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Payments for ecosystem services and poverty reduction: concepts, issues, and empirical perspectives

ERWIN H. BULTE*
Development Economics Group, Wageningen University, and Department of Economics, Tilburg University, Box 8130, 6700 EW Wageningen, Netherlands. Email: Erwin.bulte@wur.nl

LESLIE LIPPER
Agricultural and Development Economics Division, United Nations Food and Agriculture Organization, Rome, Italy. Email: leslie.lipper@fao.org

RANDY STRINGER
School of Agriculture, Food and Wine, University of Adelaide, Adelaide, Australia. Email: randy.stringer@adelaide.edu.au

DAVID ZILBERMAN
Department of Agricultural & Resource Economics, University of California at Berkeley, USA, and the Giannini Foundation. Email: zilber@are.berkeley.edu

> *The labour of Nature is paid, not because she does much but because she does little. In proportion, as she becomes niggardly in her gifts, she exacts a greater price for her work. Where she is magnificently beneficent, she always works gratis.* (Ricardo, 1817)

Paying for the provision of environmental services is a recent policy innovation attracting much attention in both developed and developing countries. This innovation, referred to as 'payments for ecosystem services' (when the emphasis is on enhancing 'nature' services) or 'payments for environmental services' (when amenities provided by the built environment are also included) is referred to here as PES. PES programs aim to harness market forces to obtain more efficient environmental outcomes. Since so many opportunities for PES programs could involve farmers in poor regions, international aid agencies and private donors, looking for a double dividend, increasingly consider using PES programs as a potential way of meeting both social and environmental objectives.

This special issue presents articles that provide conceptual, methodological, and empirical perspectives on the performance and potential of PES both as a mechanism for environmental protection and for poverty reduction. The effectiveness of PES meeting these twin objectives

depends both on context specific circumstances and program design. The studies presented here offer insights into the design of PES programs, their direct and indirect impacts, and the constraints affecting their performance.

This introductory paper provides a short overview of PES programs, within the context of the economics of environmental regulation. It also provides a guide to the studies presented in this special issue. We start with methodological and empirical studies that attempt to identify the program design and overall conditions when PES programs can benefit the poor. Next, we address studies that deal with issues of targeting, and, finally, we consider special case studies that illustrate the diversity of PES programs and the wide range of situations where they have been and are being introduced.

PES as economic policy tools

Economists realize that generating positive environmental externalities, as well managing public environmental goods, generally necessitates public policy interventions of various forms. Until now, governments' attempts to correct environmental externality problems have primarily been through the use of command-and-control and other forms of direct intervention, which are fairly easy to implement, but can be quite inefficient. Coase (1960) argued that effective legal structures with well-defined and enforceable policy rights can lead to systems of voluntary contracts, overcoming many problems of market failure associated with environmental externalities. Coase's arguments hold in cases where transaction costs are low and information is available cheaply. Baumol and Oates (1989) present an overview of various more efficient market-based approaches to achieve environmental objectives. Pollution taxes and fees have been recommended frequently as remedies to pollution problems. Carbon taxes are favored by many economists as the preferred tool for addressing climate change problems. However, the 'polluter pays' principle is often difficult to introduce and implement for political and legal reasons. A more recent market-based alternative is the 'cap and trade' approach, where policymakers establish an aggregate target level of, say, pollution emissions, allocate emission rights among firms, and allow trade in these rights to meet the emission targets at least cost. Many polluting industries prefer 'cap and trade' to pollution taxation because, with trading, income is redistributed within the industry, while taxation transfers resources to the government. PES can be a complement to market-based environmental regulatory mechanisms; under cap and trade regimes, such as carbon emissions offset trading schemes, payments for emission reductions are a large and growing category of PES. Other types of PES programs, particularly large government funded programs such as the Conservation Reserve Program (CRP) in the US, are managed to encourage socially optimal levels of positive environmental amenities.

