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LETTER

Simple Incentives and Group Dependence for Successful Payments for Ecosystem Services Programs: Evidence from an Experimental Game in Rural Lao PDR

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Abstract

In this article, we use a new game-based tool to evaluate the immediate and longer term behavioral change potential of three different payments for ecosystem services (PES) delivery mechanisms: direct payments for individual performance, direct payments for group performance, and insurance. Results from four rural shifting-cultivation dependent communities in Lao PDR suggest that easily understood group-oriented incentives yield the greatest immediate resource-use reduction and experience less free-riding. Group-based incentives may succeed because they motivate participants to communicate about strategies and coordinate their actions and are perceived as fair. No incentive had a lasting effect after it ceased, but neither did any crowd out the participants' baseline behavior. Temporary reductions in resource dependence may provide a buffer for development of new livelihoods and longer term change. Games like the one developed here can help policy makers appropriately target environmental incentive programs to local contexts and teach program participants how incentive schemes work.

Introduction

When forest-derived greenhouse gas emissions are avoided, the benefits are worldwide, but the burden of reduced forest resource availability is local. Protected areas are an important defense against deforestation, but additional lands are required to meet international conservation goals (Mora & Sale 2011). Fortunately, there is ample evidence that communities can self-organize to manage natural resources like forests (Ostrom 1990; Hayes & Ostrom 2005). When conservation benefits accrue outside of a community (like global climate regulation from carbon sequestration or water sparing for downstream consumers), and burdens fall on local resource users, compensation for their incurred costs is important. Payments for ecosystem services (PES) are an attractive policy option that promote resource use reductions. PES is a central mechanism in "reducing emissions from deforestation and forest degradation" (REDD+) to motivate sustainable forest management (Engel *et al.* 2008; Pattanayak *et al.* 2010). When implemented with sensitivity to local conditions, performance-based PES may bring benefits locally and more broadly. However, research into how best to deliver incentives is in its infancy (Wunder 2008). In this article, we use a forest-framed experimental game to address these questions in the context of shifting cultivation landscapes in rural Lao PDR.

A basic question about PES is how to best deliver incentives to local users. Direct cash payments (either to a group or individual) are perhaps the simplest option (Alston *et al.* 2013; Loft *et al.* 2014). Technical assistance, insurance against crop failure, contributions to communal services, and access to credit are other possibilities

(Engel *et al.* 2008; Wong 2014; Chantarat 2011; Yang *et al.* 2015; To *et al.* 2012). Some programs combine two or more of these options. Empirical and experimental evidence about these mechanisms' effectiveness is mixed (Narloch *et al.* 2012).

A common concern is that PES may "crowd out" resource users' intrinsic motivation to protect resources, undermining long-term policy goals (Frey & Jegen 2001; Muradian *et al.* 2013). Once incentives end, targeted populations may lose motivation to conserve, and degrade resources below preprogram conditions. Crowding out happens in some experimental and real-life settings, mostly when the intervention is an externally imposed regulation (Cárdenas *et al.* 2000; Frey & Jegen 2001; Kerr *et al.* 2012). Conversely, interventions could instill new habits (Rode *et al.* 2015) or provide capital for new livelihoods (e.g., De Mel *et al.* 2012), reducing long-term resource dependence. This outcome, known as "crowding in," has also been observed in some studies (e.g., Travers *et al.* 2011; Narloch *et al* 2012; Lopez *et al.* 2013). Research into which policy features lead to crowding in or crowding out is ongoing (Rode *et al.* 2015). A preliminary list includes who initiated the incentives, framing of the incentive to the community, the delivery mechanism, and complementary programs (Lopez *et al.* 2013; Murtihno *et al.* 2013).

