Payments for agrobiodiversity conservation services (PACS): Creating incentive mechanisms for the sustained on-farm utilization of plant and animal genetic resources

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Abstract: This paper builds on the experiences from the numerous payment for environmental services (PES) and PES-like schemes in order to establish a framework for evaluating the potential of PES as an incentive mechanism for the conservation of agrobiodiversity *per se* in poor farming communities. Such – often indigenous – communities conserve much of the world's threatened plant and animal genetic resources (PAGR) and hence can potentially play an important role in the cost-effective, in-situ conservation of agrobiodiversity. Payment for agrobiodiversity conservation services (PACS) schemes are understood as market-based instruments that can increase the private benefits from utilizing PAGR on-farm by: i) alleviating market failures through individual-based or community-based reward mechanisms (monetary or non-monetary); or ii) reducing market frictions by developing/improving market chains in order to increase the competitiveness of certain species, varieties or breeds. As with PES, implementing of PACS schemes in practice requires the consideration of a number of demand-side, supply-side and institutional issues. This paper assesses the potential performance of PACS in terms of ecological effectiveness, economic efficiency and social equity, including through a comparative analysis of a range of PACS instruments, such as direct payment mechanisms, competitive tender approaches, and market chain development.

Keywords: Payment for environmental services, genetic diversity, incentive mechanisms, least-cost conservation, sustainable livelihoods

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1. Introduction

With the signing of the Convention of Biological Diversity (CBD), the importance of conserving a broad range of biodiversity was highlighted. Yet biodiversity at the ecosystem, species and genetic levels is increasingly lost from agricultural landscapes mainly due to agricultural practices aiming at the maximisation of food and fuel production (FAO 1997; Swift et al. 2004; MEA 2005; Perrings et al. 2006; FAO 2007a; Swinton et al. 2007). Either extensification of agriculture via the expansion of marginal land into areas rich in wild biodiversity, or intensification via adoptation of monocultures, may be linked to a further decline in biodiversity (Green et al. 2005). Certain traditional crop species/varieties and animal breeds are often replaced by more financially profitable "improved" ones, so that agricultural systems can often be increasingly characterised as very intensive with a low level of diversity, thereby undermining the flow of ecosystem services in the long-run (Jackson et al. 2005, Swinton et al. 2006, FAO 2007b, Jackson et al. 2007).

The focus of this paper is on plant and animal genetic resources (PAGR), that is the diversity at the genetic (i.e. variety or breed) and species level. In this context, agrobiodiversity is understood as all diversity within and among plant and animal species found in domesticated systems (as per Smale and Drucker 2008). On-farm utilization of agrobiodiversity is one component of in-situ conservation, which is complementary to ex-situ conservation strategies, but has far gained relatively little attention (e.g. Maxted et al. 2002; Bellon 2008). The conservation of PAGR is found to play a crucial role in sustainable agricultural practices by contributing to agrobiodiversity conservation services (FAO, 1997; Jackson et al. 2005; FAO 2007a; Jackson et al. 2007; Hajjar et al. 2008). PAGR provide a mix of private and public conservation values, i.e. seeds and breeds with rival/excludable traits and genetic information with non-rival/non-excludable characteristics (see Heisey et al. 1997; Smale et al. 2004; Eyzaguirre and Dennis 2007; Bellon 2008). In a complex world of uncertainty and surprise, including due to climate change, the public benefits from the conservation of global option values associated with genetic diversity are likely to be high (Perrrings 1998; Anderson and Centonze 2007; Bellon 2008). The loss of many traditional PAGR is expected to lead to genetic erosion and genetic vulnerability with far-reaching consequences, especially for the livelihoods of poor farming communities (PFC), where a large proportion of the world's remaining agrobiodiversity is to be found (Brush and Meng 1998; IPGRI 2002; Andersen 2003; Gruère et al. 2008). For instance, many small-scale farmers located in remote areas utilize agrobiodiversity as an insurance mechanism to manage the risk of weather variability and pest and diseases (Smale et al. 1998; Birol et al. 2006; Di Falco et al. 2007; Baumgärtner, 2007; DiFalco and Chavas, forthcoming, Narloch and Pascual forthcoming).

Despite the importance of these values, incentives are often biased towards specific “improved” crop species/varieties and animal breeds, as markets tend to capture only part of the value of the services provided by genetic resources conservation, thus underestimating the true worth of these resources (Gruère et al. 2008). Market imperfections, via constraints on the demand for conservation services or on the supply of genetic resources, undermine agrobiodiversity conservation efforts (Bellon 2004). Additionally, market failures and the public goods characteristics of diversity lead to perverse incentives as ecosystem services are provided by individuals to wider society as a positive externality (see Turner and Daily 2008). Market-based mechanisms, such as payment for environmental services (PES), may be a means of aligning the private and social incentives and to manage the public good characteristic of biodiversity in a decentralized way (Pascual and Perrings 2007).

PES schemes in general have been hailed by some observers as, “*arguably, the most promising innovation in conservation since Rio 1992*” (Wunder, 2005). However, they have tended to focus on carbon sequestration and storage, watershed protection, protection of landscape aesthetics and non-domesticated biodiversity protection. Consequently, they have frequently focused on forest conservation. A review of the PES literature covering hundreds of PES and PES-type schemes reveals that there is hardly any consideration of PES in the context of crop and livestock genetic diversity and only limited consideration of indigenous farmer contexts (*inter alia*, Landell-Mills and Porras 2002; Pagiola et al. 2002; Mayrand and Paquin, 2004; Wunder, 2007; Ravnborg and et al. 2007; Dasgupta et al. 2008). By building on the experiences from PES-schemes, this paper seeks to develop a framework for payment for agrobiodiversity conservation services (PACS) in PFC. As biodiversity conservation is in many cases driven by economic forces (Kontoleon et al. 2008), there is increasing need to prioritize their conservation on the basis of their economic values and their level of threat, subject to the limited conservation funds available (Weitzman 1992, 1993, 1998; Metrick and Weitzman 1999). PACS schemes may well be able to contribute to this task.

This paper addresses the potential of PACS as an incentive mechanism for effective, efficient and equitable agrobiodiversity conservation and is organized as follows: Section 2 identifies some of the major differences between the design of payment schemes for the conservation of wild biodiversity and agrobiodiversity. Section 3 considers supply-side and demand-side, as well as generic institutional constraints for PES and PACS implementation, while section 4 presents a comparative analysis of PES and PACS. Section 5 describes and assesses a number of different PACS instruments, such as direct payments, tender approaches and market chain development. Conclusions are presented in Section 6.

2. Payment for environmental services: Conserving wild biodiversity versus agrobiodiversity

A widely-used definition of PES schemes is that they involve: i) a voluntary transaction where ii) a well defined environmental service or a land-use likely to secure that service iii) is being bought by a (minimum one) service beneficiary iv) from a (minimum one) service provider v) with payment conditional on the service provider fulfilling his/her contractual obligations (Wunder 2005). While ”genuine” PES schemes fulfil all five criteria, many conservation programmes are only ‘PES-like schemes’, fulfilling only some of the above criteria (Wunder 2007). This definition of PES implies that property rights are shaped in such a manner that the land-holder has the right to use the land for any purpose and will be compensated for providing ecosystem services, so that it involves a kind of “provider gets” principle (Hodge 2000).

