFAV region than in the COMATSA region. The majority of respondents (57.8%) said that they make these decisions jointly with their husband/partner, with no significant differences across regions.

TABLE 14: OTHER DECISION-MAKING BY REGION

	Overall		COFAV		COMATSA		Signif.
	N	Percentage	N	Percentage	N	Percentage	
Who makes decisions about female respondent's healthcare?							
Self	567	16.44	503	15.85	64	26.56	***
Husband/partner	567	45.96	503	47.46	64	20.31	***
Self and husband/partner jointly	567	37.41	503	36.58	64	51.56	*
Someone else	567	0.09	503	0.00	64	1.56	
Other	567	0.11	503	0.11	64	0.00	
Who makes decisions about major household purchases?							
Self	567	16.47	503	16.89	64	9.38	*
Husband/partner	567	20.41	503	20.51	64	18.75	
Self and husband/partner jointly	567	63.12	503	62.60	64	71.88	**
Someone else	567	0.00	503	0.00	64	0.00	-
Other	567	0.00	503	0.00	64	0.00	-
Who makes decisions about visiting family or relatives?							
Self	567	18.94	503	18.22	64	31.25	***
Husband/partner	567	22.58	503	23.26	64	10.94	***
Self and husband/partner jointly	567	57.81	503	57.81	64	57.81	
Someone else	567	0.67	503	0.71	64	0.00	
Other	567	0.00	503	0.00	64	0.00	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.6.2   Home and Land Ownership

More than 86% of respondents indicated at least partially owning their home. When asked about the ownership arrangement of their home, 64.0% of women reported owning their home jointly with their husband or partner, while just 13.7% owned their home alone. The share of women who reported owning their home alone was significantly higher in the COMATSA region (33.8%) than in the COFAV region (12.6%). Conversely, the share of women who reported owning their home jointly was more than 36 percentage points higher in the COFAV region (66.0%) than in COMATSA (29.7%). The share of women who indicated that they did not own their home was significantly higher in the COMATSA region than in the COFAV region.

Approximately one quarter of respondents had a title, deed, or other government-recognized document for their home, with a significantly higher share in the COMATSA region (52.8%) than in the COFAV region (22.9%). Among households that did have a form of documentation for their home, 60.3% indicated that the female respondent's name appeared on that document.

TABLE 15: HOME OWNERSHIP BY REGION

	Overall		COFAV		COMATSA		Signif.
	N	Percentage	N	Percentage	N	Percentage	
Home ownership							
Alone only	671	13.72	597	12.57	74	33.78	***
Jointly with husband/partner	671	64.04	597	66.00	74	29.73	***
Jointly with someone else	671	1.96	597	2.07	74	0.00	**
Jointly with husband/partner and someone else	671	6.60	597	6.75	74	4.05	
Both alone and jointly	671	0.44	597	0.47	74	0.00	
Do not own	671	13.24	597	12.14	74	32.43	***
Home titling							
Has a title, deed, or other document	657	24.50	585	22.90	72	52.78	***
Female respondent's name appears on document	144	60.30	106	60.27	38	60.53	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

Similar to the results discussed above, **table 16** reports on the ownership arrangement and titling for land. Nearly 80% of respondents indicated owning land. The most common ownership arrangement reported by female respondents was jointly with their husband/partner (43.9%), followed by owning the land alone (20.3%). The share of women that reported owning land alone was significantly higher in the COMATSA region (44.6%) than in the COFAV region (18.9%). Conversely, the share of respondents that indicated owning land jointly with their husband/partner was significantly higher in the COFAV region (45.8%) than in the COMATSA region (10.8%).

36.5% of respondents reported having a title, deed, or other recognized document for their land, with no significant difference across regions. Among those that had such documents, 64.5% indicated that the female respondent's name appears on the land document. This also did not significantly differ by region.

TABLE 16: LAND OWNERSHIP BY REGION

|	Overall		COFAV		COMATSA		
	N	Percentage	N	Percentage	N	Percentage	Signif.
Land ownership							
Alone only	671	20.32	597	18.93	74	44.59	***
Jointly with husband/partner	671	43.92	597	45.82	74	10.81	***
Jointly with someone else	671	7.77	597	7.83	74	6.76	
Jointly with husband/partner and someone else	671	5.04	597	5.25	74	1.35	
Both alone and jointly	671	1.37	597	1.37	74	1.35	
Do not own	671	21.59	597	20.81	74	35.14	**
Land titling							
Has a title, deed, or other document	660	36.50	586	36.27	74	40.54	
Female respondent's name appears on document	215	64.54	185	64.40	30	66.67	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

5.6.3   Gender-Based Violence Attitudes

Women were asked if they believe it is justified for a husband to hit or beat his wife under five different circumstances.[33] The share of women indicating that this form of gender-based violence is justified ranged from 11.6-26.8%, with the highest percentage of women reporting that hitting or beating is acceptable if the wife neglects the children, followed by going out without telling her husband. The share of women that agreed with this statement for arguing with the husband, refusing to have sex with him, or burning food ranged from 11-13%. None of these items significantly differed by region.

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[33] Although enumerators requested to interview women alone for these sensitive questions, we found no statistically or practically significant differences in responses between women who were successfully interviewed alone and those who responded to these questions with someone else in the room. Therefore, we include all female respondents in our results.

FIGURE 35: GENDER-BASED VIOLENCE ATTITUDES BY REGION
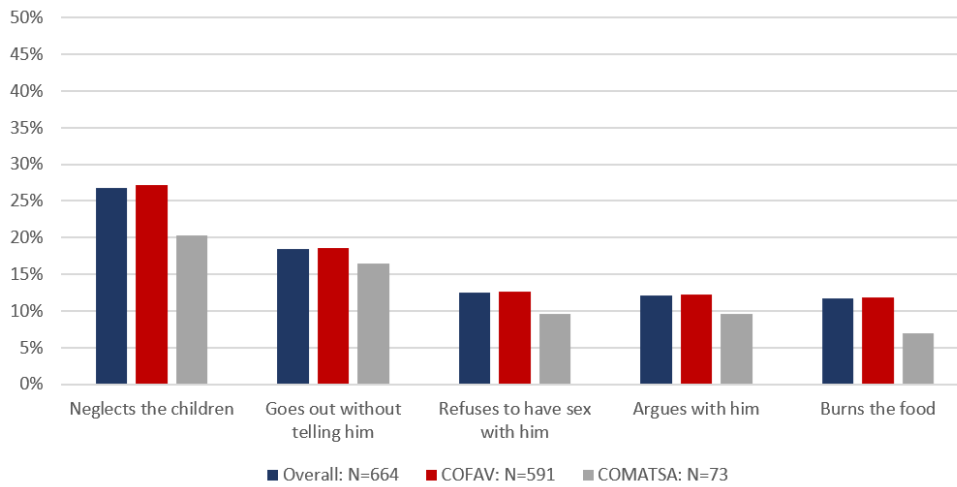
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

6.   CONCLUSIONS

As widespread poverty in Madagascar drives an array of threats to the country's diverse ecosystems, USAID/Madagascar is planning three activities to promote sustainable ecosystem management, economic development and social support programs that help protect biodiversity, and decentralized natural resource governance. The TSIRO Alliance aims to conserve ecosystems and improve the well-being and prosperity of farmers and their communities by supporting farmers and planting more than 1.5 million trees in agroforestry systems that incorporate food and spice crops such as cacao, vanilla, cinnamon, and wild pepper. The purpose of the TSIRO Baseline Survey was to provide pre-intervention estimates that will inform activity implementation and serve as a benchmark for future assessments. All aspects of the baseline survey were designed by INRM with support from USAID/Madagascar, the TSIRO Alliance, and CAETIC.

The geographic focus of the TSIRO Baseline Survey was the COMATSA and COFAV regions, located in the northwest and southeast of Madagascar, respectively. The survey was not intended to be representative of all households in the intervention Districts, as TSIRO is working with targeted farmer groups. Instead, the survey focuses on collecting data that reflect the characteristics of participant households, based on lists of targeted or participating farmer groups and farmers provided to INRM by the TSIRO Alliance.

As summarized below, the results of this survey demonstrate the significant and multifaceted needs of the target community, highlighting the potential benefits of an integrated approach. Respondents report high levels of belief in the importance of conserving their environment and reliance on their forest resources, yet they also face immediate needs with high levels of poverty and food insecurity and low levels of dietary diversity and access to finance from formal institutions.

We find significant differences across a range of outcome areas between participants in the COFAV and COMATSA regions. Households in the COMATSA region tended to be significantly

better off than those in the COFAV region, with higher rates of education, literacy, food security, and dietary diversity and lower rates of poverty.

Access to credit through formal institutions is very low in the TSIRO intervention area and instead appears to be largely based on personal connections or micro-finance groups. Households most commonly borrowed cash or in-kind from a friend, relative, or group-based micro-finance organization, while fewer than 3% borrowed from a formal lender. Among households that did borrow in the last year, the majority of respondents indicated making borrowing decisions jointly.

Households on average cultivated 4.3 crops and held approximately 3 hectares of land. The most commonly grown crops were rice, cassava, vanilla, and fruits. Among the four TSIRO activity crops, the share of households growing each ranged from 13.9% for cacao to 66.0% for vanilla. Households in the COMATSA region were significantly more likely to grow cacao, while those in the COFAV region were significantly more likely to grow black pepper and cinnamon.

Cacao farmers in COMATSA were significantly more likely to sell their cacao directly to companies. However, we did not find any significant differences in yield or sales between regions for any of the targeted crops. Average earnings from cacao were substantially higher than from all other targeted crops.

More than a third of all households had no documents for their land, while a quarter held certified land. Households in the COFAV region were significantly more likely to hold titled and certified land, while those in the COMATSA region were significantly more likely to hold non-titled land with formal or simple documents.

Food security and dietary diversity were low and were significantly lower in COFAV. More than 70% of all households were classified as moderately or food insecure, and just 20% of women of reproductive age consumed a minimally acceptable diet in the 24-hours prior to data collection. Households in the COFAV region experienced a higher frequency and severity of coping behaviors related food consumption than those in the COMATSA region. Use of seven of the 14 coping strategies significantly differed by region, with a higher share of households in the COFAV region than the COMATSA region using each in all seven cases, further highlighting the differing food security situations in the two implementation regions.

Almost half of households surveyed report collecting forest products. Among those collecting firewood, approximately 85% noted that it was important or very important to their livelihood, yet almost 40% overall, and more than 70% in COMATSA, reported difficulty in accessing over the last year.

At the time of data collection, 86% of households believed that there were current threats to their community's ecosystem. The threats that households most commonly reported were slash-and-burn agriculture, illegal logging, climate change impacts, and unsustainable farming practices. Despite the recognition of ecosystem threats, the majority of households reported that they intend to clear land for cultivation or livestock in the next year, a result that was consistent across regions. The most common reasons given for clearing land in the future were to increase the size of the household's land, to grow more crops to consume, and to grow more crops to sell.

