Ecological Economics 152 (2018) 378–388

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Economic Impacts of Payments for Environmental Services on Livelihoods of Agro-extractivist Communities in the Brazilian Amazon

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ARTICLE INFO

Keywords:
Agriculture
Bolsa Floresta
Bolsa Verde
Deforestation
Manioc
PES

ABSTRACT

Rural communities in the Brazilian Amazon rely on manioc, produced in a swidden-fallow system that uses land cleared from forest areas. Increased agricultural production could reduce fallow period length with implications for manioc flour (farinha) production. We hypothesize that payments for environmental services (PES) programs may exacerbate reduction of fallow periods, thereby reducing per stem farinha productivity. To understand the household scale economic impacts of avoided deforestation under PES programs, we conducted interviews in 158 households from 32 communities in the Brazilian state of Amazonas. Using regression models, we assessed which variables most influenced farinha production, and calculated production costs and total revenues, with and without a PES program. Manioc yield increased by 22.83 kg per household per year for each additional year that the forest was left to recover before being cleared. Although production costs were higher for land cleared from older secondary forests, net profits on land cleared from primary forests were still higher. Total income from PES programs, when added to the secondary forest manioc profit, were higher than the foregone production in primary forest areas. However, when we considered only direct cash payments, we identified potential trade-offs. We conclude that PES programmes should consider possible long-term effects of payments on the livelihoods of participants.

1. Introduction

Payments for environmental services (PES) have been proposed as an economic tool to help alter land use behavior, such as inhibiting deforestation (Wunder, 2005; Pagiola et al., 2013) often while aiming to reduce rural poverty (Wunder, 2005; Pagiola et al., 2005; Zilberman et al., 2006; Grieg-Gran et al., 2005; Muradian et al., 2010; FAS, 2017a). PES programs offer financial rewards to landowners and land users who adopt practices to conserve natural resources, and have been extensively implemented in developing countries as an economic alternative to activities that result in tropical deforestation (Wunder, 2005). PES programs that focus on carbon sequestration are increasingly common in tropical forest contexts, in part as a result of Reducing Emissions from Deforestation and forest Degradation *plus* forest management (REDD+) programs that aim to both protect forests and improve the livelihoods of local communities (Pacheco et al., 2012). However, in protecting primary forests from further agricultural expansion, PES programs could also incur detrimental economic and environmental costs by increasing competitive demand on previously cultivated agricultural plots (hereafter, *roçados*).

Integrating conservation and development objectives is a challenge for PES programs (Pereira, 2010): although there are some successful examples of PES meeting tangible benefits, many often fail to meet local subsistence needs due to either market volatility or underestimated payments (Martin et al., 2008; FAS, 2017a). There are multiple responses from local PES participants, which may range from program withdrawal, increased swidden-fallow rotation, reduced fallow period, changes in livelihood strategy, and migration.

Whether or not a PES program provides a 'win-win' solution for conservation and development will depend in part on fine-tuning its design with respect to local context. PES programs in the Brazilian Amazon therefore need to consider the complexities and idiosyncrasies

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https://doi.org/10.1016/j.ecolecon.2018.05.016
Received 1 November 2017; Received in revised form 16 April 2018; Accepted 25 May 2018

Table 1
Characteristics of the two PES programs and focal protected areas surveyed in this study in western Brazilian Amazonia (FAS, 2017a; MMA, 2013).

	Bolsa Floresta	Bolsa Verde
Administration	Fundação Amazonas Sustentável (FAS)	Brazilian Federal Government Ministry of Environment (MMA)
Program established	2007*	2011
Program reach	9601 households in 581 communities, in 16 protected areas (totalling 10.9 million ha) across the Brazilian state of Amazonas.	48,000 households in 877 federal rural settlements, in 68 federal conservation units (totalling 46 million ha) in 23 states across Brazil.
Eligibility	Non-opening of new cultivation areas within native primary forest, participation in workshops, training in climate change and environmental services, enrolment of children in schools, adherence to the reserve management plan, be living in the reserve for at least two years.	Residence in rural area, income of less than US$ 21.00 per capita, registration in other social programs, adherence to other social programs` rules and the reserve management plan.
PES value (US$)	US$ 186.00 direct payments per household annually + indirect benefits to community or reserve. Combined total = approx. US$ 421.60 per household per year	US$ 372.00 direct payments per household per year
Focal reserve in this study	Reserva de Desenvolvimento Sustentável Uacari (RDS Uacari)	Reserva Extrativista Médio Juruá (ResEx Médio Juruá)
Management	Amazonas State Governement - Secretaria do Estado do Meio Ambiente e Desenvolvimento Sustentável (SDS)	Brazilian Federal Government - Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio)
Year of decree	2005	1997
Reserve area (ha)	632,949	253,227

* Established and initially implemented by the State of Amazonas government.

of each socio-ecological system in which they are to be implemented in order to effectively compensate local opportunity costs and address social justice (Newton et al., 2012b). For example, opportunity costs vary dramatically between the Amazon agricultural frontier, where the payoffs for forest conversion into pasture or cropland can be high, and more remote areas, where there is little immediate threat (Börner and Wunder, 2008; Börner et al., 2010). The motivation for payments in the latter case, may instead be related to the compensation of management practices that contribute to the provision of ecosystem services over time. This type of payment approach may result in high efficiency, but its success will therefore depend in part on whether PES programs can maintain or improve local livelihoods (Newton et al., 2012b). Given the complexity of the economic system in rural Amazonian communities (Futemma and Brondízio, 2003), the importance of manioc cultivation, and the large number of households affected by PES programs across the region, it is important to assess the economic impacts of these programs (Börner et al., 2013).

Manioc or cassava (*Manihot esculenta* Crantz) is the staple food crop for rural communities in the Brazilian Amazon, representing up to two thirds of all agricultural income (Souza, 2010; Newton et al., 2012b). Manioc is cultivated using swidden-fallow (or slash-and-burn) agriculture, and its tuberous roots are processed locally into a dry flour (hereafter, farinha) (Clement et al., 2010). This widely used tropical swidden-fallow system (Scatena et al., 1996) consists of alternate cropping (*roçado*) and fallow second-growth (capoeira) phases, after which often young secondary forests are cut and allowed to dry before being burned or removed to begin a new cropping cycle (Silva-Forsberg and Fearnside, 1997; Metzger, 2003; Fraser et al., 2012). Additional manioc plots (*roçados*) may also be created by clearing primary, rather than secondary, forest plots.

Biomass burning releases nutrients for the next cropping cycle, thereby re-establishing soil fertility over the fallow period (Nye and Greenland, 1960; Fraser et al., 2012). The longer the fallow, the greater the forest biomass and the more nutrients will be released after clearance and burning, directly influencing manioc production. In typical low-nutrient Oxisols and Ultisols, which account for 75% of all