Social preferences in conservation under external rewards and the role of group heterogeneity and market orientation: Experimental evidence from the Andes

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Paper presented at the 13th Biennial Conference of the International Association for the Study of the Commons (IASC) on "Sustaining Commons: Sustaining our Future", in Hyderabad, India, 10- 14 January 2011

Abstract: External reward mechanisms may provide resource users with an incentive to cooperate in common resource dilemmas so as to conserve that what benefits wider society, such as public ecosystem services. Yet relatively little is known so far about the extent to which these formal institutions interact with existing social preferences subject to group heterogeneities and different market contexts. This paper seeks to contribute to filling this research gap, by building on an impure public goods game incorporating unequal initial resource endowments, as well as different payment modes, in the context of agrobiodiversity conservation. Field experiments were conducted with farmers in market orientated communities from Bolivia and subsistence based ones from Peru. Findings indicate that farmers from commercial orientated backgrounds tend to free-ride on one another, whereas in subsistence-based communities inequality aversion plays an important role in determining conservation levels. Further, it is found that in the latter context, where pro-social behaviour is strong, rewards from outside the community might do more harm than good by spurring free-riding behaviour. Promisingly though, in communities that have suffered from an erosion of pro-social norms, certain reward systems appear to reverse anti-social dynamics and thus may contribute to solving conservation problems. These results highlight the importance of existing social preferences in determining the effectiveness of external rewards and the social costs involved by such interventions.

Key words: *Payments for Environmental Services, Cooperation, Collective action, Public goods game, Crop diversity, Bolivia, Peru,*

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1. INTRODUCTION

Payment for Environmental Services (PES) have been praised as an effective instrument to conserve that which benefits wider society (Ferraro and Kiss 2002; Landell-Mills and Porras 2002; Wunder 2006; Pascual and Perrings 2007). In general such sort of external reward mechanisms could provide resource users with an incentive to cooperate in common resource dilemmas (CRD), i.e., when private incentives are at odds with common interests. That said, they appear to be a promising means to increase cooperative behaviour in the conservation of common resources, so as to enhance the provision of public ecosystem services. Yet it has widely been neglected that PES are embedded in social systems and thus interact with existing institutions, be it formalised community rules or rather informal and occasional patterns of collective action influenced by social preferences among community members (Corbera et al. 2007; Muradian et al. 2010).

Globally, it has been found that rural communities have created self-governing mechanisms for the sustainable management of their ecosystems (Ostrom 1990; Henrich et al. 2001; Cardenas and Carpenter 2008). In such contexts external regulatory mechanisms[1] may crowd-out existing local resource management practices built social preferences (Cardenas et al. 2000). Recently, it has been argued that PES could also replace intrinsic motivations for environmental protection and thus hamper existing conservation efforts (Clements et al. 2010; Pattanayak et al. 2010). In this case these policy interventions might not only imply an economic cost (i.e. spending money without generating additional ecosystem services), but also a social one (i.e. undermining other-regarding preferences).

Increasing individual-based economic incentives, for instance through individual-level PES, could affect existing patterns of cooperating behaviour towards the conservation of public ecosystem services. By increasing self-interest-based behaviour, they may possibly erode existing pro-social behaviour. Collective reward systems in the form of community-level PES might be more successful in enhancing cooperation to solve CRDs, as they may build on existing social preferences. The responses to such incentive mechanisms, however, may vary significantly from community to community (Velez et al. 2010), as relevant social preferences evolve given daily social and economic interactions (Ostrom 2000; Seki and Carpenter 2010). Bowles (1998) argues that social preferences are shaped in many ways by economic institutions, such as markets. Furthermore, group characteristics, such as existing heterogeneities, determine cooperative behaviour (Baland and Platteau 1999; Varughese and Ostrom 2001; Cardenas 2003). For instance, Baland and Platteau (1999) note, that inequality in access to natural resources can influence the provision of public services in ambiguous ways. Given the increasing implementation of PES schemes in the developing world, empirical analysis of the social preferences relevant for the implementation of these external mechanisms is needed. These ought to be studied in different market contexts taking into account the role of group heterogeneities, in order to provide guidance on how to design such incentive mechanisms, so that they may build upon rather than undermine existing cooperating behaviour.

[1] The literature also refers to formal institutions (vs. informal ones) or centralized resource management (vs. decentralized resource management).

The application of framed experiments in the field can shed light on behavioural dynamics by the resource users in question when confronting external institutions designed to resolve CRDs, as such experiments can incorporate real resource users' characteristics, as well as their group contexts, given different pay-off situations (Cardenas and Ostrom 2004). This paper draws on an impure public goods game[2] in the context of crop variety choices. The on-farm conservation of crop genetic diversity involves private benefits to the farmer him/herself (e.g. provision of food and income), as well as public benefits to the farming community (e.g. regulating services, as well as insurance, cultural and option values) [see Heisey et al. 1997; Smale et al. 2004; Bellon 2008], so that many farming communities build on patterns of cooperating behaviour in order to manage agrobiodiversity and complementary inputs (e.g. land) collectively (Eyzaguirre and Dennis 2007). More recently, research is emerging on the application of PES-like reward mechanisms in the context of agrobiodiversity conservation (see Narloch et al. 2009).

Field experiments have been conducted with 160 farmers from the Andean *Altiplano.* Half of them come from market orientated communities in Bolivia and the other half from subsistence-based ones in Peru. The impure public goods game does incorporate different endowment and different reward settings, so that we can test for the role of market contexts, endowment statuses and reward modes in CRDs. Doing so, this paper seeks to identify how conservation is determined by social preferences given (i) increasing market orientation, (ii) group heterogeneity, and (iii) individual as opposed to collective reward mechanisms. At the same time this paper addresses several research gaps in the literature, as there is hardly any application of field experimental research regarding the provision of impure public goods in poor farming communities[3], in particular in the form of crop genetic resource diversity, and the impact of PES like reward mechanisms[4]. Results indicate that social preferences vary with endowment status and market context and interact in different ways with external reward mechanisms, so that the latter do not necessarily lead to a higher provision of public services.

The remainder of this paper is structured as follows: The next section provides a brief overview of the experimental literature on cooperating behaviour under external regulations, with special attention paid to potential crowding-out effects. In section 3 the study site background and the experimental design are described. Section 4 presents the empirical results from the impure public goods game, before the main findings, are discussed in section 5. Section 6 concludes with the main policy implications along with areas for future research.