Nearly 80% of households reported being directly affected by the loss of an ecosystem service in the last 12 months. The vast majority of households reported that their economic well-being was most affected (86.3%), followed by their medical health (12.8%), and emotional, psychological, or spiritual well-being (0.6%).

The most commonly used fuel sources among activity participants were firewood, kerosene, and charcoal and coal. Whereas households in the COMATSA region were significantly more likely to use firewood and kerosene, those in the COFAV region were significantly more likely to use charcoal and coal. The average household traveled two kilometers to collect firewood in the last 30 days, while needing to travel just 0.2 kilometers for charcoal and coal.

Rates of acceptance of gender-based violence was relatively high in both regions. When asked whether they believe it is justified for a husband to hit or beat his wife under different circumstances, the share of women indicating that this form of gender-based violence is justified ranged from 11.6-26.8%, with the highest percentage of women reporting that hitting or beating is acceptable if the wife neglects the children, followed by going out without telling her husband.

APPENDIX A: TSIRO BASELINE SURVEY INSTRUMENT

The final survey instrument will be provided to USAID as a separate attachment.

APPENDIX B: TSIRO BASELINE SURVEY GANTT CHART

	MAY				JUNE					JULY				AUGUST				SEPTEMBER				OCTOBER				NOVEMBER					DECEMBER			
M-F dates:	5/3-5/7	5/10-5/14	5/17-5/21	5/24-5/28	5/31-6/4	6/7-6/11	6/14-6/18	6/21-6/25	6/28-7/2	7/5-7/9	7/12-7/16	7/19-7/23	7/26-7/30	8/2-8/6	8/9-8/13	8/16-8/20	8/23-8/27	8/30-9/3	9/6-9/10	9/13-9/17	9/20-9/24	9/27-10/1	10/4-10/8	10/11-10/15	10/18-10/22	10/25-10/29	11/1-11/5	11/8-11/12	11/15-11/19	11/22-11/26	11/29-12/3	12/6-12/10	12/13-12/17	12/20-12/24	12/27-12/31
Week #:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35

PRE-FIELDWORK PREPARATIONS
1. Finalize SOW and approach — 5/14
2. Develop inception report & survey protocol — 5/28
3. Local consultant recruitment and onboarding
4. Develop survey instruments
5. INRM sends CAETIC enumerator manual template
6. Program survey instrument
7. CAETIC review of survey instrument
8. CAETIC translation of survey instrument
9. INRM sends CAETIC full list of beneficiaries for sampling
10. Develop IRB application
11. IRB review

HOUSEHOLD SURVEY FIELD WORK
12. CAETIC mobilization
13. Enumerator training
14. Piloting
15. Data collection — 8/13

HOUSEHOLD SURVEY ANALYSIS AND REPORTING
16. Data cleaning
17. Data analysis
18. Develop final report draft — 10/22
19. USAID reviews draft report
20. Revise final report based on USAID feedback — 11/23
21. Data de-identification and IRB review
22. Data submission — 12/10

REMOTE SENSING FOREST COVER ANALYSIS
- Develop methodology memo — 7/2
- Collect publicly available data
- Undertake preliminary analysis with historical data
- Conduct weekly monitoring and provide regular updates to TSIRO
- Develop report on approach and ongoing monitoring — 11/19
- Provide trainings to TSIRO and USAID

Key:
- Deliverables (expected submission date in white)
- Fieldwork
- INRM Work
- CAETIC Work

APPENDIX C: SAMPLING LIST

TABLE C1: SAMPLED HOUSEHOLDS BY LOCATION

Region	District	Commune	Fokontany	Households
Diana	Ambanja	Antranokarany	Ambalamahogo	19
Diana	Ambanja	Antranokarany	Ampamakia	2
Diana	Ambanja	Antranokarany	Ampondrabe	1
Diana	Ambanja	Antranokarany	Ankotika	1
Diana	Ambanja	Antranokarany	Antanimena	6
Diana	Ambanja	Antranokarany	Antranokarany	32
Diana	Ambanja	Antranokarany	Befitina	2
Diana	Ambanja	Antranokarany	Mangabe	1
Diana	Ambanja	Antranokarany	Marosely	1
Diana	Ambanja	Antsatsaka	Ambodifinesy	16
Diana	Ambanja	Antsatsaka	Ambodimantaly	1
Diana	Ambanja	Antsatsaka	Antanambe Sambirano	2
Diana	Ambanja	Antsatsaka	Antsatsaka	1
Vatovavy Fitovinany	Ifanadiana	Androrangavola	Ambohimisafy	33
Vatovavy Fitovinany	Ifanadiana	Ifanadiana	Antafotenina	22
Vatovavy Fitovinany	Ikongo	Ambatofotsy	Ambodiara sakorihy	11
Vatovavy Fitovinany	Ikongo	Ambatofotsy	Ampiatsaha	20
Vatovavy Fitovinany	Ikongo	Ambohimisafy	Ambohimisafy	11
Vatovavy Fitovinany	Ikongo	Ambohimisafy	Vakoanina	11
Vatovavy Fitovinany	Ikongo	Ambolomadinika	Sahanimanga	11
Vatovavy Fitovinany	Ikongo	Ikongo	Ananarena	2
Vatovavy Fitovinany	Ikongo	Ikongo	Mangarivotra	10
Vatovavy Fitovinany	Ikongo	Manampatrana	Manambato	9
Vatovavy Fitovinany	Ikongo	Manampatrana	Manampatrana	22
Vatovavy Fitovinany	Ikongo	Tolongoina	Tolongoina	11
Vatovavy Fitovinany	Mananjary	Ambalahosy nord	Ambodihasina	22
Vatovavy Fitovinany	Mananjary	Ambohimiarina ii	Ambohimiarina ii	11
Vatovavy Fitovinany	Mananjary	Ambohinihaonana	Ambohimahavelona	20
Vatovavy Fitovinany	Mananjary	Ambohinihaonana	Ambohimahavelona Ankalaitra	11
Vatovavy Fitovinany	Mananjary	Ambohinihaonana	Ambohimiadana	11
Vatovavy Fitovinany	Mananjary	Ambohinihaonana	Ambololona	11
Vatovavy Fitovinany	Mananjary	Ambohinihaonana	Ankalaitra	11
Vatovavy Fitovinany	Mananjary	Andonabe	Andonabe	11
Vatovavy Fitovinany	Mananjary	Andonabe	Mahatsara ii	11
Vatovavy Fitovinany	Mananjary	Kianjavato	Ambodifandramanana	11
Vatovavy Fitovinany	Mananjary	Kianjavato	Kianjavato	22
Vatovavy Fitovinany	Mananjary	Mahavoky nord	Ambodiriana ifanantara	11
Vatovavy Fitovinany	Mananjary	Mahavoky nord	Lavakianja	11
Vatovavy Fitovinany	Mananjary	Mahavoky nord	Mahatsara nord	8
Vatovavy Fitovinany	Mananjary	Mahavoky nord	Mahavoky nord	22
Vatovavy Fitovinany	Mananjary	Marokarima	Ankarimalaza	11
Vatovavy Fitovinany	Mananjary	Marokarima	Marokarima	44
Vatovavy Fitovinany	Mananjary	Marokarima	Tsaramiadana	31
Vatovavy Fitovinany	Mananjary	Marosangy	Marosangy	22
Vatovavy Fitovinany	Mananjary	Tsarahafatra	Tsarahafatra	11
Vatovavy Fitovinany	Mananjary	Tsaravary	Ampasimbola	11
Vatovavy Fitovinany	Mananjary	Tsiatosika	Ambalakondro	55
Vatovavy Fitovinany	Mananjary	Tsiatosika	Ambohimiarina i	88
Vatovavy Fitovinany	Mananjary	Tsiatosika	Tsarahafatra	22
Total				**757**

FIGURE C1: MAP OF SAMPLED HOUSEHOLDS BY DISTRICT

Number of Sampled Households
14 - 63
0 - 14
0 - 0
No data

Number of Sampled Households
314 - 518
93.5 - 314
63.5 - 93.5
50 - 63.5
No data

Number of Sampled Households
36 - 126
27.5 - 36
19 - 27.5
9 - 19
No data
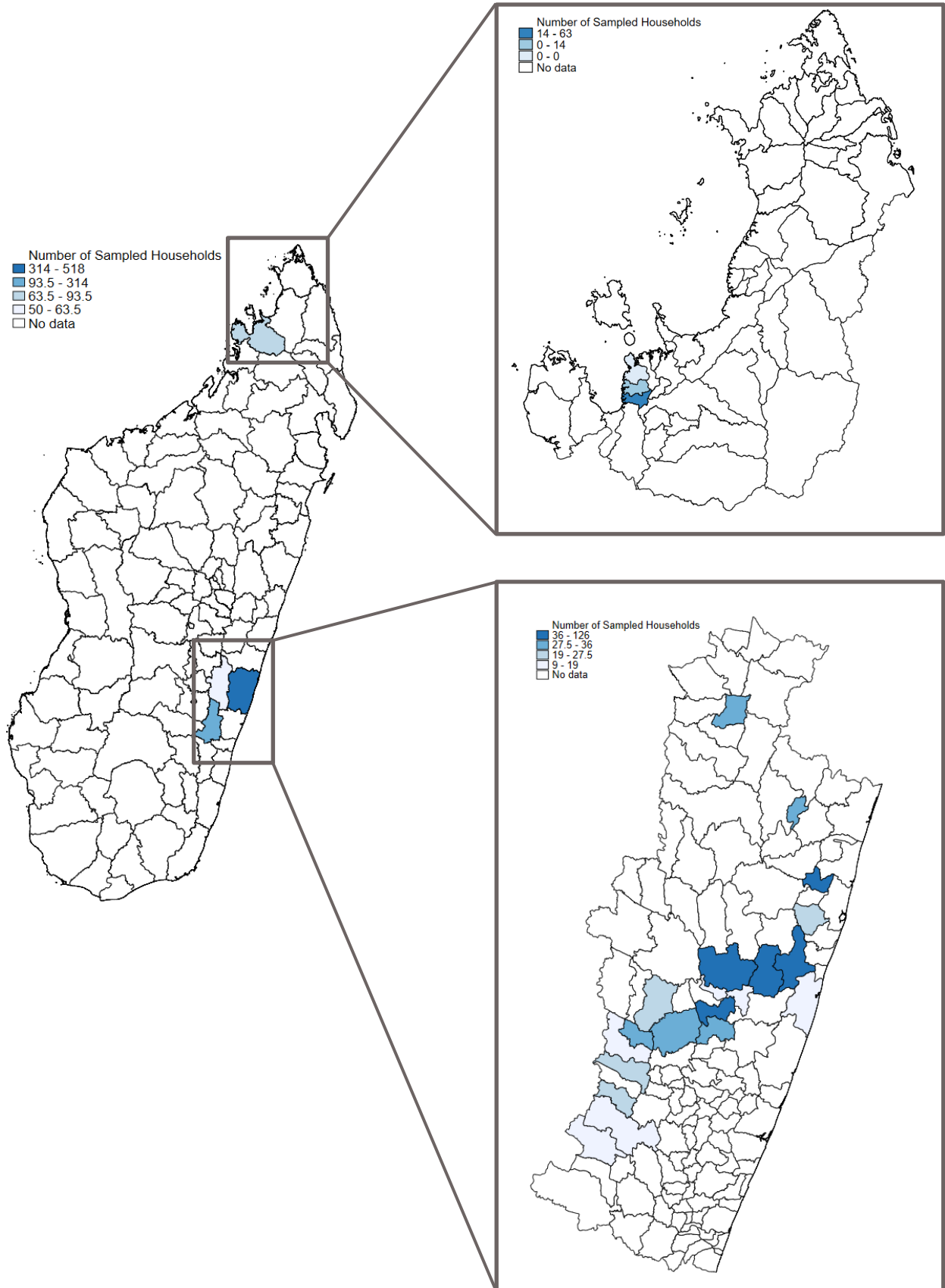
APPENDIX D: SUPPLEMENTAL RESULTS