It is useful to divide PES programs into three categories according to their function. Some PES programs pay mostly for *pollution control*. These include payments to eliminate or reduce animal waste, or agricultural chemical residues that reach water reservoirs. For example, Vittel, the bottled water company, entered into agreements with farmers to change

land management practices to reduce nitrates in the source water (Perrot-Maître, 2006). PES may also be payments *for the conservation of natural resources and ecosystems* including forest resources and wetlands, wild flora and fauna species, and agricultural crop and livestock species. Finally, some PES are used *to generate environmental amenities that are public goods.* Examples include planting trees to sequester carbon to reduce greenhouse gases in the atmosphere (a global public good), and/or to regulate water flows and soil erosion to improve watershed function (a local or regional public good).

Another useful distinction is between land diversion and working-land PES programs. An example of a land diversion program discussed in this issue, comes from Kenya, where a PES program is proposed to pay farmers to divert some of their cropland near Amboseli National Park to allow elephants access to food sources and migration routes. An example of a working-land program is the Silvopastoral Project described by Pagiola and colleagues in this issue.

Gainers and losers from PES programs

Some of the reasons for strong interest in using PES programs for poverty reduction include the high incidence of poverty in rural areas, as well as the reliance of poor rural households on natural resources, often of low quality, for their livelihoods. The rural poor may be located on steep slopes in upper reaches of watershed or on the margins of biodiversity rich forests (Heath and Binswanger, 1996; Chomitz *et al*., 2007; FAO, 2007). Poverty can drive people to deplete natural resources, generating negative environmental externalities as well as long-term losses to the producers themselves (Vosti and Reardon, 1997). Paying the poor to improve their environmental management could generate benefits to these households, and to others in the form of local and global environmental goods and services (FAO, 2007). Examples of these types of PES schemes are discussed in the Antle and Stoorvogel, Graff-Zivin and Lipper, and Pagiola *et al.* papers in this issue.

Managing PES for poverty reduction raises two basic questions: (i) do payments make poor households better off, and (ii) to what extent is PES compatible with an economically viable development trajectory for economies as a whole? To date, most of the debate focuses on the first question. Probably this is because PES efforts are currently too small to have any significant impact at the aggregate level. This could change, as suggested by the rapid and widespread impacts of biofuel development on food prices, and thus food security and the poor. Implemented on a significant scale, PES programs have the potential to impact the price of food, labor, and land, any of which could have considerable impacts on the poor (Zilberman *et al*., this issue).

Two papers in this issue provide a general examination of the effect of PES on environmental quality and poverty. Zilberman *et al.* have taken a welfare economic approach to address this issue, while Wunder uses economic logic and preliminary evidence to develop several key hypotheses and initial results. The two papers reach similar conclusions and are complementary in their approaches and in their findings. Two major points that affect the

results in both papers are the emphasis on heterogeneity and diversity on the one hand, and the distinction between disparate program effects on participants and non-participants on the other.

The Zilberman *et al*. paper considers the impacts of land diversion and working-land programs, where the sellers of environmental services are diverse in terms of farm size, environmental quality, and wealth. They show that land diversion programs are only likely to benefit the poor when they are owners of lands poor for agricultural production but high in environmental service potential, or if the environmental services generated are important for the poor (e.g. water quality). Otherwise, the urban poor, landless and smaller landowners are likely to lose, while larger landowners are likely to gain under such programs, particularly in areas with large population of landless and urban poor, poorly linked to the external economy through impacts on food prices and wages. Increased integration of a rural market with the global economy, providing alternative sources of food and income, will reduce the negative effects of PES programs.

Compared with land-diversion PES, working lands PES are more likely to increase labor demand. In these cases, the urban poor may gain from PES programs that increase productivity and agricultural output (through effects on food prices), but lose if a decline occurs, and the landless are likely to gain from labor market effects. Landowners who participate in PES programs benefit from the payments, but non-participants may lose from higher labor costs and lower output prices.

The conceptual analysis by Wunder expands the range of issues that determine the impact of PES on the poor. First, Wunder emphasizes the existence of constraints limiting the ability of the poor to participate as sellers of environmental services. Among the constraints are informal and insecure land tenure and high transaction costs facing buyers working with numerous smallholders. These constraints may be reduced by modifying inappropriate access restrictions, by developing smallholder bundling schemes and by reducing transaction costs. To the extent that participation of poor providers is a major concern, Wunder suggests explicit poverty targeting (farm size limits, etc.) and subsidies.