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[2] This is a modified version of the standard public goods game, as detailed in Marwell and Ames (1979).

[3] Bouma et al. (2008) link a cooperativeness measure from a trust game to real on-farm behaviour in the provision of conservation maintenance, an impure public good,

[4] Reichhuber et al. (2009) apply a common pool resource game under a collective tax and subsidy mechanism.

2. ADVANCES IN FIELD EXPERIMENTS ON EXTERNAL ENFORCEMENT MECHANISMS IN CRDS

Framed economic experiments with a certain subject pool can contribute to an understanding of human behaviour given different regulatory mechanisms in the context of CRDs. Behavioural economics has applied game-theory based experiments to analyse group-dynamics, such as cooperating behaviour under varying individual and collective incentives. Although, these experiments have most often been applied in laboratory settings, especially in the context of natural resource dilemmas it has been proven to be important to conduct such experiments with the relevant subject pool, in order to learn about resource user's decision-making subject to their real group context (Cardenas 2000; Velez et al. 2010).

Social dilemmas related to the conservation of public ecosystem services can be framed as a common pool resource game (i.e. exploitation activities undertaken by a resource user increases individual benefits but decreases the benefits to others) or a public goods game (i.e. resource users can invest for the benefit of the group or for their own benefit only). Although neoclassical economic theory would predict individuals mostly following their self-interests and free-riding on others, there is ample evidence from field experiments in many different settings that resource users cooperate to a certain extent to overcome CRDs related to the overexploitation of common pool resources (e.g., Cardenas 2000, 2004; Cardenas et al. 2002; Velez et al. 2009; Reichhuber et al. 2009; Janssen et al. 2010) and the provision of public goods (e.g., Carpenter et al. 2004; Henrich et al. 2005; Fehr and Leibbrandt 2009; Carpenter and Seki 2010).

Individuals are normally driven by a combination of self-interest and social preferences, such as reciprocity, norms of fairness, altruism and conformity (Carpenter and Cardenas 2008; Velez et al. 2009). These may determine conditional as well as unconditional cooperation patterns and inequity aversion, and thereby affect conservation decisions. Existing group contexts appear to affect conservation behaviour in CRDs to a very large extent (Cardenas 2003; Cardenas and Ostrom 2004; Cardenas and Carpenter 2008), as social preferences are endogenously shaped within communities (Henrich 2000; Castillo and Saysel 2005; Carpenter and Seki 2010).

In small-scale societies market integration has been found to explain a substantial part of variation in cooperative behaviour (Henrich et al. 2001). Markets foster the interactions of individuals and thus enhance social learning, as well as the evolution of social norms (Bowles 1998), so that it has been found that more market integrated societies are more cooperative (Emsinger 2004). At the same time subsistence based communities are, nevertheless, more likely to build on patterns of collective action, since they depend more on the sustained management of their common resources (Ostrom 1990), so that market integration might also hamper cooperation in CRDs. This is in particular a problem when markets raise the private benefits from resource use practices that undermine conservation efforts (Agarawal and Gautam 1997).

Group heterogeneities are found to be another important factor determining the evolution of social preferences and thus cooperative behaviour in conservation problems (Varughese and Ostrom 2001; Cardenas 2003). Perceptions of local fairness, as for instance based on inequalities in burden-sharing and/or benefit distribution, are likely to affect how individuals behave in overcoming CRDs (Cardenas et al. 2002; Janssen et al. 2010). When allocating scare resources for conservation purposes, the relative opportunity costs are often significant for the most disadvantaged households. By contrast, wealthier resource users' opportunity costs associated with contributing to group projects are generally lower, while at the same time they can ensure that group benefits are generated, when thresholds have to be reached to generate a cooperation-related pay-off (Baland and Platteau 1999). According to Cardenas et al. (2001), while better-off resource users tend to conserve more in absolute terms, poorer households bear most of the burden in providing group benefits. Such unfair outcomes may trigger even more inequality, thereby undermining efficient conservation levels (Janssen et al. 2010).

On the subject of regulatory solutions, it has been found that even self-regulating mechanisms in the form of improved communication, as well as peer sanctions and rewards enable communities to solve CRDs (Ostrom et al. 1992; Cardenas et al. 2000; Cardenas 2004; Carpenter et al. 2004). Additionally, the revelation of an individual's conservation efforts in front of other group members can be a simple means to increase cooperation (Lopez et al. 2009). However, the effectiveness of such approaches might be substantially undermined by inequality in endowments (Cardenas 2000).

On the role of external regulatory mechanisms in CRD it has been found that their effectiveness depends very much on existing local resource management practices (Velez et al. 2010). If self-governing mechanisms are built on reciprocity, cooperation might actually be a very fragile phenomenon. Once non-compliance occurs, a non-cooperative process might take place that creates a vicious circle that is hard to break. According to Rodriguez-Sickert et al. (2008), low fine rates can actually function as a "yellow card", so as to stabilize conservation levels. By contrast, if resource users tend to stick to their initial behaviour (i.e. either they comply or they do not comply), it would require relatively high additional incentives to increase conservation efforts (Reichhuber et al 2009). Nonetheless, Lopez et al. (2009) find no difference in conservation levels under either low or high fine rates. There is also some evidence suggesting that conservation levels under external regulations, as opposed to self-governance, may not be significantly different (see e.g., Cardenas 2004). Whilst external interventions may not create additional incentives at all, they may also hamper the formation of pro-social norms or undermine existing ones (Cardenas et al. 2000; Ostrom 2000). In both cases the institutions brought from outside the community would have been ineffective, but in the latter case they would also be associated with a social cost. Similarly, external sanctions or rewards might relieve resource users from the guilt of non-cooperative behaviour and thus undermine conservation via a "guilt-relief" effect (Rodriguez-Sickert et al. 2008).

Accordingly, the empirical evidence indicates that "regulatory interventions sometimes do more harm than good, are sometimes completely ineffective, and at other times complement existing community efforts" (Velez et al. 2010: 264). Generally, it appears that external regulations might be beneficial where self-regulating mechanisms are weak or unstable, but might be harmful or at least ineffective where pro-social local norms and rules are strong and robust (Cardenas and Carpenter 2008). Therefore, it is important to account for the social preferences of the resource users in question when designing external institutions to overcome CRDs (Cardenas 2004; Carpenter and Seki 2010).