The allocation of such property rights, as advocated by Coase (1960), provides a means through which socially optimal incentives can be generated in contexts where missing markets are the predominant problem. Genuine PES schemes, based on such a Coaseian solution in order to internalize farmers' contribution to ecosystem services are however rare. Many PES-like approaches cannot build on pure market transactions associated with property rights allocations but instead depend on a publically-funded Pigouvian subsidy that facilitates the capture by farmers of the positive externalities associated with biodiversity conservation (Quaas and Baumgaertner, 2008).

Such PES-mechanisms might be used in agricultural landscapes in order to enhance biodiversity in its broadest sense by aiming at the following measures (see FAO 2007b):

i) reduction of agricultural expansion into areas rich in wild biodiversity.
ii) support for the adoption of biodiversity-friendly practices, such as the extension of natural vegetation, ecosystem-friendly resource management practices and integration of wildlife species in agricultural production systems
iii) promotion of the on-farm utilization of traditional but neglected PAGR.

While there are only a very limited number of examples for PES-like schemes in the context of PAGR[2], there are a few which promote ecosystem-friendly farm management practices[3].

[2] An exception is related to EU support payments for threatened breeds under Regulations 1257/99 and 1750/99 and the now completed GEF-funded project in Ethiopia “A Dynamic Farmer-Based Approach to the Conservation of African Plant Genetic Resources (see http://www.gefonline.org/projectDetails.cfm?projID=351) which are both PES-like, although not described as such.

Conservation efforts for wild biodiversity through PES are numerous. Accordingly, Landell-Mills (2002) identified 72 payment schemes for biodiversity, mostly in an experimental stage[4], while Ravnborg and et al. (2007) found that of 167 reviewed references, half of them were PES schemes dealing with biodiversity conservation. Most of these programmes focus on forest conservation by placing emphasis on the importance of avoiding agricultural land-use in biodiversity rich areas instead of promoting biodiversity-friendly practices in agricultural landscapes (FAO 2007b).

A comparative analysis of forest biodiversity PES schemes and potential PACS schemes suggests the following. The conservation of wild biodiversity is linked to promoting certain types of land-use, e.g. maintaining forest areas while halting the expansion of agricultural land. The intervention in the case of wild biodiversity is to discourage people from undertaking specific actions (including those that are nominally forbidden anyway, such as illegal timber extraction). While land-use change may also be a feature of PACS, interventions may be more closely associated with encouraging the continuation of an agricultural practice that leads to conservation through sustainable utilization of genetic resources on-farm.

The ecosystem services linked to wild biodiversity encompass regulating and supporting services (such as nutrient recycling, primary production, water regulation, soil conservation), as well as cultural values, existence values, and option values (MEA 2005). Therefore, wild biodiversity conservation is often associated with significant national or global public benefits. By contrast, PAGR are impure public goods, providing a mix of private goods, i.e. seeds with rival/excludable traits and national and global public goods, i.e. genetic information with non-rival/non-excludable characteristics (see Heisey et al. 1997; Smale et al. 2004; Eyzaguirre and Dennis 2007; Bellon 2008). Accordingly, private property rights are usually associated with the crop and livestock resources within which the genetic resource is embedded, while the attachment of property rights to the public good aspects is more complex and rare, but gaining more and more attention (Brush 2007; Bertachini 2008).

Consequently, the conservation of PAGR may be linked to the capture of more immediate private benefits, while maintaining wild biodiversity is not necessarily associated with generating direct use values for farmers. Furthermore, PAGR, especially crops, are normally managed under

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[3] For example: China's Grain for Green program which promotes reforestation in order to reduce soil erosion; the introduction of natural vegetation contour strips in the Philippines; integrating short-term improved fallow systems into smallholder agricultural systems in Kenya and Zambia; shade-grown coffee cultivation in Bolivia; windbreaks in Costa Rica; and the Silvopastoral Ecosystem Management Project (RISEMP), funded by the Global Environmental Fund (GEF) in Colombia, Costa Rica and Nicaragua (see FAO 2007b).

[4] See Annex 2 in Landell-Mills and Porras (2002). Further examples can be found in Mayrand and Paquin (2004, Appendix I) and in Kumar (2005, Table 6, p. 23).

private and relatively secure tenure rights. Accordingly, agrobiodiversity conservation activities can be associated with a single farmer, while wild biodiversity conservation may require the cooperation of much larger numbers of private individuals on common or on state-owned land. Finally, the verifiable indicators associated with a PACS scheme (e.g. land areas dedicated to specific landraces, amount of quality seed produced, number of animals of a specific breed) may be more easily observable than for wild biodiversity PES schemes. This is because, for the latter, there may be a high degree of uncertainty about the level of wild biodiversity associated with certain types of land-use.

3. From PES to PACS design

Given the special features of PAGR, PACS instruments might differ from genuine PES instruments and they may be very different from the tools originally used for the conservation of wild biodiversity. Based on the experiences from various PES schemes we define PACS as follows: *Payment for agrobiodiversity conservation services schemes are market-based instruments that increase the private benefits from utilizing plant and animal genetic resources on-farm by: i) alleviating market failures through individual-based or community-based reward mechanisms (monetary or non-monetary) for agrobiodiversity conservation; or ii) reducing market frictions by developing/improving market chains in order to increase the competitiveness of threatened species, varieties or breeds.* In what follows demand-side, supply-side and institutional factors are discussed for the design of PACS in comparison to PES with a focus on wild biodiversity. Table 1 provides a summary of this comparative analysis.

[TABLE 1]

3.1 Demand side constraints: Who pays for the service?

Contrary to so-called “genuine” – i.e. privately financed - PES schemes, many PES schemes are publically funded (Wunder 2005; FAO 2007b; Engel et al. 2008). The demand for wild biodiversity conservation is often a result of its global values and the numerous beneficiaries are dispersed, so that NGOs and other types of organisations often need to play an intermediary role as a service purchaser (Landell-Mills and Porras 2002; Mayrand and Paquin 2004)[5]. These schemes might also be categorised as “supply-based”, as they are directed towards ecosystem providers, with payments coming from non-private funds (Pagiola and Platais 2007).

[5] International conservation organisations and the Global Environmental Facility (GEF) are the most important actors on the demand side of biodiversity services (Mayrand and Paquin 2004).

Such public schemes emerge because the beneficiaries of the ecosystem services are not able or willing to pay due to high transaction costs and incentives to free-ride (Engel et al. 2008; Pagiola 2008). Firstly, high transaction costs may be an impediment to the functioning of markets for ecosystem services in developing countries (Landell-Mills and Porras 2002; Wunder 2005; Pagiola et al. 2007b). Secondly, even if market exchange can work smoothly, beneficiaries might not be willing to pay for the services they receive, due to the public-goods characteristics of the ecosystem services (Kroeger and Casey 2007; Turner and Daily 2008). Thirdly, difficulties in measuring service flows linked to biodiversity also contribute to this situation (Mayrand and Paquin 2004; Kroeger and Casey 2007).