Wunder also argues that even when the poor sell environmental services, they are not always likely to be better off. Frequently, they are forced to participate in programs and a key ingredient for assuring gains is free choice. Large, singular cash payments may have local detrimental effects, while well-designed conditional and continuous cash transfers can promote growth and welfare gains, a conclusion supported by the analysis in the Antle and Stoorvogel, Graff-Zivin and Lipper, and Pagiola *et al*. papers in this issue. Sellers of environmental services, especially in working land programs, can benefit from asset transfers such as tree transplants, as well as non-income gains from training, etc. However, Wunder suggests that because of market power, buyers may be in a better position to extract most of the rent gains from PES and collective action by or on behalf of poor sellers may enhance their benefits.

Wunder emphasizes that environmental services can have significant local benefits for the poor. Some of these benefits are intended, but

others may just be incidental to other environmental goals. For example, payments to improve water quality for fisheries may also benefit local water consumers. He suggests that, in some cases, the poor can be organized and contribute to the coalition that buys environmental services, and, more importantly, donor and NGO efforts should be coordinated in the program design to enhance benefits for the environment and the poor.

Like Zilberman *et al*., Wunder emphasizes some of the negative impacts of PES on non-participants, such as the landless, especially when open access to natural resources is limited. He suggests that the debate on PES and poverty suffers frequently from lack of perspective: PES are not likely to change dramatically the poverty picture, either by increasing substantially resources availability to the poor or by restricting their opportunities. Setting restrictions on PES to meet poverty criteria may be counterproductive and a pragmatic approach would view them mostly as tools to achieve environmental objectives. Wunder's conclusions imply the value of analysis in improving PES design and achieving a more realistic perspective on PES program outcomes through case studies.

The analyses presented in both the Wunder and Zilberman *et al.* papers suggest that PES programs cannot always serve to both eliminate poverty and improve environmental quality. Achieving two objectives for the price of one policy is tricky and depends on the specific conditions. Concern about the well-being of the poor implies many PES programs should be accompanied by safety-net activities to compensate for any losses to the poor.

The papers by Antle and Stoorvogel, Graff-Zivin and Lipper and Pagiola *et al*. in this issue illuminate various aspects of the concerns raised in the Wunder and Zilberman *et al*. papers. Pagiola *et al*. present an empirical study analyzing the participation of the poor in a PES project implemented in Nicaragua aimed at enhancing the adoption of certain silvopastoral practices on degraded pastures. Key concerns about the participation of the poor include access to credit and technological assistance. They find that despite significant participation requirements, the poor and extreme poor can (and, indeed, did) participate in the PES scheme. Participation may be facilitated by the project's flexibility, which allows farmers to choose the package that suits them best. The paper argues that transaction costs may be a greater threat to participation of the poor than household characteristics (including their ability to finance certain management activities). Economies of scale in purchasing ecological services provides a strong incentive for the buyer to search for large landowners. Unless mechanisms can be designed to reduce transaction costs, the poor may be shut out.

Antle and Stoorvogel focus on cases where PES generate both private and public benefits; using the example of payments to promote the sequestration of soil carbon in farming systems in Machakos (Kenya), Cajamarca (Peru), and Southern Peanut Basin (Senegal). Increasing the carbon content of soils could contribute towards rural poverty alleviation by increasing agricultural productivity, and reduce food insecurity in marginal agricultural areas. They present the results of a series of simulation analyses that indicate that carbon contracts would substantially increase

adoption of carbon-sequestering technologies. In addition to the provision of global public goods, the adoption of these technologies leads to enhanced sustainability of farming systems and higher incomes. However the impact on poverty alleviation per se appears modest.

Graff-Zivin and Lipper investigate the impacts of risk considerations on the adoption of conservation agriculture, a technology that generates soil carbon sequestration. This technology tends to increase production risks in the short run during a transition phase, but with the potential of reducing risk and increasing productivity in the long term. They model the technology within a dynamic optimization framework, assuming that farmers are risk averse and earn profits from production and payment for soil carbon sequestration. The paper divides the effects of adoption on agricultural profits into two main categories: the 'technology' effects of adopting a new production system and the 'productivity' effects of changes in soil carbon on agricultural productivity. Results of the model suggest that payments for soil carbon sequestration are not likely to be sufficient to induce changes in farmers' practices in developing countries, unless they also involve significant agricultural co-benefits. However, even for those that do generate higher long-term gains, risk is a major barrier, particularly for the poor, in adopting these technologies. In this setting, payments for soil carbon sequestration services can be an effective means of overcoming the constraint, but only if designed appropriately. Graff-Zivin and Lipper suggest that pooling soil carbon sequestration payments and using them to support group insurance schemes could be an effective way to promote increases in both public and private benefits through soil carbon sequestration.