3. AN IMPURE PUBLIC GOODS GAME ON AGROBIODIVERSITY CONSERVATION

3.1 Background to the case study

A very interesting example for self-governing mechanisms related to CRD in farming systems can be found in Bolivian and Peruvian communities from the Altiplano of the Andes. A group of farmers – sometimes the whole community - decides collectively on which plots to be planted with a certain crop species (or to be left as fallow land). Each farmer then individually manages his/her piece of land according to such community-level decisions (Canahua et al. 2002).). Farmers who do not comply with such collective decisions normally face severe sanctions. These traditional rotation practices, known as *Aynoka*, *Suyo* or *Manta* illustrate well-functioning self-regulating mechanisms where individual interests (e.g., maximizing cultivation of the most profitable crop) might be at odds with collective interest (e.g., rotating crops in order to maintain soil quality and other regulating services. As farmers can freely choose the crop varieties to plant, such systems are associated with a high range of diversity within the selected crop species, as for example for quinoa (Canahua et al. 2002).

Quinoa is a crop known as ‘Inca-corn’ in the Northern hemisphere, whose centre of origin and diversity can be found in the Andean Altiplano (Tapia and Fries, 2007). In recent years there has been a significant price increase for certain quinoa varieties due to a rise in demand for organic quinoa products from Europe and North America. These changing market conditions, favouring a subset of the existing portfolio of quinoa varieties in the region, may have been responsible for the loss of a large number of quinoa landraces from the productions systems of the Altiplano with negative consequences for the livelihoods of Andean famers (Canahua et al. 2002; Rojas et al. 2009).

There are some significant differences between the communities from the Northern Altiplano (around Lake Titicaca) in Peru and the ones from the Southern Altiplano (around the Salar of Uyuni) in Bolivia. In the latter quinoa is one of the only crops cultivable given the harsh climatic conditions.[5] In this mono-cropping system, plots are rotated between quinoa and fallow periods of up to 5-8 years, while livestock also plays an important role in complementing farmers’ livelihoods (VSF 2009). By contrast, conditions in the Northern Altiplano favour many different crops, so that farmers normally follow a multi-crop rotation system, alternating between potatoes, quinoa, other cereals, beans and fallow periods (Canahua et al. 2002). Farmers in both contexts take part in market interactions to fulfil their consumption needs, but the extent to which their production systems are market orientated varies. Whilst

[5] Rainfall levels are very low and concentrated in the months of January and February, with heavy frosts from June to August

farmers in the Northern Altiplano have a predominantly subsistence-orientation, those in the Southern Altiplano tend to manage more commercialized farming systems, as they have the potential to continue to expand land under cultivation and utilize modern equipment, such as tractors (Rojas et al. 2006). The increasing market-orientation in the Southern Altiplano due to the rise in quinoa market prices may have also spurred self-interested behaviour, negatively affecting pro-social norms and undermining social cohesion (VSF 2009).

The context of the Andean Altiplano thus provides an interesting background to evaluate whether reward schemes could be designed as a mechanism to create incentives for decentralised behaviour towards the conservation of agrobiodiversity by farmers, as opposed to narrowing down the set of crop varieties used for cultivation. The consideration of subsistence based communities from the Northern Altiplano in Peru along with market orientated ones from the Southern Altiplano in Bolivia allows to investigate the role of social preferences and their interactions with external incentive mechanisms given varying market contexts.

3.2 Game set-up

The set-up of the game incorporates the impure-public goods characteristics of agrobiodiversity, while the framing seeks to resemble farmers' real life decisions. Each participant farmer forms part of a group and disposes of a number of land units ($\bar{X}$). These can be allocated to the production of a commercial quinoa variety (*C*) or to the conservation of a threatened and non-commercial variety (*T*). The private benefit from allocating a land unit to the cultivation of a threatened quinoa variety (P_T) is assumed to be lower than for the commercial variety, due to the price difference obtained in the market, i.e., $P_T < P_C$. However, each X_T allocated by farmer *i* as well as by any other group member *j* (where $j \neq i$) generates public benefits (B_T) in the community, and is hence accrued by every group member. But such benefits can only be realised if the sum of land units cultivated under variety *T* reaches a given threshold *H* of land units under cultivation, i.e., $X_{Ti} + \sum X_{Tj} \geq H$. The pay-off for farmer *i* in round *t* is:

$$\pi_{it} = P_C(\bar{X}_i - X_{Tit}) + P_T X_{Tit} + B_T(X_{Tit} + \sum X_{Tjt}) \qquad \text{with} \quad B_T = 0 \ \text{ if } X_{Tit} + \sum X_{Tjt} < H \qquad (1)$$

This *baseline game* is then adapted to one in which external rewards associated with X_T are introduced (henceforth referred to as the *rewards game*). Under an *individual reward* (R_I), that is a reward accrued only to farmer *i* for allocating X_{Ti} units of land to conservation, the private benefit associated with each X_T becomes P_T+R_I. The general pay-off structure is:

$$\pi_{it} = P_C(\bar{X}_i - X_{Tit}) + (P_T + R_I)X_{Tit} + B_T(X_{Tit} + \sum X_{Tjt}) \quad \text{with} \quad B_T = 0 \ \text{ if } X_{Tit} + \sum X_{Tjt} < H \qquad (2)$$

If instead of an individual reward, a collective reward (R_G) is provided to the entire group of farmers, once the threshold *H* is reached, the public benefit from X_T becomes B_T+R_G, so that the pay-off structure is:

$$\pi_{it} = P_C(\bar{X}_i - X_{Tit}) + P_T X_{Tit} + (B_T + R_G)(X_{Tit} + \sum X_{Tjt}) \quad \text{with} \quad B_T = 0 \ \text{ if } X_{Tit} + \sum X_{Tjt} < H \qquad (3)$$

It can be easily observed that above the threshold *H,* the marginal opportunity cost (*MC*) of allocating a unit of land to *T* is $MC_{Ha} = P_C - P_T - R_I - B_T - R_G$ (with R_I or R_G being associated with the individual and collective rewards, respectively). Below the threshold the marginal opportunity cost is $MC_{Hb} = P_C - P_T - R_I$. It would be individually rational to allocate an additional unit of land to variety *T* only if $MC<0$. One special situation arises when someone's contribution just allows the threshold to be reached, in which case one would move from a situation without public benefits to a situation in which these would just be realised, so that allocating one additional land unit to would be rational as long as $(P_C - P_T - R_I)X_{Ti} < H(B_T + R_G)$.