Genuine PES schemes only work if the newly defined *property rights attached to the ecosystem service* fulfil the following criteria: i) the service is clearly defined, ii) enforceable, iii) verifiable, iv) valuable, and v) transferable and in many cases these criteria are not fulfilled for wild biodiversity conservation services (Murtough et al. 2002). Conservation of wild biodiversity can lead to some transboundary ecosystem service impacts that are difficult to define and measure, such as regulating and supporting services. Accordingly, the flow of such services is often only partially verifiable. Additionally, many of these services are not privately appropriable, due to their public goods characteristics, making rights over biodiversity difficult to enforce. Nonetheless, transfers between private agents are possible in certain cases. For example, agri-business/chemical companies sometimes pay for bioprospecting services and consumers in developed countries are willing to pay for biodiversity friendly products (see Landell-Mills and Porras 2002).

Similar issues apply for agrobiodiversity conservation. Beneficiaries of public good conservation services may be constrained in their willingness/ability to pay for these services. Regarding local public benefits (e.g. the maintenance of traditional knowledge and culture), the service user is the indigenous community itself, and such communities are often too poor to compensate service providers. At the global level, society as a whole is the beneficiary of conserving option values. Companies with forward or backward linkages to agriculture may, through potential future product development, be identified as an additional category of beneficiaries. However, the marginal commercial value of agrobiodiversity conservation is normally not high enough to fund larger-scale conservation efforts (Swanson and Goeschl 2000). Therefore, conservation agencies and international organisations that acknowledge the importance of agrobiodiversity conservation values have to take on the role of the service purchaser, including through the use of public funds that might have been generated through private sources (e.g. donations).

Yet other potential service purchasers might be identified due to the *private values* that can be attached to the production outcome from using PAGR. For example, local governments may purchase agricultural products made from nutritious but threatened PAGR and distribute these to schools (e.g. school-meal programme in Tamil Nadu, India), the army or other public facilities. Moreover, regional and global consumers have been shown to be willing to pay for agrobiodiversity-related products in order to satisfy very specific tastes and preferences through eco-labelling and certification schemes. Even though such private-based schemes that build on agricultural market channels fulfil all the criteria of genuine PES-schemes and thus may enhance certain conservation services, they may not align the private incentives with the total social benefit, as public conservation values are not necessarily incorporated in the private benefits from conserving PAGR.

3.2 Supply side constraints: Which service providers to address?

Payment/rewards from PES programmes are directed toward farmers whose land management decision has an impact on the flow of ecosystem services. PES for biodiversity conservation normally focuses on farmers that pose a *serious threat* (in the short-run and in the long-run) to resources deemed worthy of conservation (Wunder 2007; Asquith et al. 2008). While targeting small farmers with a low impact on ecosystem services may not result in the desired level of ecosystem service provision, small farmers often do in fact pose a major threat to biodiversity-rich areas by expanding their land-use into marginal zones of forest areas (Swallow et al. 2005). As many valuable ecosystems are located in rural areas of developing countries, where many of the world's poor people live, PES can play a role in assisting poor farmers (Gutman 2003; Pagiola et al. 2005).

In PACS schemes the potential service providers are farmers that carry out de-facto conservation of threatened PAGR. Such communities, which are frequently located in relatively remote areas and consist of indigenous small-scale farmers, play a key role in the conservation of species, varieties or breeds with unique adaptive traits (e.g. disease resistance, drought tolerance) bred over thousands of years of domestication across a wide range of environments. But also in such communities agrobiodiversity is increasingly lost due to higher financial profitability of improved varieties and cash crops (Brush and Meng 1998; IPGRI 2002; Andersen 2003; Gruère et al. 2008). Focusing on de-facto conserving communities, PACS involves land-users whose changing preferences may result in further genetic erosion in future seasons as a result of "neglect", whereas most PES schemes address landholders that pose an immediate and "active" threat to conservation. Given that such de-facto conserving communities might switch to improved varieties and breeds as soon as the production environment becomes more favourable, PACS schemes could bring substantial conservation benefits at least-cost over the medium- to long-term.

Generally, PES schemes target service providers who hold land capable of generating ecosystem services. Yet this focus on de jure land titles might ignore many de-facto land-users (i.e. people able to access specific land areas regardless of tenure). Tenure arrangements are location-specific, shaped by historical and political factors, and in PFC they are often not solely based on private resource ownership (Bracer et al. 2007). Many farmers whose practices have an impact on wild biodiversity use public or communal land (e.g. in frontier areas of the tropics). Where land-users do not have formal land rights, PES schemes should not focus only on titled land-users but also on de-facto users, as such de facto users are particularly important in the context of PFC (Rosa et al. 2004; FAO 2007b; Wunder 2007). Land rights over crop agricultural land are normally better established, as farmers would not invest in agricultural production if their land-use rights (or at least their rights to harvest the crop) were not relatively secure (see e.g. Deininger and Jin 2006). Nevertheless, in some country contexts PAGR are managed by landless resource users on land that they do not formally hold (Eyzaguirre and Dennis 2007; Howard and Nabanoga 2007). For instance, livestock is often held on grazing land with relatively less private tenure security (e.g. forest land margins) and/or on common rangelands (see Anderson and Centonze 2007).

3.3 Institutional constraints: How to match beneficiaries and providers?

Many studies identify a number of generic institutional constraints in designing PES schemes (e.g. Ferraro and Kiss 2002; Ferraro and Simpson 2002; Pagiola et al. 2002, 2004, 2005; and Wunder 2005, 2007). PES/PACS schemes may require the creation of new institutions[6] of exchange and market arrangements in order to implement negotiation, transaction, monitoring and enforcement mechanisms (Wunder 2006; Bracer et al. 2007; Cobera and Brown 2008). Yet *PES institutions are also likely to need to interact with existing institutions,* for example those related to property rights, as well as those related to current patterns of access, exchange, use and management (Bracer et al. 2007, Corbera et al. 2007b).

Where PES focuses on land-users with insecure tenure rights, this can provoke *tenurial conflict*. For instance, *de facto* forest land-users might be excluded from land they used to access as part of improved forest management practices. Similarly, more powerful farmers might oust smallholders from the land they use in order to obtain the rewards from PES programmes (Landell-Mills and

[6] Leach et al (1999) define institutions in the context of natural resource managements as regularised, either formalised (e.g. law) or informal (e.g. habits and traditions), patterns of behaviour between individual and groups in society that shape the ways in which people command ecosystem goods and services. Thus they may be understood as mediators between agro-ecosystems and farmers.

Porras 2002). Accordingly, PES schemes need to carefully consider whether they might have the unintended consequence of excluding poor farmers from land they used to access and manage. By contrast, PACS schemes, particularly for crop genetic resources, might be expected to engender few tenurial conflicts, as farmers with agricultural land often have relatively more secure tenure or usufruct rights and, in order to fulfil their PACS contract, they do not need to exclude any *de facto* users.