Targeting PES

Effective management of PES programs requires detailed data on the distributions of various indicators of environmental quality across space, as well as potential profitability from alternative activities, primarily agriculture. Obtaining such information has become feasible with the improvement of remote sensing technologies, emergence of geographic information systems, and improved monitoring and communication technologies. Initially, most payment programs for land diversion had a fixed payment per land unit, attracting the least profitable lands while maximizing the area enrolled. This approach maximizes the environmental quality obtained given the program budget when there is a negative correlation between environmental amenities provided and profitability in alternative use. However, when more profitable lands also provide more environmental amenities per hectare, the targeting of cheaper lands by the program may misfire.

An alternative approach is targeting the lands with the highest environmental benefits. This approach maximizes benefits obtained given the overall budget if, for example, all lands have the same production value, but vary in their environmental amenities. However, when economic values generated per hectare vary, targeting the lands with the best environmental benefits may be less effective if those lands also provide the most economic value in production. The environmental benefits given the program budget

are maximized if lands are selected to the program using an environmental benefits per dollar paid criteria. Namely, only lands in which environmental benefits per acre exceed a given threshold are targeted for the program. Early studies on targeting address the performance of the CRP in the United States, and have shown that these targeting techniques may expand total benefits obtained with a given budget by 30 per cent and more (Babcock *et al*., 1996). This led to purchasing decisions guided mostly by a benefits-per-hectare criteria. Participation in the CRP is now based on proposals where each landowner provides information on several indicators of environmental quality provided by the land and information on economic performance and the requested pay.

The paper by Alix-Garcia *et al.* suggests that both the literature and program design ignore the fact that environmental preservation is done under risky conditions. In some locations, the risk of soil erosion and deforestation is much higher than in others. The paper demonstrates that PES programs aimed at reducing deforestation in Mexico can improve by targeting schemes that consider heterogeneity of environmental quality of preserved forest and risk of deforestation among so-called ejidos, communities who share land. The analysis considers the benefits of cloud forests, which provide hydrological benefits, to be higher than that of other forests and quantifies the benefits accordingly. It also assumes that ejidos will modify their behavior if payments are at least as high as potential earnings from deforestation.

Alix-Garcia *et al.* compare three program designs. The first is similar to the current PES program with a flat payment per hectare, and an upper bound on total payment per ejido. The second payment scheme adjusts payment per hectare according to risk of deforestation, thus targeting high deforestation risk forests. The third program distributes payments to maximize environmental benefits given a budget constraint. This program targets ejidos where forest preservation provides the highest expected benefits per dollar spent, taking into account both the risk of deforestation and the quality of environmental benefits provided. Their analysis shows that the flat payment scheme with a cap on eligible land size is the most equitable but least efficient in terms of environmental benefit per dollar spent. The benefits maximizing program will produce four times the environmental benefits of the flat payment program, but analysis of the distributional implications show that with the benefits maximizing program, benefit per member to poor and indigenous are much lower than to their counter parts, because the poor provide lower quality forest protection. A flat payment scheme distributes the payment more or less equally across size and poverty classes.

The analysis of Alix-Garcia *et al*. expands the findings of previous studies to show that alternative targeting schemes offer policy makers, and purchasers of environmental services, tradeoffs. When the purchaser of environmental services is an environmental group, they are more likely to pursue an environmental benefits maximizing strategy, but when the payer is a government, political economic forces may lead to strategies that provide more poverty reduction and less environmental benefit given the budget.

Payments for wildlife conservation

Much of the PES literature emphasizes payments for water quality protection and for carbon sequestration in the context of crop or forest systems. However, growing concerns about the environmental risks of avian flu, invasive species, and endangered species in livestock and wildlife systems have led to consideration of PES as a solution here as well. Two of the papers in this special issue address PES in the context of wildlife; one by Bulte *et al*. and the other by Horan *et al*.

