Chapter 14
Improving Productivity, Profitability and Sustainability of Degraded Grasslands Through Tree-Based Land Use Systems in the Philippines

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Abstract This study aimed to quantify and analyze the productivity, profitability and sustainability of alternative land uses in the degraded grasslands using a bioeconomic modeling approach. It was conducted in Claveria, Misamis Oriental in Mindanao, the Philippines. Results of bioeconomic analysis showed that tree-based land use systems have significantly higher financial profitability and environmental benefits. The latter were measured in terms of higher carbon sequestration, least soil erosion, and sustained soil nutrients relative to current farmers' practice of maize cropping. Despite these, survey results showed the extent of tree farming remains low (<10 percent of land area). The risk analysis indicated that while timber-based systems earned the highest net present value (NPV), they seemed to be the most risky options as reflected by the high coefficient of variations of the NPV ranging from 164 percent to 205 percent. The study recommended measures to reduce price risk and the need to improve risk management capability of farmers to promote expansion of smallholder tree farming. Provision of relevant and timely price information and price risk insurance are such possibilities. It is also suggested that payments to farmers for environmental services like carbon sequestration be explored to encourage expansion of tree-based land use systems.

Keywords Bioeconomic analysis, carbon sequestration, *Imperata* grasslands, land use, risk analysis, tree growing

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14.1 Introduction

Uplands are important geographical components of Philippine agriculture. Vast areas of the uplands in the Philippines are covered with grassland vegetation mostly dominated by *Imperata cylindrica* or cogon indicating low soil fertility and productivity level. Historically, these vast degraded uplands are the results of a land use transformation from natural forest to grassland areas through shifting cultivation and consequently into permanent agriculture due to increasing population pressures in the uplands (Bandy et al. 1993; Garrity and Agustin 1995).

Traditionally, shifting cultivation is sustainable with interspaced long fallow periods. When the fallow period shortens, soil fertility declines significantly. Grasses invade areas with soils low in organic matter and prone to soil erosion. In the Philippines, the environmental consequences of shifting cultivation in upland areas are severe and widespread with soil erosion as the worst outcome (World Bank 1989). Estimated total annual soil loss from the Philippines varied from 74.5 million tons (DENR 1992) to 80.6 million tons (Francisco 1994). Soil erosion is a natural process, however, it is greatly accelerated by human activities.

The intensive cultivation of upland areas without adopting appropriate soil conservation practices produces high rates of soil loss and threatens the long-term sustainable productivity of the upland resource base (Francisco 1998; Nelson and Cramb 1998). This has serious implications for the economic welfare of a growing upland population with few feasible livelihood alternatives. There is evidence to claim that the future of low input shifting cultivation in the uplands is grim (Menz and Grist 1998). Where smallholder farmers continue intensive cultivation without applying new technologies or inputs, returns to labor will fall and most of these upland farms will no longer be viable (Menz and Grist 1998; Nelson et al. 1998; Magcale-Macandog et al. 1998a). The challenge therefore is to improve the productivity and profitability of degraded uplands by enhancing (and subsequently maintaining) the environmental quality of this resource in order to achieve sustainable livelihood among upland smallholders.

Tree-based farming systems are potential profitable alternatives for improving the productivity and sustainability of marginal upland areas. Tree growing is recognized to be effective in the control of *Imperata* and other grasses through shading (Menz and Grist 1996; Gouyon 1992). It also provides additional public benefits in the form of carbon fixation by sequestering atmospheric carbon through their growth process (Nowak 1993). Tree growing is the only known practical way to remove large volumes of greenhouse gases (GHGs), especially carbon dioxide (CO_2), from the atmosphere (Trexler and Haugen 1995). CO_2 is the most abundant and important GHG under human control (Moura-Costa 1996; Houghton 1996) and it is expected to account for more than 50 percent of the radiative forcing of GHGs released from human activity over the next century (Houghton 1996; Houghton et al. 1990).

In this study we aimed to quantify the economic and environmental impacts of grassland conversion to tree-based land use systems. Specifically, we here (i) estimate and analyze the private profitability, social and environmental benefits of