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Unraveling the effects of payments for ecosystem services on motivations for collective action

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ABSTRACT

This paper addresses the differential impacts on decisions towards collective action in the context of payments for ecosystem services (PES) where individual and collective rewards are conditional on a minimum collective conservation level being achieved. Interactions between the different reward types, farmers' social preferences, social ties and communication are identified. A field game experiment is conducted with Andean farmers in Peru and framed around their decisions to conserve agrobiodiversity as an impure public good. The main results are that PES schemes could be effective in motivating collective action for agrobiodiversity conservation and that individual rewards are likely to be more effective and less sensitive to social factors than collective rewards. The latter might have a positive effect on conservation when they are shared within socially closely-related groups or in situations where communication and deliberation about collective action are possible.

1. Introduction

Payment for Ecosystem Services (PES) schemes have been implemented across a wide range of contexts and countries (Wunder et al., 2008; Landell-Mills and Porras, 2002; Ferraro and Kiss, 2002). A large body of evidence has consequently developed around issues related to the design of effective PES schemes, including in the context of the management of common pool resources and with regard to the reward systems used.[1]

In assessing PES effectiveness, it is necessary to account for contexts where individuals cooperate voluntarily or engage in collective action (Ostrom, 1990). Such pro-social behavior affects the baseline against which PES schemes may be judged. Altruism, inequity aversion, reciprocity and other intrinsic motivations (i.e. personal motivations that pre-exist external incentives) can affect behavior, as do social ties and social interactions (e.g. communication). Social ties have been found to increase cooperation, in particular in public good games (Peters et al., 2004; Haan et al., 2006). Communication has also been shown to be capable of supporting collective action in common pool resource and public goods problems (e.g., see: Ostrom et al., 1994; Ledyard, 1995, and Ostrom, 2000) and can also impact upon the effectiveness of external interventions (Velez et al., 2006). In the same way, intrinsic motivations can interact with external interventions. Such interactions do not always have a positive impact. Under certain circumstances, external interventions have been shown to undermine intrinsic motivations and thus either achieve their goals at high social cost or even, potentially, do more harm than good (Deci, 1971; Frey, 1994; Frey et al., 1996; Ostmann, 1998; Frey and Jegen, 2001). Yet, despite such findings, only a limited body of research has considered the potential interactions between reward systems and collective action (Vollan, 2008; Velez et al., 2006; Narloch et al., 2012).

The main aim of this paper is to compare the effectiveness of collective (i.e. proportional to the group's contribution) and individual (i.e. proportional to the individual's contribution) reward systems to

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[1] See for instance Pattanayak et al., 2010; Engel et al., 2008; Wunder, 2007; Wunder, 2005; Tacconi, 2012, Kinzig et al., 2011; Travers et al., 2011, Narloch et al., 2012.

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increase the public good provision of agricultural biodiversity conservation. Here we use the terms 'rewards' and 'payments' interchangeably as we refer to PES in a broad way (e.g., Muradian et al., 2010) and thus do not enter into the debate about semantic differences. In fact the analysis is not affected by whether the external intervention is called a payment or reward in what follows.[2]

We build on Narloch et al. (2012) to answer the following three questions: i) are collective and individual rewards equally effective in conserving biodiversity? ii) do the reward systems interact in similar ways with social preferences?; and iii) do communication and social ties affect the effectiveness of such reward systems? While Narloch et al. (2012) assessed the effectiveness of individual and collective rewards through their effect on social preferences, by exploring a modified version of their reward experiment, this paper adds to their findings the abovementioned questions. Another development from Narloch et al. (2012) is that in the present paper *all* reward types are conditional on a conservation threshold being achieved. Finally, we also consider the effects of communication and social ties.

To answer the above questions, we conducted framed field experiments with farmers who carry out de facto conservation of agricultural biodiversity, in order to study collective action dynamics when rewards are introduced. As suggested by Smith (1994), experiments are particularly well-suited to the study of the impact of institutions on individuals' decision making processes. The game is an impure public goods one with a threshold effect framed around the kind of decisions that farmers are used to making in daily life. They are required to choose between growing a commercial variety of quinoa or a traditional one, knowing that the latter brings lower private market returns, but can generate public good benefits (mainly non-marketed ecological and cultural ones) for the community subject to a minimum conservation level being reached (see Narloch et al., 2011, 2012 for a description of the different types of benefits).

The next section provides an overview of the literature regarding the way social preferences, communication and social ties may affect cooperation, as well as the potential impacts of different types of rewards (collective and individual) on collective action. Section 3 describes the study context and the design of the game, before results are presented and discussed in Section 4. Finally, the conclusions are presented in the last section.

2. Conceptual background

2.1. Intrinsic motivations, crowding in and crowding out effects

In many situations where social interactions take place, such as the management of common pool resources or the provision of public goods, individuals cooperate even though it may appear to be contrary to their individual interest (see e.g. Ostrom, 2000, and Cardenas and Carpenter, 2008). Pro-social behaviors emerge because individuals are not only driven by self-interest. Instead, intrinsic motivations, such as altruism, inequity aversion and reciprocity, can also play a role and reflect social norms (Ostrom, 2000; Bowles and Gintis, 2002; Fehr et al., 2002; Fehr and Fischbacher, 2003[3]). Yet, these intrinsic motivations are fragile and can easily be undermined by external interventions (Frey, 1994; Frey and Oberholzer-Gee, 1997; Bowles, 2008[4]). For example, monetary incentives designed for self-centered agents may prove counterproductive if individuals' true motivations incorporate a pro-social dimension. In such cases, pro-social behavior may be 'crowded out'.

Whether intervening is beneficial or not (partial or net crowding in/out of pro-social behavior), depends on the relative size of two potentially countervailing effects: i) the direct impact of the economic incentive, which, by construction, is positive, and ii) an indirect impact through its crowding effect on intrinsic motivations (Frey and Jegen, 2001), which can be either positive (crowding in) or negative (crowding out). As a result, the total effect of the reward depends on the direction and the strength of such crowding effects. If intrinsic motivations are crowded out there are two possible outcomes. On one hand, if this effect is weak and compensated by the positive direct effect of the incentive, the reward will still lead to an increase in cooperation. Under such circumstances, the external motivation provided by the reward compensates for the loss of intrinsic motivations to cooperate. On the other hand, if the crowding effect of intrinsic motivations is relatively stronger than the direct impact of the reward, the intervention will crowd out pro-social behavior.

In field experiments, a crowding out of pro-social behavior by external incentives has been observed in common pool resource games with regulation and sanctioning instruments (Ostrom et al., 1992; Cardenas, 2000; Cardenas et al., 2000; Vollan, 2008). By contrast, and despite the growing application of PES schemes for conservation (Ferraro and Kiss, 2002; Wunder et al., 2008; Wunder, 2005, 2007), the literature is scant regarding their effects on pro-social behavior (Vollan, 2008); and even fewer authors have compared the impact of different types of rewards (Narloch et al., 2012). Here we consider how different types of rewards, namely individual and collective ones, can impact the pro-social behavior of different types of individuals.