Bulte *et al*. conduct a simple cost–benefit analysis to consider the economic rationale of paying Maasai near Amboseli National Park, Kenya, to improve wildlife habitat. Traditional grazing grounds, shared by wildlife and livestock, are increasingly converted into agricultural fields. As these fields are fenced in to protect the crops from predation, migratory routes for species like elephants are blocked. An integrated and spatially explicit ecosystem-household model is developed to explore the ecological response to changes in economic incentives, and in particular to analyze the conservation effects of introducing a PES scheme that restores pastoralism as a competitive activity. The main result is that the conservation effects of a PES scheme are likely sufficiently large to warrant implementation. However, an important caveat is in order: feedback or leakage effects may undermine the long-run success of a PES scheme. If households use conservation payments to expand their livestock herd – buy more goats and cattle – the outcome would be enhanced competition for forage, with possible detrimental effects for the abundance of wildlife species.

Horan *et al*. consider PES to address two problems that cause extinction of endangered species. One is habitat loss and fragmentation, and the other is the spread of disease. Some diseases may be carried by domestic animals. For example, Horan *et al*. model the case of the Andean deer which is vulnerable to cross-species transmission of disease from livestock. Developing an optimal strategy that maximizes discounted benefits from the two species, minus costs, and leads to sustainable outcomes requires understanding the population dynamics of the two species and several actions. Their model includes expansion of land available for the endangered species and vaccination of the domesticated species. These actions can be triggered by PES and the optimal solution suggests that initially the payment will be to landowners to allow movement of, and increase habitat for, the endangered species. Later on, payment for vaccinations will go to owners of livestock.

The Horan *et al*. model demonstrates the complexity of designing PES programs to recover endangered species populations, especially when the ecological problem may involve interdependency between species and complementary action is required. The PES schemes are complex because they require payments to different economic agents, where timing and amount of payment are dependent on monitoring wildlife and domestic livestock populations. Horan *et al*. also note that implementing these programs means addressing potential corruption problems, as well as strategic behavior by the owners of domesticated animals.

Conclusions

The evidence on PES and poverty reduction presented in this issue gives some reason for optimism; we can identify locations and situations where the poor are likely to benefit, we have considerable insights on the types of program designs needed to facilitate their capacity to benefit, and we have empirical evidence indicating that the poor do indeed participate in, and benefit from, PES programs. These findings support the analysis of Pagiola *et al*. (2005) who suggested that the pre-condition for PES programs to have beneficial effects on poverty reduction is that the poor should: (i) be in the 'right place'; (ii) want to participate (e.g., it should 'fit' into the farm practice); and (iii) be able to participate (e.g., they should be able to make the necessary investments, have sufficiently secure tenure, etc.). It is quite easy to design programs that fail to meet one or more of these conditions, and such programs are unlikely to help in fighting poverty. If resource users go uncompensated, say because they lack formal property rights to the resource they use, diverting resources to the provision of ecosystem services may result in high opportunity cost in the form of foregone development, exacerbating poverty.

However, the analyses presented here also indicate that tying PES and poverty reduction may result in lower efficiency in meeting either objective – and in fact it may be better to focus programs on one or the other objective separately. Nonetheless, since PES programs can have indirect effects on the poor-through changes in food prices, wages and land access – poverty and the poor do need to be taken into consideration in designing PES programs, even if poverty reduction is not an objective of the program.

If PES reaches the poor, we may infer that it will make them better off and in fact evidence presented by Pagiola (this issue) indicates this is the case. Zilberman *et al.* (this issue) find that the poor are most likely to benefit from participation in PES programs when the returns to ecosystem services and agriculture are negatively correlated over space. Flexible payment schedules and the importance of effective collective action amongst suppliers are also identified as key to success. The potential of PES to provide a relatively stable flow of income, and therefore reduce income fluctuations amongst participants, can be valuable for people close to the margin. There may also be positive non-income effects, ranging from improvements in the supply of ecosystem services, which are critical to the poor, as well as the potential impact of PES agreements on the formation of social capital.

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