D.1   DEMOGRAPHICS & BACKGROUND CHARACTERISTICS

TABLE D1: HOUSEHOLD SIZE AND COMPOSITION BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Household size	755	5.62 (0.15)	678	5.66 (0.16)	77	4.96 (0.32)	0.70	0.05	*
Number of adults (>18)	755	2.74 (0.06)	678	2.74 (0.06)	77	2.74 (0.08)	-0.00	0.98	
Number of adult males (>18)	755	1.40 (0.04)	678	1.39 (0.04)	77	1.44 (0.10)	-0.05	0.64	
Number of adult females (>18)	755	1.34 (0.03)	678	1.34 (0.04)	77	1.30 (0.04)	0.04	0.50	
Number of females of reproductive age (15-49)	755	1.26 (0.05)	678	1.27 (0.05)	77	1.08 (0.04)	0.19	0.00	***
Number of youth (15-29)	755	1.56 (0.06)	678	1.56 (0.06)	77	1.38 (0.14)	0.19	0.20	
Number of children over five years of age	755	2.39 (0.11)	678	2.42 (0.11)	77	1.71 (0.16)	0.71	0.00	***
Number of children under five years of age	755	0.67 (0.04)	678	0.67 (0.04)	77	0.64 (0.10)	0.04	0.74	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D2: GENDERED HOUSEHOLD TYPE BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Adult Female no Adult Male	755	6.82	678	6.64	77	10.39	-3.75	0.08	
Adult Male no Adult Female	755	3.50	678	3.55	77	2.60	0.95	0.55	
Male and Female Adults	755	89.67	678	89.81	77	87.01	2.80	0.32	
Child no Adults	755	0.00	678	0.00	77	0.00	0.00	-	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D3: EDUCATION AND EMPLOYMENT OF HOUSEHOLD HEAD BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Highest education level									
None	755	12.05	678	11.86	77	15.58	-3.72	0.35	
Preschool	755	2.10	678	2.21	77	0.00	2.21	0.00	***
Primary	755	53.46	678	54.08	77	41.56	12.53	0.04	*
Secondary first cycle	755	22.62	678	21.98	77	35.06	-13.09	0.00	***
Secondary second cycle	755	7.72	678	7.78	77	6.49	1.29	0.69	
Higher education / university	755	1.73	678	1.82	77	0.00	1.82	0.00	***
Literacy									
Can read or write	748	78.49	671	78.24	77	83.12	-4.87	0.30	
Employment									
Worked in last 12-months	748	98.65	671	98.65	77	98.70	-0.05	0.96	
Paid in cash only	734	28.25	658	29.39	76	6.58	22.81	0.00	***
Paid in cash and in-kind	734	16.46	658	17.32	76	0.00	17.32	0.00	***
Paid in-kind only	734	3.28	658	3.45	76	0.00	3.45	0.00	***
Not paid	734	52.01	658	49.83	76	93.42	-43.59	0.00	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

D.2   LIVELIHOODS

TABLE D4: PREVALENCE OF POVERTY AT THE $1.90/DAY POVERTY LINE

	Overall		Group 1		Group 2		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
			COFAV		**COMATSA**				
Below the $1.90/day poverty line	755	49.76	678	50.46	77	36.36	14.10	0.01	**
			Male and Female Adults		**Adult Female No Adult Male**				
Below the $1.90/day poverty line	755	49.76	668	48.73	56	59.25	-10.52	0.16	
			Male and Female Adults		**Adult Male No Adult Female**				
Below the $1.90/day poverty line	755	49.76	668	48.73	31	57.57	-8.84	0.34	
			Literate Household Head		**Non-literate Household Head**				
Below the $1.90/day poverty line	755	49.76	561	44.95	187	66.27	-21.32	0.00	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D5: DWELLING CHARACTERISTICS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Roof material									
Thatch/palm/leaves	755	65.35	678	67.20	77	29.87	37.33	0.00	***
Motte grass	755	5.70	678	6.00	77	0.00	6.00	0.04	*
Wooden boards	755	0.30	678	0.32	77	0.00	0.32	0.16	
Sheet	755	28.34	678	26.16	77	70.13	-43.97	0.00	***
Tile	755	0.00	678	0.00	77	0.00	-	-	-
Other	755	0.31	678	0.33	77	0.00	0.33	0.32	
Wall material									
Thatch/palm/leaves	755	47.68	678	49.90	77	5.19	44.70	0.00	***
Mud	755	19.34	678	20.35	77	0.00	20.35	0.00	***
Wooden boards	755	10.36	678	10.70	77	3.90	6.80	0.06	
Sheet	755	0.43	678	0.39	77	1.30	-0.91	0.53	
Cement	755	5.18	678	3.55	77	36.36	-32.81	0.00	***
Brick and mortar	755	1.49	678	1.57	77	0.00	1.57	0.04	*
Other	755	15.51	678	13.55	77	53.25	-39.70	0.00	***
Lighting source									
Oil lamp	755	37.96	678	39.20	77	14.29	24.91	0.00	***
ADAPS	755	28.45	678	29.33	77	11.69	17.64	0.00	***
Solar panel	755	29.56	678	27.44	77	70.13	-42.69	0.00	***
Candle	755	0.00	678	0.00	77	0.00	-	-	-
Electricity	755	3.15	678	3.11	77	3.90	-0.78	0.85	
Other	755	0.87	678	0.92	77	0.00	0.92	0.01	**
Cooking energy source									
Firewood	755	91.88	678	93.42	77	62.34	31.09	0.00	***
Charcoal	755	8.05	678	6.58	77	36.36	-29.79	0.00	***
Gas	755	0.06	678	0.00	77	1.30	-1.30	0.27	
Electricity	755	0.00	678	0.00	77	0.00	-	-	-
Other	755	0.00	678	0.00	77	0.00	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D6: BORROWING BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Percentage of households borrowing from each source									
Non-governmental org. (NGO)	755	4.05	678	4.06	77	3.90	0.16	0.96	
Informal lender	755	0.87	678	0.91	77	0.00	0.91	0.06	
Formal lender	755	2.77	678	1.97	77	18.18	-16.21	0.00	***
Friend or relative	755	36.23	678	37.31	77	15.58	21.72	0.00	***
Group-based micro-finance	755	20.64	678	19.41	77	44.16	-24.75	0.01	**
Informal credit/savings group	755	0.76	678	0.59	77	3.90	-3.30	0.09	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D7: GROUP MEMBERSHIP BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Agricultural producer's group									
Present in community	749	59.82	675	58.96	74	77.03	-18.07	0.03	*
Member of group	441	85.17	384	85.12	57	85.96	-0.85	0.87	
Water users' group									
Present in community	749	16.16	673	14.95	76	39.47	-24.52	0.03	*
Member of group	109	47.17	79	48.15	30	40.00	8.15	0.57	
Forest users' group									
Present in community	741	18.76	671	18.63	70	21.43	-2.80	0.68	
Member of group	110	45.96	95	48.11	15	^	-	-	-
Credit/micro-finance group									
Present in community	751	45.65	676	43.43	75	89.33	-45.90	0.00	***
Member of group	365	54.18	298	53.60	67	59.70	-6.10	0.48	
Mutual help/insurance group									
Present in community	740	3.02	667	2.83	73	6.85	-4.02	0.10	
Member of group	26	^	21	^	5	^	-	-	-
Trade/business association									
Present in community	736	5.51	663	4.47	73	26.03	-21.55	0.00	***
Member of group	48	35.13	29	33.08	19	^	-	-	-
Civic groups									
Present in community	748	6.60	675	5.77	73	23.29	-17.52	0.00	***
Member of group	62	52.41	45	46.41	17	^	-	-	-
Local government									
Present in community	752	77.64	675	76.60	77	97.40	-20.80	0.00	***
Member of group	567	14.03	492	14.07	75	13.33	0.74	0.84	
Religious group									
Present in community	740	60.20	663	59.20	77	79.22	-20.02	0.00	***
Member of group	451	52.86	390	53.00	61	50.82	2.18	0.77	
Women's group									
Present in community	333	81.83	288	81.15	45	91.11	-9.96	0.26	
Member of group	269	68.64	230	67.78	39	79.49	-11.71	0.10	
Other group									
Present in community	744	4.44	671	4.32	73	6.85	-2.53	0.31	
Member of group	43	86.73	38	87.27	5	^	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D8: GROUP MEMBERSHIP BY GENDER

	Overall		Male		Female		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Agricultural producer's group	441	85.17	280	84.77	161	85.86	-1.10	0.78	
Water users' group	109	47.17	80	49.11	29	42.07	7.04	0.62	
Forest users' group	110	45.96	79	42.73	31	55.25	-12.52	0.31	
Credit/micro-finance group	365	54.18	230	46.90	135	65.30	-18.40	0.01	**
Mutual help/insurance group	26	^	17	^	9	^	-	-	-
Trade/business association	48	35.13	37	33.19	11	^	-9.22	0.61	
Civic groups	62	52.41	47	56.77	15	^	15.41	0.41	
Local government	567	14.03	360	15.75	207	11.16	4.59	0.18	
Religious group	451	52.86	302	47.18	149	64.13	-16.95	0.00	***
Women's group	269	68.64	49	52.56	220	71.30	-18.74	0.13	
Other group	43	86.73	32	88.05	11	^	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D9: SOCIAL ASSISTANCE PARTICIPATION BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
USAID, government, NGO participation									
Govt./NGO/other activities	752	43.41	675	43.51	77	41.56	1.95	0.84	
USAID activities	750	38.45	674	39.48	76	18.42	21.06	0.00	***
Agroforestry, forest conservation, natural resource management participation									
Natural resource training	755	29.36	678	28.45	77	46.75	-18.30	0.00	***
Business, financial literacy participation									
Financial literacy training	755	7.71	678	7.44	77	12.99	-5.55	0.15	
Employment/business training	755	8.23	678	8.32	77	6.49	1.83	0.42	
Nutrition participation									
Nutrition trainings/meetings	755	11.90	678	12.11	77	7.79	4.32	0.20	
Agriculture participation / assistance									
Agriculture/livestock trainings	755	38.64	678	38.35	77	44.16	-5.80	0.34	
Health/livestock/crop insurance	755	2.03	678	1.87	77	5.19	-3.33	0.16	
Received agricultural inputs	755	23.45	678	23.86	77	15.58	8.28	0.11	
Reinvested ag. revenue	61	41.36	56	42.23	5	^	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

