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PAY, TALK, OR 'WHIP' TO CONSERVE FORESTS: FRAMED FIELD EXPERIMENTS IN ZAMBIA

By

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EXECUTIVE SUMMARY

Forests are important havens for biodiversity. If left standing, they sequester and store carbon, and thereby help mitigate climate change. Forests supplement household incomes for a large share of rural people, perform a myriad of other ecosystem functions and contribute to national incomes. Yet forests are overexploited and degrading, threatening the products and services they supply. Sustainable use and conservation of forests is, therefore, high on national policy agendas, but it is less clear how to do so effectively and efficiently.

We conducted framed field experiments (FFEs) to test, ex-ante, the impact of three possible policies for forest conservation in Zambia: community forest management (CFM), command and control (CAC), and payments for environmental services (PES). The experiments were designed to mimic how local dwellers use forests in real life. A random sample of 191 forest users drawn from four villages in Mpika and Serenje districts, the actual localities where they make forest use decisions participated in the experiments, using actual tree branches as the commodity in the task of harvesting trees. A total of 24 groups, each with eight participants played the experiments and made harvest decisions for 10 rounds.

Relative to open access, PES to individuals reduced harvest by 18 percentage points while each of CAC and CFM reduced harvest rates by 6 percentage points. Communication in the CFM treatment improved cooperation and to some extent ignited non-pecuniary, prosocial and other – regarding choices among our participants. The large effects of individual pay underscores the merit in paying forest users through incentive-based schemes, provided the transaction costs of such individual payments can be kept at a reasonably low level. Free and easy-riding and uncertainty on how others will respond dampens the positive effects of group pay for forest conservation, as do externally imposed sanctions in CAC.

We conclude that individual pay performs better than group pay for forest conservation. Optimal forest conservation outcomes might, however, be achieved by some combinations of CFM and individual PES. Clarifying benefit sharing mechanisms in Zambia's community forest management and taking into account individuals' non-pecuniary motives will be important to achieve win-win outcomes for conservation and livelihoods.

Key words: Framed field experiments, community forest management, command and control, payment for environmental services, Zambia.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAC	Command and Control
CBNRM	Community Based Natural Resource Management
CFM	Community Forest Management
CPR	Common Pool Resources
DFNRMP	Decentralized Forest and other Natural Resource Management
FAO	Food and Agriculture Organization of the United Nations
FFEs	Framed Field Experiments
GRZ	Government of the Republic of Zambia
JFM	Joint Forest Management
OLS	Ordinary Least Squares
OA	Open Access
PES	Payment for Environment Services
REDD+	Reducing Emissions from Deforestation and Forest Degradation
TLU	Tropical Livestock Unit
UN-REDD	United Nations Program on Reducing Emissions from Deforestation and Forest Degradation

1. INTRODUCTION

Agricultural land expansion and overexploitation of forest resources are the leading causes of tropical deforestation, which accounts for about 10% of current greenhouse gas emissions (IPCC 2013). Reducing these emissions is critical to mitigate climate change. At the same time, new agricultural land and forest products are critical in the livelihoods of poor rural people. One comparative study of 8,000 households in 24 developing countries estimated that forest income contributes about 22% of total household income (Angelsen et al. 2014). Achieving win-win outcomes, i.e., both conservation/climate and poverty/livelihood objectives, is challenging.

Various policies have been proposed to promote forest conservation and climate mitigation. This paper explores three of such policies: community forest management (CFM), command and control (CAC) and payment for environmental services (PES), relative to open access (OA).[1] OA represents scenarios where access to and use of a forest is unregulated and open to all, better known as unregulated OA. CFM typifies cases where forest resources are managed, regulated and controlled by the local community—sometimes in partnership with or with consent from the central government—as done in Zambia.

CFM builds on experiences from Joint Forest Management (JFM) and Community Based Natural Resource Management (CBNRM) schemes which emphasize communities sharing in the benefits from natural resources. JFM and CBNRM schemes have not been very successful in Zambia, casting doubt on the extent to which they can serve as platforms for REDD+ implementation (Kokwe 2012; Leventon et al. 2014). This is exacerbated by the fact that more than 78% of forestry in Zambia is under customary tenure (Matakala, Kokwe, and Staatz 2015). CFM seeks to devolve forest management and regulations to local forest users and aims to clarify benefit sharing mechanisms to avoid policy challenges encountered under earlier CBNRM approaches and JFM. CFM is promoted by the Decentralized Forest and other Natural Resources Management Program (DFNRMP), which is a joint effort by the Governments of Finland and Zambia.[2] The Community Forest Regulations of 2018 and the Forest Act of 2015 provide the legal framework for the implementation and management of CFM in Zambia (GRZ 2015 and 2018), while the national forest policy gives the policy direction (GRZ 2014).

CAC in this context refers to policies that use bans and fines type—instruments to promote conservation. An example is protected areas, exemplified by national forests. Protected national forests are forests of national importance established to conserve water catchment areas and preserve biodiversity (Kokwe 2012; GRZ 2015). Harvest and collection of forest products is prohibited in national forests. Local forests are another variant of protected areas where CAC principles of licensing, fines and bans are applied. Unlike in national forests, harvest and collection of forest products is allowed but regulated in local forests.

PES is a market-based mechanism that seeks to pay (compensate) forest owners or users for providing public goods of carbon sequestration and storage (or possibly also other forest public goods). Public goods entail a positive externality problem that PES interventions aim to solve, by providing monetary incentives to the users for providing these services.

We study these policies in the context of a common pool resource (CPR)—community forest—where the resource stock provides some public goods, but it is difficult to exclude others from accessing and using, and potentially degrading the resource (Ostrom 1990). Ostrom, Gardner, and

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[1] As we explain below, our design is different from a typical REDD+ PES scheme that relies mostly on carbon incomes. Here, we include incomes from any other sources under community forest management.

[2] https://www.dfnrmp.org.zm/

Walker (1994) and Cardenas, Stranlund, and Willis (2000) show that under certain conditions, 'cheap talk' or communication has the potential to foster cooperation and conservation of the commons under CFM. While experiences from protected areas (CAC) in South America show positive results on conservation (Angelsen 2010), the story is different in Zambia. Nearly half of Zambia's protected forest areas, which represent 6.3% of land and of which 88% are located on customary land have been encroached for human settlements (Kokwe 2012; Matakala, Kokwe, and Staatz 2015). The effects of PES on conservation are mixed. Recent reviews of REDD+ intervention in the tropics suggest that positive effects of PES on conservation are rare (Bos et al. 2017).

Despite these results from elsewhere, several policy questions remain unanswered in the Zambia context: what policy instruments among (CFM, CAC and PES) have better conservation outcomes? Can CFM—currently emphasized in policy documents—deliver better conservation outcomes than the business as usual OA, traditional ban and fine (CAC) or the market-based PES? Within PES, is paying individuals better than paying groups? Answering these questions is problematic. First, some of these policies and supporting regulatory provisions are fairly recent and yet to be implemented comprehensively in Zambia. For example, community forestry regulations were only assented to in 2018 even if community forest management was provided for in the 2015 Forest Act and policy guidance provided in the 2014 national forest policy (GRZ 2014, 2015, and 2018). Second, these policy instruments are in most instances implemented singly, making cross comparisons challenging. And lastly, there is a classical missing data problem because the counterfactual is unobserved. It is unknown how forest users under one management regime would behave had they been under a different one because we only observe forest users under one forest management regime at a given time. Yet, it is important to evaluate *ex-ante* the likely impacts of CFM, CAC and PES on forest conservation in order to avoid grand policy implementation failures and to inform the current impetus encouraging CFM in Zambia.[3]

This study was designed to contribute towards filling this gap. We experimentally evaluate *ex-ante* the impacts of CAC, CFM, and PES (relative to OA) on forest conservation using economic framed field experiments (FFEs) (Harrison and List 2004). We also test two versions of PES – individual versus group pay. Our experimental design is informed by classical papers by Ostrom, Gardner, and Walker (1994) and Cardenas, Stranlund, and Willis (2000). Local forest users are confronted with a social dilemma where individual rationality drives them to harvest more but the social optimum, which is a desirable outcome, dictates that they harvest less. We introduced treatments to try and solve the social dilemma.

PES individual pay outperformed all the other treatments considered in our study. As expected, OA had the worst conservation outcome, and PES group pay performed poorly perhaps due to free riding. CAC did not perform as expected, possibly because introducing exogenous rules crowded-out intrinsic conservation motives or the other-regarding motives (Cardenas, Stranlund, and Willis 2000). CFM promoted forest conservation, stabilizing at a level comparable to PES individual pay in the final round of the experiment.

We provide contextual background and motivate the study in section 2. The experiment details in section 3 highlight the treatments, framing, and field work. Results in section 4 are discussed in section 5. We conclude and draw implications for policy in section 6.

[3] Readers are referred to Kokwe (2012); Leventon et al. (2014); and Matakala, Kokwe, and Staatz (2015) for a discussion on alternative forest management policy options in Zambia.

2. BACKGROUND AND MOTIVATION

Zambia has approximately 50 million hectares (ha) or 66% of the total land area covered by forests (FAO 2010; Kalinda 2013; FAO 2015). The country has 480 forest reserves, 175 of which are national forests and 305 are local forests.[4] However, deforestation, estimated between 167,000 and 300,000 ha or 0.3 - 0.6% of total land area per annum, biodiversity loss and forest degradation remain repugnant challenges in natural resources management. Unsustainable forest use, agricultural land expansion, charcoal production, urbanization and industrialization are among the main drivers of deforestation and forest degradation in Zambia (Vinya et al. 2011; Zulu and Richardson 2013; Richardson et al. 2015). Underlying these proximate drivers of forest loss are several factors including low uptake of energy efficient technologies, population growth, poverty, legal and institution failures, and limited alternative livelihood options (Vinya et al. 2011; Kokwe 2012; Zulu and Richardson 2013; Day et al. 2014; Leventon et al. 2014; Matakala, Kokwe, and Staatz 2015; Dlamini et al. 2016).