In the context of the present case study the following parameterisation is chosen: Each group consists of four players and disposes a total of 16 land units. Games with *uniform* and *heterogeneous* groups, in terms of the land units allocated to participants, are played, in order to incorporate different endowment settings. In the uniform groups, $\bar{X}_i=4$, i.e., each player is endowed with four land units. By contrast, in the heterogeneous game, two players have an endowment of six units of land while the remaining two players have only two units of land each. The threshold is set to $H=7$, so that no player on his/her own can make *H* be reached. The payoff parameters are in turn set as follows: $P_C=12$, $P_T=2$, $B_T=4$. This makes the returns associated with X_T in the *baseline game* (i.e., $R_I=0$, $R_G=0$) as just half of those compared to the returns from X_C if the threshold is reached. In the *individual rewards game* with $R_I=4$ the returns from X_T are just below the ones from X_C when the threshold is reached. In the *collective rewards game* with $R_G=1$ a total of four payment units are awarded to the group for every land unit cultivated under variety *T*. This parameterisation guarantees that the total rewards externally provided for every land unit cultivated under *T* is the same in both the individual and collective reward game, albeit farmers benefit differently under the alternative reward modes.

[INSERT TABLE 1]

By design the social optimum (X°_{Tit}), i.e., where the group's total benefits would be maximized, is reached when all the group members allocate all their land units towards conservation. The social dilemma results from the participants' private incentive to free ride on the others given the private optimum of X^{*}_{Tit}. Generally, purely selfish acting participants would allocate no land to X_T above (below) the threshold since the marginal opportunity costs are constantly above zero, i.e. $MC_{Ha}=6$ ($MC_{Hb}=10$). Only when the participants' conservation activities can ensure the threshold is reached certain situations arise in which the opportunity costs of conservation would be negative. In the baseline game this occurs when the other group members conserve six (five) land units, so that the best response would be to assign one (two) land unit(s) to conservation regardless of their private land endowments.

The optimal conservation strategies are summarized in Table 1 for the different games. It can also be seen that reward systems decrease the opportunity costs of conservation. At the threshold the set of optimal strategies now further includes the conservation of three land units (when the other group members conserve four land units) under individual and collective rewards and four land units (when the other group members conserve three land units) in the individual rewards setting According to the parameterisation of the game, the social optimum could only be reached in uniform groups under individual reward systems in one special case: when everyone in the group expects each of the other group members to conserve three land units.

3.3 Experimental setting

Under the above parameterisation, a total of five groups of four farmers each (i.e., 20 participants per session) were organised, randomly arranging the participating farmers into three 'uniform' and two 'heterogeneous' groups of four participants each. All participants within a given session interact with each other in their daily lives as they come from the same community or from a neighbouring one, but belong to different quinoa farming households. Information on group-membership was not provided to participants, so group composition during the game was unknown to the participants. In order to guarantee anonymity, participants were not allowed to communicate with one another.

After reading the instructions in Spanish, the game dynamics were illustrated by explaining several pay-off examples on large posters. Most of the participants were literate and numerate, and could understand and communicate fluently in Spanish[6]. Between three and seven people assisted with the field games. Participants only had to enter the number of land units they wanted to assign to the commercial and/or the threatened variety on their game formats. After each round the assistants collected the formats, calculated and entered the pay-offs, and then redistributed the formats among the participants. From the formats the participants could also learn about the conservation levels of their (anonymous) group-peers. When finishing the first six rounds of the baseline game, one of the rounds was drawn randomly to be the one that actually would be remunerated with real money. Following another six rounds of the rewards game another winning round was drawn. Finally, after completing a rapid survey with questions on household structure, social organization and cooperation with other households as well as production systems, participants received the cash equivalent according to the pay-offs earned in the two winning rounds. In addition each player was paid a fixed participation-bonus[7], so that each participant earned an average of 7US$, which is approximately the daily wage in both the study regions.

In total eight sessions with 20 farmers each were realised between February and April 2010 (four in the Northern Altiplano in Peru[8] and four in the Southern Altiplano in Bolivia. The individual and collective rewards games were played each in tow sessions per country. Generally, sessions were played in different communities,

[6] In the case of the very few exceptions, local assistants ensured that the participants understood the rules of the games and entered their number of land units according to their decision.
[7] 25 Bolivianos in Bolivia and 10 Soles in Peru, corresponding to approx. 3.5US$, equivalent to a half day's work in the rural communities.
[8] One of the first Peruvian sessions was realized with two uniform groups only, as too few people had shown up. We do not further mention these results in this paper, as decisions could have been biased due to the smaller group environment. Consequently, we organized a fifth session in April 2010, which we are referring to instead.

which were very remote from the main provincial town and which were quite dispersed from one another, so that there is no concern about cross-talk effects[9]. Table 2 provides a description of the game participants, uncovering significant differences between the two countries. In Peru more women took part in the experiments. Participants in Bolivia were less educated and older. To a large extent the participants reflect the above described differences in farming systems between the Northern and Southern Altiplano. Farmers in Bolivia cultivate larger land areas, are more commercialized, and manage larger livestock holdings. Agricultural land in both countries is quite unevenly distributed among the game participants, with Gini-coefficients of between 0.44 and 0.50, respectively.

[INSERT TABLE 2]

4. RESULTS

4.1 Group level analysis

Figure 1 presents the average group conservation levels per country over the twelve rounds of the game, differentiating between the payment mode and the group's endowment status. It can be observed that conservation levels oscillate around the threshold. In Bolivia the level of land under traditional landraces starts off at the same level for both the heterogeneous (dotted line) and uniform groups (solid line). In both cases conservation levels are relatively close to the threshold, which is not very often passed. In Peru, uniform groups allocate significantly more land for conservation purposes than their heterogeneous counterparts. With the introduction of individual rewards, conservation levels pick up in both countries regardless of the groups' endowment status and only in very few rounds do average levels fall below the threshold. Collective rewards seem to have more of an effect in Peru. Although starting below the threshold in round seven, heterogeneous as well as uniform groups assign on average more than seven land units to conservation in most of the subsequent rounds. By contrast, in Bolivia average conservation levels are below the threshold in most of the rounds under the collective rewards setting. A Kruskal-Wallis test shows that there are no structural differences over the rounds within the baseline or the rewards game, hence rejecting the presence of time (i.e. round) effects. This result holds for both countries as well as with regard to endowment status and reward modes.