D.3 AGRICULTURE

TABLE D10: NUMBER OF PLOTS AND TOTAL AREA BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Number of plots	754	3.01	677	2.99	77	3.42	-0.43	0.08	
		(0.10)		(0.10)		(0.22)			
Total area of plots (hectares)	755	3.02	678	2.98	77	3.83	-0.85	0.61	
		(0.47)		(0.49)		(1.63)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D11: LAND IN PROTECTED AREAS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Percentage of households with agricultural plots that overlap with:									
Protected area	713	3.14	638	3.10	75	4.00	-0.90	0.66	
Transfert de gestion	713	2.98	638	2.92	75	4.00	-1.08	0.65	
None of the above	713	94.05	638	94.16	75	92.00	2.16	0.52	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D12: CROPS GROWN BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Cacao	747	13.94	670	9.47	77	98.70	-89.23	0.00	***
Vanilla	747	66.01	670	66.76	77	51.95	14.81	0.11	
Black pepper	747	21.54	670	22.54	77	2.60	19.94	0.00	***
Cinnamon	747	30.63	670	32.25	77	0.00	32.25	0.00	***
Maize	747	7.60	670	7.38	77	11.69	-4.30	0.23	
Rice	747	95.41	670	95.51	77	93.51	2.01	0.53	
Cassava	747	72.82	670	76.32	77	6.49	69.83	0.00	***
Groundnuts	747	9.15	670	9.63	77	0.00	9.63	0.00	***
Soybean	747	0.44	670	0.46	77	0.00	0.46	0.17	
Potato / sweet potato	747	15.49	670	15.90	77	7.79	8.11	0.05	*
Beans and pulses	747	18.39	670	18.75	77	11.69	7.06	0.18	
Vegetables	747	17.71	670	17.00	77	31.17	-14.17	0.03	*
Fruits	747	62.56	670	63.74	77	40.26	23.48	0.00	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D13: PRODUCTION AND YIELD OF TARGETED CROPS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Cacao (last 12-months)									
Total area planted (hectares)	140	0.10 (0.02)	64	0.08 (0.02)	76	0.13 (0.04)	-0.05	0.28	
Total area cultivated (hectares)	140	0.89 (0.43)	64	0.10 (0.02)	76	2.32 (1.21)	-2.22	0.07	
Total area harvested (hectares)	140	0.75 (0.40)	64	0.00 (0.00)	76	2.10 (1.10)	-2.10	0.06	
Yield (tons per hectare harvested)	80	2.49 (0.31)	4	^ ^	76	2.79 (0.30)	-	-	-
Black Pepper (last 12-months)									
Total area planted (hectares)	169	0.04 (0.01)	167	0.04 (0.01)	2	^ ^	-	-	-
Total area cultivated (hectares)	169	0.13 (0.02)	167	0.12 (0.02)	2	^ ^	-	-	-
Total area harvested (hectares)	169	0.07 (0.02)	167	0.07 (0.02)	2	^ ^	-	-	-
Yield (tons per hectare harvested)	104	0.56 (0.23)	102	0.56 (0.23)	2	^ ^	-	-	-
Cinnamon (last 12-months)									
Total area planted (hectares)	224	0.15 (0.03)	224	0.15 (0.03)	0	^ ^	-	-	-
Total area cultivated (hectares)	224	0.48 (0.10)	224	0.48 (0.10)	0	^ ^	-	-	-
Total area harvested (hectares)	224	0.17 (0.06)	224	0.17 (0.06)	0	^ ^	-	-	-
Yield (tons per hectare harvested)	83	1.52 (0.63)	83	1.52 (0.63)	0	^ ^	-	-	-
Vanilla (last 12-months)									
Total area planted (hectares)	461	0.19 (0.04)	421	0.19 (0.04)	40	0.18 (0.06)	0.01	0.85	
Total area cultivated (hectares)	461	0.39 (0.07)	421	0.38 (0.07)	40	0.51 (0.13)	-0.13	0.35	
Total area harvested (hectares)	461	0.18 (0.04)	421	0.18 (0.04)	40	0.27 (0.06)	-0.09	0.18	
Yield (tons per hectare harvested)	233	0.30 (0.05)	210	0.30 (0.05)	23	^ ^	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

TABLE D14: SALES OF TARGETED CROPS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Cacao (last 12-months)									
Total sold (tons)	140	1.89	64	0.00	76	5.34	-5.34	0.10	
		(1.10)		(0.00)		(3.17)			
Value sold (USD)	134	1,420.97	58	0.00	76	3,749.51	-3,749.51	0.14	
		(913.54)		(0.00)		(2,537.34)			
Black Pepper (last 12-months)									
Total sold (tons)	169	0.01	167	0.01	2	^	-	-	-
		(0.00)		(0.00)		^			
Value sold (USD)	169	13.23	167	13.16	2	^	-	-	-
		(2.30)		(2.33)		^			
Cinnamon (last 12-months)									
Total sold (tons)	224	0.06	224	0.06	0	^	-	-	-
		(0.02)		(0.02)		^			
Value sold (USD)	215	44.35	215	44.35	0	^	-	-	-
		(14.53)		(14.53)		^			
Vanilla (last 12-months)									
Total sold (tons)	461	0.01	421	0.01	40	0.03	-0.01	0.13	
		(0.00)		(0.00)		(0.01)			
Value sold (USD)	444	134.98	404	126.59	40	328.70	-202.11	0.10	
		(34.51)		(35.95)		(119.83)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D15: SOURCE OF SALES FOR TARGETED CROPS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Cacao (last 12-months)									
Directly to a company	140	36.86	64	15.18	76	76.32	-61.14	0.00	***
To a local buyer/trader	140	12.12	64	6.48	76	22.37	-15.89	0.01	**
To a local market	140	4.30	64	3.77	76	5.26	-1.50	0.59	
To another source	140	48.12	64	74.58	76	0.00	74.58	0.00	***
Black Pepper (last 12-months)									
Directly to a company	169	5.64	167	5.67	2	^	-	-	-
To a local buyer/trader	169	36.67	167	36.59	2	^	-	-	-
To a local market	169	29.02	167	28.89	2	^	-	-	-
To another source	169	28.67	167	28.85	2	^	-	-	-
Cinnamon (last 12-months)									
Directly to a company	224	5.05	224	5.05	0	^	-	-	-
To a local buyer/trader	224	25.89	224	25.89	0	^	-	-	-
To a local market	224	14.87	224	14.87	0	^	-	-	-
To another source	224	55.34	224	55.34	0	^	-	-	-
Vanilla (last 12-months)									
Directly to a company	461	7.02	421	6.69	40	15.00	-8.31	0.16	
To a local buyer/trader	461	40.15	421	40.46	40	32.50	7.96	0.25	
To a local market	461	6.47	421	6.12	40	15.00	-8.88	0.03	*
To another source	461	46.62	421	47.00	40	37.50	9.50	0.30	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D16: USE OF IMPROVED MANAGEMENT PRACTICES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Use of improved seeds, planting materials, or seedlings	747	18.75	670	19.26	77	9.09	10.17	0.02	*
Use of soil fertilization technologies	747	62.13	670	64.79	77	11.69	53.11	0.00	***
Use of water management	747	71.24	670	74.39	77	11.69	62.70	0.00	***
Use of techniques for weed management	747	94.86	670	95.00	77	92.21	2.79	0.34	
Use of biopesticides to manage crop diseases and pests	747	11.10	670	11.07	77	11.69	-0.62	0.87	
Use of post-harvest processing techniques	747	79.36	670	79.71	77	72.73	6.98	0.15	
Use of improved animal shelters	747	11.15	670	11.06	77	12.99	-1.93	0.67	
Use of vaccination, deworming	747	32.72	670	30.95	77	66.23	-35.28	0.00	***
Use of techniques feed animals through locally available foods	747	23.56	670	20.14	77	88.31	-68.17	0.00	***
Use of race selection	747	7.19	670	6.96	77	11.69	-4.73	0.08	
Use of improved practices to apiculture beekeeping, pisciculture	747	2.06	670	2.03	77	2.60	-0.57	0.74	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D17: USE OF IMPROVED NATURAL RESOURCES MANAGEMENT PRACTICES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Techniques to cover soil for landscape restoration	754	38.06	677	37.27	77	53.25	-15.97	0.10	
Techniques to manage soil fertility	754	52.72	677	54.79	77	12.99	41.81	0.00	***
Integrated agroforestry with cash crop production	754	53.57	677	53.05	77	63.64	-10.59	0.28	
Techniques to protect soil from bush fires	754	58.13	677	60.35	77	15.58	44.77	0.00	***
Water management techniques	754	53.41	677	55.52	77	12.99	42.53	0.00	***
Techniques to control erosion	754	23.57	677	23.51	77	24.68	-1.16	0.81	
Watershed management techniques	754	13.28	677	12.62	77	25.97	-13.35	0.00	***
None of the above	754	5.03	677	4.75	77	10.39	-5.64	0.25	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D18: LIVESTOCK PRODUCTION BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Raised any livestock in last 12 months	754	79.36	677	79.23	77	81.82	-2.59	0.60	
Raised chickens in last 12 months	593	92.35	530	93.91	63	63.49	30.42	0.00	***
Raised geese in last 12 months	593	4.57	530	4.82	63	0.00	4.82	0.00	***
Raised ducks in last 12 months	593	21.91	530	21.29	63	33.33	-12.04	0.01	**
Raised goats in last 12 months	593	0.65	530	0.00	63	12.70	-12.70	0.02	*

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D19: LAND OWNERSHIP ARRANGEMENT BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Percentage of households with ownership arrangement:									
State owned	755	0.92	678	0.97	77	0.00	0.97	0.19	
Titled	755	6.13	678	5.63	77	15.58	-9.95	0.02	*
Certified	755	27.44	678	28.19	77	12.99	15.21	0.02	*
Non-titled privately-owned with formal documents	755	38.44	678	37.60	77	54.55	-16.94	0.04	*
Non-titled privately-owned with simple documents	755	8.96	678	8.08	77	25.97	-17.90	0.00	***
No documents	755	37.54	678	37.67	77	35.06	2.60	0.69	
Other	755	2.02	678	1.85	77	5.19	-3.34	0.20	

^ Results not statistically reliable, n<30

Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

D.3   FOOD SECURITY AND HEALTH

TABLE D20: FOOD INSECURITY EXPERIENCE SCALE BY REGION

Disaggregation Category	N	Little to No (%)	Moderate (%)	Severe (%)	Moderate or Severe (%)
Overall	755	28.94	62.48	8.58	71.06
Region					
COFAV	678	27.09	63.99	8.91	72.90
COMATSA	77	69.33	29.40	1.26	30.66
Gendered household type					
Adult Female no Adult Male	52	34.69	58.67	6.65	65.31
Adult Male no Adult Female	26	^	^	^	^
Male and Female Adults	677	28.70	62.63	8.66	71.29