Forest-loss threatens to erode the nearly 4.7% contribution of forests to national income in Zambia (Turpie, Warr, and Ingram 2015). The losses might be higher for poor rural households who, in a comparative 24 country study, derive about 22% of their household incomes from forest resources (Angelsen et al. 2014). Forests also provide various ecosystem services such as watershed protection, pollination, climate regulation, and forests are biodiversity havens. Therefore, addressing deforestation and forest degradation—both to reduce emissions and for the economic benefits of forest resources—is high on Zambia's forestry and climate change policies (GRZ 2014 and 2016), and it is the main thrust of the country's REDD+ strategy (Matakala, Kokwe, and Staatz 2015).

To this end, Zambia has supportive policy frameworks that promote sustainable natural resource management. Within the forestry sector, the Forest Act of 2015, the 2014 National Forestry Policy, and Community Forestry Regulations of 2018 provide for joint forest management and community forests management regimes (GRZ 2014 and 2015, Matakala, Kokwe, and Staatz 2015). The National REDD+ strategy promotes sustainable landscapes as an avenue to reduce deforestation in the forestry sector and other key sectors such as agriculture, water, wildlife, energy, mining, and land use (Matakala, Kokwe, and Staatz 2015).

Benefits from community forest management emanate from various sources. PES schemes such as those promoted under REDD+ are one option. Other potential income sources include proceeds from the use of forest products, fees from community permits, fines and charges for illegal acts and revenue from the disposal of confiscated forest products. How best should these proceeds be shared to maximize livelihood and conservation benefits? Is it better to pay individuals or to pay the groups or even communities?[5] In addition, community forest management groups have the mandate to impose fines on violators of community forest rules and regulations (GRZ 2018). Do these CAC instruments increase conservation, and how do they compare with typical PES and CFM schemes? These are important questions to inform current efforts aimed to improve forest management in Zambia.

It is challenging to measure local forest users' preferences for benefit sharing mechanisms, and the impacts of these pay modalities and other policy instruments on conservation. First, the counterfactual is unobserved—how would forest users under one management regime behave had

[4] National forests are forests of national importance and managed by the Forestry Department on behalf of the Zambian Government. They protect water catchments or other natural resources. Local forests are managed by traditional leaders such as headmen or chiefs.

[5] We do not consider community payments in this study.

they been under a different one. We only observe forest users under one forest management regime at a given time. Second, most of these regulations and incentives are yet to be implemented on the ground.

Framed field experiments (FFE) based on Common Pool Resource (CPR) experiments provide an opportunity to address the two issues in a cost effective way (Cardenas, Stranlund, and Willis 2000; Harrison and List 2004; Hayo and Vollan 2012). Common pool resources are characterized by subtractable resource units and non-excludability (on account of costs) of others from using the resource (Ostrom 1990; Vollan 2008). Using the different forest management regimes—CAC, PES and CFM—as treatments, FFEs are used to observe local forest users' behavior regarding forest extraction while at the same time assessing the effects of the different treatments on conservation.

Ours is not the first paper to use FFEs to study the management of common pool resources in the region. Several scholars have used CPR experiments to study the various commons in sub-Saharan Africa. Handberg and Angelsen (2015) studied the impacts of CAC, OA and CFM policy instruments on forest conservation in Tanzania, while Vollan (2008) and Hayo and Vollan (2012) studied group heterogeneity, cooperation and crowding-out in the management of common grazing lands in Namibia and South Africa. In a study of its kind, Hailu (2018) used FFEs to assess the impacts of setting different forest reference levels, and individual versus group pay on forest conservation in Ethiopia.

We add to this literature in a number of ways. Unlike Cardenas, Stranlund, and Willis (2000) and Handberg and Angelsen (2015), our CAC treatment is stricter and was strongly enforced. We segregated the PES treatment into individual and group pay as in Hailu (2018) instead of testing only one option, as in Handberg and Angelsen (2015), but add more treatments than the former. In sum, our study compares more treatments than previous studies applying FFEs in forest management and had a control group (OA) in the design.

3. DATA AND METHODS

3.1 Study Area and Sampling

Fieldwork was conducted in the forest-rich districts of Mpika and Serenje in Muchinga Province of Zambia in May 2018. In each district, two villages with forests within a 5 km walking distance and with more than 48 households were purposively selected. Using village registers obtained from village leaders, 48 households were randomly selected from each of the four villages and invited to participate in the experiments that were held at the village meeting place, the headman's place or any central location. For each selected household, we invited either a male or female household head to participate in the experiment because they both make decisions on forest resource use. We alternated whether to invite the male or female household head so that if a male was invited from the first sampled household, we would invite a female in the second household and so forth. Overall, 57% males and 43% females participated in the experiments; the numbers being unbalanced due to availability.

Each selected participant was randomly assigned to a pre-determined group of eight persons with a specific treatment. Each of the four villages had six groups (experimental sessions), each with eight participants for a total sample of 191 participants.[6]

3.2 Experimental Design and Basic Game Structure

We conducted FFEs inspired by Harrison and List (2004) in the actual villages where forest users (participants in the experiments) make their real-life decisions. This enabled us to relate the sample, tasks and framing to forest use. Participants played the CPR games with randomly assigned community members to reduce kin altruism (Rodriguez-Sickert, Guzmán, and Cárdenas 2008).

Our experimental design was inspired by a number of previous studies (Cardenas, Stranlund, and Willis 2000; Rodriguez-Sickert, Guzmán, and Cárdenas 2008; Vollan 2008; Hayo and Vollan 2012; Handberg and Angelsen 2015; Hailu 2018), but more closely followed the design in Hailu (2018). Each experiment was a one-shot game, repeated 10 times. At the start of each session, a group of eight participants was endowed with 60 tokens of trees (tree branches) to represent a common pool forest resource. This resource was collectively owned and management by the community of eight people.

Detailed instructions (given in Appendix B) in local language were read out at the start of each session and participants were allowed to ask as many questions as they wanted. This was done to ensure that the participants understood the procedures. Participants were not informed of the number of rounds to avoid backward induction and strategic behavior. Sitting in a circle, with the common resource endowment in the center, participants played the CPR game and made their private harvest decisions simultaneously under different treatments. Participants indicated their harvests by marking against the number of trees on visual decision sheets handed out at the start of every round (sample in Appendix D). Using visual decision sheets made it easier for the less educated participants to make decisions independent of research assistants.

Following the typical protocol, the total harvest from each round—the sum of individual harvests—was announced at the end of each round, while the individual harvest rates and payments remained a secret to participants. The number of trees harvested from each round was removed from the stock

[6] One group had seven and not eight participants because one participant did not show up and it was impossible to find a suitable replacement

in order to give participants a near-real-life effect of their harvest decisions on the forest stock. The forest stock was reset to 60 at the start of each round in order to simplify the computation of payoffs and in keeping with the previous literature (Vollan 2008; Hailu 2018).[7]

3.2.1 Payoff Function

The payoff (π_{it}) to participant *i* of cutting x_{it} trees in round *t* was computed as the sum of the value of the individual's harvest px_{it} and the value of the standing trees (q/N) multiplied by initial stock (X_s) less individual *i*'s harvest (x_{it}) and the group harvest (x_it). Following Hailu (2018), this pay off function can be represented as:

$$\pi_{it} = px_{it} + \left(q/N\right)\left[X_s - x_{it} - \sum x_{-it}\right], x_{it} < x^{\max} \tag{1}$$

p is the marginal private benefit from harvesting a tree and captures the reasons why an individual would cut a tree, *q* is the benefit of a standing tree to the group (*N*), x^{max} is the technical harvest limit set to five per individual per round to ensure that the initial stock is not depleted and negative harvests are avoided. Zero harvest was a valid choice.

We used a simple linear payoff structure in order to enable participants to understand the stakes. The structure gives a social dilemma where individual rationality compels participants to harvest the maximum amount, while the social optimum requires that each harvest the minimum amount.

All participants played the game with the same initial payoff function for the first five rounds, representing the case of open access (OA). Treatments, explained below were introduced from round six to ten. After playing the game for 10 rounds and completing a short survey (questionnaire in Appendix C), participants were paid their individual payoffs earned during the 10 rounds. The payment amounted to about US$5 on average.

The CPR game used in this study and the social dilemma it creates is best illustrated with examples. We parameterized the payoff functions using the following parameters: N = 8, $x^{max} = 5$, $X_s = 60$, p = 0.5 (the shadow wage of rural labor computed in Ngoma and Angelsen (2017)), and q = 1, which is twice the private marginal benefits per tree. These parameters were arrived at using both literature (Cardenas, Stranlund, and Willis 2000; Handberg and Angelsen 2015; Ngoma and Angelsen 2017; Hailu 2018) and expert opinions. We also used the practice round to test the parameters on actual forest users.

If participants act in their own self-interest, the pure Nash equilibrium outcome is achieved when each player harvests the maximum allowable harvest for a total group harvest of 40 trees. This yields an individual payment of ZMW 5, with 20 trees left for society. This is the dominant strategy. The social optimum is however attained when each player harvests nothing (all 60 trees are saved) and each player earns ZMW 7.50. This creates a social dilemma: each individual aims to maximize their own harvest but earns less than is possible if they maximized benefits to society. Assuming symmetry in extraction costs, Table A6 shows the payoff matrix for player *i* given the aggregate harvest of the other seven players.

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[7] This is a simplifying assumption. We do not explicitly include forest regeneration and growth as done for example in Handberg and Angelsen (2015) and argue that these balance off with extraction to keep the stock at similar levels in our short-run game. In real life, it is also expected that this may have little or no effect on short-term behavior, as degradation rather deforestation may be the main issue (Hailu 2018).

3.2.2 Framing

Following Cardenas, Stranlund, and Willis (2000), we consciously framed the experiment such that participants understood that private and social benefits diverged. If everyone chose to be selfish and harvested the maximum, everybody earns less than if they cooperate and reduce harvest. All participants played one practice round at the start of the experiments to become familiar with the game.