[INSERT FIGURE 1]

Based on average conservation levels within the baseline game Table 3 provides some initial insights into the effectiveness of the different rewards systems. During the baseline game, uniform groups from Peru conserve significantly more land than their heterogeneous counterparts and more than Bolivian groups. These results indicate that conservation might be facilitated in cases where there is an equal distribution of initial endowments in the Peruvian farming context. On the matter of reward systems, it appears that on the one hand, individual rewards result in a

[9] Only two sessions in Peru were played with participants from the same community. However, both sessions were organized during the same morning, with one group doing the game and the other group doing the survey, so that participants from different sessions could not talk to each other.

significant increase of conservation levels in both homogeneous and heterogeneous groups regardless of the country and thus market context. On the other hand, collective rewards only seem to have a positive effect in heterogeneous groups from Peru. Individual rewards thus seem to be an effective means to increase conservation levels under a range of market and group endowment settings, while collective rewards only seem to provide additional incentives in less market orientated and heterogeneous group settings.

[INSERT TABLE 3]

4.2 Individual level analysis

This group level analysis can provide a first description of the conservation dynamics, but these patterns result from individual decisions. The latter are not only shaped by different reward and endowment settings but also by the social preferences that determine cooperation in CRD. In order to analyse the dynamics of cooperating behaviour over time, we can take advantage from the panel structure of the dataset in order to analyse. Treating the very first round as a learning round for the participants, we are left with observations from 80 participants over 11 rounds in Peru and Bolivia. To compare conservation levels between heterogeneous and uniform groups, we take the share of land units allocated to conservation as the dependent variable. As this variable is bound from below by zero and from above by one, we apply a random effects Tobit model, allowing for participant-level heterogeneity.

[INSERT TABLE 4]

Participant level control variables are included (see Table 2), in addition to variables reflecting cooperativeness measures as well as the different game settings, presented (Table 4). These are used to proxy social preferences. The conservation share in the first round, i.e. when farmers have not yet learnt from the behaviour of the others, serves as a measure for unconditional cooperativeness. Conditional cooperativeness can be measured by the coefficient associated with the variable reflecting the sum of the other participants' conservation effort in the previous round. A positive coefficient would indicate reciprocity, while a negative one would uncover free-riding behaviour. We further add a dummy for having reached the threshold in the previous round, as group pay-offs change substantially once the threshold is passed and thus might affect cooperative behaviour. To control for endowments status we differentiate between better-off and worse-off game participants. With the participants from uniform groups as the reference category, the coefficient associated with these variables reveal the effect of inequality in initial endowments. Moreover, we test for the impact of receiving individual versus collective rewards. The estimation results are presented in two steps; first the overall effects of variables related to cooperativeness measures and the game settings are presented in *model 1* in Table 5 and then the interaction terms between these two set of variables re added to analyse to what extent the payment-mode and the initial endowment status interact with the revealed cooperativeness measures[10] both in Bolivia and Peru (see *model 2* in Table 5).

[10] Interacting payment mode and endowment status does not reveal any significant interactions.

[INSERT TABLE 5]

Table 5 illustrates that participant-specific control variables only explain conservation levels to a limited extent. For instance, commercial orientation of individual farmers does not affect conservation levels. Participants with larger landholdings and fewer livestock tend to allocate a larger share of endowments in the game to conservation purposes. Interestingly, farmers conserving a higher share in the first round are found to conserve more in the subsequent ones. Therefore, unconditional cooperativeness increases conservation levels in both market settings. In Bolivia, though, there seems to be some evidence for the potential existence of free-riding behaviour, given the negative conditional cooperativeness coefficient (statistically significant at the 5% level). In Peru worse-off farmers seem to allocate a lower share of their endowments to conservation activities, possibly indicating that these farmers are averse to inequity. Model 1 further shows for both countries that individual rewards have a highly significant positive effect on conservation, while collective rewards do not have any impact.

The latter findings are further refined when taking into account the interaction terms between payment mode and cooperativeness measures (model 2 in table 5). It appears that collective rewards on its own provide an incentive for increased conservation levels in Peru. However, such mechanisms also trigger free-riding behaviour as indicated by the negative coefficient of the interaction variable with conditional cooperativeness, so that the net impact of collective rewards as indicated in model 1 might be zero. Interestingly, the positive coefficient for individual rewards from model 1 turns negative in model 2 and in Bolivia this result is even significant at 1% level. The overall positive effect of individual rewards on conservation as uncovered in model 1 appears to be due to an interesting set of interactions with social preferences in Bolivia. Specifically, in the latter market-context individual rewards seem to enhance conservation of those farmers who are unconditionally cooperative. As the positive coefficient related to the interaction of conditional cooperation and individual rewards implies, the latter seem to unleash reciprocity behaviour. At the same time, the coefficient of interaction with the threshold effect has a negative sign, indicating that in groups that operate below the threshold, individual rewards can create incentives to allocate more of their endowments to conservation in Bolivia.

Through the inclusion of the interaction between endowment status and cooperativeness measures, the threshold effect becomes significant in Bolivia, indicating that farmers tend to conserve less when thresholds have not been reached in the previous round. However, worse-off farmers tend to decrease their contribution to conservation above the threshold. The latter seems valid for both countries. In Peru we further see that better-off farmers are unconditionally cooperative and thus willing to incur a higher burden arising from their conservation activities.

5. DISCUSSION

Here we further discuss these main findings to gain insight into cooperation towards the conservation of common resources, such as agrobiodiversity as in this study. Attention is drawn to (i) the role of market orientation differentiating between the Bolivian and the Peruvian market context, (ii) the role of group heterogeneity discussing results related to the different endowment statuses, and (iii) the effect of external rewards including the role of different payment modes when comparing individual with collective rewards.