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D21: MINIMUM DIETARY DIVERSITY-WOMEN BY REGION

	Overall		COFAV		COMATSA				
	N	Estimate	N	Estimate	N	Estimate	Diff.	p-val.	Signif.
MDD-W									
MDD-W (percent consuming five or more food groups)	474	19.93%	422	17.90%	52	55.77%	-37.87%	0.00	***
Average number of food groups consumed (out of 10)	474	3.32	422	3.26	52	4.42	-1.16	0.00	***
Percent consuming each food group									
Grains, white roots and tubers, and plantains	474	97.17%	422	97.01%	52	100%	-2.99%	0.01	**
Pulses (beans, peas and lentils)	474	12.92%	422	12.89%	52	13.46%	-0.58%	0.89	
Nuts and seeds	474	5.01%	422	4.75%	52	9.62%	-4.87%	0.24	
Dairy	474	3.47%	422	2.90%	52	13.46%	-10.56%	0.00	***
Meat, poultry, and fish	474	40.12%	422	38.03%	52	76.92%	-38.89%	0.00	***
Eggs	474	7.25%	422	7.33%	52	5.77%	1.56%	0.67	
Dark green leafy vegetables	474	69.65%	422	70.76%	52	50.00%	20.76%	0.00	***
Other vitamin A-rich fruits and vegetables	474	16.53%	422	15.83%	52	28.85%	-13.02%	0.15	
Other vegetables	474	45.21%	422	42.42%	52	94.23%	-51.81%	0.00	***
Other fruits	474	35.08%	422	34.23%	52	50.00%	-15.77%	0.08	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D22: COPING STRATEGIES INDEX BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Estimate	N	Estimate	N	Estimate			
Average CSI Score									
CSI score	755	33.22	678	34.62	77	6.31	28.31	0.00	***
Percent using each coping strategy									
Skip entire days without eating	755	3.66%	678	3.72%	77	2.60%	1.12%	0.53	
Limit portion size at mealtimes	755	17.73%	678	17.64%	77	19.48%	-1.84%	0.71	
Reduce number of meals eaten per day	755	15.66%	678	16.21%	77	5.19%	11.01%	0.00	***
Borrow food or rely on help from friends/relatives	755	15.68%	678	15.82%	77	12.99%	2.84%	0.26	
Rely on less expensive/preferred food	755	19.76%	678	19.51%	77	24.68%	-5.17%	0.45	
Purchase/borrow food on credit	755	17.01%	678	17.28%	77	11.69%	5.59%	0.10	
Harvest immature crops	755	12.03%	678	12.59%	77	1.30%	11.29%	0.00	***
Send household members to eat elsehwere	755	3.13%	678	3.22%	77	1.30%	1.92%	0.23	
Send household members to beg	755	1.29%	678	1.36%	77	0.00%	1.36%	0.01	**
Reduce consumption so children can eat	755	15.37%	678	16.11%	77	1.30%	14.81%	0.00	***
Gather unusual types/amounts of wild food/hunt	755	6.53%	678	6.87%	77	0.00%	6.87%	0.00	***
Use of savings	755	16.04%	678	16.20%	77	12.99%	3.21%	0.35	
Consume seed stock reserved for the next season	755	16.30%	678	16.74%	77	7.79%	8.95%	0.00	***
Send children to work	755	3.82%	678	4.01%	77	0.00%	4.01%	0.00	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D23: SHOCK EXPOSURE BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Estimate	N	Estimate	N	Estimate			
Share of households experiencing each type of shock in the last 12-months									
Drought	755	22.50	678	23.40	77	5.19	18.21	0.00	***
Flood/water logging	755	4.93	678	4.78	77	7.79	-3.02	0.64	
Strong winds or storms	755	1.60	678	1.62	77	1.30	0.32	0.82	
Crop disease or pests	755	13.17	678	13.79	77	1.30	12.49	0.00	***
Livestock disease or deaths	755	11.18	678	11.63	77	2.60	9.03	0.00	***
Loss of job/non-payment	755	4.19	678	4.41	77	0.00	4.41	0.00	***
Large fall in sale price of crops	755	23.78	678	23.67	77	25.97	-2.31	0.58	
Large rise in prices of food	755	31.96	678	32.81	77	15.58	17.23	0.00	***
Death in household	755	18.54	678	17.94	77	29.87	-11.93	0.02	*
Break-up of household	755	2.30	678	2.41	77	0.00	2.41	0.00	***
Illness	755	47.55	678	47.05	77	57.14	-10.09	0.08	
Theft	755	14.86	678	15.23	77	7.79	7.44	0.03	*
House damaged due to fire	755	0.77	678	0.81	77	0.00	0.81	0.02	*
End of regular assistance, aid or remittances	755	0.00	678	0.00	77	0.00	-	-	-
Other	755	18.19	678	18.39	77	14.29	4.11	0.41	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D24: HEALTH SERVICES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Health expenditures (USD, last 3-months)	750	19.66	674	18.04	76	51.01	-32.97	0.04	*
		(4.12)		(4.26)		(15.56)			
Typical distance traveled for health services (km)	755	4.92	678	5.07	77	2.02	3.05	0.01	**
		(0.41)		(0.42)		(0.99)			
Number of outpatient consultations (last 3-months)	752	1.77	675	1.75	77	1.97	-0.22	0.54	
		(0.10)		(0.11)		(0.35)			
Consultation with community health agent (last 3-months)	755	0.04	678	0.04	77	0.09	-0.05	0.12	
		(0.01)		(0.01)		(0.03)			
Consultation with community health center (last 3-months)	754	1.27	677	1.28	77	1.08	0.20	0.30	
		(0.10)		(0.11)		(0.16)			
Consultation with traditional healer (last 3-months)	755	0.05	678	0.03	77	0.34	-0.31	0.18	
		(0.02)		(0.02)		(0.23)			
Consultation with government hospital (last 3-months)	755	0.21	678	0.20	77	0.47	-0.27	0.01	**
		(0.06)		(0.06)		(0.09)			
Consultation with other source (last 3-months)	755	0.20	678	0.20	77	0.05	0.15	0.04	*
		(0.05)		(0.05)		(0.05)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

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TABLE D25: ECOSYSTEM THREATS BY REGION

| | Overall | | COFAV | | COMATSA | | Diff. | p-val. | Signif. |
	N	Percentage	N	Percentage	N	Percentage			
Believes there are current threats to the community's ecosystem	755	85.88	678	85.62	77	90.91	-5.29	0.20	
Biggest threats to ecosystem									
Illegal logging	637	52.75	567	51.72	70	71.43	-19.71	0.00	***
Slash-and-burn agriculture	637	76.82	567	79.33	70	31.43	47.90	0.00	***
Poaching	637	7.70	567	7.88	70	4.29	3.60	0.27	
Wildlife trafficking	637	0.07	567	0.00	70	1.43	-1.43	0.35	
Illegal fishing by using beach seine net	637	1.50	567	1.03	70	10.00	-8.97	0.00	***
Illegal fishing in other ways (closed season, non-respect of minimum size)	637	0.07	567	0.00	70	1.43	-1.43	0.26	
Climate change impacts	637	40.05	567	38.87	70	61.43	-22.56	0.00	***
Unsustainable farming practices	637	23.86	567	24.62	70	10.00	14.62	0.00	***
Other unsustainable resource use	637	1.86	567	1.96	70	0.00	1.96	0.04	*

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D26: IMPORTANCE OF ECOSYSTEM SERVICES BY REGION

| | Overall | | COFAV | | COMATSA | | Diff. | p-val. | Signif. |
	N	Percentage	N	Percentage	N	Percentage			
'Agree' or 'strongly agree' that it is important to protect ecosystem services in order to:									
Filter water to keep it clean and safe	755	94.03	678	93.92	77	96.10	-2.18	0.52	
Provide clean air	755	98.12	678	98.09	77	98.70	-0.61	0.71	
Keep soil fertile and productive	755	97.18	678	97.24	77	96.10	1.13	0.60	
Protect communities and property from storm impacts	755	82.20	678	81.95	77	87.01	-5.06	0.13	
Provide raw materials for making and building things	755	94.95	678	94.89	77	96.10	-1.21	0.53	
Pollinate plants and crops to produce food	755	91.31	678	92.08	77	76.62	15.46	0.00	***
Reduce or control the spread of many diseases	755	83.53	678	83.62	77	81.82	1.80	0.70	
provide raw materials for most medicines	755	92.46	678	92.34	77	94.81	-2.47	0.44	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D27: TREE ACCESS AND PLANTING BY REGION

	Overall		COFAV		COMATSA				
	N	Percentage	N	Percentage	N	Percentage	Diff.	p-val.	Signif.
Access to trees									
Own a tree nursery	755	6.57	678	6.91	77	0.00	6.91	0.00	***
Member of a tree nursery	755	10.59	678	11.14	77	0.00	11.14	0.01	**
Access to woodlot	755	27.30	678	28.52	77	3.90	24.62	0.00	***
Other access to trees	755	37.38	678	37.64	77	32.47	5.17	0.38	
None of the above	755	31.87	678	30.22	77	63.64	-33.42	0.00	***
Tree planting									
Planted trees in last 3 years	755	52.06	678	51.11	77	70.13	-19.02	0.02	*
Reasons for planting trees									
Reforestation/restoration	392	51.17	338	49.66	54	72.22	-22.56	0.00	***
Firewood for own use	392	23.90	338	25.48	54	1.85	23.62	0.00	***
Firewood for sale	392	1.77	338	1.90	54	0.00	1.90	0.05	*
Charcoal for sale	392	0.25	338	0.13	54	1.85	-1.72	0.23	
Spices/fruits for sale	392	9.23	338	9.89	54	0.00	9.89	0.00	***
Spices/fruits to eat	392	19.02	338	19.99	54	5.56	14.43	0.00	***
Timber for sale	392	6.98	338	7.48	54	0.00	7.48	0.00	***
Timber for own use	392	59.79	338	62.61	54	20.37	42.24	0.00	***
Soil improvement/erosion control	392	27.27	338	26.18	54	42.59	-16.41	0.03	*
Shade for agriculture	392	24.74	338	22.40	54	57.41	-35.01	0.00	***
Other	392	0.45	338	0.48	54	0.00	0.48	0.17	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D28: LAND CLEARING IN LAST THREE YEARS BY REGION