We implemented the games in the vicinity of local forests that the participants use in real life. As in Hailu (2018), we framed the tree tokens as 50 cm branches of dry local wood in order to enable participants more closely relate to the commodity and task. Using real local tree branches that participants were able to identify added context and could improve external validity. In conducting the task, we framed the games such that participants made harvest decisions over several rounds to mimic the frequency with which they harvest forest products in real life. Removing the total harvest at the end of every round added context and reminded participants that their harvest decisions in the experiment were consequential.

3.2.3 Treatments

The experiments were played in two stages. Rounds 1-5 was the base with a payoff structure in Eq. (1) and was common to all participants. In the second stage, we introduced a particular treatment in rounds 6-10. Four treatments were used in the experiments. OA continued with the setup in the initial five rounds for another five and serves as a control group and was common in the first five rounds of every treatment.

In line with Ostrom, Gardner, and Walker (1994), Cardenas, Stranlund, and Willis (2000), and Handberg and Angelsen (2015), we allowed communication (cheap talk) about harvest rates and anything else under CFM, for a maximum of three minutes at the start of each of the rounds 6 -10. Once the experiment started, communication was not allowed.

Punishment and sanctions for violators of community forest regulations were introduced under CAC. The community rule adopted set the maximum allowable harvest at three trees under CAC, but five trees still remained as the technical harvest limit. When each player had made their harvest decision under CAC, the researcher played a lottery and asked the player to randomly select a number between one and four. If the number two was selected (25% chance of being inspected), the player's harvest was inspected and if in violation, the participant was penalized by giving them a zero harvest (in private). Further, the participant could not partake in the group benefits for standing trees from that round.[8] The total harvest from this participant was also counted and removed at the end of the round.

We used two variants of the PES treatment. Using the historical average harvest from the initial five rounds as a benchmark or reference level (x^{RL}), individuals under PES were paid an additional 80% (r) of the private benefits for every standing tree as long as their harvest is below that benchmark, otherwise they don't quality for additional PES payment. Including PES payment at 80% of the full value reflects the idea that full compensation is unlikely in a typical PES scheme like REDD+ (Handberg and Angelsen 2015), and also reflects common insurance compensation schemes that are never 100%. The payoff function for the PES individual pay treatment was modified as:

[8] These punitive measures are meant to highlight the gravity of not adhering to community regulations.

$$\pi_{it} = px_{it} + (q/N)\left[X_s - x_{it} - \sum x_{-it}\right] + Max\left\{r\left(x^{RL} - x_{it}\right), 0\right\}, x_{it} < x^{\max} \tag{2}$$

In this setup, the payoff to an individual will be desirable if $(r + q/N > p)$, as long as $x_{it} < x^{RL}$.

The group payoff modified Eq. (2) by imposing a requirement that the average group harvest for that round should be below x^{RL} for any additional group PES to be effected. The payoff function for the group pay PES treatment was modified as:

$$\pi_{it} = px_{it} + (q/N)\left[X_s - x_{it} - \sum x_{-it}\right] + Max\left\{r\left(x^{RL} - \frac{\sum_{i=1}^{N} x_{it}}{N}\right), 0\right\}, x_{it} < x^{\max} \tag{3}$$

3.3 Data Analysis

Data were analyzed in stages. First, the impacts of treatment on harvest rates were analyzed using graphs. The goal here was to show the harvest trends by experiment round, village and player attitudes toward risk, time and social preferences. We also tested for differences in harvest rates between and within treatments using the student t-test. The second stage of analysis tested the impacts of treatments on harvest rates, while controlling for several confounding variables in a multivariate regressions framework. We used the fractional probit model because the dependent variable is a proportion within [0,1] and without any significant pile-ups at either end (Papke and Wooldridge 2008; Wooldridge 2010). We took advantage of the 10-round experimental sessions and used panel data methods to control for any unobserved player heterogeneity that may confound the outcomes.

We controlled for forest dependence using the number of trips taken to harvest forest products per week and whether the participant sold any forest products in the month prior to the survey. We hypothesized that high forest dependence should raise harvest rates and that being altruistic (measured by whether the participant thinks of others all the time—prosocial) would reduce harvest rates, while risk loving and being impatient would have the opposite effects.[9] These additional controls also help to, in some ways, test for external validity.

Tropical Livestock Units (TLUs) computed following Jahnke (1982) and land holding sizes are used to control for wealth effects, and age, education and gender are other factors controlled for in the regressions. While it is difficult to sign these *a prori*, we expected older and more educated participants to harvest less, and male participants to harvest more.

[9] We also tested whether these effects are stronger only for certain treatments

4. RESULTS

4.1 Sample and Experiment Characteristics

Table 1 presents the summary statistics of key variables. Our 191 participants had an average age of 46 years, with 43% being female. Their average land holding was reasonably large, at about 4.5 ha, with some possessing land of 50 ha. They make an average of slightly more than two trips to the forest per week, and 18% sold forest products in the month preceding the survey.

The participants were equally split between the four major treatments (21 % in each), with slightly fewer in the control group of open access (16%). On aggregate, participants harvested 46% of the allowable harvest in all rounds and groups.

In the post-experiment survey, about 50%, 41% and 9% of the participants stated that they considered themselves to be altruistic, risk loving and impatient, respectively.[10]

Table 1. Summary Statistics of Treatments and Participant Characteristics

Variable Name	Description	Mean	SD	Min	Max
Characteristics					
Age	Age of participant	46	16	18	88
Education	Education level of participant	2.03	0.71	1	3
Female (yes = 1)	Female participant (yes = 1)	0.43	0.50	0	1
Tropical Livestock Units	Number of livestock owned in Tropical Livestock Units	1.01	1.84	0	12
Land holding	Total land holding size (ha)	4.48	7.63	0	50
Number of trips to forest	Frequency of forest resource harvesting per week	2.16	1.32	0	7
Sold forest prod. last month (yes =1)	Whether sold any forest product previous month	0.18	0.39	0	1
Treatments and behavior in the experiment					
Open Access (yes =1)	Open access treatment	0.16	0.37	0	1
CFM (yes = 1)	Community forest management treatment	0.21	0.41	0	1
CAC (yes = 1)	Command and Control treatment	0.21	0.41	0	1
PES, individual pay (yes = 1)	Payment for Environmental Services to individuals	0.21	0.41	0	1
PES, group pay (yes = 1)	Payment for Environmental Services to groups	0.21	0.41	0	1
Harvest rate	Average harvest rate over all rounds, and sessions	0.46	0.31	0	1
Stated preferences in the questionnaire					
Indv. pay preferred (yes =1)	Payment to individuals preferred	0.40	0.49	0	1
Altruistic (yes = 1)	Thinks about others first	0.50	0.50	0	1
Risk loving (yes = 1)	Takes on activity with uncertain outcomes	0.41	0.49	0	1
Impatient (yes = 1)	Wants to get things now	0.09	0.28	0	1

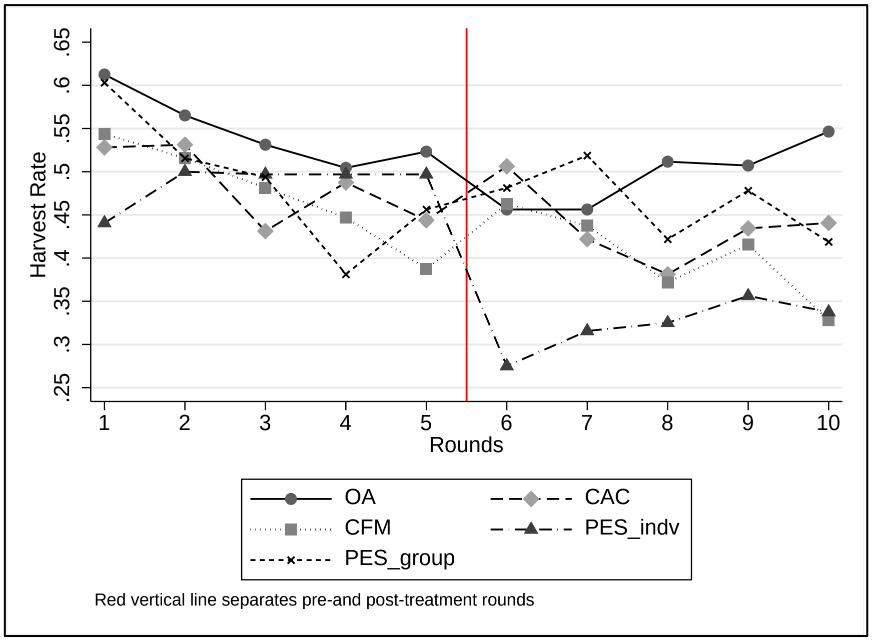
Source: Authors for all tables unless otherwise indicated.

[10] Risk, time, and social preferences were measured using Likert- type scale questions. Each participant chose a statement that best described their preference/attitude towards a factor. Taking risk preference as an example, participants chose between 0 and 3, where 0 meant very risk averse and 3 very willing to take risks, and 4 for I don't know. Details are given in the questionnaire in Appendix C.

4.2 Impacts of Treatment on Forest Harvest

Figure 1 shows the trends in harvest rates for all treatments and experiment rounds. While harvest rates declined throughout the experiment rounds, the decline was larger in the treated second stage, in rounds 6 – 10. From highs of > 50% in the pre-treatment rounds (1 – 5), harvest stabilized at bout 40 – 50% by the fifth round and further reduced to about 30 – 45% by the 10th round for all treatments except the control, OA (Figures 1 and 2). Figure 2 separates the pre- and post-treatment rounds in order to better amplify the harvest rate trends in the two stages of the game.

Figure 1. Harvest Trends by Experiment Round and Treatment



Source: All figures by authors unless otherwise indicated.