Additionally, PES shape new forms of *property rights* by defining service providers (i.e. those who have rights to use the natural resource) and service beneficiaries (i.e. those who have rights over the service stream). In doing so, PES may run the risk of endorsing illegal resource utilization, such as land-use of common or national forest areas, and thus clash with existing local or national laws. By contrast, PACS schemes are unlikely to face such issues, as they are simply building on farmers' existing rights to use their land for any agricultural practice.

With regard to other institutions, PES/PACS schemes often involve intermediaries that act as transfer agents or brokers in the *negotiation* process. They play a key role by establishing contact between different actors, by providing new information, by extending and linking existing networks and by assisting in contracting (Bracer et al. 2007). PACS schemes that depend on developing existing agricultural market chains would be one example of where these roles may be carried out by the market itself, assuming adequate market development takes place.

Concerning *payments/rewards*, the PES/PACS design has to identify: i) which environmental service should be paid for; ii) how much should be paid; iii) who should be paid; and iv) what type of payment mechanism should be used (FAO 2007b). More specifically, this comprises the amount of payments, the distribution of such payments (individual-based versus community-based), the payment mode (cash versus in-kind), the timing of payments and the length of a contract. All these issues are very context-specific (see e.g. Wunder et al. 2008).

With regard to *monitoring and enforcement*, institutional arrangements have to be created that deal with baselines, verification of service delivery and sanctions in case of non-compliance. Determining baselines requires the construction of performance metrics that allow evaluation over the contract period. Such performance indices should be easily understandable, but should also be a proxy for ecosystem service delivery (Tomich et al. 2004). As biodiversity *per se* can be difficult to measure directly, many PES schemes use a second-best approach which focuses on promoting specific types of land-use that can be expected to lead to higher levels of biodiversity. Nevertheless, links between specific land-uses and ecosystem service delivery may be poorly understood, so that some PES schemes might be based on weak scientific foundations (Wunder et al. 2008). By contrast, the conservation of PAGR can be directly linked to land allocated to specific plant genetic resources and seed saved from the previous harvest or to specific livestock populations. Such *performance measures* may thus be easier to link to agrobiodiversity conservation. This is despite the fact that some diversity metrics are based on rather complex concepts, for example indices based on relative abundances or dissimilarity (see Baumgärtner 2008 for a useful discussion of diversity metrics).

Moreover, the conservation of PAGR may largely be undertaken on agricultural lands under the farmer's private ownership, while the loss of wild biodiversity may occur on any land that is accessible to a community member. Hence, the area to be controlled for is likely to be much larger in case of PES than in case of PACS. Taken together, monitoring requirements may be greater under programmes for the conservation of wild diversity than for conserving PAGR. Accordingly, the extent and the frequency of controls, as well as sanctions for non-compliance, may not need to be as high under PACS schemes as under PES in order to ensure compliance.

4. A comparative analysis of the performance of PES versus PACS

Following Adger (2003), PES and PACS may be evaluated concerning their *effectiveness*, *efficiency*, and *equity* outcomes, as all these factors might undermine the *legitimacy* of such programmes. Given the dynamics on the supply- and demand side, and the many institutional considerations, PES (and by extension, PACS) schemes may not be successful if their potential outcomes are not carefully evaluated *ex ante*. PES/PACS schemes might not attain their conservation goal (*effectiveness*), they may not reach the goal at least cost (*efficiency*), or they may lead to unfair distributional outcomes (*equity*).

4.1 Ecological effectiveness: Reaching the conservation goal

PES/PACS schemes may not provide the necessary level of ecosystem services if: i) payments are not sufficient to compensate for opportunity costs, i.e. land-users who can potentially provide ecosystem services do not enrol in PES/PACS; and if ii) rules are not effectively enforced, i.e. land-users do not comply with the contractual conditions related to specific land-use requirements. However, even if the above are not constraints, PES schemes can only be considered to have been effective (i.e. lead to a higher level of ecosystem services), if the following conditions are fulfilled: a) the level of ecosystem services would be lower without the programme (*additionality*); b) the scheme does not adversely affected non-targeted ecosystems (*leakage effect*); and iii) the gain should be permanent (*sustainability*) [Sierra and Russmann (2006)].

Additionality is not achieved where the promoted land-use does not bring the desired level of ecosystem services. Although due to scientific uncertainty there might be PES schemes that foster land-uses that do not actually enhance the flow of targeted ecosystem services, this is rather unlikely if PES schemes foster the conservation of areas near-natural conditions (Wunder et al. 2008). However, a*dditionality* is sometimes not achieved where farmers receive payments who would have used the land in an environmentally-friendly manner anyway. Nevertheless, it would be considered highly unfair to pay farmers who pose a threat to biodiversity, while farmers who conserve biodiversity do not obtain any reward. This might even create perverse incentives, i.e. forest conserving farmers log their trees in order to receive payments for undertaking reforestation afterwards (Pagiola and Platais 2007). PACS schemes that focus on *de-facto* conservers of agrobiodiversity might be considered to have fairly low levels of additionality associated with them unless land areas dedicated to specific varieties or numbers of a given breed are already below the level that is being targeted by the PACS scheme (often associated with a safe minimum population measure). However, given the existence of downward population trends for targeted species/varieties or breeds, additionality may be considered to increase over longer time periods. Furthermore, Weitzman (1992, 1993) provides a strong justification for interventions designed to secure the continued existence of unique genetic resources that contribute significantly to overall diversity prior to their actually becoming threatened. Such interventions may also be much more cost-effective than once much smaller and threatened population levels of the resource in question have been reached.

PES and PACS might be associated with *leakage* at different scales. In the case of conserving wild biodiversity, farmers might simply move some of their biodiversity-threatening land-use activities to places that lie outside of the area monitored by the PES programme. Similarly in the case of PACS, farmers planting targeted PAGR on monitored land areas might clear land in non-targeted areas, in order to go on cultivating certain improved varieties or cash crops. Where such areas are wild biodiversity-rich lands, this would be a cause for concern. However, such (agriculturally marginal) land types may not be particularly appropriate for improved varieties/cash crops. Alternatively, PACS schemes might result in leakage at the farm level if farmers were to replace other threatened livestock breeds and crop varieties by the targeted PAGR. Such a case may be of particular concern where it is possible to develop profitable markets for some (but not all) targeted species/varieties and breeds.

The *sustainability* of both PES/PACS schemes, i.e. the permanence of providing conservation services, depends very much on the length of payment flows. In many cases farmers do not self-sustain certain land-uses or agricultural practices once payments dry up (e.g. Uchida et al. 2005; Pagiola and Platais 2007; Pagiola 2008; Wunder and Alban 2008). As with PES, the sustainability of PACS depends on the nature of the source of funding. Where compensation flows are not generated by pure market transactions, but through public funds, the finite nature of such funds might result in a limited life-span of such programs and thus undermine their sustainability. Yet the relatively low opportunity costs faced by farmers who are already carrying out *de facto* conservation of specific varieties means that the level of conservation funding required may in fact be relatively small, particularly when compared to other types of agricultural subsidy. Together with the potential for market chain development for some targeted varieties, this suggests that sustainable sources of PACS funding could be found. The sustainability of PACS schemes may also be enhanced through a regular re-assessment of the targeted species/varieties or breeds that form the priority conservation portfolio. As threat levels and opportunity costs change, so will the targeted species/varieties or breeds thereby ensuring that the PACS scheme is both diversity-maximising and cost-effective.