Individuals who have intrinsic motivations for conservation are likely to cooperate without knowing about the willingness to cooperate of others, i.e. they are unconditionally cooperative. These motivations include pro-environmental and pro-social ones. For instance, individuals can cooperate initially because they value the environment, as a result of altruism or because cooperation raises self-esteem or self-image through reputation building (Andreoni, 1989, 1990; Bowles and Gintis, 2002; Frey, 1994; Frey and Jegen, 2001). Frey and Stutzer (2006) have argued that such intrinsic motivations may be 'crowded-out' by an external intervention if it was felt to be controlling participants, or 'crowded-in' if the intervention was felt to be supportive. Vollan (2008) has noted that, as rewards may be seen as an acknowledgement of effort, they might be perceived as supporting instruments, and thus can have a positive effect on collective action. He tested this assumption by comparing the impact of a penalty and a reward on cooperation in a common pool resource game, both being imperfectly monitored. He found that rewards did not crowd out pro-social behavior, contrary to penalties. Similarly, Narloch et al. (2012) compared the impact of both individual and collective rewards on the conservation of agricultural biodiversity in Peru and Bolivia, and looked at their interactions with intrinsic motivations. In Bolivia, they found that the individual reward performed better on unconditional cooperators while the collective reward did not affect unconditional cooperativeness. This suggests that different kinds of rewards may impact intrinsic motivations differently. On the one hand, individual rewards may be more likely to crowd in unconditional cooperativeness than collective ones because they acknowledge the individual effort. On the other hand, both types of rewards can also decrease individuals' feelings of self-determination and impair self-esteem. Under such circumstances, rewards could crowd out unconditional cooperativeness.

Individuals' intrinsic motivations also determine whether they are conditionally cooperative (i.e. reciprocal) or not; that is, whether they cooperate more actively when they see that others are also doing so (Ostrom, 1998; Fischbacher et al., 2001; Keser and Van Winden, 2000; Bowles and Gintis, 2002). Narloch et al. (2012) found that individual rewards trigger reciprocity and can thus stabilize levels of collective action, while (against expectations) collective rewards caused free-riding.

[2] In the field, however, the framing used to present the PES to stakeholders might impact its effectiveness.

[3] For additional literature on social preferences, see for instance Andreoni (1990), Fehr and Falk (2002), Gintis et al. (2003), Fehr and Schmidt (1999, 2006), Fischbacher and Gächter (2010).

[4] For additional literature on crowding effects, see for instance: Ostmann (1998), Gneezy and Rustichini (2000), Reeson and Tisdell (2008), and the seminal work from Deci (1971).

The latter can occur as collective rewards increase the potential payoff an individual can get from the group, regardless of his/her own contribution, creating a temptation to free-ride. At the same time it can also intensify feelings of guilt/gratitude among non-cooperative recipients of a reward and thus encourage them to cooperate later on. In this case, it would create reciprocity rather than free-riding behavior. Individual rewards have the opposite effect: they increase the potential payoff an individual can get from his/her own contribution, regardless of the group outcome. In this way, individual rewards may loosen rather than strengthen the ties between individuals' payoffs and group outcomes. This in turn could decrease reciprocity because of a guilt-relief effect (Rodriguez-Sickert et al., 2008; Ketelaar and Tung Au, 2003). But, as showed by Narloch et al. (2012), it can also stabilize collective action by decreasing free-riding incentives.

2.2. Social ties

Social ties also affect people's willingness to cooperate to produce public goods and conserve resources.

For instance, people might trust each other more (Vollan, 2011), be more altruistic (Leider et al., 2009; Branas-Garza et al., 2012) and care more about their reputation in socially close groups such as those where kinship relationships are strong. In such contexts, individuals might be more cooperative (Peters et al., 2004; Haan et al., 2006). By shaping social norms and motivations, social ties can also influence the success or failure of an external policy. Vollan (2008) showed, for instance, that sanctions aiming at reducing grazing pressure on common lands are less effective in areas where trust is initially high. In these contexts, the introduction of an individual or collective reward can raise expectations about the pro-social behavior of others, thereby increasing cooperation. By contrast in contexts where trust levels are low, collective rewards might increase individuals' expectations of free-riding, thereby preventing cooperative behavior. Kerr et al. (2012), for instance, showed that participation in a group payment scheme in Mexico was lower where people distrust leaders. In contexts of low trust, individual rewards, on the contrary, might ease this fear of free-riding and lead to more cooperation. In addition, people might care more about their image when they interact in socially close groups. Hence, external policies which help individuals to convey a good image of themselves are likely to perform better in these groups. This is the case of collective rewards, which enable individuals to 'vote with their feet' regarding their willingness to work for the benefit of the community. Individual rewards, by contrast, do not provide the same potential to build such a good reputation, as the existence of the reward can cast doubt about the true motives of the individuals involved.

It can therefore be expected that the strength of the social ties of the group members influences the effectiveness of the rewards. In particular, it may be expected that collective rewards can perform better in socially closer groups.

2.3. Communication

In real-life situations, farmers make their decisions where they can communicate with each other (Cardenas and Ostrom, 2004; Prediger et al., 2011; Hayo and Vollan, 2012). As previously noted, strong social ties (e.g. family ties) tend to favor cooperation. The ability to effectively communicate with peers can also impact decisions about cooperation. An important body of literature shows that allowing participants to cheap talk (i.e. talking without binding commitment) can lead to higher levels of cooperation in public goods and common pool resources dilemmas (see Ledyard, 1995; Ostrom et al., 1994 and Ostrom, 2006 for surveys of the literature on this subject).[5] Nevertheless, despite Vollan (2008) noting that it would be interesting to explore how external rules interact with communication, relatively few papers have in fact focused on the interactions between communication and rewards. Velez et al. (2006) studied the effect of combining an external penalty with communication but they found no strong complementarities between penalty and communication. Travers et al. (2011) introduced both the possibility to communicate and external sanctions or rewards at the same time. They found a high level of cooperation when both communication and external instruments were introduced. However, they studied neither the impact of communication alone, nor the effect of rewards alone, so that conclusions regarding the complementarities between communication and rewards cannot be derived from this study. Communication could nevertheless potentially improve the effectiveness of rewards by helping individuals to coordinate on a collective outcome or by increasing trust between individuals. This is particularly true in the case of collective rewards, in which individual payoffs depend strongly on the decisions of others.

Table 1 summarizes some of the key theoretical and empirical findings about the interactions between types of reward incentives and determinants of cooperation, including unconditional and conditional cooperativeness, communication and social ties. The potential impacts of different reward incentives are sensitive to the socio-ecological context in which they are implemented, calling for additional empirical studies.

3. Design of the experiment

3.1. Case study

We conducted a field experiment in farming communities on the Andean *Altiplano* (Highplains) in Peru in September 2012. This experiment was framed around issues related to the conservation of agrobiodiversity and, consequently, around farmers' decisions to cultivate either traditional or commercial crop varieties. Both in the Andes and globally, crop and livestock genetic resources are threatened (FAO, 2007, 2010) despite the fact that agrobiodiversity conservation and use can generate significant tangible private (e.g. production outputs) and socio-environmental (e.g. maintenance of evolutionary processes, landscape level resilience, traditional knowledge and cultural practices) benefits (Narloch et al., 2011; Smale et al., 2004). Within the context of the field experiment, the private net benefits arising from the cultivation of a traditional crop variety are assumed to be smaller than the benefits that would arise from cultivating a commercial variety. The private value that can be captured is directly linked to the farmer's own cultivation decisions and does not depend on the actions of other farmers. The generation of public benefits, however, depends on critical thresholds being reached, for example, in accordance with ensuring the conservation of a safe minimum population (Drucker, 2006).