Figure 2. Harvest Trends by Experiment Round, Pre- and Post-treatment

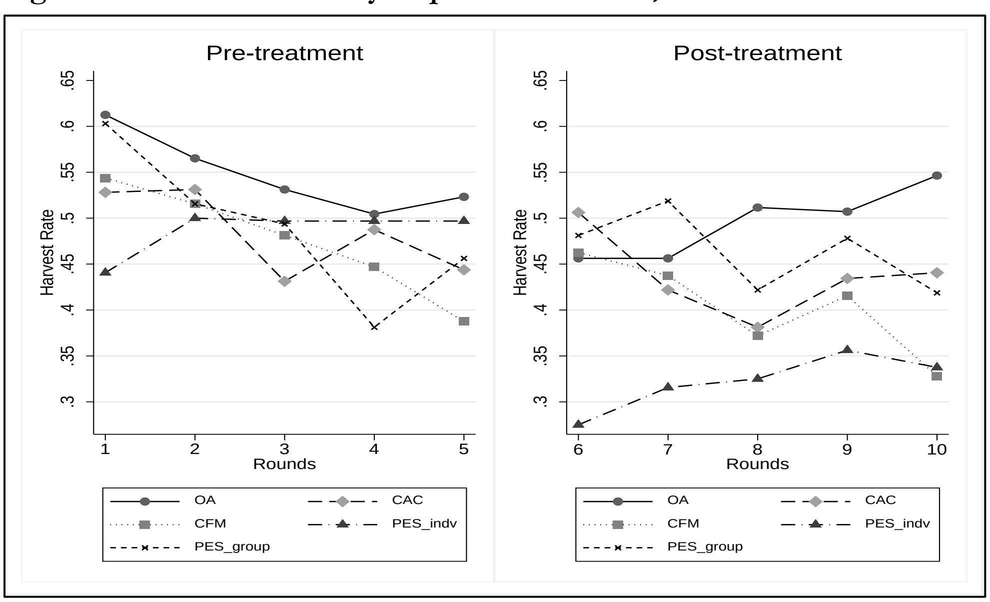
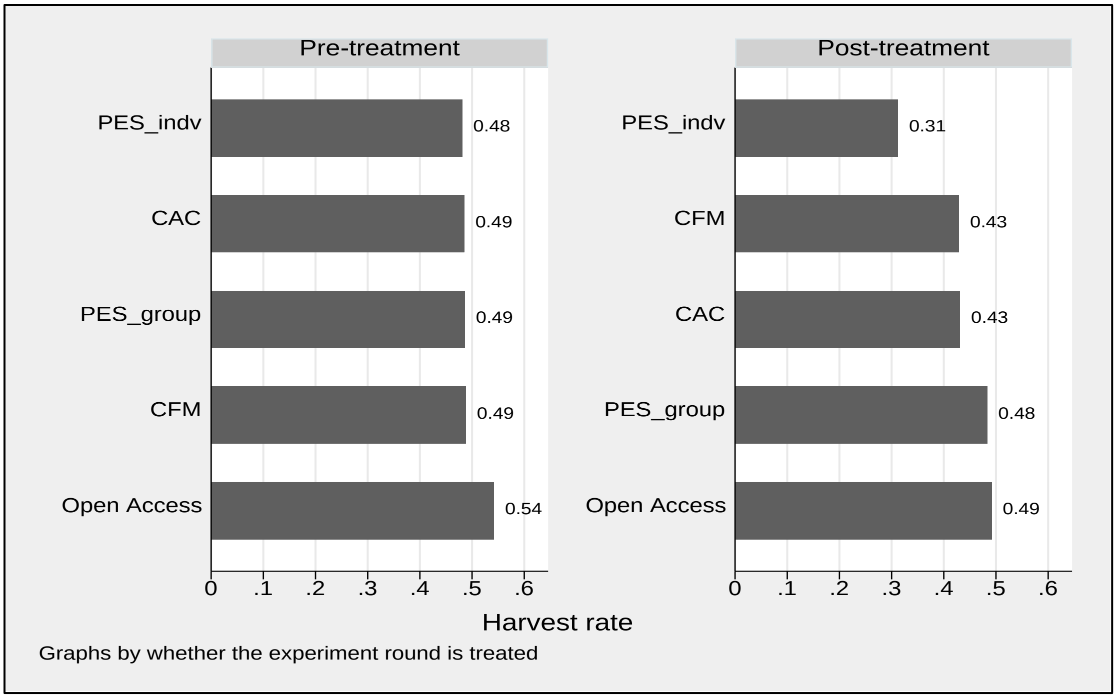


Figure 3. Mean Harvest Rates by Treatment, Pre- and Post-treatment

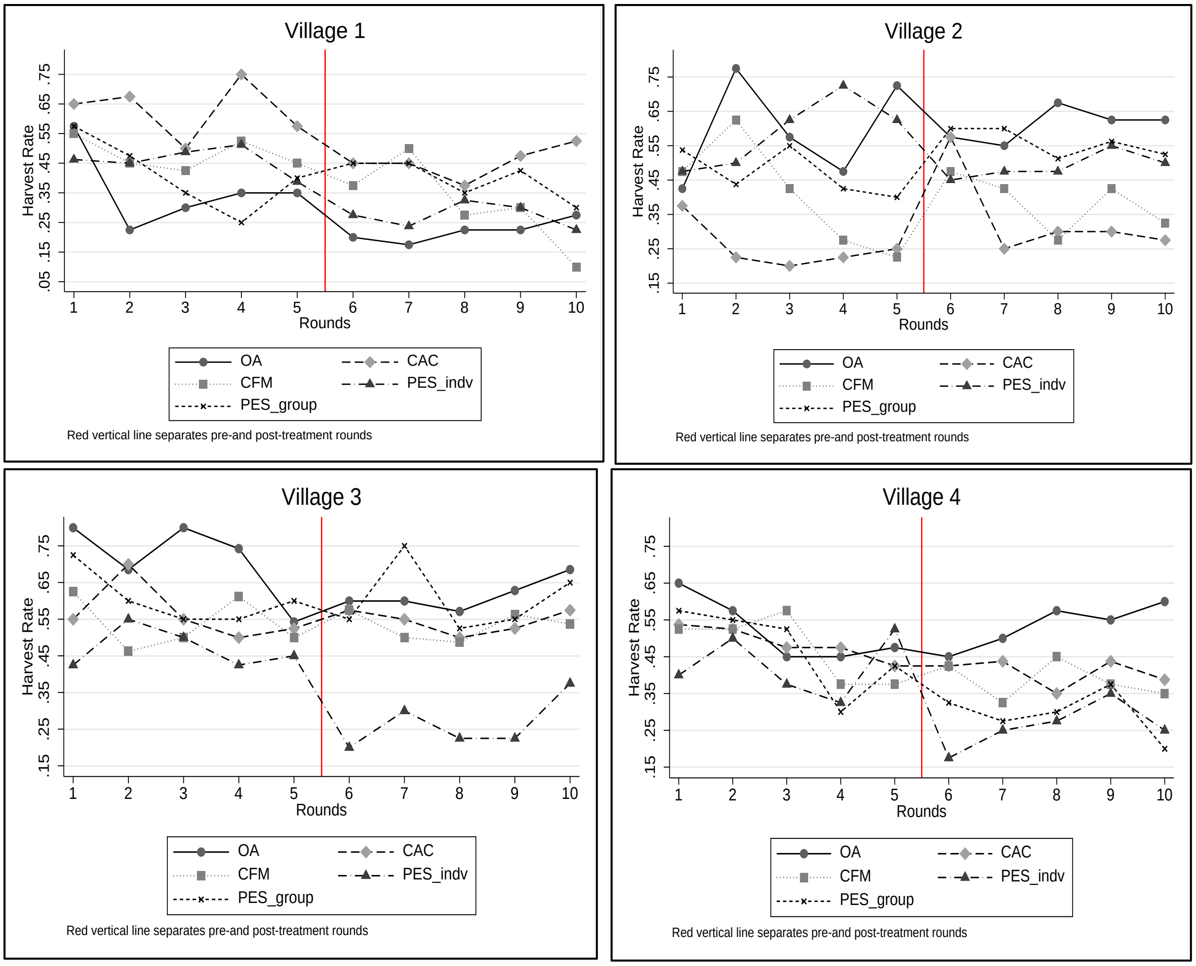


We observe some differences in the pre-experiment rounds, in spite of the payoff structure being identical (OA) and groups assigned to the later treatment randomly (Figure 3). This suggests some heterogeneity across groups, and that the number of experimental groups for each treatment (5) is relatively low. Thus we make intra-group comparisons of change in harvest rates after treatment. Harvest under the PES group pay treatment had the second highest mean harvest post-treatment, while PES individual pay had the lowest harvest rates overall (Figure 3). The treatment PES to individuals posted the largest reduction in harvest rates at 17 percentage points between pre- and post-treatment.