	Overall		COFAV		COMATSA				
	N	Percentage	N	Percentage	N	Percentage	Diff.	p-val.	Signif.
Land clearing									
Cleared land for cultivation/livestock	755	29.37	678	30.16	77	14.29	15.87	0.01	**
Type of land cleared									
Forest	200	5.73	189	5.42	11	^	-	-	-
Fallow agricultural land	200	90.91	189	91.14	11	^	-	-	-
Other	200	3.35	189	3.44	11	^	-	-	-
Where land was cleared									
Protected area	200	0.00	189	0.00	11	^	-	-	-
Sacred forest	200	0.00	189	0.00	11	^	-	-	-
Transfer de gestion	200	3.18	189	2.81	11	^	-	-	-
Fallow land	200	93.78	189	94.07	11	^	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D29: LAND CLEARING IN NEXT 12-MONTHS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Future land clearing									
Plans to clear land for cultivation/livestock	755	60.97	678	61.30	77	54.55	6.76	0.18	
Plans to clear land in a protected area / transfert de gestion / sacred forest	424	5.63	384	5.20	40	15.00	-9.80	0.01	**
Reason for future land clearing									
Grow more crops to sell	457	39.59	415	40.21	42	26.19	14.02	0.18	
Grow more crops to consume	457	45.57	415	46.58	42	23.81	22.77	0.00	***
Grow different types of crops	457	21.10	415	21.75	42	7.14	14.61	0.00	***
Existing/past land no longer productive	457	1.72	415	1.46	42	7.14	-5.68	0.05	*
Increase the size of land	457	78.11	415	77.97	42	80.95	-2.98	0.57	
Prevent others from claiming or acquiring it	457	1.91	415	1.89	42	2.38	-0.49	0.86	
Other	457	0.23	415	0.24	42	0.00	0.24	0.32	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D30: IMPORTANCE OF FOREST RESOURCES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Household collects forest resources	755	48.99	678	48.43	77	59.74	-11.31	0.29	
Resource is 'important' or 'very important' to livelihood									
Honey	400	18.62	354	18.28	46	23.91	-5.63	0.30	
Mushrooms	400	17.34	354	18.45	46	0.00	18.45	0.00	**
Caterpillars, locusts, or other insects	400	3.84	354	3.67	46	6.52	-2.86	0.43	
Wild fruits	400	33.10	354	31.18	46	63.04	-31.87	0.00	***
Bushmeat	400	10.21	354	8.49	46	36.96	-28.47	0.00	***
Medicinal plants	400	49.92	354	47.95	46	80.43	-32.48	0.00	*
Firewood	400	85.67	354	86.01	46	80.43	5.58	0.18	
Charcoal	400	8.40	354	5.59	46	52.17	-46.59	0.00	***
Fish	400	17.76	354	13.73	46	80.43	-66.71	0.00	***
Other	400	10.06	354	10.57	46	2.17	8.39	0.03	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D31: USE OF FOREST RESOURCES IN LAST YEAR BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Honey									
Increased use	400	1.82	354	1.80	46	2.17	-0.37	0.87	
Unchanged use	400	81.59	354	81.38	46	84.78	-3.40	0.45	
Decreased use	400	16.59	354	16.82	46	13.04	3.77	0.38	
Difficulty accessing	400	20.73	354	20.53	46	23.91	-3.38	0.53	
Mushrooms									
Increased use	400	2.13	354	2.26	46	0.00	2.26	0.01	**
Unchanged use	400	84.27	354	83.26	46	100.00	-16.74	0.00	***
Decreased use	400	13.60	354	14.48	46	0.00	14.48	0.00	***
Difficulty accessing	400	14.31	354	15.23	46	0.00	15.23	0.00	***
Caterpillars, locusts, or other insects									
Increased use	400	0.60	354	0.64	46	0.00	0.64	0.14	
Unchanged use	400	94.56	354	95.05	46	86.96	8.09	0.09	
Decreased use	400	4.84	354	4.31	46	13.04	-8.73	0.06	
Difficulty accessing	400	6.69	354	5.86	46	19.57	-13.70	0.00	***
Wild fruits									
Increased use	400	7.92	354	8.15	46	4.35	3.80	0.13	
Unchanged use	400	79.15	354	80.60	46	56.52	24.08	0.00	***
Decreased use	400	12.94	354	11.25	46	39.13	-27.88	0.00	***
Difficulty accessing	400	13.42	354	11.77	46	39.13	-27.36	0.00	***
Bushmeat									
Increased use	400	1.78	354	1.89	46	0.00	1.89	0.01	**
Unchanged use	400	90.18	354	91.37	46	71.74	19.63	0.00	***
Decreased use	400	8.04	354	6.74	46	28.26	-21.52	0.00	***
Difficulty accessing	400	10.89	354	7.96	46	56.52	-48.57	0.00	***
Medicinal plants									
Increased use	400	16.19	354	15.28	46	30.43	-15.16	0.01	*
Unchanged use	400	70.91	354	72.39	46	47.83	24.56	0.00	***
Decreased use	400	12.90	354	12.33	46	21.74	-9.41	0.06	
Difficulty accessing	400	11.14	354	9.35	46	39.13	-29.79	0.00	***
Firewood									
Increased use	400	23.72	354	24.55	46	10.87	13.68	0.04	*
Unchanged use	400	60.97	354	61.40	46	54.35	7.05	0.31	
Decreased use	400	15.31	354	14.06	46	34.78	-20.73	0.01	**
Difficulty accessing	400	38.21	354	36.06	46	71.74	-35.68	0.00	***
Charcoal									
Increased use	400	2.39	354	1.70	46	13.04	-11.34	0.04	*
Unchanged use	400	95.39	354	96.77	46	73.91	22.86	0.00	***
Decreased use	400	2.22	354	1.53	46	13.04	-11.52	0.04	*
Difficulty accessing	400	4.42	354	2.05	46	41.30	-39.26	0.00	***
Fish									
Increased use	400	3.31	354	2.97	46	8.70	-5.73	0.08	
Unchanged use	400	86.77	354	89.83	46	39.13	50.70	0.00	***
Decreased use	400	9.92	354	7.20	46	52.17	-44.97	0.00	***
Difficulty accessing	400	10.91	354	7.27	46	67.39	-60.12	0.00	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D32: LOSS OF ECOSYSTEM SERVICES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Directly affected by loss of ecosystem service	755	78.90	678	78.54	77	85.71	-7.17	0.17	
Loss affected household most via:									
Economic well-being	579	86.63	513	86.82	66	83.33	3.49	0.72	
Medical health	579	12.78	513	12.56	66	16.67	-4.11	0.67	
Cultural heritage	579	0.00	513	0.00	66	0.00	-	-	-
Emotional, psychological, or spiritual well-being	579	0.59	513	0.62	66	0.00	0.62	0.10	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D33: FUEL SOURCES USED IN LAST 30-DAYS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Biomass and candles									
Agricultural Residue	755	0.00	678	0.00	77	0.00	-	-	-
Dung	755	0.06	678	0.00	77	1.30	-1.30	0.27	
Firewood	755	92.53	678	93.96	77	64.94	29.03	0.00	***
Other traditional biomass	755	0.00	678	0.00	77	0.00	-	-	-
Charcoal & Coal	755	11.98	678	9.90	77	51.95	-42.05	0.00	***
Candles	755	0.67	678	0.70	77	0.00	0.70	0.04	*
Gaseous and liquid fuels									
Kerosene	755	43.97	678	44.64	77	31.17	13.47	0.02	*
Gasoline	755	2.05	678	1.55	77	11.69	-10.14	0.00	***
Diesel	755	0.47	678	0.15	77	6.49	-6.34	0.06	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D34: FUEL SOURCES USED IN LAST 30-DAYS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Biomass and candles									
Agricultural Residue	755	0.00	678	0.00	77	0.00	-	-	-
Dung	755	0.06	678	0.00	77	1.30	-1.30	0.27	
Firewood	755	92.53	678	93.96	77	64.94	29.03	0.00	***
Other traditional biomass	755	0.00	678	0.00	77	0.00	-	-	-
Charcoal & Coal	755	11.98	678	9.90	77	51.95	-42.05	0.00	***
Candles	755	0.67	678	0.70	77	0.00	0.70	0.04	*
Gaseous and liquid fuels									
Kerosene	755	43.97	678	44.64	77	31.17	13.47	0.02	*
Gasoline	755	2.05	678	1.55	77	11.69	-10.14	0.00	***
Diesel	755	0.47	678	0.15	77	6.49	-6.34	0.06	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D35: QUANTITY OF FUEL SOURCES USED IN LAST 30-DAYS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Biomass and candles									
Agricultural Residue (Kg)	755	0.00	678	0.00	77	0.00	-	-	-
		(0.00)		(0.00)		(0.00)			
Dung (Kg)	755	0.05	678	0.00	77	1.04	-1.04	0.27	
		(0.05)		(0.00)		(0.95)			
Firewood (Kg)	755	284.38	678	294.62	77	87.97	206.64	0.00	***
		(34.79)		(36.31)		(11.04)			
Other traditional biomass (Kg)	755	0.00	678	0.00	77	0.00	-	-	-
		(0.00)		(0.00)		(0.00)			
Charcoal & Coal (Kg)	755	7.95	678	7.10	77	24.27	-17.17	0.00	***
		(3.38)		(3.53)		(2.55)			
Candles (Kg)	755	0.00	678	0.00	77	0.00	0.00	0.08	
		(0.00)		(0.00)		(0.00)			
Gaseous and liquid fuels									
Kerosene (Liters)	755	6.83	678	7.10	77	1.57	5.53	0.41	
		(6.28)		(6.63)		(0.83)			
Gasoline (Liters)	755	0.38	678	0.13	77	5.19	-5.06	0.07	
		(0.23)		(0.06)		(2.79)			
Diesel (Liters)	755	1.45	678	0.93	77	11.43	-10.50	0.15	
		(1.02)		(0.93)		(7.34)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D36: DISTANCE TRAVELED TO COLLECT FUEL SOURCES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Biomass and candles									
Firewood (Km)	697	2.02	647	2.06	50	1.08	0.97	0.00	***
		(0.19)		(0.19)		(0.21)			
Charcoal & Coal (Km)	98	0.20	58	0.21	40	0.15	0.06	0.56	
		(0.07)		(0.09)		(0.06)			
Gaseous and liquid fuels									
Kerosene (Km)	361	2.72	337	2.79	24	0.92	1.87	0.10	
		(0.62)		(0.65)		(0.96)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D37: FIREWOOD USE IN LAST 30-DAYS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Percent of total use on each item									
Lighting	697	0.07	647	0.07	50	0.00	0.07	0.32	
		(0.07)		(0.07)		(0.00)			
Cooking	697	92.46	647	92.23	50	99.00	-6.77	0.00	***
		(0.90)		(0.93)		(1.13)			
Space heating	697	2.22	647	2.23	50	2.00	0.23	0.89	
		(0.87)		(0.91)		(1.47)			
Water heating	697	5.55	647	5.75	50	0.00	5.75	0.00	***
		(0.82)		(0.85)		(0.00)			
Other	697	1.46	647	1.47	50	1.00	0.47	0.69	
		(0.42)		(0.43)		(1.13)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D38: CHARCOAL AND COAL USE IN LAST 30-DAYS BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif
	N	Mean (se)	N	Mean (se)	N	Mean (se)			
Percent of total use on each item									
Lighting	98	0.00	58	0.00	40	0.00	-	-	-
		(0.00)		(0.00)		(0.00)			
Cooking	98	88.08	58	85.84	40	96.25	-10.41	0.02	*
		(3.71)		(4.01)		(1.81)			
Space heating	98	0.00	58	0.00	40	0.00	-	-	-
		(0.00)		(0.00)		(0.00)			
Water heating	98	7.40	58	9.42	40	0.00	9.42	0.00	***
		(2.74)		(2.82)		(0.00)			
Other	98	4.49	58	4.52	40	4.38	0.14	0.96	
		(1.33)		(1.62)		(2.07)			