In the Northern Altiplano, around Lake Titicaca, farming systems still have a predominantly subsistence-orientation. Farmers normally follow a multi-crop rotation system, alternating between potatoes, quinoa, cereals and fallow periods of one to two years. Each year, farmers decide which crop to cultivate based on this rotation scheme but also which crop variety to sow for each of the crops. With regard to quinoa, farmers make a choice between growing traditional landraces versus commercially improved varieties obtained through selection by national agricultural research agencies such as the Peruvian National Institute for Agricultural Innovation (INIA).

Over the past decade, the consumption of quinoa has grown significantly in the USA and the EU. Exports of quinoa from Peru, Bolivia, Ecuador and Chile, together with prices have increased sharply. For instance, between 2000 and 2010, Peruvian prices increased from around US$ 300/ton to almost US$ 1200/ton (FAOSTAT). Improved varieties are generally easier to sell on the international market and provide higher

[5] See Cardenas (2000), Cardenas et al. (2000), Cardenas et al. (2004), Velez et al. (2006), Travers et al. (2011) and Cardenas et al. (2011) for more recent studies on the effect of communication.

Table 1
Overview of studies and findings related to interactions between reward types and determinants of cooperation.

Determinants of cooperation	Individual reward	Collective reward	References
Unconditional cooperativeness	(+): Crowding in: acknowledge the individual effort /(−) Crowding out: impair self-esteem and self-determination	(+): Crowding in: acknowledge the collective effort /(−) Impair self-esteem and self-determination	Frey and Stutzer (2006), Vollan (2008), Narloch et al. (2012)
Conditional cooperativeness	(+) Decrease the incentive to free-ride (−) Decrease reciprocity through a guilt-relief effect	(+) Increase reciprocity (through a guilt-intensifying effect) (−) Increase incentive for free-riding	Ketelaar and Tung Au (2003), Rodriguez-Sickert et al. (2008), Narloch et al. (2012),
Communication	(+) Positive effect of communication on the reward's effectiveness (increase trust and facilitate coordination)		Ledyard (1995), Ostrom (2006), Velez et al. (2006)
Social ties	No effect of social ties on the rewards' effectiveness	(+) Positive effect of social ties on the reward's effectiveness (higher trust level)	Peters et al. (2004), Haan et al. (2006), Vollan (2011)

margins than the majority of traditional varieties. As a consequence, many farmers on the Altiplano are shifting from growing traditional quinoa varieties to growing commercial ones, thereby potentially jeopardizing the continued survival of many landraces through displacement. Three varieties of quinoa make up 75% of total exports (Astudillo, 2007).

In total, the experiment was run in nine farming communities in the province of Puno (the same province as in Narloch et al. (2012)). Five communities were located in the ethnic Aymara region (south of the lake) while the other four were located in the Quechua region (north of the lake). Only participants from communities that had not participated in the earlier round of games in 2010, as per Narloch et al. (2012), were selected in order to avoid potential biases due to the relatively short recall period between the two rounds of games in the area (2010 and 2012).

In these communities, as in much of the Andean Altiplano, there are a number of labor exchange and crop choice-related collective action institutions. For example, *faina* involves each inhabitant of the village having to undertake a share of work for the community, such as helping to build a school. On *aynoka* collective lands, the community as a whole decides about which crops will be planted. Farmers are nonetheless assigned individual plots, can select the crop variety to be planted and benefit privately from its cultivation.

3.2. The game

3.2.1. Experimental design

We adapt the experimental game by Narloch et al. (2012). In this game, each participant forms part of a group of $n = 4$ players and disposes of four units of land. Over 12 rounds (t), participants decide on how many of these four land units X_T to allocate to the conservation of a traditional but threatened variety (landrace) T or to a commercial variety C (X_C). The experiment is divided into two parts. All farmers play a baseline game for six rounds, followed by one of four different treatments for six additional rounds.[6]

3.2.1.1. Baseline game (rounds 1–6). Private returns for the traditional variety P_T are lower than for the commercial variety P_C. Yet, the cultivation of T is associated with public conservation benefits per land unit B_T that accrue equally to every group member once the total number of land units allocated to the conservation of the traditional variety in a group reaches a certain threshold θ. It is assumed that below θ, not enough of the traditional variety is being cultivated in order to generate these benefits. Each participant i thus has the following payoff function in round t, which depends on both their individual conservation level (X_{Tit}) and the aggregate conservation level of their group ($\sum_k X_{Tkt}$):

$$\pi_{it} = \begin{cases} P_C\ X_{Cit} + P_T\ X_{Tit} + B_T\left(\sum_k X_{Tkt}\right) & if\ \sum_k X_{Tkt} \geq \theta \\ P_C\ X_{Cit} + P_T\ X_{Tit} & otherwise \end{cases}. \tag{1a}$$

The parameters are set as follows: the payoff for each land unit cultivated with the commercial variety is $P_C = 12$ points; the payoff for each land unit cultivated with the traditional variety is $P_T = 2 < P_C$; public benefits are set to $B_T = 4$ points; and the threshold θ is reached when the traditional variety is cultivated on at least seven land plots by the farmer group. This translates into the following payoff function:

$$\pi_{it} = \begin{cases} 12\ X_{Cit} + 2\ X_{Tit} + 4\left(\sum_k X_{Tkt}\right) & if\ \sum_k X_{Tkt} \geq 7 \\ 12\ X_{Cit} + 2\ X_{Tit} & otherwise \end{cases}. \tag{1b}$$

It is apparent that choosing the traditional variety instead of the commercial one represents a direct cost to any farmer of $10\ (= 12-2)$ points per land unit while the public benefits of cultivating landraces are uncertain since they depend on the decisions of the other members of the group.

3.2.1.2. Treatment (rounds 7–12). We designed four treatments to investigate the impact of rewards and communication. In particular, two treatments were specifically designed to look at the impact of two types of rewards for agrobiodiversity conservation: a collective reward, which is proportional to the aggregate conservation level, and an individual reward, which is proportional to the individual conservation level. Each farmer played one of the four treatments after playing the baseline.

The first treatment is a 'communication treatment' where farmers play the same game as before but have the possibility, at the beginning of each round, to discuss their strategies within their group before making their individual decisions.

The second treatment involves the introduction of a collective reward for growing the landrace T. As, in this context, the aim of rewards is to encourage the provision of certain agrobiodiversity related public goods which depend on a minimum threshold of conservation being reached (Drucker, 2006; Narloch et al., 2012), it is given only if the group allocate at least $\theta = 7$ units of land to the landrace. Under this collective reward scheme, each farmer receives a payment CR_{it} which is proportional to the area allocated to the traditional variety in the group:

$$CR_{it} = \begin{cases} R\left(\sum_k X_{Tkt}\right) & if\ \sum_k X_{Tkt} \geq \theta \\ 0 & otherwise \end{cases}. \tag{2a}$$

[6] The instructions of the experiment are available upon request.

R is set to be equal to 1, so each farmer faces the following payoff function:

$$\pi_{it} = \begin{cases} 12\ X_{Cit} + 2\ X_{Tit} + 5\left(\sum_k X_{Tkt}\right) & \text{if } \sum_k X_{Tkt} \geq 7 \\ 12\ X_{Cit} + 2\ X_{Tit} & \text{otherwise} \end{cases} \tag{2b}$$

where the reward obtained by the farmer is added to the payoff when the collective threshold is reached.

