Land Use Policy 51 (2016) 244–259

Contents lists available at ScienceDirect

Land Use Policy

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

A portfolio analysis of incentive programmes for conservation, restoration and timber plantations in Southern Ecuador

Leander Raes[a,b,*], Marijke D'Haese[a], Nikolay Aguirre[c], Thomas Knoke[d]

[a] Department of Agricultural Economics, Ghent University, Coupure Links 653, 9000 Ghent, Belgium
[b] Division of Resource Economics, Humboldt University, Philippstr. 13, Haus 12, 10115 Berlin, Germany
[c] Biodiversity and Ecosystem Services Research Program, Universidad Nacional de Loja, EC 110101 Loja, Ecuador
[d] Institute of Forest Management, Technische Universität München, Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising, Germany

ARTICLE INFO

Article history:
Received 23 September 2014
Received in revised form 9 November 2015
Accepted 18 November 2015
Available online 30 November 2015

Keywords:
Diversification
Land use
PES
Portfolio
Poverty
Risk

ABSTRACT

This paper uses portfolio analysis to study how the Ecuadorian incentive programme for forest conservation and restoration (Socio Bosque), and an incentive programme for timber plantations, may reduce income risk and/or maximise returns for a given level of risk for farmers in the municipality of Loja. The main existing land use in the research area is milk production on pasture, with some farmers having forest land. Our results suggest that most farmers would significantly increase the area under conservation and/or restoration as part of their risk reduction strategies, compared to a decision based solely on expected returns. However, in land use allocations that maximise the return per unit of risk, a small group of milk producers without forest would continue milk production on most of their land. In addition, milk producers with forest would significantly decrease deforestation under the land use allocations made when conservation incentives are available. Against this we also identify a likely shift of milk production from existing pasture to new pasture established on deforested land, which provides evidence of a potential 'leakage effect'. In addition, the incentive programmes would only lead to small areas of tree plantations being established. None of the land use combinations (portfolios) analysed would increase the income of all households to above the poverty line, as the monetary incentives are too low and many farms are too small. For forest holders all the land use combinations we studied would have a positive impact on income, but we observed a negative impact on household income for milk producers without forest. For producers without any forest, there seems to be a trade-off between maximising household income and risk reduction through combining incentives for restoration and tree plantations.

1. Introduction

The undervaluation of ecosystem services provided by forests and other natural ecosystems is considered one of the main causes of their ongoing degradation (Pearce, 2007; Swallow et al., 2009; Tacconi, 2000). One solution that has been proposed to address to this, is to pay private and communal landholders to maintain and restore forests and other ecosystems under their stewardship (Engel et al., 2008; Rodríguez de Francisco et al., 2013). These incentives, broadly categorised as payments for ecosystem services (PES) or PES-like schemes, aim to maintain the current level of ecosystem services, or to restore or increase them (Sommerville et al., 2009; Tacconi, 2012; Wunder, 2008).

A recurrent question is how important the expected returns are in encouraging farmers to keep land under conservation management instead of converting it to other income-generating activities. Similarly, expected returns can play a role in a farmer's decision to continue with existing land-use practices, or adopt land uses that could improve ecosystem service provision. When payment levels from PES schemes are at least as high as any alternative gains from the land, one would expect the scheme to be more successful in gaining and retaining participants (Farley et al., 2011; Secchi et al., 2009). However, in PES schemes payments are often lower than the opportunity costs faced by participants (Mahanty et al., 2013; Wunder and Alban, 2008). In addition, PES participation is also influenced by intangible factors (Kosoy et al., 2007), such as the value participants place on ecosystem services (Bremer et al.,

* Corresponding author. Fax: +3 292646246.
E-mail addresses: leander.raes@ugent.be (L. Raes), Marijke.DHaese@UGent.be (M. D'Haese), nikolay.aguirre@gmail.com (N. Aguirre), knoke@tum.de (T. Knoke).

http://dx.doi.org/10.1016/j.landusepol.2015.11.019
0264-8377/

2014a) or their general concern for the environment (Zanella et al., 2014).

A broad range of factors affect farmers' land use decisions, including environmental and agricultural policies and regulations, markets, climatic conditions, the physical attributes of land and socio-economic and personal factors (e.g. beliefs, values), demographics and gender (Gasson, 1973; Lambin et al., 2001; Malawska et al., 2014; Villamor et al., 2014). Farmers' decisions about land allocation and land management are contingent upon multiple natural (e.g. variable climate) and financial uncertainties (e.g. crop or input price fluctuations) (Jakoby et al., 2014; Knoke et al., 2011). The resulting uncertainty in the expected profit from any given land use makes land use decisions risky (Engle Warnick et al., 2011).

Land owners are generally considered to be risk-averse (Knoke et al., 2008), an observation widely supported both in developed (Bocquého et al., 2014; Bond and Wonder, 1980; Just and Pope, 2002) and developing countries (Antle, 1987; Moscardi and Janvry, 1977; Tanaka and Munro, 2014). Risk-averse farmers tend to choose land uses with the least uncertainty, despite their lower potential rewards (Aimin, 2010). Farmers often diversify their activities and land uses in order to spread risk (Engle Warnick et al., 2011). Hence, in addition to differences in expected returns, comparing potential investments in different land uses requires analysing the trade-offs between the uncertainties and profitability associated with different activities. Similarly when analysing PES, the effect of the contracts on income uncertainty should be taken into account.