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

D.5   NATURAL RESOURCES AND ENERGY USE

TABLE D39: EARNINGS AND DECISION-MAKING BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Who makes decisions about money earned by female respondent?									
Self	567	37.33	503	36.86	64	45.31	-8.45	0.23	
Husband/partner	567	8.24	503	8.63	64	1.56	7.06	0.01	**
Self and husband/partner jointly	567	44.62	503	44.12	64	53.13	-9.01	0.20	
Other	567	9.82	503	10.39	64	0.00	10.39	0.00	***
Female respondent's income compared to partner/husband									
Greater than husband/partner	567	13.15	503	12.63	64	21.88	-9.24	0.03	*
Less than husband/partner	567	51.59	503	51.41	64	54.69	-3.28	0.54	
About the same	567	21.95	503	22.05	64	20.31	1.74	0.61	
Husband/partner has no income	567	10.76	503	11.21	64	3.13	8.08	0.00	***
Other	567	2.55	503	2.70	64	0.00	2.70	0.00	***

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D40: OTHER DECISION-MAKING BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Who makes decisions about female respondent's healthcare?									
Self	567	16.44	503	15.85	64	26.56	-10.72	0.00	***
Husband/partner	567	45.96	503	47.46	64	20.31	27.15	0.00	***
Self and husband/partner jointly	567	37.41	503	36.58	64	51.56	-14.98	0.02	*
Someone else	567	0.09	503	0.00	64	1.56	-1.56	0.15	
Other	567	0.11	503	0.11	64	0.00	0.11	0.32	
Who makes decisions about major household purchases?									
Self	567	16.47	503	16.89	64	9.38	7.51	0.03	*
Husband/partner	567	20.41	503	20.51	64	18.75	1.76	0.63	
Self and husband/partner jointly	567	63.12	503	62.60	64	71.88	-9.27	0.01	**
Someone else	567	0.00	503	0.00	64	0.00	-	-	-
Other	567	0.00	503	0.00	64	0.00	-	-	-
Who makes decisions about visiting family or relatives?									
Self	567	18.94	503	18.22	64	31.25	-13.03	0.00	***
Husband/partner	567	22.58	503	23.26	64	10.94	12.32	0.00	***
Self and husband/partner jointly	567	57.81	503	57.81	64	57.81	0.00	1.00	
Someone else	567	0.67	503	0.71	64	0.00	0.71	0.19	
Other	567	0.00	503	0.00	64	0.00	-	-	-

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D41: HOME OWNERSHIP BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Home ownership									
Alone only	671	13.72	597	12.57	74	33.78	-21.22	0.00	***
Jointly with husband/partner	671	64.04	597	66.00	74	29.73	36.27	0.00	***
Jointly with someone else	671	1.96	597	2.07	74	0.00	2.07	0.01	**
Jointly with husband/partner and someone else	671	6.60	597	6.75	74	4.05	2.69	0.32	
Both alone and jointly	671	0.44	597	0.47	74	0.00	0.47	0.16	
Do not own	671	13.24	597	12.14	74	32.43	-20.29	0.00	***
Home titling									
Has a title, deed, or other document	657	24.50	585	22.90	72	52.78	-29.88	0.00	***
Female respondent's name appears on document	144	60.30	106	60.27	38	60.53	-0.26	0.98	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D42: LAND OWNERSHIP BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Land ownership									
Alone only	671	20.32	597	18.93	74	44.59	-25.67	0.00	***
Jointly with husband/partner	671	43.92	597	45.82	74	10.81	35.00	0.00	***
Jointly with someone else	671	7.77	597	7.83	74	6.76	1.07	0.57	
Jointly with husband/partner and someone else	671	5.04	597	5.25	74	1.35	3.90	0.09	
Both alone and jointly	671	1.37	597	1.37	74	1.35	0.02	0.99	
Do not own	671	21.59	597	20.81	74	35.14	-14.32	0.01	**
Land titling									
Has a title, deed, or other document	660	36.50	586	36.27	74	40.54	-4.27	0.50	
Female respondent's name appears on document	215	64.54	185	64.40	30	66.67	-2.27	0.83	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

TABLE D43: GENDER-BASED VIOLENCE ATTITUDES BY REGION

	Overall		COFAV		COMATSA		Diff.	p-val.	Signif.
	N	Percentage	N	Percentage	N	Percentage			
Female respondent believes a husband is justified in hitting/beating his wife if she:									
Goes out without telling him	664	18.42	591	18.53	73	16.44	2.10	0.65	
Neglects the children	665	26.80	591	27.18	74	20.27	6.91	0.24	
Argues with him	662	12.05	589	12.19	73	9.59	2.60	0.40	
Refuses to have sex with him	658	12.44	585	12.60	73	9.59	3.01	0.55	
Burns the food	663	11.64	591	11.90	72	6.94	4.96	0.16	

^ Results not statistically reliable, n<30
Differences found to be statistically significant are indicated by level: * p<0.05, ** p<0.01, *** p<0.001.

APPENDIX E: MEASUREMENT OF SOCIOECONOMIC STATUS

Using poverty prediction tools as a cost-effective, survey-based measurement approach

In this Appendix, we briefly present the **limitations to traditional measures of socioeconomic status (SES)** including income, consumption, and wealth indices, and present an alternative approach to predicting poverty. We discuss the benefits and limitations to existing prediction tools and **discuss the approach behind the development of our own poverty predictions** that use machine learning methods to analyze up-to-date information from recent surveys conducted in Madagascar.

Income and Consumption

Income and consumption are the foremost measures of SES, but each have serious limitations to their use. As summarized by Poirier et al. (2020), "there are challenges in using income or consumption measures in many LMICs, since income can be highly variable from month to month or difficult to accurately measure. Alternatively, consumption data, such as that measured by the Living Standards and Measurement Studies, can be extremely time consuming and expensive to collect."[i]

While consumption is considered the "gold standard" to measure SES (and indeed, is used by Feed the Future and other USAID programs), the cost and time to collect detailed consumption data is prohibitive, with standard approaches taking well over an hour. This alone may make it impractical for HEARTH, but it also raises questions about data accuracy as survey duration increases. While one cost-effective approach is to aggregate items into 10-20 high level categories, these approaches come with a large cost in terms of accuracy,[ii] as "efforts to aggregate categories or skip less frequently consumed items are consistently biased to underestimate consumption and therefore overestimate poverty."[iii] Some more innovative approaches, such as the Rapid Consumption Survey[iv] which relies on a core module and then each household completing one of several optional modules, still take on average 45-60 minutes.

Wealth Indices

Wealth indices are often used a proxy for SES when income or consumption cannot be measured directly. There are several examples of established wealth indices developed to allow for cross-country comparisons which include the following:[v]

- Comparative Wealth Index (CWI)[vi] – Used by Feed the Future and other USAID programs, the CWI calculates wealth indexes that are comparable across surveys and time, and that allow for direct comparison of levels of economic status. Feed the Future survey method guidance for constructing CWI is based on more than 40 questions, covering housing characteristics, asset ownership, and access to basic services, and takes about 5 -10 minutes on average.

- International Wealth Index (IWI)[vii] – Similar to CWI but based on a shorter set of questions (7 assets, 3 housing characteristics, and 2 access to basic services questions). There are some drawbacks to this

approach, including (1) the loss of information on the full spectrum of assets, and (2) as computations are done at one point in time, there is a risk that the weights in the index will become less meaningful over time.[viii]

While wealth indices would be more cost-effective to implement than consumption measures, there are concerns about the time scale over which we would be able to measure change. While impacts to income/consumption would occur in the short term, the accumulation of wealth would occur more slowly, thus, there is a likelihood that effects on consumption would not necessarily be picked up by changes in wealth indices. Additionally, wealth indices can still be quite lengthy, with some indices asking questions about more than 40 different assets.

An Innovative Approach: Poverty Probability Index

The Poverty Probability Index (PPI®) is a poverty measurement tool that is statistically-sound, yet simple to use: the answers to 10 questions about a household's characteristics and asset ownership are scored to compute the likelihood that the household is living below the poverty line.[ix] See example question set for Madagascar in the Annex.

The PII is an established tool used by nearly 600 organizations around the world, with scorecards currently available for 60 countries. It is accurate – when tested, the difference between scorecard estimates of groups' poverty rates and the true rates at a point in time for the national poverty line is –1.7 percentage points.[x] Since it is "off-the-shelf," it is also relatively cost-effective to implement. Using just 10 questions to predict poverty would also significantly reduce data collection costs compared to other approaches and allow more time in the household surveys to measure additional outcome indicators.

However, the existing PPI for Madagascar is based on data that is not the most up-to-date available (e.g., 2010 data for Madagascar). Also, more up-to-date methods based on machine learning (cross-validation and parameter regularization) have been used to construct the more recent PPI scorecards, but the current version for Madagascar uses an outdated methodology.

TSIRO Baseline Approach, Methodology, and Results

Introduction

Based on the limitations above, USAID/Madagascar, TSIRO, and INRM decided that INRM will replicate the PPI approach – using similar machine learning methods to analyze up-to-date information from the 2020 FFP Endline Survey in Madagascar to predict poverty in relation to current poverty national and international poverty lines. The PPI has demonstrated that this is a statistically valid approach that can produce highly accurate poverty predictions. If of interest to USAID, we could explore further adjusting the approach to not just predict whether a household falls under/over a poverty line, but also their level of consumption/expenditures.[34]

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[34] This approach has not yet been tested however, and so we cannot guarantee that we would be able to generate predictions with the level of precisions and accuracy necessary.

Variable Selection

We start with variable selection to determine which subset of the 700+ variables included in the 2020 FFP Endline Survey in Madagascar best predicts poverty using the Least Absolute Shrinkage and Selection Operator (LASSO) Ordinary Least Squares (OLS) regression. For an accessible background on this method, see this link. Note that Kshirsagar et al (2017) use the elastic net approach, which combines LASSO and the closely related Ridge regression. We have chosen to use LASSO as we expect it to yield a similar solution with comparable results.

Our approach also differs from Kshirsagar et al (2017) in that we fit an OLS model rather than a logit model. We have chosen this approach because OLS's functional form is additive, so coefficients can easily be converted to a scorecard format, where points are awarded in proportion to coefficient magnitudes.

In the 2020 FFP Endline Survey in Madagascar, approximately 69 percent of households in the sample were below the poverty line. This closely resembles the World Bank's estimate for Madagascar (75 percent), although we note that the data used here are from five specific regions, rather than a nationally representative sample.