In the third treatment, players have the possibility to communicate with other members of their group prior to making their decisions and are offered a collective reward. This treatment represents a combination of the first and second treatments.

Finally, in the fourth treatment, an individual reward (IR) is introduced. It is also offered to farmers for cultivating the landrace only if the group collectively reaches the threshold (θ), but in this case, each farmer receives a payment IR_{it} that is proportional to his individual conservation level:

$$IR_{it} = \begin{cases} r * X_{Tit} & \text{if } \sum_k X_{Tkt} \geq \theta \\ 0 & \text{otherwise} \end{cases} \tag{3a}$$

with the individual reward set at $r = 4$, each farmer has the following payoff function (3b):

$$\pi_{it} = \begin{cases} 12\,X_{Cit} + 2\,X_{Tit} + 4\left(\sum_k X_{Tkt}\right) + 4X_{Tit} & \text{if } \sum_k X_{Tkt} \geq 7 \\ 12\,X_{Cit} + 2\,X_{Tit} & \text{otherwise} \end{cases} \tag{3b}$$

with $r = 4$ and $R = 1$, the individual and the collective reward are equivalent cost-wise in terms of total conservation cost for the social planner. If the group does not reach the threshold, the reward is not offered so there is no conservation cost, but if the group reaches the threshold the cost of the individual reward is equal to the cost of the collective reward (c.f. Eq. (4)).

$$Cost_{IR,t} = 4\left(\sum_k X_{Tkt}\right) = Cost_{CR,t}. \tag{4}$$

In contrast to the design by Narloch et al. (2012), under this individual reward treatment, farmers receive the payment *only* if the group reaches the conservation threshold. Hence, farmers cannot a priori know whether they will receive such a reward, so a degree of uncertainty is introduced. In the case of the collective reward, we follow the design by Narloch et al. (2012) and thus also share the uncertainty/conditionality element with their experiment. Consequently, the differences that could be observed regarding the effectiveness of the different reward types explored by Narloch et al. (2012) could partially result from this existence of different levels of uncertainty associated with individual vs. collective rewards. We correct for this issue, thus adding more comparability between the effects of individual versus collective-type rewards. Insofar as the allocation of land units to the traditional variety by a group of farmers so as to generate a mix of private and public benefits for the group as a whole may be interpreted as collective action, here, in contrast to Narloch et al. (2012), the individual reward is also designed to motivate collective action.

3.2.2. Theoretical considerations

A summary of the set of best private strategies and Nash equilibria in each game is shown in Appendix A. The social optimum i.e., where the group's total benefits would be maximized, is reached when all the group members allocate all their land units towards the traditional variety. By contrast, as the private benefits from the commercial variety are higher, participants' best private strategy is generally not to allocate any land units at all to the traditional variety and to instead free-ride on others in order to earn the collective benefits, B_T. Nonetheless, since significant public benefits are generated only once the threshold is reached, situations may arise in which the best private strategy is to allocate a sufficient land area to the traditional variety so as to ensure that the group reaches the threshold, i.e., $\sum X_{Tkt} = 7$. However, this happens only when farmers expect the others to allocate between 3 and 6 land plots to the traditional variety. As a consequence two types of Nash equilibria arise. The first is the free-riding Nash equilibrium where nobody in the group allocates any land units to the traditional variety. The second is the "cooperative" Nash equilibrium, where the total group contribution reaches the threshold of seven land units.[7] In the baseline game, the best private strategies are to allocate zero, one or two land units to the traditional variety, depending on what farmers expect the others in the group will do. Under the collective reward setting, conserving three land units becomes a best strategy if it is expected that the rest of the group conserves four units of land. Under the individual reward setting, conserving four land units also becomes a best strategy when farmers expect the rest of the group to conserve three units of land.

The social optimum, where all farmers allocate four units of land to the traditional variety, is never a Nash equilibrium, even under the possibility of receiving a reward. Indeed, if a farmer expects his group peers to conserve 12 units of land, his/her best strategy is to grow only the commercial variety. As a result, neither type of reward (individual or collective) provides by itself the necessary incentive to achieve the social optimum. Consequently, our analysis focuses on the effectiveness (i.e. additionality) of the rewards rather than on their efficiency (i.e. capacity to lead to the social optimum). Rewards are thus considered to be effective if they significantly increase conservation levels compared to the baseline game.

With regard to the experimental design and the comparability between the two types of rewards, there is an a priori expectation that they are both capable of increasing conservation levels as they both extend the set of best strategies to include more cooperative ones. Yet in order to ensure that the two types of rewards would be comparable in terms of the conservation costs faced by a decision-maker/social planner, the individual rewards need to be designed in such a way that they are expected to be slightly more effective than the collective reward. Specifically, in the case where farmers expect the rest of the group to conserve three units of land, their best strategy is to conserve four land units under the individual reward but zero land units under the collective reward. This is the only case which differs between the two different types of rewards. Hence, we do not directly compare the effectiveness of both rewards but rather analyze them separately, i.e. by considering whether both rewards increase agro-biodiversity conservation as expected.

Table 2
Treatment characteristics.

Part 1 (rounds 1–6): Baseline game	Part 2 (rounds 7–12): Treatment game
All farmers (176 participants):	Communication only (40 participants)
No communication	Collective reward only (40 participants)
No reward	Communication + collective reward (56 participants[a])
	Individual reward only (40 participants)

[a] Corresponding to the 40 subjects of the sessions with communication and the collective reward plus the 16 subjects from the first session.

[7] However note that not all cases where the group contribution is equal to seven are in fact Nash equilibria. For instance, in the baseline game, if a player expects his peers to conserve three units of land, assigning four units of land to the traditional variety is not the best private strategy, even if it would allow the group to receive the public benefits.

Table 3
Experimental field game participant variables and characteristics.

Variable	Description	Average	Standard deviation	Minimum	Maximum
Fem	1 if participant is a woman, 0 if a man	0.61	–	0	1
Age	Age of the participant	45	14	18	85
Higher_ed	1 if the participant went to secondary school, 0 otherwise	0.57	–	0	1
Kg_quinoa	Kg of quinoa sold during the previous season	148	248	0	2070
Agri_orga	1 if the participant is part of a farming organization, 0 otherwise	0.46	–	0	1
Area_cons	Area cultivated under a quinoa landrace in previous season (hectares)	0.12	0.27	0	1.5
Family	Number or group members belonging to the same family	0.59	0.84	0	3
Neighbor	Number of group peers who live close to the farmer	0.60	0.89	0	3
Co-worker	Number of group peers who collaborate with the farmer	0.23	0.62	0	3

3.2.3. Experimental setting

Nine experimental field game sessions were implemented in September 2012.[8] They were run with "paper and pen", and four assistants watched, explained and answered participants' questions. To facilitate farmers' decision-making process as far as possible, payoff tables were distributed (c.f. Appendix B) and the game description included carefully chosen examples. These examples, as well as the main features of the game, were summarized on posters and put up on the walls, so that farmers could refer to them whenever needed. To further guarantee their understanding of the game, farmers played the baseline game for two practice rounds before the beginning of the experiment. Their decisions during these two rounds were not taken into account in the calculation of final winnings. After these two rounds they were informed that, from this point onwards, their decisions would affect the size of the winnings they would receive at the end of the game. These winnings included a show-up fee of 10 Peruvian Nuevo Sols (PEN) as well as a variable part which was calculated as follows: after both the baseline and the treatment, one round was drawn out of the six rounds played and farmers received 10 cents for each point collected in each of these two rounds. Final earnings were thus between 12 and 30 PEN, with an average around 21 PEN, which corresponds approximately to a daily wage in the area. Finally, farmers did not have to write anything but numbers on their decision sheets, so that even those with writing difficulties could participate. The minimum requirement for participants was to know how to count up to four and how to add and multiply small amounts.