4.2.1 Impacts of Treatment on Harvest by Village

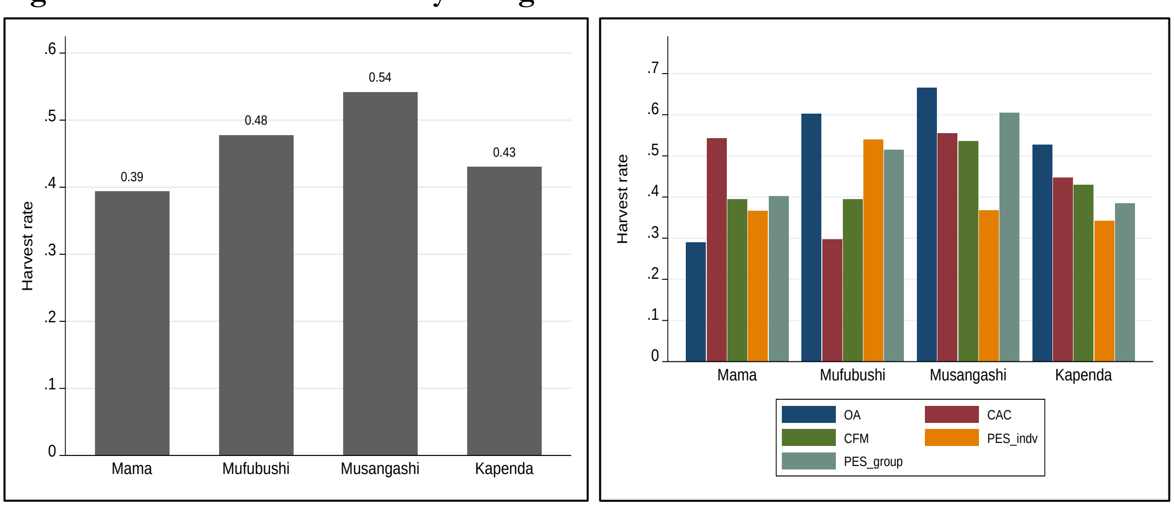
Harvest rates followed a similar declining trend at village level. Surprising, OA was notably lower in village one compared to the other three villages (Figure 4 on the following page). Village three is of special interest because it was composed of settlers in Musangashi Forest Reserve of Central Province. Forest dependence was higher in this village as can be seen from higher initial harvest rates for all groups and treatments. Of note is the high initial value for OA which averaged 76% in the first round. Harvest rates, however, reduced in the subsequent rounds but not as much as in the other villages. Village two had much more dispersed harvest rates across treatments and rounds, although the harvest rates tended to decline as the game progressed to the 10th round.

Figure 4. Harvest Trends by Experiment Round, Treatment, and Village



As expected, harvest rates were higher under the control OA in three out of the four villages (Figure 5). Village one was an exception: CAC, PES individual and group pay had higher harvest rates than OA. Harvest rates were also much higher under CAC and PES group pay in most villages (Figure 5).

Figure 5. Mean Harvest Rates by Village and Treatment



4.2.2 Impacts of Treatment on Forest Harvest by Risk, Time, and Social Preference

We assessed whether participants' stated risk, time and social preferences affected harvest decisions in our experiments. There are reasons to suspect so: risk loving and impatience might be associated with high harvest rates while prosocial behavior might be pro-conservation. Harvest rates increased with risk loving preferences (Figure 6). Except for the 'I don't know' category, harvest rates were higher among the very risk loving participants, especially in the CAC and PES group pay treatments, but were lower for the very risk averse participants (Figure 6). OA had relatively higher harvests under all risk preference categories. Except for CFM, harvest rates were much lower for all treatments under the very risk averse participants.

Aggregate harvest rates increased with decreasing time preference. Except for the CFM treatment, harvest rates were highest under the very impatient participants (Figure 7).

Figure 6. Mean Harvest Rates by Risk Attitudes and Treatment

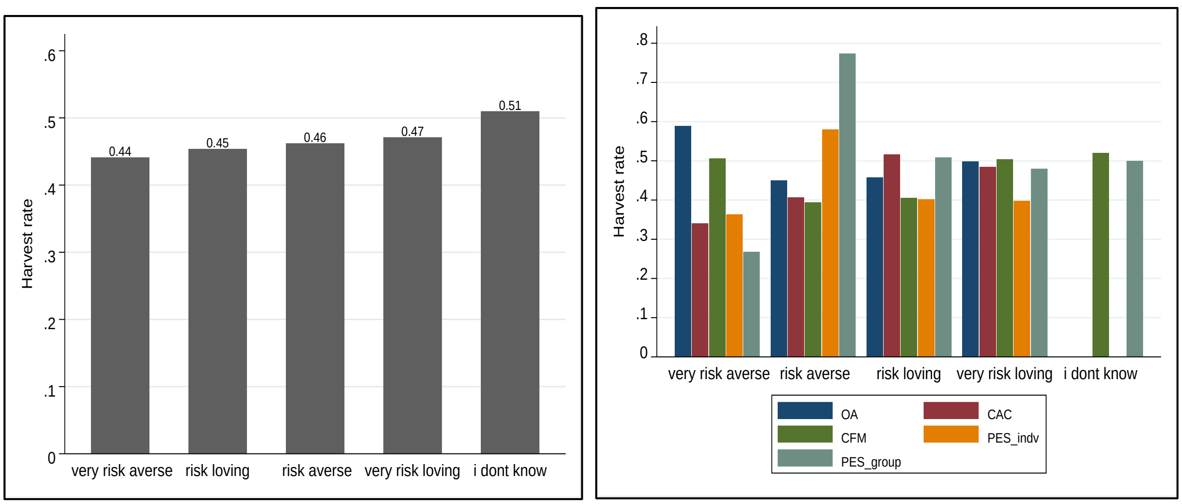


Figure 7. Mean Harvest Rates by Time Preferences and Treatment

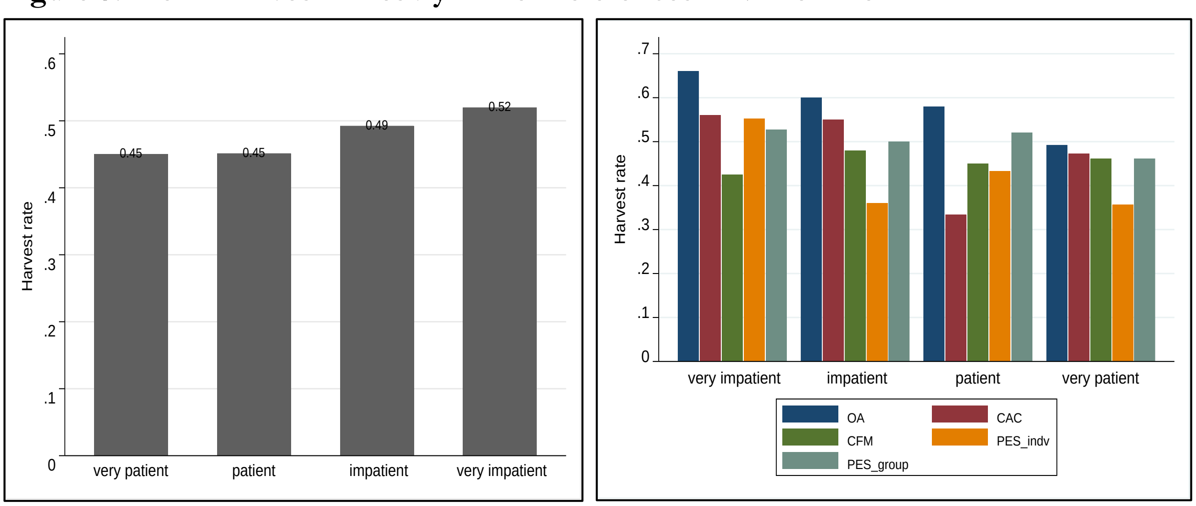
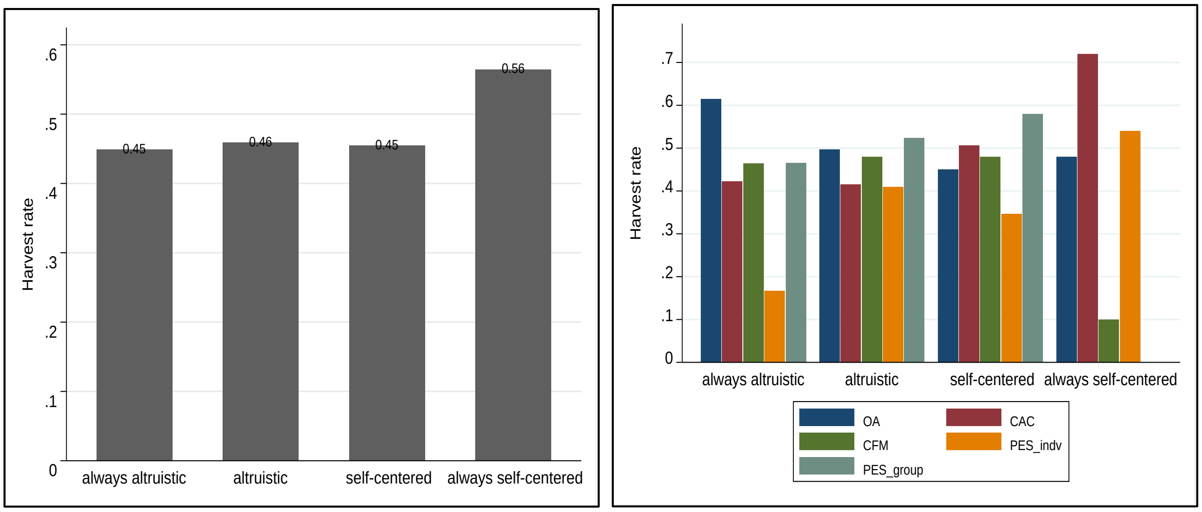


Figure 8. Mean Harvest Rates by Social Preferences and Treatment



Further, harvest rates were substantially higher among the always self-centered participants, and especially so for the CAC and PES individual pay treatments (Figure 8). Being prosocial (always altruistic) and being always self-centered were seemingly associated with reduced harvest in the PES individual pay treatment and CFM, respectively.

4.3 Do Harvest Rates Vary Significantly within and between Treatments?

Overall, harvest rates reduced by seven percentage points between the pre- and post-treatment stages of the game (Table 2). This result is statistically significant at the 1% level. As expected, there was no significant difference in mean harvest within OA, pre- and post-treatment stages. PES individual pay posted the largest reduction in harvest at 17 percentage points compared to a six percentage point reduction under each of CFM and CAC (Table 2).

The between treatment results in Table 3 are for the post-treatment stage only. Mean harvest rates were significantly higher under the control (OA) compared to all other treatments except the PES group pay (Table 3). The PES individual pay treatment had statistically significant lower harvest rates compared to CAC, CFM and PES group. Both CAC and CFM had significantly lower harvest rates than PES group pay. Harvest rates between CFM and CAC were not statistically different. We return to these results in the discussion section of the paper.