Firstly, the results uncover significant country differences and thus hint at the important role market orientation can play in cooperating behaviour. In the baseline situation of the experimental games without introducing any type of external reward, conservation levels are significantly higher in the Peruvian communities than in the Bolivian ones. This is in accordance with other experiences from the study sites indicating that the increasing commercialization of farming systems in the Bolivian site goes hand in hand with a loss of agrobiodiversity as well as an erosion of collective action institutions and pro-social norms. This finding puts a slightly different perspective on findings in other field experiments, such as Henrich et al. (2001). These authors point out that more market integrated societies tend to better solve CRD, since they better understand to interact with other members of society. While this finding might be relevant when comparing communities which are barely integrated in markets, this might be less so for communities which normally take part in market activities, as the ones from the Andean Altiplano. In the Andean communities strongly market orientated production systems, as due to the increasing market potential of quinoa in the Bolivian communities under review, might be rather harmful for the cooperation in conservation problems. Taken together with the results in Henrich et al. (2001), the relationship between market integration and cooperation might follow a reverse U-form: isolated as well as highly market orientated societies might be least cooperative. Similarly, we find that farmers from the commercial farming communities in Bolivia tend to free ride on one another in order to maximize their private benefits. Only with the awareness of the need to reach a threshold to realize public benefits do farmers in Bolivia appear to be willing to contribute to conservation. This may be either due to their general pro-social attitudes being unleashed by the reduced opportunity costs of conservation above the threshold, or because they act in a purely selfish manner seeking to ensure that the threshold is reached continuously in order to take advantage of the increased pay-offs associated with the public benefits.

Secondly, on the subject of group heterogeneity, the experimental games provide some evidence that initial endowments affect the extent to which farmers contribute to the conservation of public benefits. We find that the worse-off farmers conserve less above the threshold. It seems that these farmers are no longer willing to share the burden of conservation once the generation of group benefits is ensured. This holds for both market contexts, while other dynamics emerge that depend on the degree of market orientation. In the more subsistence based Peruvian communities worse-off farmers with limited endowments seem to be highly averse to inequity to differing earning possibilities. Better-off farmers tend to be unconditionally cooperative and thus willing to invest a higher share of their endowments in the provision of public goods. Contrary to Cardenas et al. (2002), who find that less wealthy households bear most of the burden in conservation, this paper highlights that in subsistence-based production systems better-off households generally bear a higher burden. This would imply that policy interventions might be more effective when targeting larger landowners, whose conservation activities can more easily make thresholds be passed and conservation goals be reached. In more market-orientated contexts though, inequality plays hardly any role. Possibly, as markets often produce winners and losers, farmers in commercial production systems may be used to differing earning possibilities and hence not be influenced very much in their behaviour by the presence of inequality. This also relates to the previous finding in so far that growing market orientation seems to perturb pro-social norms, such as local fairness perceptions. As the data does not reveal significant interactions between endowment status and payment mode, group heterogeneities though, do not seem to affect the effectiveness of reward systems.

Thirdly, findings show that external reward mechanisms interact with social preferences subject to the degree of market orientation. Consequently, reward modes may differ in their effectiveness to enhance conservation efforts given different market contexts. In subsistence based communities collective rewards on their own seem to provide an incentive to increase conservation efforts. However, at the same time they provoke free-riding behaviour, possibly because the benefits from doing so do increase under group payments. This is a worrying result, as it implies a high social cost associated with such payment modes in communities where self-regulating mechanisms to govern CRD are found to still be relatively strong. In more market-orientated contexts collective rewards seem to have no impact at all, and thus would be completely ineffective, although this finding may be due to the rather small reward level chosen in the experiment to compare the effectiveness of individual and collective rewards with one another. Regardless of the payment mode the signal sent by a reward involving a rather small fraction of the total pay-offs may be much weaker than when the reward is set at a much higher level.

Results further demonstrate that individual rewards result in increased conservation efforts, especially in market-orientated farming contexts. Interestingly though, these rewards on their own are associated with lower conservation levels. This might be interpreted as a guilt-relief effect in the sense that, due to the existence of the external enforcement mechanism, participants feel less obliged to follow pro-social norms as discussed in Rodriguez-Sickert et al. 2008. If the norm is to cooperate to a certain extent in CRD, so as to share the costs of conservation, a reward system that reduces these costs, leaves farmers feel less guilty of violating the social norm than without the intervention. As such the individual reward system appears to relieve farmers from the guilt of not contributing to the group’s conservation activities, thereby hampering conservation efforts. It is only the interaction with social preferences which makes individual rewards effective in spurring overall conservation levels. In market orientated systems as in Bolivia, these rewards seem to provide an additional incentive to those farmers who would unconditionally conserve anyway. They further increase conservation in groups that operate below important thresholds and as such they may be an important means to motivate people to put in more effort towards conservation activities in order to reap the collective benefits of such investments. Furthermore, these reward systems also seem to be a way to facilitate reciprocity-based behaviour, as they reduce the costs of cooperation. This is a very promising finding in communities where free-riding behaviour takes place, pointing towards the potential of external rewards to compensate for the negative social dynamics.

6. CONCLUSION

This paper attempts to shed light on the potential of external reward mechanisms to solve common resource dilemmas (CRD), such as the conservation of public ecosystem services. Despite of being a rapidly growing research area due to the increasing number of Payments for Environmental Services (PES) programs, mainly in the developing world, experimental research in real field settings is widely missing thus far. Based on an impure public goods game in the context of agrobiodiversity conservation in Andean farming communities, this paper assesses the degree to which alternative reward types, such as individual versus collective payments, brought from outside the community interact with social preferences that underlie existent resource management practices. Special attention is drawn to the role of group heterogeneities by controlling for different endowments in resources that can be invested for conservation purposes. By drawing on field experiments from the Northern Altiplano of Peru, where farming systems tend to be subsistence-based, and from the Southern Altiplano in Bolivia, where production is more commercially oriented, the results are compared across different market contexts.