4.2 Economic efficiency: Least-cost conservation

Efficiency depends very much on the effectiveness of PES programmes. If no additional ecosystem services are generated, any payment would be a waste of scarce resources. If PES contribute to ecosystem service provision, then efficiency is related to total implementation costs, as least-cost schemes do not compensate farmers for the total economic value of the conservation service they provide[7]. Total costs comprise: i) *opportunity cost* payments to the farmer, ii) *implementation costs* and iii) *transaction costs* (Wunder et al. 2008).

Opportunity costs are the forgone benefits for alternative land-uses to the farmer. If the opportunity costs for other land-uses are comparatively high, payment levels have to be correspondingly high. From a cost-efficiency point of view, PES schemes should be directed at areas where land opportunity costs are low but there is high potential to provide non-agricultural ecosystem services (i.e. high environmental benefits), as is the case in dryland areas (Lipper et al. 2006). Accordingly, Wunder (2007: 56) states: “PES makes most sense at the margin of profitability, when small payments to landowners can tip the balance in favour of the desired land-use”. Least-cost conservation of PAGR would focus on species/varieties/breeds and agricultural practices that provide considerable private values to the farmer and high public values to wider society (Smale et al. 2004). As PFG are often carrying out *de facto* conservation, they may be

[7] Accordingly, economic efficiency can also be understood as cost-effectiveness.

expected to provide opportunities to implement relatively low-cost conservation strategies, because such communities have very low (close to zero) opportunity costs. By contrast, reward-levels for PES schemes may be higher than those for PACS, since farmers' opportunity costs of not using land for agriculture would normally be expected to be higher than those of agreeing to continue the existing agricultural practice or undertaking an alternative one.

In addition to opportunity costs the farmer could incur *implementation costs* if investment in land-use change is required. While opportunity costs are permanent costs, implementation costs are often one-off costs associated with changing the agricultural system to a more environmentally-friendly land-use such as silvopasture (Pagiola et al. 2004). PES schemes might be expected to involve higher implementation-costs, since they are directed towards land-use changes (e.g. afforestation). Contrarily, PACS are not associated with any implementation costs if the focus is on the de-factor resource users or they might require less costly interventions, where farmers change their agricultural practice (e.g. improving access to certain seeds or agricultural knowledge, assistance with rotation of male breeding animals between villages, etc.).

Transaction costs occur in any PES/PACS programme. Start-up costs (such as costs of search, information, program design, negotiation and contracting) and permanent costs of running the scheme (administration, monitoring, enforcement) form part of the overall programme costs and thus contribute to determining the degree of efficiency in achieving the specific outcomes of the scheme (Wunder 2007). As conservation of PAGR may be relatively easier to monitor and to enforce, transaction costs might be expected to be lower for PACS than for PES. Where PACS/PES schemes can focus on communities rather than on individuals, some cost savings might be obtainable, since economies of scale tend to reduce average transaction costs. Contracting a few large farmers rather than many small ones, as do some PES-schemes, could also be a strategy to reduce transaction costs (Pagiola et al. 2005, Wunder and Alban 2008)[8]. However, where the PACS goal is to conserve local public values (such as traditional knowledge and culture), rather than just national/global option values, a minimum network/number of farmers would still be required. Furthermore, there is also a trade-off between efficiency and equity that needs to be considered (Wunder 2007).

4.3 Social equity: Pro-poor outcomes

Many authors have highlighted the potential of PES schemes as a multipurpose instrument, with their design guided by different motivations, such poverty reduction and social equity in addition

[8] For instance, the 'Coffee and Biodiversity' project in El Salvador has widely ignored smallholders (Rosa et al. 2004).

to their environmental goals (e.g. Landell-Mills and Porras 2002; Rosa et al. 2004; Cobera and Adger 2004; Grieg-Gran et al. 2005; Pagiola et al. 2005; Swallow et al. 2007; Wunder et al. 2008; Bulte et al. 2008, Wunder 2008). But if PES were to be used primarily used as a poverty alleviation instrument, there would be other – more cost-efficient ways – of reaching such goals (Wunder 2005). As PES programmes may be considered to have their primary emphasis on their environmental outcomes (Wunder 2007), it may be that a socially desirable goals need to be traded-off or even that existing inequities and vulnerabilities are exacerbated (for example, see Corbera et al. 2007a, Corbera et al. 2007b, van Noordwijk et al. 2007). As such outcomes might prove to be destructive for poor farming communities and might undermine the success and legitimacy of PES, there is a need to take equitable mechanisms on board (Swallow et al 2007). Such mechanisms would imply a three-tiered equity framework, as developed by Brown and Corbera (2003) who consider: i) equity in decision-making, ii) equity in access and iii) equity in outcome.

Firstly, *equity in decision-making* is reached through procedural fairness. That means that different stakeholder groups should have an opportunity to participate in the design of PES/PACS schemes, or at least their interests should be taken into account. Otherwise, powerful actors who are generally more likely to intervene in decision-making processes could quite easily favour a design that supports only their narrower interests, for example shaping new property rights in such a way as to reinforce existing imbalances.

Secondly*, equity in access* is based on farmers' potential to participate in PES/PACS programmes. To determine household participation, the following factors have to be analysed: i) eligibility to participate; ii) desire to participate; and iii) ability to participate (Pagiola et al. 2005*). Eligibility to participate* depends on the degree of targeting. PES schemes for wild biodiversity conservation generally focus on poor farmers that tend to clear forest for agricultural land, but participants may be required to have a minimum farm size for cost-efficiency reasons. In some contexts the *ability to participate* is positively linked to household wealth variables (Zbinden and Lee 2005) and to tenure security which might exclude the poorest (Wunder 2005, Grieg-Gran et al. 2005, WWF 2006). Transaction costs imposed on participating farmers may be an additional impediment for poor households (Rosa et al. 2004, Wunder 2005, WWF 2006, Pagiola et al. 2007b, Pagiola 2008). The *desire to participate* is determined by the payment levels and these should be higher than the opportunity costs incurred. Poor households dependent on subsistence agriculture may nonetheless incur high relative opportunity costs of using land for conservation rather than primarily for food production (Börrner et al. 2007). Taken together, PES schemes might favour wealthier households[9]. Nevertheless, small-scale farmers may also be least-cost providers of agrobiodversity conservation services. It seems probable that de-facto conserving farmers of traditional PAGR belong to marginalised groups of societies in developing countries, so that PACS might enhance equity by giving such groups access to reward mechanisms and facilitating their ability to participate in such schemes.