Table 2. Within Treatment Comparison of Mean Harvest Rates, Pre- and Post-Treatment

	Harvest rate (pre-treatment (1))	Harvest rate (post-treatment (2))	Diff (1)-(2)	N
OA	0.542 (0.024)	0.492(0.027)	0.050	310
CAC	0.485(0.021)	0.431(0.019)	0.054*	400
CFM	0.488(0.023)	0.429(0.022)	0.059*	400
PES, individual pay	0.481(0.021)	0.312(0.017)	0.169***	400
PES, group pay	0.486(0.023)	0.483(0.024)	0.003	400
Overall effects	0.494(0.010)	0.426(0.010)	0.068***	1,910

Standard errors in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table 3. Between Treatment Comparison of Mean Harvest Rates in the Second Stage of the Game

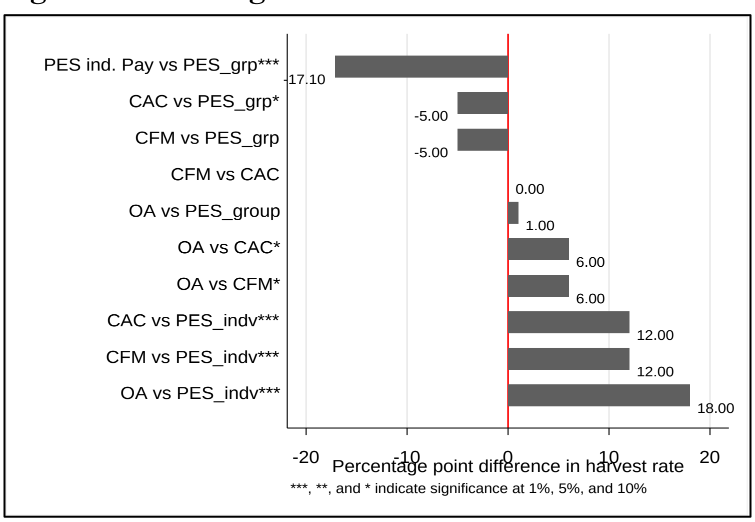
Comparison variable (1)	Compared variable (2)	Mean/SE (1)	Mean/SE (2)	Difference (1) –(2)	T-statistic
OA	CFM	0.49(0.03)	0.43(0.02)	0.06	1.82*
	CAC	0.49(0.03)	0.43(0.02)	0.06	1.87*
	PES individual pay	0.49(0.03)	0.31(0.02)	0.18	5.74***
	PES, group pay	0.49(0.03)	0.48(0.02)	0.01	0.24
CFM	CAC	0.43(0.02)	0.43(0.02)	-0.00	-0.07
	PES individual pay	0.43(0.02)	0.31(0.02)	0.12	4.27***
	PES, group pay	0.43(0.02)	0.48(0.02)	-0.05	-1.64
CAC	PES individual pay	0.43(0.02)	0.31(0.02)	0.12	4.78***
	PES, group pay	0.43(0.02)	0.48(0.02)	-0.05	-1.69*
PES ind. pay	PES, group pay	0.31(0.02)	0.48(0.02)	-0.17	-5.78***

Standard errors in parentheses; ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Figure 9 shows the percentage point differences in mean harvest rates by treatment. Negative and positive percentage points show that the mean harvest rate for the comparison treatment is lower and larger, respectively, than for the compared variable.

While the preceding results are interesting, they are bivariate and do not control for potential confounding factors. Harvest rates may differ across treatments not only because of treatment, but due to differences in participants' social economic factors, forest dependence and village, and experimental session – specific factors. Unobservable participant heterogeneity such as attitudes and perceptions towards forest could also affect harvest decisions. While randomization ensures that these differences are not systematic and therefore should not confound treatment and outcomes, a multivariate analysis is a good complement as the numbers of sessions is limited and there might be heterogeneity across treatment groups.

Figure 9. Percentage Point Differences in Mean Harvest Rates between Treatments



4.4 Overall Impacts of Treatments on Forest Harvest

Results in Tables 4 and 5 control for potential confounders and report robust standard errors. Column 1 in Table 4 present results from a base model estimated using pooled OLS. Since the dependent variable is within [0,1] interval without pile-ups at either end, the appropriate model is the fractional probit model (Papke and Wooldridge 2008). Table 4 presents the fractional probit model results in column 2 for a bare-bone model with treatment variables as the only regressors, and the full model in column 3. Unless otherwise stated, we will interpret and discuss results in column 3.

After controlling for potential confounding factors, some earlier descriptive results are confirmed. Relative to OA, CFM and PES individual pay significantly reduced harvest rates, with the latter posting the largest reductions (Table 4). Females and age of the participants, and being impatient were associated with significantly higher harvest rates, but higher wealthy as measured by TLU was associated with lower harvest rates (Table 4).

Because the treatments considered in this paper are inherently different and are likely to be implemented singly, we re-estimated the main model for each treatment as robustness checks. Columns 1, 2, 3 and 4 in Table 5 show results for CFM, CAC, PES individual pay and PES group pay, respectively. The main results are preserved: relative to OA, PES individual pay significantly reduced harvest. Forest dependence (measured by whether the participant sold any forest product in the month preceding the survey) significantly increased harvest across all treatments while being altruistic significantly reduced harvest under PES individual pay treatment (Table 5). The other results in Table 4 are preserved.

Table 4. Average Partial Effects of Factors Influencing Harvest Rates

	(1)		(2)		(3)	
			Panel data fractional response model			
	POLS	SE	Treatments	SE	Full	SE
CFM (yes = 1)	-0.084***	0.026	-0.051	0.051	-0.083*	0.048
CAC (yes = 1)	-0.025	0.027	-0.056	0.048	-0.021	0.052
PES, individual pay (yes = 1)	-0.151***	0.023	-0.123***	0.046	-0.152***	0.042
PES, group pay (yes = 1)	-0.021	0.026	-0.031	0.053	-0.021	0.048
Number of trips to the forest	-0.010	0.007			-0.009	0.014
Sold forest product last month (yes =1)	0.046**	0.019			0.050	0.039
Indv. pay preferred (yes =1)	0.012	0.016			0.015	0.031
Altruistic (yes = 1)	-0.052***	0.017			-0.047	0.036
Risk loving (yes = 1)	0.006	0.015			0.004	0.031
Impatient (yes = 1)	0.132***	0.026			0.140***	0.051
Tropical Livestock Units	-0.042***	0.010			-0.032*	0.017
Land holding	-0.001	0.003			0.001	0.005
Age	-0.004	0.003			0.002**	0.001
Education level	0.049	0.058			-0.027	0.022
Female participant (yes = 1)	0.128***	0.015			0.119***	0.030
Village fixed effects	yes	yes			yes	yes
Experiment round fixed effects	yes	yes			yes	yes
Observations	1,880		1,910		1,880	1,880
R-squared	0.163					

Notes: ***, **, and * indicate significance at the 1, 5, and 10 %; the estimation include square terms for age, education, tropical livestock units and landholding size; the dependent variable is harvest rate [0,1].

Table 5. Average Partial Effects of Factors Influencing Harvest Rates by Treatment Sub-sample

	(1) CFM	SE	(2) CAC	SE	(3) PES, indv.	SE	(4) PES,group	SE
CFM (yes = 1)	-0.041	0.038	-	-	-	-	-	-
CAC (yes = 1)	-	-	0.035	0.042	-	-	-	-
PES, individual pay (yes = 1)	-	-	-	-	-0.128***	0.036	-	-
PES, group pay (yes = 1)	-	-	-	-	-	-	0.042	0.038
Number of trips to forest	-0.006	0.014	-0.003	0.014	-0.004	0.014	-0.005	0.014
Sold forest prod. last month (yes =1)	0.079**	0.036	0.077**	0.038	0.058	0.038	0.084**	0.036
Indv. pay preferred (yes =1)	0.027	0.031	0.018	0.033	0.010	0.030	0.028	0.032
Altruistic (yes = 1)	-0.014	0.033	-0.026	0.032	-0.061*	0.033	-0.028	0.030
Risk loving (yes = 1)	-0.004	0.032	-0.003	0.031	0.008	0.030	-0.003	0.031
Impatient (yes = 1)	0.114**	0.050	0.117**	0.051	0.131**	0.052	0.108**	0.051
Tropical Livestock Units	-0.032*	0.018	-0.033*	0.017	-0.031*	0.017	-0.031*	0.018
Land holding	0.001	0.004	0.002	0.005	0.001	0.004	0.000	0.004
Age	0.002*	0.001	0.002	0.001	0.002**	0.001	0.002*	0.001
Education	-0.034	0.022	-0.031	0.023	-0.026	0.022	-0.035	0.023
Female participant (yes = 1)	0.105***	0.031	0.107***	0.031	0.117***	0.029	0.104***	0.031
Village fixed effects	yes		yes		yes		yes	
Experiment round fixed effects	yes		yes		yes		yes	
Observations	1,880		1,880		1,880		1,880	

Notes: ***, **, and * indicate significance at the 1, 5, and 10 %; the estimation included square terms for age, education, tropical livestock units and landholding size; dependent variable is harvest rate [0,1].

5. DISCUSSION

5.1 Overall Treatment Effects on Harvest

As expected, harvest rates continued to reduce throughout the experiment rounds and for all treatments. The fact that we did not observe any significant increases in the last round suggests no significant end-game effects. This is expected because the number of rounds was not announced to the participants at the start of the experiment. The insignificant differences in harvest rates under OA in the pre- and post-treatment stages validates our experimental design. OA was used a control and as such, it was comparable in the two stages.

The mean post-treatment harvest rates of 0.49 for OA, 0.43 for each of CFM and CAC are higher than the 0.41, 0.28 and 0.24 for similar treatments in experiments conducted in Tanzania (Handberg and Angelsen 2015). Our harvest rates for PES individual pay and PES group pay at 0.31 and 0.48, respectively, are lower than the 0.47 and 0.53 harvest rates in close to identical experiments conducted in Ethiopia (Hailu and Angelsen 2018), but are comparable to the 0.36 harvest rate for individual PES in Handberg and Angelsen (2015). The harvest rates in our paper are lower than the estimates for similar treatments in (Ostrom, Gardner, and Walker 1994; Cardenas, Stranlund, and Willis 2000; Rodriguez-Sickert, Guzmán, and Cárdenas 2008). Context and framing could account for these differences.