We find that depending on the market setting social preferences, such as unconditional and conditional cooperativeness, threshold effects and inequality aversion, can play varying roles in the conservation of common resources, such as agrobiodiversity. For instance, the findings indicate that farmers from market orientated backgrounds tend to free-ride on one another, whereas in subsistence-based communities inequality aversion may undermine conservation efforts. The pathways through which different reward systems affect conservation levels are very context dependent too. It appears far too simple to generally assume that external reward mechanism, such as PES, can solve CRDs. In certain settings they are highly ineffective and against expectations do not result in any behaviour change at all. In other settings they interact with social preferences in important but complex ways. So, on the one hand, external incentive mechanisms might do more harm than good by crowding out existing pro-social behaviour in settings where farmers can build on highly developed self-regulating mechanisms based on social norms. On the other hand, in communities that have suffered from an erosion of such norms, certain reward systems might be able to reverse anti-social dynamics and thus contribute to solving conservation problems. Policymakers ought to take these possible social dynamics into account when designing policy interventions, such as PES, so these can draw upon, support and complement existing resource management practices.

These findings highlight the importance of a careful assessment of existing social preferences that are of relevance for the success of formal institutions brought from outside the community. As according to Velez et al. (2010) there may be “geographical variation in the effectiveness of regulatory interventions” study site specific research on existing resource management practices prior to the design of PES schemes is urgently needed. Besides widening the understanding of the ways external rewards affect existing self-governing mechanisms given various market and group contexts, further field experimental studies may provide important lessons for the design of PES. Experimental research may, for instance, focus on (i) the role of group heterogeneities in terms of group size and cultural background, (ii) the importance of power positions when claiming the stakes in group-level rewards, (iii) the impact of varying reward levels within different reward modes, and (iv) the effect of risk aversion when non-stochastic rewards complement the pay-offs from land use decisions which are generally uncertain. These studies could bring important policy implications for the design of PES in such a way as to provide incentives for increased conservation efforts and to avoid social costs by crowding out pro-social behaviour.

ACKNOWLEDGEMENTS

This paper is part of Bioversity International's payment for agrobiodiversity conservation services projects financed by the Syngenta Foundation for Sustainable Agriculture and the CGIAR Systemwide Program on Collective Action and Property Rights (CAPRi). We are highly indebted to Juan-Camilo Cardenas and Daan van Soest for their useful guidance during the game set-up. We also thank our national partners, the Centro de Investigación de Recursos Naturales y Medio Ambiente (CIRNMA) in Peru and the Fundación Promoción e Investigación de Productos Andinos (PROINPA) in Bolivia, for organizing and assisting the field experiments.

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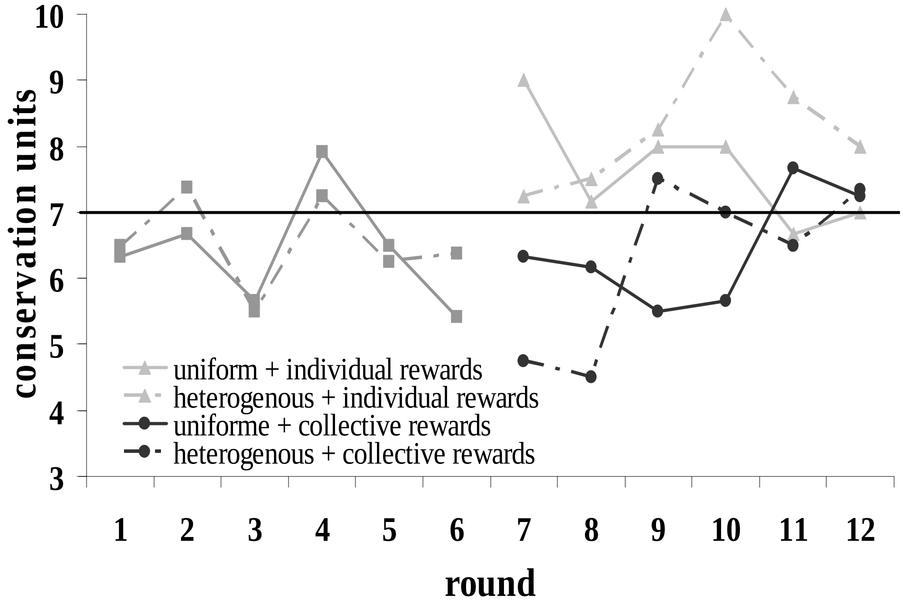
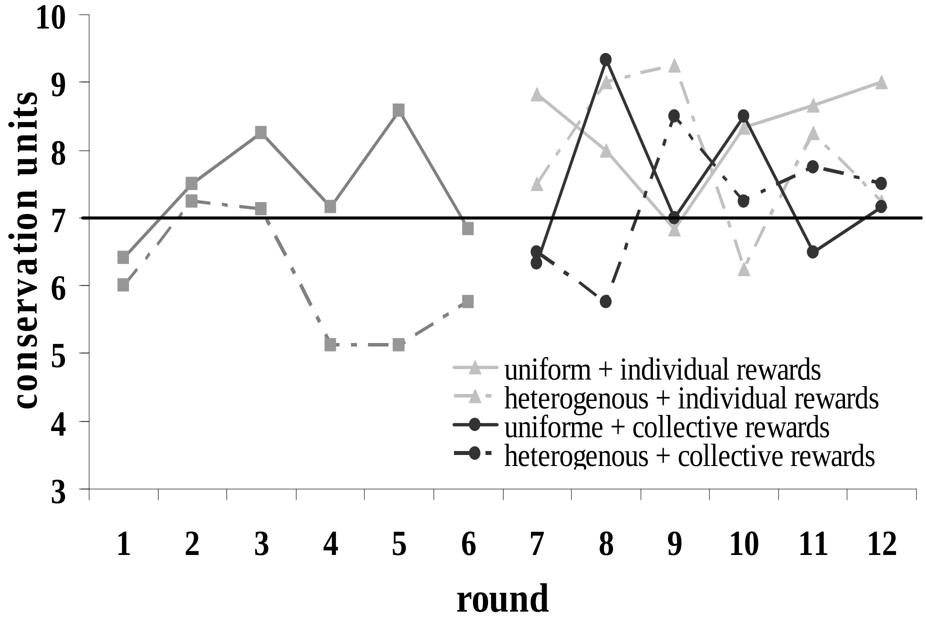
FIGURES