PES incentives must consider the cultural and environmental context of resource-based livelihoods. Here, we examine different incentives to shifting cultivators dependent on unpredictable rainfall. Shifting cultivation, also known as swidden, is a form of rotational agriculture central to the food security of millions in tropical regions worldwide (Van Vliet *et al.* 2012; Minang *et al.* 2014). Its practitioners are frequently disadvantaged minority peoples with traditional resource rights recognized by themselves and their neighbors, but not always by governments (Fox *et al.* 2009; Padoch *et al.* 2007; Kenney-Lazar 2013). Swidden is often misrepresented as unproductive (Fox *et al.* 2009), and conflated with poverty and deforestation, in spite of growing evidence that dynamic agroforest mosaics provide environmental services, forest products, and biodiversity habitat (Rerkasem *et al.* 2009, Bruun *et al.* 2013; Magnuszewski *et al.* 2015). Shifting cultivation has unique complexities among PES-targeted systems. First, in contrast to situations (like watershed management) where most environmental benefits accrue outside of targeted communities, agricultural deintensification delivers improved soil fertility and other benefits to swidden farmers, but the temptation remains to disproportionately capture benefits, harming the wider community. Second, swidden is typically rain-fed, making it vulnerable to drought and requiring incentives targeted to reduce livelihood uncertainties. Nascent REDD+ trials in Laos have largely adhered to the national development discourse targeting swidden stabilization to align poverty reduction with national environmental goals (Dwyer & Ingalls 2015). Our work sits at the nexus of these issues, making it particularly relevant for policy makers.

In this study, we assess potential PES mechanisms for their immediate and longer-term impacts using a forest-framed experimental game in four swidden-practicing communities in northern Laos. Participants decide how much land to clear and plant, balancing the need for food and income with potential weather-related crop failures. This mirrors real-life dilemmas faced by shifting cultivators who may remain dependent on swidden, but might restrain their forest use if buffered against threats like drought. Because incentive programs eventually end, this study tracks cultivation in a postincentive period. Participants communicate before making decisions, reflecting the reality of close-knit rural communities. We test three specific incentive mechanisms: individually-directed payments (IP), group-based payments (GP), and insurance (INS). To our knowledge, no previous study has compared these incentives and their postincentive efficacy in the context of shifting cultivation. We seek to answer the following questions:

(1) Which incentive best reduces resource use intensity?
(2) Which incentive has the biggest lasting impact after incentive programs end?
(3) Do players' communication, motivation, and fairness perception explain incentive outcomes?
(4) How do individual attributes like age, leadership, resource dependence, and education affect participation in and lasting impact of PES incentives?

Direct payments outperformed insurance and group-level payments reduced incentive-round cultivation better than individual payments. No postincentive crowding out or crowding in was observed under any mechanism. Increased communication, cooperation, and perceived fairness under the group payment appear linked to its success. Individual socioeconomic traits had little relation to within-game decisions.

Methods

We addressed these questions with a forest-framed game (see Supplementary information for a detailed description) in which groups of eight participants individually and simultaneously decided how many patches (up to 10 per round) to cultivate in a stylized forest with space for 100 agricultural plots. As in real-world shifting cultivation, a new area of forest was used in each

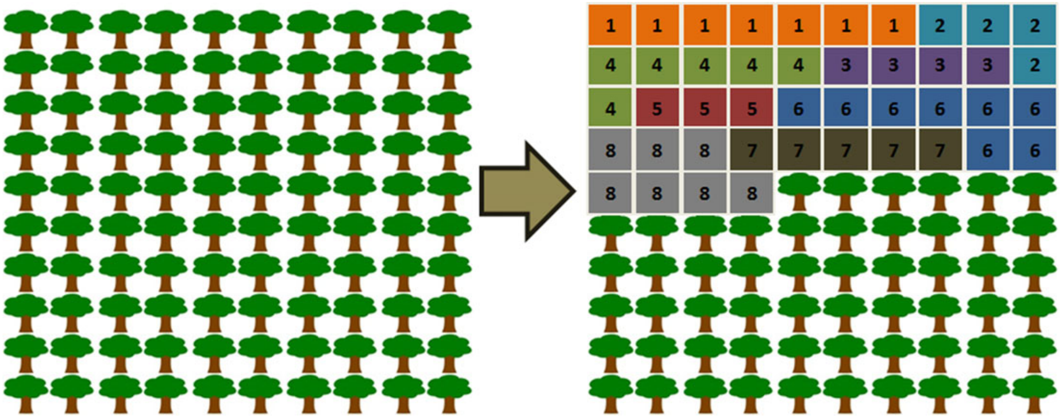

Figure 1 An example round of the shifting cultivation game. The left side of the figure represents the forest before cultivation with 100 available patches. The right side shows a hypothetical round of cultivation with a different color for the patches belonging to each player. The total cultivation by all players in this example is 44 patches, meaning 56 patches remain in the forest. In this example, player 1 would earn $7 \times 56 \times 1 = 392$ points if rainfall is poor, or $7 \times 56 \times 3 = 1176$ if the rainfall is abundant. Full details of the game mechanics and payoff structure are found in the Supporting Information.