Reductions in harvest rates without treatment under OA suggest that there were strong non-pecuniary benefits and prosocial behavior which drove conservation among participants. These effects seemed stronger in villages with stronger social cohesion (village 1).[11] Within treatments, PES individual pay had the largest impact and reduced harvest by 17 percentage points (pp). This estimate is close to the 20 pp reduction in mean harvest for PES individual pay in Hailu and Angelsen (2018). As expected, the PES group pay treatment had the second highest harvest rates after OA. Free riding could drive up mean harvest in group pay schemes and so would uncertainty and mistrust (Hailu and Angelsen 2018). Participants are unlikely to reduce their individual harvest if they are uncertain others will reciprocate and if there is mistrust within the community (among participants).

Several individual factors directly influenced harvest rates. Forest dependence (measured by whether the participant sold any forest product in the month preceding the survey) significantly increased harvest as did being impatient. In line with Hailu and Angelsen (2018) and Handberg and Angelsen (2015), female participants in our experiments had significantly higher harvest rates than males. This result runs counter to assertions suggesting that females are more pro-conservation, but it is not unexpected for our sample, where fuelwood (firewood and charcoal)—a woman dominated activity—was the most collected/harvested forest product used by some 85% of the sample.

While it is generally argued that age of the participant is negatively associated with harvest, as in Hailu and Angelsen (2018), we found that older participants harvested more. The positive effect of age on harvest in our paper is similar to findings in Handberg and Angelsen (2015) and could suggest that older people are more dependent on forest resources. Having more livestock (measured by TLU) significantly reduced harvest. If livestock ownership is used as a proxy for wealth as is the case in most rural Zambia, this result suggests that forest dependence and wealth are inversely related.[12]

[11] Village 1 had a strong religious movement common to everyone in the area.
[12] The correlation between TLU and forest dependence (number of trips to forest per week) is -18%.

5.2 Community Forest Management and Forest Conservation

CFM along with individual PES significantly reduced harvest in our experiments. These results suggest that communication or cheap talk can significantly affect conservation efforts because it enhances cooperation and reduces self-interest (Ostrom, Gardner, and Walker 1994; Cardenas, Stranlund, and Willis 2000). This can be achieved in a number of ways. First, our results in Figures 7 and 8 suggest that communication dampens the negative effects of impatience (high discounting) and self-centeredness on conservation. Thus, even without regulations, communication might have a norm-stabilizing effect that is pro-conservation (Rodriguez-Sickert, Guzmán, and Cárdenas 2008). Participants in the CFM treatment tended to talk a lot about the need to cooperate and reduce harvest in order to preserve the forest. Second, even if this is not measured directly, we conjecture that mistrust plays a role. Participants are more likely to reduce harvest following cheap talk if they trust that everybody else will reduce their harvest (Hailu and Angelsen 2018). This may have been the case in our survey areas and more so in village 1 (with a common religious movement) where CFM posted the largest reduction in harvest rates by the 10^{th} round.

The effect of communication in this study is however much lower than is found elsewhere (Cardenas, Stranlund, and Willis 2000; Handberg and Angelsen 2015). While it is difficult to say why, we can speculate that different context and framing could affect our results. Also, our low estimate could be as a result of the fact that CFM regimes are yet to be implemented at scale in Zambia. Expanding these types of experiments to other locations is needed before we conclude on the efficacy of communication in forest conservation.

5.3. External Validity

One of the main limitations of FFEs is the low external validity of findings. There are also concerns of warm-glow and cognitive dissonance, where participants in an experiment behave differently rather in real life and tend to give responses deemed socially acceptable. We addressed these issues in a number of ways. First, we attempted to ensure that participants were selected and assigned to experimental groups randomly. We achieved this task with replacements in some cases. Second, we gave participants detailed instructions about the experiment and emphasized that they take the exercise seriously (and they did) because it had implications on how much the earned in the experiment and had significant lessons for forest management in everyday life. Lastly, we included debriefing questions in the post-experiment survey to capture a number of facets related to framing and the external validity of the experiment. Nearly all (99%) of the sample felt that the tree branches used in the experiment represented the forest in the villages, while 98% said that participating in the experiment helped them think about how they make real life forest-use decisions. About 95% of the participants had a harvest strategy in the experiment, and of these, 97% followed a harvest strategy similar to how they cut trees in real life. Asked to explain this, one participant said: *"I don't just cut trees for no use and I select what trees to cut and when. Sometimes, I come just back (home) without any tree if I cannot find a close match*."

Following the nomenclature of Handberg and Angelsen (2015), our experiment had strong behavioral validity given the strong correlates between experimental tasks and real life choices of the participants. Our experiments also had very strong treatment validity because we used treatments that are currently part of forestry policy and regulations in Zambia (GRZ 2014, 2015, 2018). CFM is emphasized as can be seen from the 2018 community forest management regulations, which provide for the creation of community forest management groups (GRZ 2018). CAC is reflected in these regulations and some guidance is given on benefit sharing mechanism. As part of the UN-REDD countries, Zambia has had several REDD+ initiatives and activities implemented, making the PES treatments very relevant.

While our experiment seems to pass both the behavioral and treatment validity tests, generalizations to the wider context should be limited. These experiments were only conducted in two adjacent provinces in Muchinga and Central. Different cultural and contextual factors in other areas might affect the results. While the exogenous rules in CAC were punitive (every player played a lottery after every round with a 25% of being inspected), this only marginally reduced harvest by 6 pp. Thus, imposing external rules may have crowded-out intrinsic pro-social and conservation motivations (Cardenas, Stranlund, and Willis 2000). Also note that we did not impose any harsh fines beyond zeroing harvest and pay for defaulters in that round, and possibly imposing some guilt and shame on participants, even if they remained anonymous to others. Thus, comparing our results to others, the level of punishment seems to matter.

That CFM had positive conservation outcomes even after controlling for potential confounders attests to the importance of cooperation (Cardenas, Stranlund, and Willis 2000). The influence of other factors, such as elite capture, not addressed in our experiments can have significant effects in real life (Handberg and Angelsen 2015) and might reduce cooperation, engendering 'grab what you can strategies' (Vollan 2008). The small group size and homogeneity in our experiments might not be a true representation of large and heterogeneous societies in real life and might have affected our PES individual pay results more than in real life. [13]

Future research can more closely assess the effects of CAC and CFM on motivation crowding out and make endogenous the sanctions in CAC. Instead of using one adjustment factor in PES, different parameters can be used to assess if the level of payment matters. Hailu and Angelsen (2018) address the last issue using different reference levels, but it would be informative to also vary the level of compensation directly. Some combined treatments, for example, CFM and CAC and CFM and PES, could be part of future research.

[13] Although, small group sizes and homogeneity are prerequisites for cooperative solutions in the management of commons

6. CONCLUSION AND POLICY IMPLICATIONS

Reducing deforestation and forest degradation to both mitigate climate change and conserve biodiversity is high on national agendas. What is not clear is how. We designed framed field experiments to test *ex-ante* the impacts of payment for environmental services, command and control, and community forest management (three common policy instruments) on forest conservation in Zambia.

Relative to open access, community forest management and payment for environmental services to individuals led to more forest conservation. The latter effect was threefold larger than the former. We can speculate that communication in the community forest management treatment might have improved cooperation and in some ways ignited non-pecuniary, pro-social and other behaviors in our participants. The large effects of individual pay, on the other hand, suggests that there is merit in paying the actual individuals or forest users in incentive based schemes and supports the core REDD+ idea. This however, depends on the transaction costs incurred in actualizing individual payments. Free and easy-riding and uncertainty on how others will respond dampens the positive effects of group pay on forest conservation as do externally imposed sanctions in command and control.

We, therefore, conclude in line with (Hailu and Angelsen 2018) that individual pay is better than group pay. While community forest management might have the desired results, its impacts are smaller than individual, pecuniary incentives. These results imply that better conservation outcomes might be achieved by some combinations of community forest management and individual payments for environmental services. Thus, clarifying benefit sharing mechanisms in Zambia's community forest management and taking into account individuals' non-pecuniary motives will be important to achieve win-win outcomes for conservation and livelihoods.

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APPENDICES

Appendix A. Payoff Table

The appendices show the pay offs for player *i* given the choices of all other players (Table A6), experiment instructions and the post – experiment survey questionnaire.

