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49. Rural landscapes and ES in Tropical countries (OPEN)

Analyzing trade-offs between food production and ecosystem services in tropical forests of lowland Bolivia

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The expansion of agricultural land is responsible for most tropical deforestation. Historically, smallholder farming and shifting cultivation has been reported as the main agent of deforestation. However, the increasing global demand for food in recent years has greatly boosted the development of medium and large-scale commercial agriculture which is nowadays causing the majority of tropical forest cover loss, particularly in Latin America. The destruction of tropical forests reduces carbon sequestration and entails biodiversity loss, water depletion, and soil erosion, representing one of the great forces in global warming. In order to avoid these harmful effects, numerous strategies have been designed to preserve and restore tropical forests (e.g. PES schemes), yet the evidence shows that it is difficult to put them into practice. Nevertheless, alleviating poverty for small subsistence farmers in tropical areas has frequently brought about deforestation practices to assure the provision of rural livelihoods. Addressing the intertwined challenge of meeting rising demand for food and conserving ecosystems will require maximizing agricultural production while minimizing ecosystem loss. In this research, we analyze the trade-offs between agriculture and ecosystem services in tropical agroforests of lowland Bolivia to explore the effectiveness of different strategies designed to support the benefits of ecosystem services (food supply, biodiversity) and reduce disservices (greenhouse gas emissions, water consumption) from agricultural activities. Extensive fieldwork, based on a large array of in-depth interviews with farmers and experts, was conducted in the Guarayos province, within the Amazonian eastern Bolivia. Derived empirical data were used to characterize the agricultural and forestry sectors, to describe the flows of ecosystem services, and to define farms and farming practices. In total, four types of farm households, ranging from subsistence to large-scale commercial farms, were identified through cluster analysis and simulated using a multi-period bio-economic optimization model. The model maximizes the discounted value of farmers' expected utility over a period of 15 years subject to agronomic, biophysical, socio-economic, and policy constraints. The model simulates farmers' behavior and permits to predict the effects of several policy actions (namely, a tax on carbon emissions per hectare, a quota for carbon emissions, and a payment to farmers for maintaining forest surface) on ecosystem services provided by agriculture, as well as on farm income, employment, and food production. Results show that low income smallholders are contributing importantly to biodiversity (in terms of crop diversity and forest surface maintenance) and producing lower carbon emissions per hectare than bigger farms. The tax and the quota on carbon emissions

produce low impacts on farm income and on the value of agricultural production but both instruments contribute importantly to reduce carbon emissions, in particular for large-intensive farms. Conversely, the payment for the maintenance of forest surface does not produce significant changes in farming activities in the large farms but it contributes to reduce importantly carbon emissions, to protect biodiversity, and to restraint deforestation, with negligible impacts on income. However, this option leads to a significant reduction of agricultural production value. Overall, this research shows that policies that take into consideration the role of agriculture for providing ecosystem services beyond agricultural products (i.e., environmental services) can produce highly significant value increases making compatible rural socio-economic development with the conservation of forest area and the maintenance of biodiversity.

Key words: food production, ecosystem services, tropical deforestation, sustainability, bio-economic modeling, Bolivian Amazon.

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