round. Open communication was always allowed, but cultivation decisions were private. Individual earnings increased with plots cultivated, but decreased with group total cultivation, setting up a common pool resource dilemma. This reflects the real-world tradeoff where planting more cash crops comes at the expense of fallow forests that provide nontimber products crucial to diet and nutritional diversity. Environmental unpredictability also impacted earnings, with payouts depending on randomly generated rainfall. Example payout calculations are shown in Figure 1. The game had three stages of eight rounds each: preincentive, incentive, and postincentive. The preincentive stage serves as a control for measuring two outcomes: (1) the "incentive effect," or the difference between pre- and during-incentive agricultural land use, and (2) the "lasting effect," the difference between pre- and postincentive cultivation (Figure 2). During the incentive rounds, one of three mechanisms was tested: an "individual payment" (IP) made directly to any player cultivating ≤ 3 patches, a group payment (GP) made directly to each player if the entire group cultivated ≤ 24 patches, and insurance (INS) that guarantees any player cultivating ≤ 3 patches a payoff equivalent to a harvest with good rainfall, even if rains fail. At the end of the game, all players received tangible goods proportioned to their in-game earnings. Each mechanism was implemented with a separate group of eight players in each of four rural communities in northern Lao PDR (Table S1). The study had a total of 96 participants (eight players, three treatments, four villages).

To ensure fair comparisons, the incentives had identical cultivation levels at the social optimum (six patches in the pre- and postincentive stages and three during the incentive stage) and individual optimum (always 10 patches). Expected payoffs were identical at the individual optimum, and nearly identical at the social optimum (Table S3). For practical reasons discussed in the

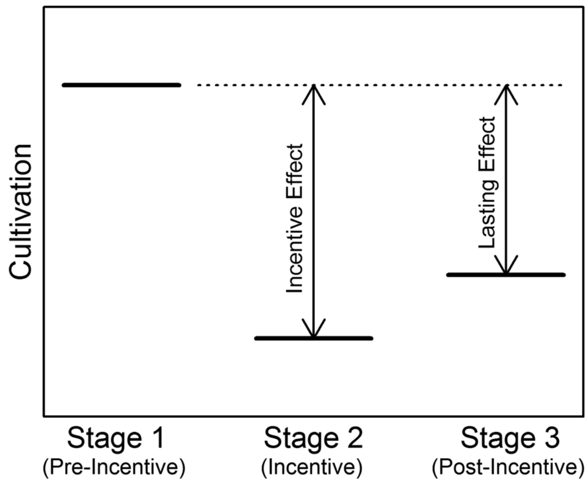

Figure 2 An idealized diagram showing the basic structure and outcome variables in the shifting cultivation game. The game is divided into three stages of eight rounds each. In stages 1 and 3, there is no external incentive to limit cultivation, although a cooperative group seeking to maximize their earnings would still do so. During stage 2, one of three possible incentives is offered as a means to reduce cultivation. Cultivation levels in stage 1 are the baseline against which choices in stages 2 and 3 are measured. This baseline allows direct comparison of groups that have different inherent cultivation levels. We use the term "incentive effect" to refer to the impact of the incentive while it is active (stage 2), and "lasting effect" to mean the impact of the incentive after it has ended. While this diagram shows both effects as reducing cultivation (as hypothesized), it is possible for either or both effects to be in the opposite direction.