Thirdly, it would be desirable for PES/PACS schemes to support *equity in outcome.* PES/PACS have an impact on the natural, financial, physical, human, and capital assets rural households can command (Landell-Mills and Porras 2002). *Natural assets* in the form of ecosystem goods and services are supposed to increase for ecosystem beneficiaries. While benefits from wild biodiversity conservation may have a large regional or global dimension, agrobiodiversity conservation services also benefit local users directly through continued access to a diverse portfolio of genetic resources, as well as for socio-cultural reasons. Additionally, ecosystem service providers may take advantage of increased land values due to PES payments (see Engel and Palmer 2008). Moreover, in case of monetary rewards, participating farmers can benefit from additional weather-independent incomes and thus are able to diversify their incomes (Grieg-Gran and Bann 2003, Mayrand and Paquin 2004)[10]. As a lack of *financial capital* is often an important impediment to further development, PES/PACS-related incomes can serve as multipliers to boost local production (Wunder 2006) in order to overcome poverty traps. If PES/PACS are linked to infrastructure development they can also improve the *physical assets* of the participating communities. Furthermore, PES/PACS could also enable poor farmers to build *human and social capital* under certain conditions, for example through improved ability to negotiate with companies (Engel and Palmer 2008) or with funding bodies (Grieg-Gran and Bann 2003, Rosa et al. 2004). However equity in decision-making and in access are necessary preconditions for obtaining a fair distribution of such assets.

In addition to that, PES/PACS might have an impact on non-participating farmers as well as landless consumers and landless workers. Large scale conservation programmes might lead to rising food prices and job-losses in biodiversity-threatening sectors (e.g. agriculture and logging), so that it has been pointed out that PES might involve a negative impact on these non-participants (Wunder 2005; Wunder 2008; Zilberman et al 2008). Whereas PES most often reduces the land area under agriculture there is no such impact in PACS. PACS with a focus on often nutritious,

[9] There are a number of examples of PES schemes that favour wealthier farmers (Kerr 2002, Zbinden and Lee 2005, Wunder and Alban 2008). Conversely, the example of the Integrated Silvopastoral Ecosystem Management Project illustrates that poor households are not automatically neglected/excluded (Pagiola et al. 2007b, Pagiola et al. 2008).

[10] Grieg-Gran et al. (2005) reviewing eight case studies and Wunder et al. (2008) summarising results from 13 case studies found positive (but rather small) income effects for participating households.

adaptive and resistant PAGR are likely to improve sustainable agricultural practices and may also increase food production in terms of quantity and quality. While many cash crops are cultivated for export markets, the promotion of local PAGR could directly enhance the nutrition of local farmers, as well as local consumers, that do not participate. Additionally, PACS help to maintain local traditions and culture and thus social cohesion in PFG by promoting the utilization of traditional PAGR. In sum, there are some reasons to expect that the impact of PACS on participating and non-participating households may well have the potential to be more pro-poor than that of PES, but this will be very context-specific.

5. PACS instruments for strengthening the sustainable on-farm use of PAGR

In the following section a number of potential PACS instruments, such as direct reward mechanisms (DRM), competitive tender approaches (CTA) and market chain development (MCD), together with potential differences in their performance, are discussed (see Table 2 for a summary). While such PACS instruments aim at increasing the demand for agrobiodiverse resources, constraints to the supply of certain PAGR resources might also be tackled at the same time. This might encompass instruments that improve credit availability, improve certain infrastructure (e.g. for processing), facilitate access to seeds/breeding males, and provide information about variety/breed traits and best practice management.

5.1 Direct reward mechanisms (DRM) to individual farmers

DRM come closest to the instrument used in genuine PES and PES-like programmes. A certain compensation level would be offered for conserving the targeted PAGR. Given these in-kind or cash rewards, farmers can decide how much land they allocate to the PAGR. On the demand-side, given that it may be difficult to generate funds from private sources, conservation agencies may have to play the role of the conservation service purchaser. On the supply-side least-cost DRM would be obliged to focus on communities that conserve high agrobiodiversity values (in terms of heterogeneous systems or very unique species) at very low (close to zero) opportunity costs.

Accordingly, the potential *effectiveness* of DRM depends very much on the reward levels offered. By addressing de-facto conservers, payment levels might be minimised, but also *additionality* would be restricted in the very short-run. Moreover, *leakage* on non-targeted areas at local and regional level, as well as on non-targeted PAGR on-farm might occur, as previously discussed. Nonetheless, although it is clear that DRM could provide incentives for the continued use of different threatened PAGR, the *sustainability* of such public-funded programmes would be closely linked to the length of the programme. The permanence of such conservation efforts, given limited public funds, must therefore be carefully considered (Pagiola and Platais 2007; Pagiola 2008), particularly given the near permanence of many types of agricultural subsidy that often create an uneven playing field between "improved" and local species/varieties/breeds in the first place.

The potential *efficiency* of schemes in which public sector organisations act as buyers of an environmental service and set a price, depends very much on their ability to identify valuable services and to estimate values appropriately (Pagiola et al. 2007a). DRM do not generally include a mechanism for identifying least-cost service providers. In fact, farmers might be able to receive rewards that are much higher than their opportunity costs, as there is no cost-revealing mechanism in DRM. Due to hidden information (adverse selection) farmers might also be able to negotiate PES payments that are above their real opportunity costs (Ferraro, 2008). In addition to payments associated with rewards, DRM involve other costs, for example transaction and programme implementation costs. However, these cost levels and thus their impact on the efficiency of DRM are very context-specific, depending on the institutional arrangements in force to encourage farmers to participate in and comply with conservation contracts.

Regarding *equity* outcomes, DRM have the potential to increase the asset endowments of participating farmers through the generation of additional income flows (if rewards are in cash), through infrastructure development, access to education or health systems, or by developing social networks (if rewards are in-kind) and through the sustained utilization of a diverse genetic portfolio. In sum, the pro-poor impact of DRM depends on the wealth status of participating farmers. The poorer the participants are the more positive is the equity outcome. If it is found that the least-cost conservers of agrobiodiversity are indeed the poorest farmers in society, then DRM could be considered as a potential means to empower poor farmers and to contribute to sustainable livelihoods.

5.2 Competitive tender approach (CTA)

A local crop variety tender is a type of auction mechanism. Communities that manage a certain level of crop and livestock diversity are invited (and provided with support) to submit proposals that outline areas of their properties which they are prepared to manage to a specified minimum standard for a suggested price. All bids are assessed on the agrobiodiversity significance of the bid area and the bid price, selecting the most cost-effective bids for funding. Examples so far are largely found in developed countries and apply to agrobiodiversity conservation at landscape level (see e.g. Bertke and Marggraf 2005; Stoneham et al. 2008).

CTA seeks to tackle the existence of information asymmetries. Normally, farmers are best placed to know the real opportunity costs of conservation, while environmental experts know most about the ecological significance of the natural resources managed by farmers (Latacz-Lohmann and van der Hamsvoort 1997). The tender process provides a framework where the purchaser identifies the outcomes that are required and the supplier identifies the cost of providing these outcomes, thereby allowing cost and benefit information to be revealed by the parties with the best knowledge. The competitive process limits the scope for rent-seeking behaviour and helps to ensure that environmental benefits are generated at lowest cost (Latacz-Lohmann and van der Hamsvoort 1997).