Each session was organized with between 16 and 20 farmers from the same communities. In total, 176 farmers took part in the field experiment. Table 2 summarizes the games played and describes the numbers of groups and participants for each of the four treatments.

The composition of the different groups was determined randomly at the beginning of each session and remained the same during the entire experiment. Following Cardenas et al. (2000), farmers sat together in their groups in order to facilitate communication when cheap talk was allowed. As a result, they knew who the other members of their group were. This setting is therefore closer to a real collective reward situation in which people know with whom they are going to share the reward.[9] After each round, farmers were informed about their payoffs and the aggregated conservation effort undertaken by their group peers. The setting of this experiment thus differs from that of Narloch et al. (2012) in that participants in this experiment could tell who their group peers were, as well as the group's land use decisions.[10] We did not, however, reveal information about individual conservation levels in order to keep the information and the complexity of the payoff sheets as simple as possible. Nevertheless, in the groups with communication, members could decide whether to exchange information about their individual conservation levels, as is likely to occur in real-life situations where group payments depend on individual contributions.

Table 3 characterizes the game participants based on a post-game survey. As group membership was randomly assigned, some farmers may have been in the same group as some of their family, neighbors or co-workers. To control for this possibility, information on social distance was gathered by ascertaining the number of group peers who were part of the farmer's extended family[11] (*Family*), the number of geographically close group members (*Neighbor*) and the number of group members with whom they collaborated frequently (*Co-worker*).

One week after the last session of the experiment, two focus group meetings were conducted with some of the participants, one in the Quechua region and one in the Aymara region, to complement the information from the experiment with qualitative information regarding the effects of rewards and communications. The main results from these focus group meetings are discussed in the next section.

4. Results and discussion

4.1. Collective conservation levels

The average group conservation level during the baseline game (first six rounds) and the following six rounds associated with the different treatments is shown in Fig. 1.

On average, group contributions in the initial round were close to the threshold. About 23% of participants chose to dedicate three or four units of land to the traditional variety in this initial round, even though it was not one of the best possible strategies; hence almost one quarter of the farmers did not behave as *homo-economicus*. A Kruskal–Wallis test to compare group contributions in the baseline game suggests that farmers' decisions are correlated with the community from which they come from (p-value = 0.0001), thus indicating that some community-effects may exist.

A comparison between the conservation levels achieved by the groups in the baseline and treatment rounds generates some preliminary findings about the potential roles of rewards and communication. Wilcoxon signed rank tests are also used to analyze the significance of these impacts, that is, to compare conservation levels before and after the introduction of each treatment. In particular, conservation levels between the baseline and treatment rounds are compared, as well as

[8] A first session was run to verify that the most complicated treatment (the one with the collective reward and communication) would be understood by farmers. It also served to check if farmers would be able to concentrate sufficiently throughout the entire experiment. This session was carried out with 16 subjects, one week before the other sessions. The eight other sessions were then conducted with 20 farmers. Since no change was made in the design of the experiment following the first session, and the results did not differ significantly from the later sessions with communication and collective rewards (Mann–Whitney test, p-value = 0.4276), we combined all the data into a single global dataset.

[9] When the farmers were making their actual decisions regarding land unit allocation they were obliged to be sitting with their backs to their group members so that they could not communicate any further or see each other's decisions.

[10] In Narloch et al. (2012), farmers received information regarding the individual levels of conservation, but only on an anonymous basis.

[11] Here, "family" is considered to include parents, children, siblings, grand-parents, grand-children, uncles, aunts, nephews, nieces and/or cousins.

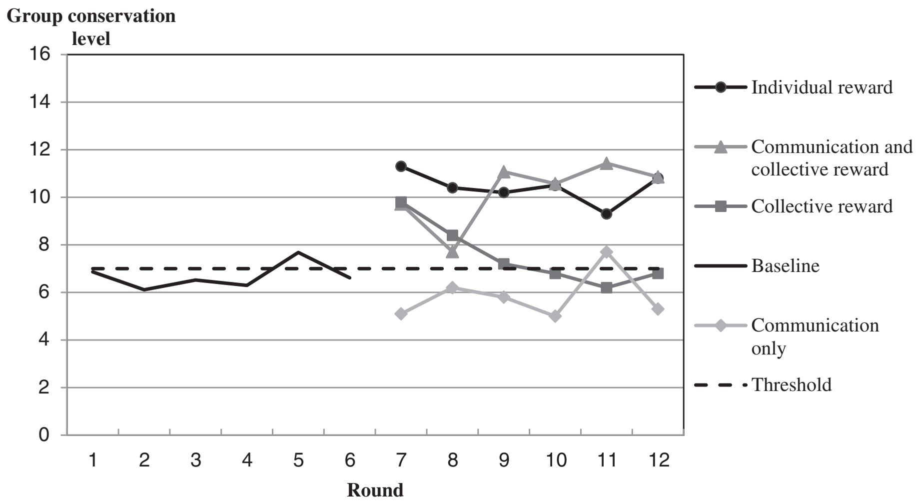

Fig. 1. Average group conservation level during the baseline (rounds 1 to 6) and under each treatment (rounds 7 to12).

conservation levels in rounds 6 and 7.[12] The results of the tests, as well as the average group conservation levels, appear in Table 4.

As can be seen in Fig. 1, when only communication is introduced, contributions decrease immediately (between rounds six and seven) and stay below the threshold in subsequent rounds. The Wilcoxon test confirms the lack of a positive effect of communication by itself. When a collective reward is introduced, contributions increase immediately but then decrease and stabilize below the threshold. The collective reward appears to be able to increase cooperation significantly but this effect does not seem to be robust in the longer run. Indeed, when conservation levels are compared between rounds 4–6 and 10–12 we find no statistically significant difference in conservation levels (Wilcoxon sign rank, p-value = 0.83). By contrast, contributions increase significantly and immediately following the introduction of an individual reward and stabilize above the threshold in subsequent rounds. This preliminary finding suggests that on average, conditional individual rewards might be more effective than conditional collective ones with regard to fostering collective action towards agrobiodiversity conservation in the case study area. Yet it should be noted that with the introduction of both a collective reward and the possibility to communicate among group members, the total contribution of the group also increases significantly and stabilizes above the threshold in subsequent rounds. This suggests that, in deliberative social settings, a collective reward may be capable of reinforcing collective action, leading to long-run increases in the group's conservation efforts.

While these results provide a first approximation of the average impact of rewards on collective action, they do not yet allow us to understand how the rewards interact with communication and farmers' intrinsic motivations. An econometric analysis is carried out for this purpose, the results of which are presented next.