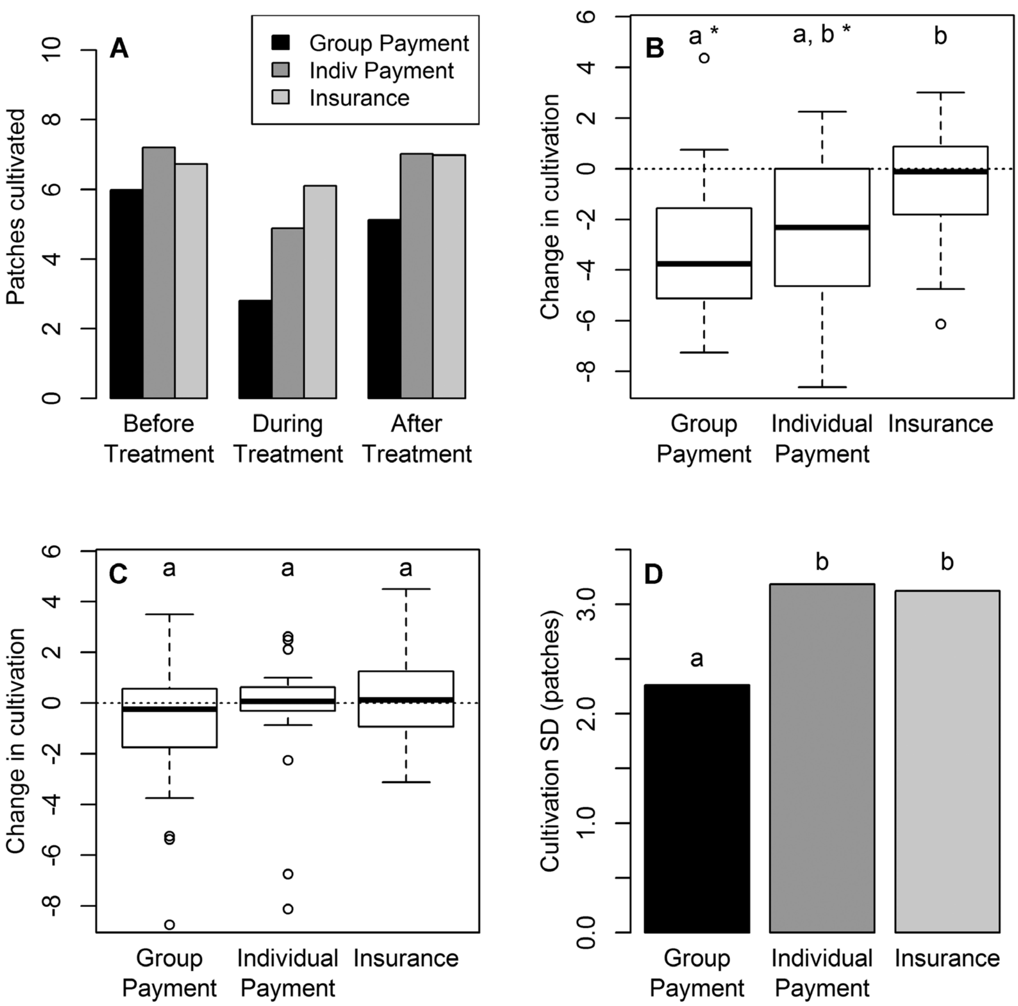

Figure 3 (A) Mean cultivation as a function of game stage and incentive type. The incentive is only applied during stage 2. (B) The incentive effect (change in cultivation) between the first (preincentive) and second (incentive) game stages. Negative numbers mean cultivation decreased relative to the preincentive rounds. The letters at the top of the figure show statistical differences at the $P < 0.05$ level assessed using a Mann–Whitney test. Stars indicate groups whose mean was significantly different from zero (Mann–Whitney test with $P < 0.05$). (C) The lasting effect after incentives end. Groups were not statistically different from one another (Kruskal–Wallis test, $P = 0.255$). No groups had a lasting effect that was statistically different from zero at the $P = 0.05$ level; the group payment incentive was closest with $P = 0.142$. (D) The within-round standard deviation of players' cultivation decisions during the incentive rounds by incentive type. Small letters indicate statistical differences among groups (Analysis of Variance, $F = 22.372$, $n = 96$, $P < 0.0001$; Tukey's HSD, $P < 0.0001$).

Supplementary information, INS had a slightly higher social-optimal payoff, 4.3% above GP and IP. This balance also ensured equal earning opportunity among the different groups. During all rounds, two observers independently rated intragroup communication on an ordinal scale from 0 to 3 and assessed who (if anyone) was the group's leader. Following the game, players were individually asked whether they were motivated by the incentive, if they perceived it as fair and how much time they spend in real forests. Demographic data about the players (age, wealth, education, sources of livelihood, household size) were collected by a separate team that visited the villages in the 2 weeks before the games. Further methodological details and analytical methods are presented in the Supporting Information.