In addition to their primary aim of conserving or increasing ecosystem service provision, PES schemes are often implemented with an eye on poverty reduction (Ingram et al., 2014; Rodríguez de Francisco et al., 2013). Through their impact on income, consumption, labour and land markets, PES can have positive effects on livelihoods even if the programmes are not explicitly designed to reduce poverty (Kollmair and Rasul, 2010; Wunder, 2006). Yet, the success of PES programmes in reducing poverty depends on the equitable distribution of benefits and on the size of the compensation payments (Grieg-Gran et al., 2005; Jack et al., 2008). Wunder (2008) argued that PES could potentially trap poor landowners if payments are lower than actual or potential revenues from alternative income-generating land uses. However, PES can also be a stable income source and a valuable way to diversify income (Grieg-Gran et al., 2005). The balance of these effects depends on how land use restrictions impact on people's livelihoods.

Against this background, this paper examines the extent to which PES schemes for conservation and restoration, and incentives for timber production could be desirable land uses compared to pasture for milk production for farmers in an area of southern Ecuador important for hydrological services and biodiversity. The PES and PES-like programmes considered in the study are conservation and restoration incentive schemes which form part of the Ecuadorian Socio Bosque Programme, and the government's Economic Incentives for Afforestation and Reforestation programme, which encourages the establishment of timber plantations. The latter programme is not a PES *per se*, but has similar outcomes in terms of the provision of certain ecosystem services. Farmers can combine participation in these programmes with commercial milk production, which is an important agricultural activity in the study area. These land use combinations are compared to the current situation, and to combinations of potential land uses in the absence of the incentive programmes (i.e. milk production and tree plantations without incentives).

In this paper we use a portfolio approach to calculate the shares each land use should have, subject to economic return and uncertainties, while allowing for a mixture of different land uses. Following Markowitz (1952), the selection of a land use portfolio is a minimization or maximization problem based on two criteria, namely the activity's expected return and the risk involved. After Knoke (2008), this study views specific land uses as single investments. As such, one area of land can be divided into sections with different uses, creating a combination of land uses that produce an optimum relation between revenue and risk. This paper builds on the research of Knoke et al. (2011), who analysed an 'Optimized Land-Use Diversification' to study the effects of carbon payments as an instrument to reduce deforestation. Instead of using a portfolio approach to estimate payment levels for a PES scheme, we use it to analyse the potential impacts on income and uncertainty of farmers diversifying in several PES and PES-like programmes.

Following Knoke et al. (2011) we use the terms risk and uncertainty interchangeably; and agree that "the phenomenon of uncertainty was simply seen as our inability to predict something (market prices in our case) with certainty" (Knoke et al., 2011; p. 1142). In our portfolio analyses, 'risk' is (narrowly) defined by the standard deviation of the expected returns, and risk reduction is defined as the minimization of this standard deviation. Land uses for which the returns have high standard deviations are considered more risky or more uncertain. With risk avoidance, various combinations of expected returns and risk may generate an identical utility, because less uncertainty may compensate for a lower expected return and vice versa (Knoke et al., 2008). Following Castro et al. (2015), we understand that our analyses show how land should be allocated to achieve risk minimization or to maximize the expected return for a given level of risk. However, as Castro et al. (2015, p. 4) state "this does not necessarily mean that the model output is a proper prediction of future land allocation. [. . .] It may just help risk averse land owners to achieve their economic objectives in a consistent way".

The paper consists of the following analytical steps: (i) net present value calculations of the expected revenue of milk production, of forest conversion to pasture for milk production, of monetary incentives for conservation of forests and the restoration of native vegetation on pastures, and of the establishment of timber (pine and Andean alder) plantations with and without the incentives; (ii) portfolio analysis of the different land-use combinations; (ii) the impact on household income of adopting different land use portfolios. The methodology is detailed in the next section.

This paper contributes to both the PES and forest economics literature. Portfolio diversification and optimization has been increasingly used to analyse PES (e.g. Benitez et al., 2006; Castro et al., 2013; Knoke et al., 2011). However, as far as we know, it has not been used to analyse the potential impact of existing PES programmes, nor to study the impact of combining several programmes. In addition, empirical evidence of the potential contribution of PES to joint social and environmental goals remains limited (Bremer et al., 2014b; Ingram et al., 2014).

2. Methodology

2.1. Research area

This research focuses on commercial milk producers who own land in the buffer zone of the Podocarpus National Park in Loja municipality in the province of Loja, Southern Ecuador (Fig. 1). The research area consists of patches of forest and pasture and covers 5475 ha, excluding the area belonging to the National Park and two protected watersheds. In addition to its role as a buffer zone for the National Park, the area's Andean ecosystems are important providers of hydrological services (Ataroff and Rada, 2000; Celleri et al., 2007). To improve the conservation of biodiversity and maintain and enhance hydrological services (water quality and dry season flow), Loja municipality is a member of the Regional Water Fund (FORAGUA). The municipality has the power to protect areas of hydrological importance through land purchases, using funds