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Analysis

# Estimating compensation payments for on-farm conservation of agricultural biodiversity in developing countries

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ABSTRACT

This paper examines the role of direct compensation payments for agrobiodiversity conservation, using minor millet landraces in India as an example. The cost of farmer participation in a hypothetical 'payments for agrobiodiversity conservation services' (PACS) scheme is estimated using a stated preference valuation approach. Significant inter-crop and inter-varietal differences are observed with respect to consumption values, upon which the compensation demanded by farm households is shown to primarily depend. Drawing on a categorisation of consumption values and farmer preferences, the paper points to the importance of simultaneously considering a range of potential interventions in order to conserve a priority portfolio of agrobiodiverse resources in predominantly subsistence-based agricultural systems.



## 1. Introduction

A vital subset of biodiversity, agricultural biodiversity (or agrobiodiversity) is the result of natural and human selection processes, with the latter driven by the needs and motivations of farmers, herders and fishers over millennia (FAO, 2004). Agrobiodiversity encompasses the full diversity of living organisms, of which the precise utilitarian function of many is largely unknown, yet closely associated with the basis of human survival and wellbeing (FAO, 2009; Jackson et al., 2007). From an economic point of view, agrobiodiversity is a component of natural capital, and the flow of services it provides proxies the interest on this capital (Perrings et al., 2006). It can also be seen as a form of natural insurance, as the portfolio of genes, species, communities and agricultural habitats can be used to ameliorate a wide range of environmental and economic risks (Pascual et al., forthcoming). However, despite the existence of a scientific consensus relating to the importance of maintaining genetic diversity within farming systems (Brush, 2004; Pascual et al., forthcoming), research and policy dialogues have tended to consider only to a limited extent the ecosystem services specifically associated with the maintenance of agrobiodiversity, the importance of their values or the incentive mechanisms required to ensure that these services continue to be maintained at socially desirable levels. Such public good ecosystem services include supporting landscape-level agroecosystem resilience (Hajjar et al., 2008; Heisey et al., 1997; Narloch et al., 2011a), maintaining socio-cultural traditions, local identities and traditional knowledge (Nautiyal et al., 2008), as well as the maintenance of evolutionary processes, gene flow and global option values (Bellon, 2009). Furthermore, while the deployment of diversity can be an effective mechanism for smallholder farmers to manage risk (Di Falco and Chavas, 2008, 2009), farmers will not in general consider the implications of their choices for the overall pattern of diversity and the implications that society as a whole faces. It is against this backdrop that external incentives that permit farmers to capture such non-market and public good components of the total economic value associated with the maintenance of agrobiodiversity are of particular relevance (Narloch et al., 2011a; Pascual et al., forthcoming).

External financial incentives may play a key role in ensuring the maintenance of socially desirable levels of agrobiodiversity, as poor smallholder farmers cannot be expected, nor be able to afford, to maintain such diversity where significant opportunity costs exist relative to the cultivation of improved crops/varieties. Arguably, in

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many instances, it is the constrained availability of agricultural inputs (including modern high yielding crop species/varieties and livestock breeds) and production technologies that form the main external constraint leading to the continued cultivation of many traditional plant and animal genetic resources (PAGR) on-farm (Hammer, 2003). However, not all *de facto* conservation of genetic resources in farmers' fields is possible as a sustainable conservation approach, given the current rapid economic development and cultural change in rural regions (Bellon, 2009). Alternatively other conservation (through use) approaches can be sought, for instance through the development of niche product markets. This approach can be seen as a potentially powerful tool for providing positive incentives to farmers to conserve and sustainably use threatened PAGR (Krishna et al., 2010). However, the degree to which such an approach can be successfully implemented in order to fully cover a strategic portfolio of diverse crop species/varieties or livestock breeds is questionable, as not every genetic resource in such a portfolio has a current market potential. In such a context, complementary incentive mechanisms, such as payments for agrobiodiversity conservation services (PACS), may emerge as being of particular significance (Narloch et al., 2011a).

PACS is one type of potential incentive mechanism and a variant or sub-category of payment for ecosystem services (PES) which focuses on the on-farm conservation of socially-valuable and threatened PAGR by providing rewards to the farmers (Narloch et al., 2011a, 2011b; Pascual and Perrings, 2007). Such schemes have been experimentally shown to be effective instrument for promoting the cost-effective maintenance of threatened PAGR (Narloch et al., 2011a, 2011b). Although the concept of PES has been hailed by some observers as "the most promising innovation in conservation since Rio 1992" (Wunder, 2005), to date, PES schemes have largely been limited to applications in the context of forest ecosystems, carbon sequestration, wild biodiversity conservation and water management (e.g., Engel et al., 2008; Landell-Mills and Porras, 2002; Muradian et al., 2010; and Wunder et al., 2008). Nevertheless, in the face of the rapid and unprecedented loss of agrobiodiversity across the world (FAO, 2007a, 2009), there is an emerging need to continue to evaluate the opportunities and constraints of PACS-like schemes to conserve threatened PAGR. Such schemes have recently been evaluated in terms of their effect on collective action and the potential impact of incentives for crowding-in or crowding-out social preferences (Narloch et al., 2012), as well as in terms of their capacity to take pro-poor/social equity trade-offs into account (Narloch et al., 2011b).