CTA can thus potentially lead to substantial *cost-savings,* as farmers and/or farming communities have an incentive to apply for tenders very close to their opportunity-costs in order to ensure that they are given the contract. Yet implementation costs are expected to be high for CTA, due to the process of inviting communities or individuals to submit tenders and due to the selection process of applications. By contrast, overall, transaction costs might be lower for CTA where economies of scale exist as a result of a community-level focus.

In terms of *effectiveness*, CTA might be even more promising if they focus on communities rather than on individual farmers. As conservation of many biodiversity components is linked to certain threshold effects, the collective action of farmers is important for maintaining a minimum population size (Landell-Mills and Porras 2002, Swallow et al. 2005). Accordingly, community-based CTA might ensure that a sufficient level of genetic diversity is conserved. Regarding additionality, leakage and sustainability, CTAs are associated with challenges similar to those associated with DRM.

Similar to DRM, the equity impact depends very much on the wealth of participating farmers and communities. CTA might contribute to pro-poor outcomes via the empowerment of PFC when enhancing financial, physical, human, social, and natural assets in the poorest sectors of society through the reward mechanism. If CTA provide rewards at a community level, the intra-community equity outcome depends very much on how the new resources will be distributed within the community. A community-level CTA focus might bring additional benefits through the strengthening of collective action institutions. Such community-based approaches could foster the self-organisation skills of such communities, as well as adaptive co-management of natural resources (Tompkins and Adger 2004; Folke et al. 2005).

5.3 Market chain development (MCD) for enhancing the competitiveness of PAGR

The creation of sufficient demand for agrobiodiversity conservation services might be one major impediment for the generation of necessary funds, either for direct payments or for competitive tenders. But as PAGR are directly linked to agricultural output, agricultural market channels can potentially provide farmers the necessary incentives to conserve genetic diversity (FAO 2007b). MCD might be a means to increase the value to certain PAGR by enhancing the competitiveness of the final (agrobiodiversity-related) product. Following Will (2008), MCD seeks to increase the returns to the final product by increasing the value-added at every stage (production, processing, trading) of the market chain by involving different actors (farmer, trader, processor, retailer, consumer).

To unlock the full potential of products from small scale farmers, MCD needs to aim at addressing specific constraints along the value chain. As small-scale farmers have limited access to capital, education, market information and marketing institutions, MCD might include measures comprising improvement of managerial skills, certification and vertical co-ordination to deliver products to markets, access to processing facilities, insurance against price fluctuations and quality labour inputs. In addition to such supply-side interventions, the demand for agrobiodiversity related products could be increased through establishing eco-labelling, certification, or origin schemes and the development of niche markets by focusing on very specific attributes that make agrobiodiversity related products suitable for certain consumer groups (Hermann and Bernet 2009), e.g. for diabetics or for consumers of organic products. Consequently, MCD brings innovation in the form of new products and processes, new technologies or new institutions, benefiting the relevant actors directly or indirectly (Bernet et al., 2006). Examples of MCD projects and related research for threatened PAGR are becoming more and more widespread (for example, see Daniel and Dudhade 2007; Gruère et al. 2007; Irungu et al. 2007; Krishna and Pascual 2008; Hermann and Bernet 2009).

Regarding the potential *effectiveness* of MCD, the exploitation of new or underutilized market opportunities leads to permanent income flows from consumers to farmers, so that the sustainability of such instruments is given as long as appropriate market conditions and consumer preferences can be sustained over long periods of time. Yet, generally relatively few crop species/varieties or breeds will be able to benefit from MCD, so that such PACS instruments are unlikely to contribute to the enhancement of the full range of agrobiodiversity. If MCD involves the generation of significant value-added, it might be associated with leakage effects, as the targeted PAGR become more preferable, while other threatened resources might be displaced by them and disappear from production systems. Land clearing may also occur in order to cultivate more of the newly profitable species/varieties in circumstances where the targeted PAGR could be managed on marginal land.

In terms of *efficiency,* MCD may be self-financing through the value-added generated at different stages of the value chain. Transaction costs for market participation may also be relatively small, depending on the type of market development that takes place. However, as the reduction of market frictions may require a substantial initial investment associated with value chain development and may result in providing incentives for production far in excess of that needed to maintain a minimum population size for the long-term survival of the threatened species, the same conservation goal might be reached more efficiently through an alternative mechanism. It is currently unclear if the one-off start-up costs involved in MCD are higher or lower than the sum of payments needed over time to guarantee the sustained use of threatened PAGR via DRM or CTA. Moreover, the scale of intervention due to MCD may not be related to achieving just a safe minimum standard. It could be far above this level, resulting in poor cost-efficiency from a purely conservation perspective

Concerning *pro-poor outcomes*, MCD may create higher incomes for farmers selling products related to the targeted PAGR, as the reduction of market frictions can lead to a significant increase in value-added. Yet such incomes might be subject to high price fluctuations (Hermann and Bernet 2009), so that the newly generated income flow would be much more variable than in the case of DRM or CTA. As supply-side based MCD may involve infrastructure improvement, technical training, and the building of networks related to the sustainable use of the targeted PAGR, poor farming communities may be empowered through the development of physical, human and social capital in addition to higher incomes. Yet only farmers that are able to participate in agricultural markets can take advantage from these benefits. It might be hypothesised from existing experiences regarding market participation, that wealthier farmers might face fewer constraints to do so. Under such a scenario, MCD would exacerbate existing inequities. Certainly, the potential socio-ecological impact of increased market integration on indigenous communities requires careful consideration.

[TABLE 2]

6. Conclusions

This paper seeks to establish a framework for evaluating the potential of payment for agrobiodiversity conservation services (PACS) schemes to provide an incentive mechanism for achieving conservation through the sustainable use of threatened animal and plant genetic (PAGR) resources in poor farming communities (PFG). The framework builds on the experiences from numerous payment for environmental service (PES) approaches and considers supply-side, demand-side and institutional factors, as well as potential instruments that are evaluated according to their ecological effectiveness, economic efficiency and social equity. PACS schemes can be understood as market-based solutions that can increase the private benefits from utilizing targeted PAGR and thus foster the sustainable use of threatened species on-farm by: i) alleviating market failures through individual-based or community-based reward mechanisms (monetary or non-monetary) for agrobiodiversity conservation; and/or ii) reducing market frictions by developing/improving market chains in order to increase the competitiveness of specific species/varieties/breeds.

PACS schemes potentially differ in some aspects from PES schemes for wild biodiversity due to the specific features of PAGR. PACS schemes have a number of demand-side, supply-side and institutional constraints to overcome, as do PES programmes. For instance, the sources of funding for the reward mechanisms are an issue for both. While the effectiveness of such schemes is very much context-specific, conservation goals of PACS may potentially be achieved at lower cost, as such schemes may be designed to focus on sustaining existing agricultural practices, while PES are more likely to be based on encouraging desirable land-use changes. By focusing on marginalised groups of society, i.e. small-scale indigenous farm communities who still have strong preferences for specific local species/varieties/breeds, PACS may also have a greater pro-poor potential. Nevertheless, careful analysis remains to be undertaken with regard to which kind of farmers within these communities are able to capture the benefits of PACS schemes. If these turn out to be the wealthier and more powerful farmers, PACS could exacerbate existing inequity within such communities. By contrast, if it is indeed the poorest households who conserve traditional PAGR at least-cost and if they can be compensated for their conservation efforts through PACS, such programs could be associated with pro-poor outcomes. In sum, PACS schemes potentially have a twofold role in building sustainable livelihoods in PFC, i.e. i) by conserving agrobiodiversity important to the livelihoods of the poor and ii) by empowering poor farmers through their reward mechanisms.