4.2. Determinants of collective action

We analyze individual conservation dynamics using an econometric analysis. The dependent variable is the individual contribution, that is, the number of land units (zero to four) farmers allocate to the traditional quinoa variety or landrace in any given round *t*. We estimate two ordered logistic models to take advantage of the panel structure of the data. To control for heterogeneity between communities and in order to allow for the possibility that farmers from the same community may be more likely to make similar decisions, we used community clusters in the regression. In both models, independent variables include socio-demographic variables (c.f. Table 3), as well as variables related to the design of the game, the actual round played and the decisions already taken in previous rounds (summarized in Table 5 below). Dummy variables are used to test the effect of communication and the use of rewards; *Coll_Rew* and *Ind_Rew* refer to collective and individual rewards, respectively. Accounting for the number of the round played allows us to control for an eventual learning effect.

Regarding social preferences, we drew on Narloch et al. (2012) and introduced three different variables. They are associated with unconditional cooperation, conditional cooperation and a threshold effect.

The first variable relates to the level of conservation undertaken by a participant in the first round *(contrib_1)*. Game participants who allocate more land to conservation in the first round demonstrate a willingness to cooperate despite not knowing the willingness to cooperate of their group peers, i.e. they are unconditionally cooperative (as in Narloch et al., 2012 and Reichhuber et al., 2009). Given that farmers, in particular subsistence ones, have been shown to be rather risk averse it is unlikely that they will be willing to risk the equivalent of a daily wage unless they have strong motives to do so, in particular pro-environmental and pro-social intrinsic motivations. The variable *contrib_1* can thus be used as a proxy for these motivations and help us to understand how different types of rewards impact farmers according to the strength of their intrinsic motivations.

The second variable measures the level of conservation carried out by other participants in the group in the previous period *(p_contrib_others)* and can be used to indicate the degree to which participants are influenced by their peers' decisions. It may be used to check for conditional cooperative behavior (Fischbacher et al., 2001; Fischbacher and Gächter, 2010). Whereas a negative coefficient would indicate that free-riding prevails, a positive one would indicate more reciprocity (or retaliation).

With regard to the third variable, as explained above, collective action decisions may depend crucially on the threshold beyond which positive external benefits and rewards are obtained. In particular, we hypothesize that reaching the conservation threshold in the previous period might influence current decisions and have a stabilizing effect. A dummy variable, *p_threshold*, to control for this effect is thus also included in the model.[13] Finally a variable *round* was used to distinguish

[12] We also compared conservation levels in rounds 4 to 6 to those in rounds 7 to 9 and in rounds 10 to 12. The results confirm those already presented and so are not included here. However, they are available from the authors upon request.

[13] Reaching the threshold is linked to the contribution of the group peers. Introducing the threshold variable therefore allows us to isolate more accurately conditional cooperativeness. Without this variable, conditional cooperativeness could be confused with whether or not the threshold has been reached in the previous round.

Table 4
Average group conservation level in rounds 1–6 and 7–12, differentiated by treatment group.

Treatment group	Average group conservation level in baseline rounds 1–6	Change between baseline and treatment rounds 7–12	Average group conservation level in round 6	Change between rounds 6 and 7
1. Communication only	5.72	+0.13	5.30	−0.2
2. Collective reward	6.17	+1.36**	6.70	+3.1*
3. Communication and collective reward	7.70	+2.55***	7.29	+2.42
4. Individual reward	6.67	+3.75***	6.90	+4.4***
Average	6.67		6.61	

* Statistical significance levels at 10% (*), 5% (**) and 1% levels (***).

the effect of treatments from an eventual learning effect throughout the game.

In the first model, interaction terms are also introduced to analyze the interactions between the different types of conditional rewards (*ind_rew* or individual rewards, and *coll_rew* or collective rewards), the possibility for communication and participants' intrinsic motivations; as well as to analyze the interactions between rewards and social ties. This model thus enables us to disentangle the direct and indirect effect of each of the treatments. The total effect, by contrast, was obtained by carrying out a second regression without interaction terms between treatment and social preferences variables. The results of both models appear in Table 6. For interpretation purposes, it should be noted that the coefficients of an ordered logistic regression cannot be interpreted in the same way as the ones obtained through a standard OLS regression. The former do not represent the expected increase in the dependent variable when an independent one increases by one unit, but rather the expected increase in the log-odds (and therefore probabilities) of an increase in the dependent variable. In what follows, we will refer to model 1 as the "interaction model" and to model 2 as the "basic model".

The results shown in Table 6 indicate that socio-demographic control variables only explain contributions to a limited extent. Age has a small negative effect on farmers' efforts to conserve the traditional variety. Some previous findings have shown that older individuals can be more risk averse than young ones (Pålsson, 1996). Older farmers might therefore prefer the commercial variety because of the strategic uncertainty attached to the traditional one. By contrast, those farmers who sold larger volumes of quinoa in the previous year are more likely to contribute more to the collective effort towards conserving traditional quinoa varieties. The role of social distance, i.e., being in a group which includes family members, neighbors or co-workers was shown not to affect individual contributions, contrary to previous findings from Peters et al. (2004).

Interestingly, communication appears to have a small direct positive impact on cooperation in the basic model. Despite the small size of this effect, this result concurs with studies which suggest that communication can foster cooperation in public good games and common pool resource dilemmas (e.g., Ostrom et al., 1992). While experimental and behavioral economists offer several reasons why communication should foster cooperation (Velez et al., 2006, Cardenas et al., 2004; Shankar and Pavitt, 2002), including through coordination improvement and trust enhancement, Ostrom (1998) pointed out that, when monitoring individual contributions becomes difficult, communication can become less effective. Under the current experimental design, farmers had the possibility to not reveal their decisions and might consequently have seized on this opportunity to free-ride while convincing others to cooperate. The focus group discussions confirm this hypothesis, as farmers said they sometimes agreed on an action plan with their peers but that not all of them subsequently kept to the plan.

Turning to the role of social preferences, as expected, the individual level of conservation in the first round appears to drive conservation in the following rounds to a large extent. That is, those who conserve more in the first round tend to conserve more during the entire baseline, regardless of the decisions of their peers. It suggests that they have

Table 5
Description of the variables related to the design of the game and decisions already taken in previous rounds.

Variable	Description
Communication	=1 if players can communicate, 0 otherwise
Coll_rew	=1 if players receive the collective reward, 0 otherwise
Ind_rew	=1 if players receive the individual reward, 0 otherwise
Contrib_1	Contribution of the subject in the first round of the game
P_contrib_others	Contribution of the group peers during the previous round
P_threshold	=1 if the group reached the threshold in the previous round and 0 otherwise
Round	Round number (1 to 12)

Table 6
Ordered logistic model estimations of individual conservation level in rounds t = 2–12.