Table A 6 Payoffs for Participant *i* Given the Strategies of the Other Seven Players

		Harvest by player *i*					
		0	1	2	3	4	5
Total Harvest by all players except *i*	0	7.50	7.88	8.25	8.63	9.00	9.38
	1	7.38	7.75	8.13	8.50	8.88	9.25
	2	7.25	7.63	8.00	8.38	8.75	9.13
	3	7.13	7.50	7.88	8.25	8.63	9.00
	4	7.00	7.38	7.75	8.13	8.50	8.88
	5	6.88	7.25	7.63	8.00	8.38	8.75
	6	6.75	7.13	7.50	7.88	8.25	8.63
	7	6.63	7.00	7.38	7.75	8.13	8.50
	8	6.50	6.88	7.25	7.63	8.00	8.38
	9	6.38	6.75	7.13	7.50	7.88	8.25
	10	6.25	6.63	7.00	7.38	7.75	8.13
	11	6.13	6.50	6.88	7.25	7.63	8.00
	12	6.00	6.38	6.75	7.13	7.50	7.88
	13	5.88	6.25	6.63	7.00	7.38	7.75
	14	5.75	6.13	6.50	6.88	7.25	7.63
	15	5.63	6.00	6.38	6.75	7.13	7.50
	16	5.50	5.88	6.25	6.63	7.00	7.38
	17	5.38	5.75	6.13	6.50	6.88	7.25
	18	5.25	5.63	6.00	6.38	6.75	7.13
	19	5.13	5.50	5.88	6.25	6.63	7.00
	20	5.00	5.38	5.75	6.13	6.50	6.88
	21	4.88	5.25	5.63	6.00	6.38	6.75
	22	4.75	5.13	5.50	5.88	6.25	6.63
	23	4.63	5.00	5.38	5.75	6.13	6.50
	24	4.50	4.88	5.25	5.63	6.00	6.38
	25	4.38	4.75	5.13	5.50	5.88	6.25
	26	4.25	4.63	5.00	5.38	5.75	6.13
	27	4.13	4.50	4.88	5.25	5.63	6.00
	28	4.00	4.38	4.75	5.13	5.50	5.88
	29	3.88	4.25	4.63	5.00	5.38	5.75
	30	3.75	4.13	4.50	4.88	5.25	5.63
	31	3.63	4.00	4.38	4.75	5.13	5.50
	32	3.50	3.88	4.25	4.63	5.00	5.38
	33	3.38	3.75	4.13	4.50	4.88	5.25
	34	3.25	3.63	4.00	4.38	4.75	5.13
	35	3.13	3.50	3.88	4.25	4.63	5.00

Appendix B. Instructions

For participants

Good morning! [Introduce oneself and the research assistant(s)].

We are from the Indaba Agricultural Policy Research Institute (IAPRI) in Lusaka. IAPRI is an indigenous Zambian organization with more than 10 years of experience in conducting applied policy research in agriculture, food security, nutrition and natural resource management. We work very closely with the Ministries of Agriculture, and Fisheries and Livestock, and the Central Statistical Office (CSO).

[Do you have any questions?]

First of all, thank you for taking time off your busy schedules to participate in this study. This is harvest time!

This is a study about the use and management of forest resources in your community. We will have an entertaining time, and we kindly request your attention and participation. But, first we need your consent.

Informed Consent Statement

This study is an effort by the Indaba Agricultural Policy Research Institute (IAPRI) aimed at studying how local forest users make decisions about forest use and harvest. Your help in participating this experiment and in answering the post-experiment questions is very much appreciated. Your responses will be kept **COMPLETELY CONFIDENTIAL** and will be summed together with those of roughly 180 other households, and general averages from analysis will be reported for scientific research purposes only. You indicate your voluntary consent by participating in this study: may we begin? If you have questions about this study, you may contact Mr. Chance Kabaghe on 0211 261194/97.

When you pay full attention and make better decisions in the following activities, you will earn money according to your performance. We will explain this later. We will then have a brief interview in the end. Enjoy your stay with us!

When you have questions, please raise your hands and ask. We will answer all your questions so that you fully understand the activities.

Now let's see the activities. Suppose this group represents people living as a community. Also suppose that there is a common forest resource nearby. *[Pointing to the tree branches]* Let us say this is the forest and there are 60 trees in the forest that everyone could access. In each round of the activities we are going to do, a member (any one of you) will decide how many trees to harvest without knowing what other members will do. It is possible to decide not to harvest any tree. The maximum number of trees one could cut in one round is **five**. When we say one round, you can think of it as one month or one season in real life. When one round of the activity ends, *[mention the name of the research assistant]* will add the total harvest in that round of the group and disclose it to the group. Then we start another round with the same 60 trees in the forest. *[Do you have any questions?]*

To indicate your decision, you will use *[showing the decision form]* this form. You will choose how many trees to cut and indicate it by putting an ***X*** mark or by signing with your fingertips in this *[show them]* column. Example, if I choose not to harvest, I mark it here *[point to the right cell]*; 3 here, 5 here and so on. *[Do you have any questions?]*

In real life, you cut trees to use them as firewood, to make agricultural tools, and to build houses. In this activity, each member will get ZMW 0.5 for each tree he/she decides to cut as a direct benefit. On the other hand, you may know that standing forests also give members of the community and its surroundings indirect benefits. For instance, forests attract rain, regulate above and underground water, serve as sources of other non-timber forest products such as wild fruits, honey, mushroom, caterpillars etc. To represent these indirect benefits, we will give the group ZMW 1 for each standing tree, which the group members will share equally.

We would like to remind you once again that everything you do is anonymous, so only you know how much you harvest. *[Do you have any questions?]*

Let us try a practice round to get us familiar with the activities! This is just for learning so you will not earn anything from this round. *[Complete a full round. Answer any further questions]*

Thank you. Now let's start the real experiment. Anything you will earn from now on will be noted and paid to you in actual money at the end of the experiment.

Appendix C. Post-experiment Questionnaire

Basic information		Response
B1	Participant ID.	
B2	Age	
B3	Gender (1=female, 0=male)	
B4	Highest education completed (1=None, 2=Primary/sub-standard education, 3=Secondary education, 4=College certificate/diploma 5=Bachelor's degree 6= Masters and above)	
B5	Are you a member of a forest users group? (1 = yes, 0=no)	
B6	Are you a member of a farmers' cooperative (1 = yes, 0=no)	
Environmental awareness		
E1	Have you heard about climate change? (1=yes, 0=no)	
E2	Do you think forests can help reduce the effects of climate change? (1=yes, 0=no) If your answer is "yes", how?	
E3	Which one is more valuable for you? For the community? (1=standing trees, 0=cut trees)	You: _______ Community _________
E4	Would you rather get direct benefit from trees you cut today than wait for shared benefits in the future? (1=yes, 0=no)	
E5	Do you use irrigation to cultivate in the dry season? (1=yes, 0=no)	
E6	Are you aware that forests regulate how much rain and water you could get? (1=yes, 0=no)	
E7	How do you see yourself: are you generally a person who is willing to take risks, or do you try to avoid taking risks? Please choose on a scale from 0 to 3: (0 = not at all willing to take risks, 1 = somewhat not willing to take risks, 2 = somewhat willing to take risks, 3 = very willing to take risks, 4= I don't know)	
E8	How do you see yourself: are you generally a person who is impatient and want to have 'things' now, or can you wait to get them later? Please choose on a scale from 0 to 3: (0 = always prefer to have things now, 1 = can somewhat not wait to have the things, 2 = can somewhat wait to have the things, 3 = willing to wait to have things, 4= I don't know)	
About forest use		
F1	Do you use forest products? (1=yes, 0=no)	
F2	What forest products do you mainly collect? (1=fire wood/charcoal, 2=polls and timber, 3=honey, mushroom, caterpillars and other non-timber forest products)	
F3	How many times per week do you go to the forest to collect forest products? (In the dry season and the rainy season)	dry :____ rainy:____
F4	Have you sold any forest products during the last month? (1=yes, 0=no)	
F5	Compared to 10 years ago, how accessible are forest products in your village? (1= readily accessible within 5km, 2=less accessible, 3=not available in my village, we gather from neighboring villages, 4 = I don't know)	
F6	How much forest products do you use compared to other families in the village? (1=less, 2=about the same, 3=more)	
F7	How important is the forest to you? (1= not important, 2=important, 3=essential)	
F8	Do you consider how your individual forest use and harvest decisions impact others in the village? (1=yes, 0=no)	
F9	How do you see yourself: are you generally a person who thinks about the well-being of others in the village? Please choose on a scale from 0 to 3: (0 = Not at all, I always think about myself, 1 = sometimes, I think about myself, 2= sometimes, I think about others, 3 = I always think about others first, 4 = I don't know)	
About forest conservation and wealth		
C1	What are your top three major sources of income? (Agriculture, own business, livestock, wage off-farm, wage on-farm, forest products) [*you may select more than one*]	
C2	What do you think is the most effective measure the government and other stakeholders can do to decrease deforestation and forest degradation?	

C3	If payments for conserving forests are to be introduced, would you prefer the payments to be made to the community, directly to the individuals or the group managing the forest resources? (1=community, 2=individual, 3=forest group)	
C4	How much land does your family own or have control over? [Enumerator probe on the units and convert to hectares (ha) using 1 lima = 0 .25 ha; 1 acre = 0.405 ha; 1m² = 0.0001 ha]	
C5	How much land do you own yourself?	
C6	How many livestock do you have? (number of cattle, goats, pigs, sheep/donkey, chicken, ducks)	c:____ g:____ p:____ s:____ d:_____ ch:___
C7	What type of material is (most of) your house's roof? (1=thatch; 2=wood and earth; 3=iron or other metal sheets; 4=tiles; 9=other, specify)	
C8	Please mention any major income shortfalls or unexpectedly large expenditures during the past 12 months that your household faced.	
Trust and social interdependence		
T1	Do you trust your neighbors (1=yes, 2=somehow, 3=no)	
T2	Do you get help from neighbors in times of shock? (1=yes, 2=sometimes, 3=no)	
T3	Considering everything else, how happy were you in the last 12 months? (1=very unhappy, 2=happy, 3=average, 4=happy, 5=very happy)	
T4	Outside this experiment, do you and your neighbors talk about how to use the forest resources in your village? (1=yes, 2=no), if yes, how often?	
About the experiment		
FFE1	Did the tree branches used in the experiment represent the forest in your village? (1 = yes, 2 = no)	
FFE2	Did participating in this experiment help you think about how you make decisions regarding forest use in everyday life? (1 = yes, 2 = no) if yes, explain	
FFE2	Did the activities in this experiment resemble how forest resources are managed in your village? (1 = yes, 2 = no) if yes, explain	
FFE3	Did you participate together with any close friends or family in the experiment? (1=yes, 0=no) If yes, how many?	
FFE4	Did you have any particular harvest strategy in the experiment? Why/why not?	
FFE5	Was your decision pattern close to your actual choices in real life? (1=yes, 0=no)	

Appendix D. Decision Forms

Harvest decision form Participant ID___________

District _______ Village_________ Camp__________

Session_______ Round__________ Name of Participate______________________

No. of trees	Decision
 5	
 4	
 3	
 2	
 1	
0	