Potential PACS instruments, such as direct reward mechanisms (DRM), competitive tender approaches (CTA) and market chain development (MCD) were discussed with regard to their potential effectiveness, efficiency, and equity outcomes. It appears that MCD is an attractive instrument for taking advantage of private values associated with certain agrobiodiversity conservation services. Such “conservation-through-development approaches” can potentially be much more sustainable than other approaches, as they build on existing agricultural market channels and generate a sustainable source of incentive funding. In conclusion, some of the main differences between MCD, on the one hand, and CTA and DRM, on the other hand, can be understood in the context of the proverb: “Give a man a fish and you feed him for a day. Teach a man to fish and you feed him for lifetime”. As Wunder (2007) notes, this proverb explains the attraction of “conservation-through-development approaches”, such as MCD.

However, under certain circumstances it might be better to pay for a fish every day. In terms of equity, MCD may itself have negative socio-cultural impacts that need to be taken into consideration. Regarding efficiency, MCD requires substantial investment into agricultural market channels and thus DRM and CTA might be a more cost-effective means for conserving a minimum population of threatened resources. Moreover, the scale of intervention due to MCD may not be related to achieving a safe minimum standard. It could be above this level (thus being in-efficient) or below (thus being in-effective). With regard to the latter, MCD cannot help to reach certain conservation goals, i.e. they would be in-effective instruments for those species/varieties/breeds with a much lower current market potential. As MCD may only be able to target relatively few PAGR this instrument may even contribute to the loss of other, non-targeted, but threatened genetic resources and thus undermine agrobiodversity. In this context, CTA and DRM are better suited, as they directly determine the necessary scale of intervention in order to maintain a safe minimum population. It therefore appears that DRM, CTA and MCD may in fact be complements, with each of them enjoying a comparative advantage under different circumstances.

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Table 1: From PES to PACS

	PES for wild biodiversity conservation	**Payment for agrobiodiversity conservation services (PACS)**
supply side factors		
service provider	-land-users in general that affect ecosystem service provision -often poor farmers in frontier areas	- farmers that are de-facto conservers of traditional PAGR -often poor farmers in remote areas
targeting	- farmers that pose an immediate and "active" level of threat on wild biodiversity	-farmers whose changing preferences result in a limited level of threat during the current season but through future neglect may result in a more serious threat in the future
land-titles	-may involve insecure and de-facto usufruct rights	- relatively more secure titles and/or usufruct rights
demand side factors		
service beneficiary	- national and global society	- national and global society -local society (e.g. the: farming community itself)
generic institutional constraints		
tenurial conflict	- de-facto land-users might be excluded	- relatively less potential exclusion of de-facto land-users
property rights	- need to avoid perverse incentives e.g. rewards for not doing something that was illegal anyway	-usually acknowledge farmers' rights to use their own land for any agricultural practice
negotiation	-intermediary	-intermediary / market
payment/contract length	-context-specific	-context-specific
monitoring	-performance measure: land area under certain use ➔ not necessarily linked to ecosystem service delivery - land area to account for is generally large	-performance measure: land area under certain plant species, seed saved, number of animals of a given breed, etc. ➔ relatively more easily observable and directly linked to conservation goal
enforcement	-frequency/extent of monitoring and associated enforcement mechanisms may be high	-frequency/extent of monitoring and associated enforcement mechanisms may be lower

Table 2: Comparative analysis of potential outcomes of alternative PACS-instruments

	Direct reward mechanisms (DRM)	Competitive tender approach (CTA)	Market chain development (MCD)
effectiveness			
participation	-depends on reward level	- open to actors that are able to submit least-cost bids	-depends on value-added and market-accessibility
additionality	-due to focus on least-cost *de facto* conservers, low in current season but potentially higher in medium- to long-term	- due to focus on least-cost *de facto* conservers, low in current season but potentially higher in medium- to long-term	-high for the targeted but relatively few PAGR
leakage	- wild biodiversity in non-targeted areas at local/regional level - successful intervention may in some cases displace other non-targeted but threatened PAGR resulting in a decline in overall diversity *per se*	-wild biodiversity in non-targeted areas at local/regional level - successful intervention may in some cases displace other non-targeted but threatened PAGR resulting in a decline in overall diversity *per se*	-wild biodiversity in non-targeted areas at local/regional level - successful intervention may in some cases displace other non-targeted but threatened PAGR resulting in a decline in overall diversity *per se*
sustainability	- scale of intervention can be designed to achieve a safe minimum standard/ population for threatened resources -but this depends on the availability of public funds, which are potentially limited	- scale of intervention can be designed to achieve a safe minimum standard/ population for threatened resources -but this depends on the availability of public funds, which are potentially limited, although less so than for DRM due to potentially lower overall costs (see below)	- scale of intervention may not be related to achieving a safe minimum standard/ population (could be above or below this level) -assuming sufficient value-addition, constant flow of financial resources as long as appropriate market conditions and consumer preferences can be sustained
efficiency			
implementation costs	-context specific, dependent on institutional arrangements	-context specific, dependent on institutional arrangements -additional costs for inviting farmers/communities to submit tenders and due to selection process of applications	-substantial investment in the market chain may be necessary - production incentives may result in conservation above safe minimum standard resulting in poor cost-efficiency from a purely conservation perspective
transaction costs	-context specific, dependent on institutional arrangements -trade-off between involving many small farmers (higher transaction costs) and fewer but larger farmers (lower transaction costs) in the context of achieving socio-cultural and equity	-context specific, dependent on institutional arrangements - economies of scale where community-level intervention possible - trade-off between involving many small farmers (higher transaction costs) and fewer but larger farmers (lower transaction costs) in the context of achieving socio-cultural and equity	-might be rather low assuming adequate market development, but this depends very much on the extent to which market frictions can be reduced

	conservation goals	conservation goals	
payments/ rewards	-potentially in excess of opportunity costs	-potentially close to opportunity costs	-possibly self-financing through value-added generated at different stages of the market chain
equity			
empowerment of poor farmers	-additional fixed income or enhancement of physical, human and social assets as a result of reward mechanism - equity outcome depends on the wealth status of farmers/ communities that are able to participate and/or capture these benefits	-additional fixed income or enhancement of physical, human and social assets as a result of reward mechanism -potential strengthening of social capital and adaptive resource management via collective action for community-focused CTA - equity outcome depends on the wealth status of farmers/ communities that are able to participate and/or capture these benefits	-potentially high additional but variable income -enhancement of physical, human and social assets related to the market-based conservation of PAGR - equity outcome depends on the wealth status of farmers that are able to participate in agricultural markets