Model	Model 1 (interaction model)		Model 2 (basic model)	
	Coefficient	p-value	Coefficient	p-value
Social preferences				
Contrib_1	0.3493***	0.000	0.1783***	0.008
P_contrib_others	0.0691	0.270	0.0442	0.285
P_threshold	0.1569	0.589	0.2006	0.345
Social ties				
Family	−0.0816	0.255	0.0360	0.651
Neighbor	−0.0152	0.827	−0.0137	0.861
Co-worker	0.0751	0.279	0.1021	0.192
Treatment variables and interactions				
Communication	0.5434*	0.080	−0.1922	0.503
Contrib._1 ∗ communication	−0.1515**	0.023	–	–
P_contrib_others ∗ communication	−0.1587	0.189	–	–
P_threshold ∗ communication	0.3693	0.492	–	–
Family ∗ communication	−0.0393	0.868	–	–
Coll_rew	−0.0270	0.960	0.2497	0.329
Contrib._1 ∗ *coll_rew*	−0.2254***	0.000	–	–
P_contrib_others ∗ *coll_rew*	0.0664	0.545	–	–
P_threshold ∗ *coll_rew*	−0.2301	0.630	–	–
Fam ∗ *coll_rew*	0.4320**	0.035	–	–
Communication ∗ *coll_rew*	1.4746***	0.001	0.9633***	0.000
Ind_rew	2.4694***	0.000	1.0985***	0.000
Contrib._1 ∗ *ind_rew*	−0.4626***	0.000	–	–
P_contrib_others ∗ *ind_rew*	−0.0196	0.751	–	–
P_threshold ∗ *ind_rew*	−0.7094**	0.015	–	–
Fam ∗ *ind_rew*	−0.0574	0.849	–	–
Control variables				
Fem	0.0288	0.778	0.0377	0.711
Age	−0.0104***	0.006	−0.0098***	0.004
Higher_ed	−0.1919	0.215	−0.1781	0.256
Kg_quinoa	0.0007***	0.000	0.0008***	0.000
Area_cons	0.0370	0.784	0.0439	0.763
Agri_orga	0.2689	0.141	0.1990	0.205
Round	0.0340	0.404	0.0171	0.635
Log likelihood	−2887.0228		−2909.522	
Number of observations	1936		1936	

* Statistical significance levels at 10%; ** Statistical significance levels at 5%; *** Statistical significance levels at 1%.

motivations for conservation which are independent of their beliefs about the cooperativeness of others, as they continue to allocate land to conservation even after observing the non-cooperative behavior of other farmers in their group. In particular, the former might be motivated to cooperate as a result of the value they place on tradition and crop diversity, because it gives them high self-esteem or because it allows them to build a good reputation in the community. It can also be observed that the level of contribution of the group peers during the previous round has no statistically significant effect on individual conservation decisions, implying that neither free-riding nor reciprocity prevails. Similarly, reaching the threshold during the previous period was shown to have no direct statistically significant impact on conservation.

We are now in a position where we can explore our three main questions, namely: i) are collective and individual rewards equally effective in maintaining the environmental service in question?; ii) do the reward systems interact in similar ways with social preferences?; and iii) do communication and social ties affect the effectiveness of such reward systems?

4.3. Interactions between rewards and communication, social ties and social preferences

Firstly, we analyze the total impact of both types of rewards on individual conservation levels. This total effect can be observed with the basic model, which permits the combination of the direct effect of the reward, that is, the economic incentive created, and the indirect effects through the interaction of the reward with social preferences. As can be seen in Table 6, individual rewards increase conservation levels significantly while collective rewards appear to have a positive effect only when social ties within the group are strong or when communication is allowed for in the group.

The indirect effect of family ties in the group indicates that farmers are more willing to increase cooperation to receive and share the collective reward among family members. When asked about the collective reward during the focus groups, farmers stated that they did not prefer it because group peers could benefit from their efforts without cooperating themselves. This may reveal insufficient trust among farmers as they think that their peers will free-ride once the collective reward is introduced. Farmers grouped within their family might trust their peers more, which could explain why collective rewards perform better in such a context. This could also explain why collective rewards perform better when participants can cheap talk. Communication might increase trust and decrease farmers' fear of free-riding, thus stabilizing collective action above the threshold when a reward is introduced, as also observed in Fig. 1. Additionally, farmers might also have stronger intrinsic motivations to generate the reward and share it with their group peers when they are from the same family. They might, for instance, care more about their family's welfare (stronger altruism) and perceptions (stronger reputation effect) than about those of others. As can be expected, no such positive impact occurs under the individual reward in such a family context, because increasing cooperation does not directly benefit other group members.

The interaction model also provides information about the way rewards interact with farmers' social preferences. Using this model's estimates, i.e. the coefficients associated with the interaction between the variable *contrib_1* and treatment variables *coll_rew* and *ind_rew*, the impact of both rewards on different types of farmers, from fully unconditionally cooperative ones to non-cooperative ones, is estimated. Results are shown in Table 7, together with the proportion of each type of participant. It can be seen that, for a fully cooperative farmer ($contrib\_1 = 4$), the odds of high conservation levels are 1.88 times greater when an individual reward is introduced. For a farmer who did not cooperate at all in the first round, the individual reward multiplies the odds of increased cooperation by 11.82; while for the average farmer, contributing 1.72 units in the first round, the odds of increased cooperation are 5.36 times higher.

Individual rewards are thus effective in increasing conservation but lose efficacy in contexts where farmers already tend to cooperate unconditionally. The corollary to this is that such rewards seem to work best in situations where unconditional cooperation is low or non-existent, suggesting that they might compensate for any lack of intrinsic motivations. No crowding out of pro-social behavior is observed as individual rewards always result in an increase in cooperation, whatever the level of unconditional cooperativeness. As explained in Section 2.1, although these rewards might undermine intrinsic motivations, they have a strong direct effect, so that their overall impact is always positive. This also suggests that, in contexts where there are strong social norms, so that farmers are likely to be more unconditionally cooperative, individual rewards will generate higher social costs and perform relatively worse than in contexts with weak social norms.

In non-family groups and when communication is not allowed, collective rewards are shown to be ineffective in increasing cooperation. Results from Table 7 show that, when they are introduced, unconditionally cooperative farmers decrease their contributions. As an illustration, the odds that a fully unconditionally cooperative farmer will increase his/her cooperation are divided by 2.50 when a collective reward is introduced. Under such circumstances, collective rewards are shown to crowd out existing pro-social behavior by undermining the role of intrinsic motivations for conservation without providing a sufficient economic incentive to compensate the loss in cooperation.

Conditional cooperativeness is often seen to affect collective action decisions (see e.g. Ostrom et al. 1999; Fehr and Gächter, 2000; Rustagi et al., 2010). If reciprocity is used to reward pro-social behavior, it can create a virtuous circle of cooperation within the group. By contrast, if it is used to punish selfish behavior, it can drive group participants into retaliation and a vicious circle that undermines cooperation. It is therefore interesting to assess the potential impact of the two different reward types on farmers' conditional cooperativeness. However, our data suggests that on average there is no statistically significant effect between the reward types on conditional cooperation. Conditional cooperators and free riders may act differently, but neither the individual nor the collective reward affects the overall level of collective action by fostering either type of behavior. Such findings are in contrast with those of Narloch et al. (2012), who found that rewards did impact conditional cooperativeness. Our contrasting results may be explained

Table 7
Effect of reward type on unconditional cooperator type.

Contrib_1	Proportion of farmers for each level of unconditional cooperativeness (%)	Multiplicative effect of the individual reward on the odds of an increase in cooperation	Multiplicative effect of the collective reward on the odds of an increase in cooperation
0	14.20	11.82	1
1	30.68	7.46	0.79
2	32.39	4.71	0.63
3	14.20	2.97	0.50
4	8.52	1.88	0.40

by differences in the experimental design related to the introduction of a collective conditionality (joint threshold) under the individual reward system and by allowing for the identity of the group peers to be known.