Results

Average individual cultivation during the preincentive stage was 6.64 patches/round, statistically higher than the social optimum of 6 (Mann–Whitney test, $M = 6.64$, SD = 2.53, $n = 96$, $P = 0.0037$; Figure 3A), but much lower than the individual optimum of 10. As expected, during the preincentive stage, cultivation was identical among the incentive types (Kruskal–Wallis test, $\chi^2 = 2.357$, df = 2, $P = 0.308$). The incentive effect differed significantly among mechanisms (Kruskal–Wallis test, $\chi^2 = 15.181$, df = 2, $P = 0.0005$), with GP and IP showing a bigger decrease in forest use than INS (Figure 3B). Under GP, cultivation was indistinguishable from the social optimum of 3, but was significantly higher than this value for IP and INS (Table S5). Postincentive cultivation always rebounded to preincentive levels (Figures 3A and C, Table S4); the lasting effect was indistinguishable among mechanisms (Kruskal–Wallis test, $\chi^2 = 2.732$, df = 2, $P = 0.255$). Postincentive cultivation was near the social optimum of 6 for all incentives (Figure 3A), but all were at least marginally different from this value (Table S6). Although equitable use of the forest resource occurred sometimes, individual cultivation frequently deviated from the mean group decision. Incentive-stage cultivation was most equitable under GP (Figure 3D).

Players communicated similarly under all three incentives during the pre- and post incentive stages (permutation tests, $P < 0.005$; Figure 4A). During the incentive stage, GP groups showed a significant spike in communication (Figure 4A). In postexperiment surveys, GP participants were more likely than IP or INS players to report that the incentive was fair and motivated them to reduce harvesting (Figures 4B and C; exact binomial tests, $P < 0.05$).

Individual covariates (age, gender, years of education, family land ownership, time spent in real forests, household size, and observed in-game leadership) showed minimal relationships with harvesting levels. Time spent in the forest was the only significant (and positive) predictor of preincentive cultivation (Table S7). However, when village differences were controlled for, this relationship grew more complicated. Forest visitation remained a significant predictor of in-game cultivation and education also became a significant, positive, predictor of cultivation (Table S7). Cultivation decisions relative to other players in the same group showed no significant relationship with any of these variables (Table S8).

Discussion

This study has revealed how shifting cultivators respond to different PES incentive structures using a forest-framed experimental game. Overall, the participants from these four villages cooperated consistently throughout the game. In no instance did any group fully adopt the uncooperative strategy of cultivating the maximum allowable. On the contrary, mean cultivation levels were

Figure 4 (A) Communication among players as a function of incentive type and experimental stage. Communication was assessed by two independent observers. Small letters refer to significant differences (see Supporting Information) among incentives within each stage (before, during, and after incentive), but *not* across stages. (B) Percentage of players reporting in a postgame survey that the incentive scheme motivated them to cultivate fewer patches. (C) Percentage of players reporting in individual postgame surveys that they felt the incentive scheme was fair. In (B) and (C), small letters indicate significant differences ($P < 0.05$) among groups as determined using exact binomial tests (see Supplementary information).

remarkably close to the social optimum for most game stages and incentives (Figure 3B). This may be due in part to communication being allowed throughout the game, a realistic feature not always included in field experiments. However, these average outcomes mask substantial variation among players' decisions (Figure 3D). Free-riding happened in spite of seemingly cooperative group-level averages, although among-player harvesting variation was lowest for the GP incentive (Figure 3D). Our results show that incentives' impacts depend on more than potential financial gain. Although the three incentives had virtually identical payoff structures, a payment contingent on group-level choices (GP) reduced cultivation more than an otherwise identical payment with only an individual-level performance requirement (IP). This may be explained by players' increased communication and perceptions of incentive fairness. In turn, both of these direct payment incentives outperformed an insurance incentive (INS) which caused no discernable change in cultivation practices.

Group- and individual-level incentives have complex impacts (Beersma *et al* 2003). Our finding that group payments outperformed individual payments is congruent with some (Travers *et al.* 2011), but not all (Narloch *et al.* 2012), previous research. Intragroup dependency promotes successful common pool resource management outcomes (Frey & Rusch 2013), and is clearly demonstrated in Lao swidden systems which rely on kinship ties, reciprocity, and risk-coping dependency (Akihiko & Chaleunsinh 2015). Compared to the IP and INS incentives, GP players lose more when free-riding occurs, but the free-rider gains no additional benefit. In spite of harsher consequences of free-riding, players reported GP to be *more* fair than either IP or INS in postgame surveys. This perception has at least three nonmutually exclusive explanations: (1) it was impossible for some players to receive the bonus payment while others do not, (2) the theoretical risk of bigger free-riding losses did not affect actual payoffs, and (3) decisions were the result of mutual agreement among the players. Intragroup dependence may drive the spike in discussion during the GP incentive and the increased motivation reported in postexperiment surveys. Previous social dilemma experiments report that communication promotes information sharing (Bornstein 1992) and the forging of group identity (Pavitt 2011). Additionally, communication motivates participants to focus on collective welfare above individual outcomes (Bicchieri 2002). That group decisions benefitted all members may explain why more cooperation emerged under GP (Travers *et al.* 2011). This interpretation is consistent with the increased communication during the GP rounds and the higher reported motivation. Regardless of the particular explanation, it is noteworthy that at least one experimental study has found the opposite result. Narloch *et al.* (2012), using an agriculture-framed common pool resource game in the highlands of Peru and Bolivia, found that individual rewards promoted conservation action more effectively than group rewards. However, multiple games were run in parallel with no communication, preventing emergence of a group identity through information sharing and decision coordination. Taken together, these findings suggest that policy makers should consider intragroup dependence as a key feature of PES interventions.