Our goal is to optimize the shrinkage parameter λ that dictates the degree to which coefficients for weak predictors are forced towards zero. Higher values of λ place a greater penalty on complexity and serve to shrink coefficients toward zero, thereby eliminating the associated variables from the model. Increasing λ will reduce in-sample accuracy but typically increases out of sample accuracy (because it doesn't overfit the sample data), until such point as the model becomes too simple and out-of-sample accuracy declines. Conversely, lower values of λ yield a more complex model, with more variables included, yielding greater in-sample accuracy but lower out of sample accuracy due to overfitting. When $\lambda=0$, lasso becomes equivalent to OLS.

The goal is to find the value of λ that improves out-of-sample accuracy by not overfitting, but is not so high as to yield an overly simple model that poorly predicts the outcome. We do this through cross validation.
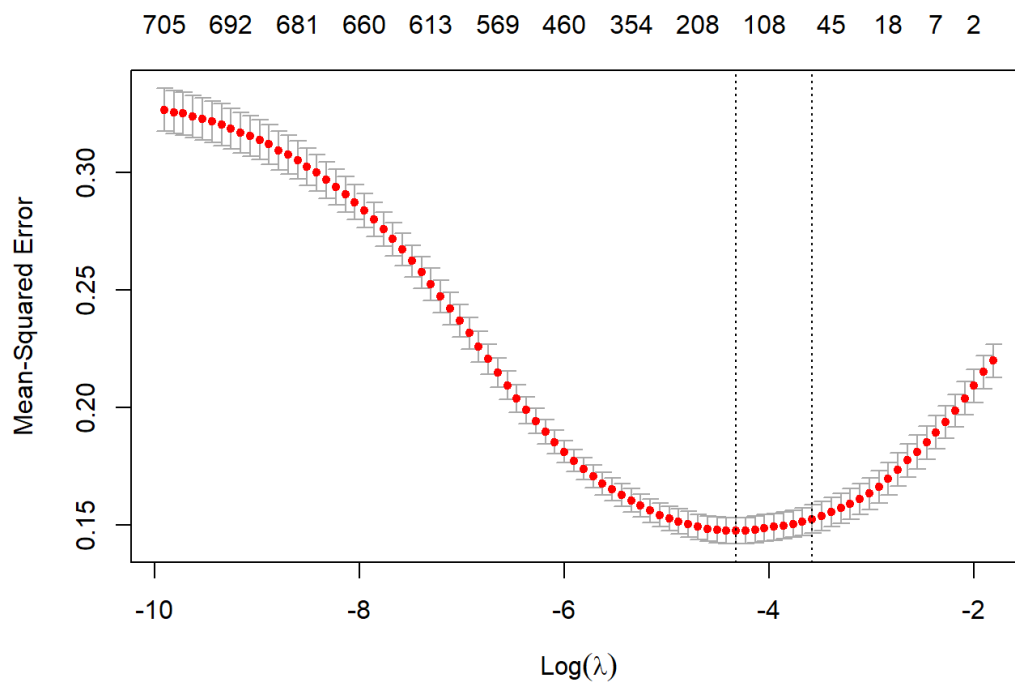
The above figure demonstrates that out of sample accuracy improves (lower Mean Squared Error) as we reduce the complexity of the model, until such point as it begins to increase because the model becomes too simple. The first vertical line indicates the value of λ that would optimize out of sample accuracy. But the curve is relatively flat here, so we can make the model even simpler without a significant loss in accuracy. Eventually, the model becomes too simple and out of sample accuracy declines (Mean Squared Error increases).

Unfortunately, both of the values of λ in the figure above yield models that have 30 or more coefficients, requiring that we increase λ, moving further to the right with some loss of accuracy. This approach yields 10 variables selected by the model with associated weights for predicting poverty (see below).

Prediction Accuracy

Using the selected variables, our model accurately predicts the poverty status of 83 percent of households in the sample. Our prediction accuracy is similar, although slightly lower, than that in Kshirsagar et al (2017). As outlined in the figure below, our predicted probability of poverty scores accurately distinguishes between those in and out of poverty, though there is some overlap, with those not in poverty scoring high on our poverty score, and those in poverty scoring low.

Out of sample accuracy
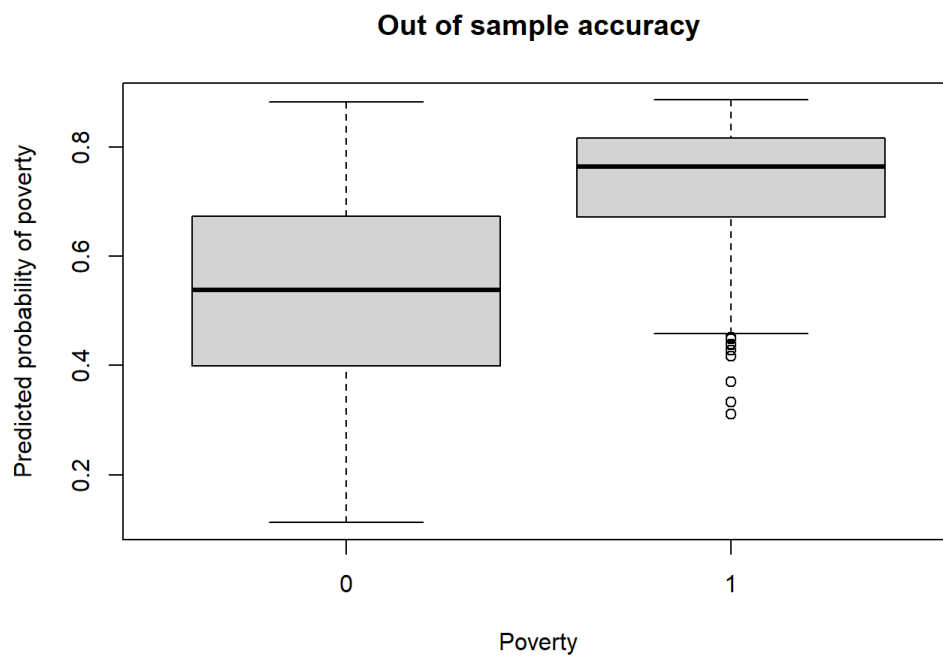
Assessing prediction accuracy by region, the below figure demonstrates that our model's accuracy is best in Atsinanana and Fitovivany regions and is slightly less accurate in Amoron.

Out of sample accuracy
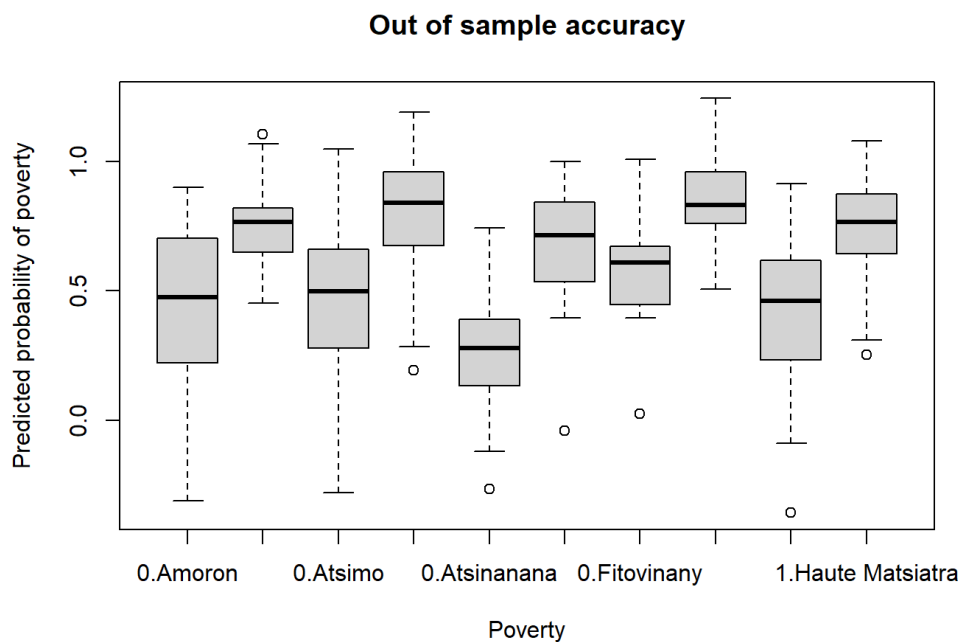
SELECTED QUESTION SET FOR MADAGASCAR

1) Does your household own a television?
2) Over the past one week (7 days), did you or any member of your household eat any of the following items?
   a. Green maize
   b. Buns, scones
   c. Spaghetti, macaroni, pasta
   d. Infant feeding cereals
   e. Other cereals (excluding infant feeding cereals or breakfast cereal)
   f. No, none of the above
3) Over the past one year (12 months), did your household gather or purchase any material for the roof?
4) Over the past one month (30 days), did your household purchase any of the following items?
   a. Clothes soap (powder, paste)
   b. Utilities: Water
   c. Toothpaste, toothbrush
   d. None of the above
5) Over the past one month, how much did your household spend on Bar soap (body soap or clothes soap)?
6) Over the past three months (90 days), did your household purchase any women's shoes?
7) Over the past one year (12 months), did you household purchase any of the following items?
8) Please show me where members of your household most often wash their hands.
   a. (Observe presence of water at the place for handwashing)
   b. (Observe presence of soap, detergent, or other cleansing agent at the place for handwashing)
9) Has any member of your household ever given birth?
10) Any primary school age (6-11) children living in the household.

[i] For more discussion, see: Poirier, M.J.P., Grépin, K.A. & Grignon, M. Approaches and Alternatives to the Wealth Index to Measure Socioeconomic Status Using Survey Data: A Critical Interpretive Synthesis. Soc Indic Res (2020). https://doi.org/10.1007/s11205-019-02187-9.
[ii] Source: Beegle, K., De Weerdt, J., Friedman, J., & Gibson, J. Methods of household consumption measurement through surveys: Experimental results from Tanzania. Journal of Development Economics, (2012). https://doi.org/10.1016/j.jdeveco.2011.11.001.
[iii] Source: https://blogs.worldbank.org/nasikiliza/measuring-poverty-in-60-minutes.
[iv] Source: http://cega.berkeley.edu/assets/miscellaneous_files/82-ABCA_-PapeMistiaen.pdf
[v] Note that there have been other approaches not listed here, such as Chakraborty et al. (2016) which developed simplified asset indices that go down to 6 – 18 questions per country, compared to 25 to 47 in the original DHS wealth index. This is not listed due to the smaller geographic coverage (16 countries) and because it seems to be less widely utilized. Source: https://pubmed.ncbi.nlm.nih.gov/27016550/.
[vi] Source: https://www.dhsprogram.com/pubs/pdf/MR9/MR9.pdf.
[vii] Source: https://www.ru.nl/publish/pages/516298/nice_12107.pdf.
[viii] Source: https://www.dhsprogram.com/pubs/pdf/MR9/MR9.pdf.
[ix] Link to website: https://www.povertyindex.org/about-ppi
[x] See paper on methods underlying the construction of the PPI and validation here: https://arxiv.org/pdf/1711.06813.pdf

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