Figure 1. Group conservation levels by experimental game round

Bolivia



Peru



TABLES

Table 1. Optimal private strategies in baseline and rewards game

		a) baseline	b) individual rewards	c) collective rewards
above threshold		$MC_{Ha}=10$	$MC_{Ha}=6$	$MC_{Ha}=10$
below threshold		$MC_{Hb}=6$	$MC_{Hb}=2$	$MC_{Hb}=5$
at threshold		$X_{Ti} < 28/10$	$X_{Ti} < 28/6$	$X_{Ti} < 35/10$
optimal strategies	$\overline{X}=4$	$X^*_{Tit} \in \{0, 1, 2\}$	$X^*_{Tit} \in \{0, 1, 2, 3, 4\}$	$X^*_{Tit} \in \{0, 1, 2, 3\}$
	$\overline{X}=2$	$X^*_{Tit} \in \{0, 1, 2\}$	$X^*_{Tit} \in \{0, 1, 2\}$	$X^*_{Tit} \in \{0, 1, 2\}$
	$\overline{X}=6$	$X^*_{Tit} \in \{0, 1, 2\}$	$X^*_{Tit} \in \{0, 1, 2, 3, 4\}$	$X^*_{Tit} \in \{0, 1, 2, 3\}$

Table 2. Summary statistics of characteristics of game participants across countries

variable	description		Bolivia			Peru	
		obs	mean	sd	obs	mean	sd
sex	share of female participants	80	0.375	0.05	80	0.550**	0.06
education	share of participants with secondary education or higher	80	0.313	0.05	80	0.500***	0.06
age	age in years of participant	80	49.4**	1.67	80	45.1	1.65
land	land cultivated in ha	80	3.9*	0.44	80	3.1	0.29
commercial	share of participants whose main income source is quinoa selling	80	0.675***	0.05	80	0.188	0.04
livestock	number of tropical livestock units	80	19.4**	4.10	80	10.8	1.08

Note: asterisk (*), double asterisk (**), and triple asterik (***) denote H0 (i.e., difference between countries ≤0) rejected at 10%, 5%, and 1% by one sided test

Table 3. Group conservation levels by endowment and reward setting across countries

	uniform groups		heterogenous groups		Pr(|T|>|t|)a for difference among groups[a]
Bolivia					
baseline	(24)	6.42	(16)	6.54	*0.767*
individual rewards	(12)	7.64**	(8)	8.29***	*0.255*
collective rewards	(12)	6.44	(8)	6.25	*0.765*
Peru					
baseline	(24)	7.46	(16)	6.06	*0.002*
individual rewards	(12)	8.28**	(8)	7.92***	*0.572*
collective rewards	(12)	7.47	(8)	7.21*	*0.665*

Note:Number of observations indicated in parentheses. [a]Pr(|T|>|t|) results from a standard two sided t-test. asterisk (*), double asterisk (**), and triple asterik(***) denote H0 (i.e., difference between baseline and respective rewards game ≤ 0) rejected at 10%, 5%, and 1% respectively by one sided t-test

Table 4. Game behaviour of participants and game settings across countries in rounds 2-12

category	variable name	description	*Bolivia*	*Peru*
game behaviour				
dependent variable	conservation share	share of land units allocated to conservation	0.428	0.455
cooperativeness measures	unconditional	share of land units conserved in first round	0.400	0.399
	conditional	total land units conserved of other group members in previous round	5.06	5.46
	threshold	total group conservation level is at least = 7 in previous round	51.8%	60.0%
game setting				
endowments	worse-off	participant endowed with two land units, reference four units	20.0%	20.0%
	better-off	participant endowed with six land units, reference four units	20.0%	20.0%
rewards	individual pay	receiving individual reward, reference no reward	27.3%	27.3%
	collective pay	receiving collective reward, reference no reward	27.3%	27.3%

Table 5. Random effects Tobit model estimation results to explain conservation share of game participants in rounds 2-12

	Bolivia				*Peru*			
	model 1		model 2		model 1		model 2	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
constant	0.406***	0.000	0.524***	0.000	0.373***	0.003	0.414***	0.002
sex	-0.011	0.813	-0.014	0.754	0.063	0.167	0.064	0.153
education	-0.061	0.211	-0.075	0.117	0.039	0.422	0.047	0.324
age	-0.001	0.689	-0.001	0.660	-0.002	0.159	-0.003*	0.077
land	0.006	0.247	0.011*	0.052	0.020**	0.018	0.022**	0.011
commercial	-0.023	0.620	-0.055	0.225	-0.032	0.571	-0.053	0.356
livestock	-0.002***	0.006	-0.002***	0.001	-0.007***	0.007	-0.007*	0.006
unconditional	0.368***	0.001	0.320**	0.048	0.358***	0.001	0.283**	0.044
coonditional	-0.025**	0.012	-0.048***	0.002	0.005	0.571	0.010	0.475
threshold	0.041	0.283	0.126**	0.039	-0.043	0.283	-0.064	0.32
worse-off	0.030	0.590	0.069	0.654	-0.213***	0.000	-0.337*	0.072
better-off	-0.013	0.800	-0.288	0.180	-0.027	0.605	-0.243	0.114
individual pay	0.131***	0.000	-0.295**	0.015	0.078**	0.021	-0.031	0.783
collective pay	-0.036	0.278	0.026	0.819	0.031	0.360	0.229**	0.046
unconditional * individual pay			0.490**	0.010			0.084	0.679
unconditional * collective pay			-0.103	0.539			-0.142	0.374
conditional * individual pay			0.063***	0.002			0.013	0.521
conditional * collective pay			-0.013	0.534			-0.039*	0.056
threshold * individual pay			-0.175**	0.047			0.011	0.904
threshold * collective pay			0.079	0.345			0.131	0.134
unconditional * worse-off			-0.123	0.581			0.163	0.603
unconditional * better-off			0.473	0.306			0.586*	0.061
conditional * worse-off			0.030	0.220			0.026	0.312
conditional * better-off			0.024	0.330			-0.007	0.784
threshold * worse-off			-0.311***	0.004			-0.212*	0.062
theshold * better-off			-0.080	0.382			0.052	0.578
No of obs	880		880		880		880	
No of groups	80		80		80		80	
Log likelihood	*-544.055*		*-528.024*		*-539.989*		*-531.964*	
Wald chi2 test	41.410	0.000	74.650	0.000	51.51	0.000	67.750	0.000
LR-test: sigma_u=0	29.420	0.000	27.040	0.000	36.250	0.000	32.920	0.000

Notes: asterisk (*), double asterisk (**), and triple asterik(***) denote variables significant at 10%, 5%, and 1% respectively