Why the insurance incentive was ineffective is not immediately clear. In theory, it provides nearly identical benefits to the direct payment incentives. However, insurance is not yet common in rural Laos, although the national government is gradually introducing crop insurance (Lao PDR Ministry of Agriculture and Forestry, 2010). In contrast, Lao communities are familiar with direct incentives based on communal performance (e.g., village revolving funds for livestock) and individual performance (e.g., interest-free microloans). Further, the relative complexity of insurance, combined with the low numeracy of many players, could mean that its benefits were not always apparent. Savings groups are a more common risk-coping strategy than insurance and other forms of network finance (Akihiko & Chaleunsinh 2015). In addition, some case studies find confusion and indifference among participants faced with complex institutions and incentives (e.g., Scheberle 2000). This does not mean insurance incentives should never be used, but does suggest policy makers should view them with caution. Participants may require help understanding insurance programs. Games like ours, framed to local contexts, could be useful training tools and can be modified for linear resources like irrigation systems.

In spite of the significant incentive effect for the direct payment groups, no incentive showed a significant positive or negative postprogram lasting effect. The GP incentive came tantalizingly but inconclusively close to a lasting cultivation reduction, illustrating the difficulty of achieving long-term impacts within a finite time frame and budget. However, this result should not be viewed pessimistically. Although no incentive had clear lasting cultivation reductions, neither did any incentive show lasting cultivation increases. We saw absolutely no evidence of crowding out, a result in agreement with most previous studies of incentive-based (as opposed to disincentive-driven) interventions (Rode *et al.* 2015). Crowding in is still a possible outcome of such incentives. Due to the necessary simplicity of our game, we could only assess direct behavioral change, but incentives can also promote long-term economic changes, as seen in research on development via nonagricultural labor, technology adoption, and cash transfers (De Mel *et al.* 2012). However, postincentive impacts cannot be taken for granted, so policy design should include pathways from medium-term gains to longer term sustainability.

By reducing dependence on forest for shifting cultivation, PES could result in more forests and fallows within the landscape via two complementary routes. One is less land dedicated to shifting cultivation, and hence more land reserved for forest or other uses (land sparing). The second is less frequent rotation, and hence older fallows. Both mechanisms would bring benefits for carbon sequestration, biodiversity, and other ecosystem services if burdens on communities are offset with PES. While these pathways are beyond the scope of our study, both outcomes are consistent with our results. The real-world impact of incentives could be land sparing, increased rotation time, or both, depending on the policy implementation and local preferences.

As in all game-based studies, the external validity of results is difficult to definitively address. That players who visited real forests more also cultivate more in the context of the game, even when these variables' covariation among villages is accounted for, shows the behavioral validity of the experiment (sensu Handberg and Angelsen 2015). Our results are relevant not just for shifting cultivation communities, but wherever incentive programs target rural resource users. Simple incentives that players understand (unlike insurance) and intragroup dependence appear to promote success, particularly when they encourage communication among participants. These findings show that swidden communities are capable partners in incentive programs encouraging land use sustainability through collective decision making, and emphasize the importance of long-term strategies to support incentive programs if policy goals are to be reached. Games can provide initial motivation for policy design, serve as a final test bed before policies are implemented, or help participants understand newly implemented programs. Recent appointments of behavioral scientists to high-level government positions in the United States and the United Kingdom (Kahneman 2013) demonstrate a growing thirst among policy makers for insights like those our study provides.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Supplementary Material

This material is available as part of the online article from:

http://www.blackwell-synergy.com/doi/full/10.1111/j.1755–263X.2008.00002.x

(This link will take you to the article abstract).

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