This paper aims to further contribute to this literature by exploring the potential for PACS to sustain the on-farm utilization of valuable-but-threatened crops based on farmers' own preferences, since this can offer valuable insights as to farmers' willingness to participate in such schemes. The paper uses a stated preference method applied at the individual farm-household level to elicit farmers' preferences and hypothetical compensation levels for the conservation of agrobiodiverse resources. Although there are a number of existing studies which value agrobiodiversity by estimating farmers' willingness to pay (WTP) for traditional crop varieties (e.g., Asrat et al., 2010) or livestock traits (e.g., Zander and Drucker, 2008), there remains only limited evidence regarding the link between farmers' subjective valuation of the genetic resource in question and the appropriateness of different *ex situ* and *in situ* agrobiodiversity conservation interventions. The feasibility of a direct payment scheme is examined for the conservation of threatened minor millet landraces using microeconomic data from the Kolli Hills, Tamil Nadu, India. The critical role of consumption preferences associated with the conservation of specific crop genetic resources (CGR) and their associated conservation costs that are borne by farmers are examined.

In the next section, we develop the conceptual framework that underpins the valuation analysis. Section 3 describes the sampling framework and study area, as well as presents the empirical analysis. Production system and socio-economic characteristics, together with the results of the contingent valuation exercise are provided in Section 4, while Section 5 discusses the major findings. Concluding remarks are provided in the final section.

## 2. Conceptual Framework

The private values accrued by farmers through the maintenance of on-farm agrobiodiversity are often less than the total benefits generated once public good values are also accounted for, resulting in sub-optimal levels of resource provision. Where high public good values exist, external incentives for agrobiodiversity conservation may be required. With agricultural intensification and monoculture, *improved* PAGR become more productive and profitable in the short-run for individual households, owing largely to their higher responsiveness to external capital inputs (Drucker and Rodriguez, 2009; Narloch et al., 2011a). The difference between the average gross margin of improved/intensified production systems and traditional systems create conservation opportunity costs for farmers. Ideally, PACS schemes would compensate for these opportunity costs. However, calculation of such opportunity costs is hampered by the existence of a multitude of non-market values related to the maintenance of agrobiodiversity, the heterogeneity of the production systems (caused by differences in farm-size, soil fertility etc.), and information asymmetries.

The stated preference of farm households' stated willingness to accept (WTA) compensation for the conservation of CGR can be used as a relevant measure of the opportunity cost of undertaking such an activity. The minimum compensation required to motivate a farm household to accept a PACS contract involving the cultivation of a fixed acreage of a given threatened CGR is assumed to signal the farmer's real opportunity cost of *in situ* agrobiodiversity conservation. Under asymmetric information, PES schemes could create perverse incentives and reduce the effectiveness of the compensation mechanisms (Pascual and Perrings, 2007), although such concerns may be overcome by introducing competitive tender approaches, with beneficiary selection based on (least) compensation demanded (Ferraro, 2008; Jack et al., 2009; Latacz-Lohmann and Van der Hamsvoort, 1998; Narloch et al., 2011b). Here we assume that under a fixed endowment of land, soil fertility and other inputs, there will be a declining marginal value product of the managerial time allocated by farming households to grow a specific crop or variety. If the household can allocate land to a second crop, it will do so until the marginal value products from its managerial time are equated between the two activities determining an endogenous (shadow) wage (Aslan and Taylor, 2009; Krishna et al., 2010; Van Dusen and Taylor, 2005).

We take a simple two-crop model where it is assumed that a farmer with a fixed amount of land can choose, given a number of production and marketing constraints, to grow a traditional crop associated with relatively high public good value and a relatively lower private use value or a crop that is associated with higher private value and relatively lower public good value. Fig. 1 provides a stylized static framework illustrating the farm household's decision regarding which crop to grow. The vertical axis represents the marginal revenue ($mr$) from land cultivated under the CGR associated with a threatened landrace (indicated by subscript $l$) identified as a conservation priority by the conservation agency and the competing, modern (improved) crop variety (indicated by subscript $c$). The horizontal axis represents the share of land allocated to each of the two crops. Let's assume that the objective of the conservation agency designing the PACS scheme is to conserve the threatened CGR following a safe minimum standard (SMS) decision rule associated with achieving a cultivated acreage of $L_l^*$. We also assume for simplicity that the marginal revenue function of the improved competing crop is fixed ($mr_c$). The farm household would optimally allocate land to the threatened CGR where $mr_c = mr_l$.