For the sake of comparison, we also investigate whether communication had an impact on intrinsic motivations and conditional cooperativeness. As can be seen in Table 6, communication does not seem to affect conditional cooperativeness either in our case study. By contrast, it has a differentiated impact on farmers with weak and strong intrinsic motivations to cooperate; when farmers are initially willing to contribute to the collective goal, communication has a smaller positive effect than when farmers are not prone to do it. This result suggests that farmers may reconsider the importance they attach to conservation when related decisions are made in a deliberative context.

Finally, we find a strong negative threshold effect in the case of the individual reward, suggesting that, once the threshold has been passed and individuals receive their conditional reward, they reduce their conservation levels. The reverse also holds when the threshold has not been reached previously. As a result, this prevents group conservation efforts from declining steadily over time, as is the case with the collective reward (c.f. Fig. 1).

5. Conclusions

This paper has presented a field game experiment conducted with Andean farmers in Peru to shed light on whether and how different types of PES-like reward systems and the possibility of communication may foster collective action for agricultural biodiversity conservation decisions. As for all these types of experimental field games, it can be argued that farmers' choices may not reflect how decisions are made in real life. Yet, the high level of control that can be exercised within these types of experiments allows for a focus on key behavioral aspects that may be otherwise difficult to identify and analyze in ongoing PES schemes.

We have found that conditional individual rewards might be more cost-effective than conditional collective ones in promoting agrobiodiversity conservation, as well as being less sensitive to the social environment in which they could be applied. In addition, the difference in the effectiveness observed between both types of rewards is greater to what was expected a priori, mainly because the collective reward approach failed to promote conservation in contexts where actual communication between farmers was not permitted. Additional information revealed that farmers who experimented with the collective reward treatment did not find it fair and would have preferred an individual reward system. This is an important aspect that deserves due attention. It poses the question about the link between the fairness perceptions of land users and the effectiveness of payment schemes. Where rewards are not being perceived as fair, they might not be legitimized and their effectiveness can be jeopardized (Muradian et al., 2013; Pascual et al., 2010, 2014; Narloch et al., 2011).

It is also worth noting that when individual rewards are conditional on reaching a certain level of conservation by a group, such conditionality does not seem to reduce the potential effectiveness of the reward and may even have a positive impact on collective action. This important finding suggests that, in contexts where public good benefits are generated only beyond a certain conservation threshold and collective action is required to reach such threshold, individual reward systems could be effectively harnessed to motivate the attainment of collective goals. This kind of reward could thus be particularly well-suited for biodiversity conservation as the public benefits associated with such conservation may arise only at the landscape-level once sufficient land has been conserved (Parkhurst et al., 2002).

While these results may be seen as tipping the scales in favor of the use of individual rewards compared to collective ones, caution in arriving at such a conclusion is needed given that it would first be necessary to account for transaction costs under both types of rewards and these may vary greatly depending on the context of application. Furthermore, collective payments can take various forms, and do not necessarily have to be shared in an egalitarian way. They can, for instance, be offered at a community or group level, with such groups then deciding how to distribute them among the participants of the conservation schemes.

Collective rewards might better fit some local perceptions of fairness and may also require farmers to self-organize, which may generate social benefits in contexts where social capital is currently limited (Narloch et al., 2013). We concur with Pascual et al. (2014) that more empirical evidence is therefore needed to gain knowledge of preferences and perceptions about fairness and equity prior to policy implementation. Future research could usefully focus on generating such information, as well as information regarding the nature of motivations behind conservation as was suggested by Rode et al. (2014). A combination of quantitative and qualitative methodologies (e.g. field experiments and focus groups) could be used for this purpose.

Moreover, we have observed that allowing for communication or deliberative situations can strengthen the effectiveness of collective rewards, possibly through enhancing trust. This may well suggest that, in real decision-making situations where farmers interact with each other on a regular basis, collective rewards might be more effective than suggested by previous experiments that did not account for such social interaction (e.g., Narloch et al., 2012). As noted above, communication seems to offset the trust sensitivity of collective rewards, thereby enhancing effectiveness. The corollary to this is that individual rewards being less sensitive to trust levels, would be expected to have their effectiveness less impacted by communication. However, more research is needed to explore this hypothesis further, as assessing the impact of communication on individual rewards was beyond the scope of the current experimental design.

Finally, it is worth noting that our results highlight the importance of accounting for both direct and indirect impacts in the design of conservation incentive mechanisms. It is the direct impacts that are most often discussed in the PES literature, through a focus mainly on issues related to the appropriate level of the payment and the targeting required to attain the best value for money. However, the current research has shown that the indirect effects of such payments schemes can be just as important as the direct ones. Such indirect effects prominently include the impacts on people's intrinsic motivations towards conservation and on their social preferences towards cooperation and collective action. The crowding effects of PES on such motivations and preferences are thus an area that deserves more focus in future research.

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Appendix A

Equilibrium denoted {1,2,2,2} means one player assigns one unit of land to the conservation of the traditional variety and the group peers each conserve 2 units of land. It is identical to equilibria {2,1,2,2}, {2,2,1,2} or {2,2,2,1}.

Table A
Set of best private strategies and of Nash equilibria.

	Baseline game/ communication treatment	Collective reward treatment	Individual reward treatment
Set of best private strategies	Xit ϵ {0,1,2}	Xit ϵ {0,1,2,3}	Xit ϵ {0,1,2,3,4}
Set of Nash equilibria	{0,0,0,0}; {1,2,2,2}	{0,0,0,0}; {1,2,2,2} {0,1,3,3}; {0,2,2,3}; {1,1,2,3};	{0,0,0,0}; {1,2,2,2}; {0,1,3,3}; {0,2,2,3}; {1,1,2,3}; {0,0,3,4}; {0,1,2,4}; {1,1,1,4};

Appendix B

Table B1
Payoff table in the baseline game.

	Own conservation effort (land units)				
Total conservation effort of the other group members (land units)	0	1	2	3	4
0	48	38	28	18	8
1	48	38	28	18	8
2	48	38	28	18	8
3	48	38	28	18	36
4	48	38	28	46	40
5	48	38	56	50	44
6	48	66	60	54	48
7	76	70	64	58	52
8	80	74	68	62	56
9	84	78	72	66	60
10	88	82	76	70	64
11	92	86	80	74	68
12	96	90	84	78	72

Table B2
Payoff table with the collective reward.

	Own conservation effort (land units)				
Total conservation effort of the other group members (land units)	0	1	2	3	4
0	48	38	28	18	8
1	48	38	28	18	8
2	48	38	28	18	8
3	48	38	28	18	43
4	48	38	28	53	48
5	48	38	63	58	53
6	48	73	68	63	58
7	83	78	73	68	63
8	88	83	78	73	68
9	93	88	83	78	73
10	98	93	88	83	78
11	103	98	93	88	83
12	108	103	98	93	88

Table B3
Payoff table with the individual reward.

	Own conservation effort (land units)				
Total conservation effort of the other group members (land units))	0	1	2	3	4
0	48	38	28	18	8
1	48	38	28	18	8
2	48	38	28	18	8
3	48	38	28	18	52
4	48	38	28	58	56
5	48	38	64	62	60
6	48	70	68	66	64
7	76	74	72	70	68
8	80	78	76	74	72
9	84	82	80	78	76
10	88	86	84	82	80
11	92	90	88	86	84
12	96	94	92	90	88

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