Policy Measures for Mitigation and Adaptation in Cattle Production Systems in the Humid and Subhumid Tropics of Latin America

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Conversion of native vegetation into different forms of land use has large implications for the energy, water and carbon exchange processes between soil, surface and atmosphere at local and regional levels. In tropical America there is an estimated 548 million ha of agricultural land and grasslands (including silvopastoral systems) constitute about 77 percent of this land (Amézquita, *et al*., 2008a). A large percentage of established pastures are degraded because of inappropriate management (e.g. grass monoculture pastures) and this leads to a net loss of soil carbon stocks. In the humid tropics of Costa Rica, Veldkamp (1994) found a net loss of 2-18 percent of carbon stocks in the top 50 cm of forest equivalent soil after 25 years under pasture in lowland Costa Rica. However, the quality of management of tropical pastures is critical to the conclusions drawn about whether the soils under this land use represent a source or a sink of atmospheric carbon. Many studies have demonstrated that the implementation of well managed grass legume pastures and agroforestry systems (including silvopastoral systems) is associated with the maintenance and or increase of soil carbon stocks depending on climate, soil, vegetation and management factors (Neil, *et al*., 1997, Ibrahim, *et al*., 2007, Amézquita, *et al*., 2008b). In the subhumid tropics soil carbon stocks measured in degraded pastures was 26.4 tonne/ha compared with in silvopastoral systems (dispersed trees in pastures, 119 tonne/ha) and in secondary forest (21 years forest, 206.8 tonne/ha), and these data indicate that well managed systems have the capacity of sequestering carbon while improving productivity and income of cattle farms (Ibrahim, *et al*., 2007). In view of the vast area of grasslands and the impacts of improved pasture and silvopastoral systems in sequestering carbon and hence on mitigation of climate change, policy-makers have become interested in providing incentives to promote the adoption of these systems.

CATIE has worked with the FAO-FAO- Livestock Environment and Development Initiative (LEAD), World Bank, Center for Research on Sustainable Agricultural Production Systems/Centro para la Investigación en Sistemas Sostenibles de Producción Agropecuaria (CIPAV) of Colombia and Research and Development Institute affiliated to the Universidad Centroamericana/Instituto de Investigación y Desarrollo adscrito a la Universidad Centroamericana (NITLAPAN) of Nicaragua to implement a project funded by the Global Environment Facility (GEF) to develop methodologies and policies for payment of environmental services (PES) to promote the adoption of silvopastoral systems that will enhance carbon sequestration, and biodiversity conservation. The

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results of the project showed that PES resulted in a reduction in the area of degraded pastures and in an increase in the area with silvopastoral systems with low and high density trees (Table 1). The land use changes that farmers made resulted in an increase in carbon stocks of 71 712 CO2 eq which amounts to an increment of 1.5 tonnes/ha/ yr (area 12 000 has). The benefits from enhanced carbon (C) sequestration were addressed in the context of significant emissions of methane and nitrous oxide from livestock production and the impact of changing management and land use. For example, many farmers adopted forages (e.g. Leucaena, Cratylia) that are of better quality than existing grass species and this was associated in an overall reduction in emissions of greenhouse gases when a life cycle analysis was conducted (Figure 1).

The adoption of silvopastoral systems is not only related to mitigation but also adaptation to climate change. For example, in Nicaragua, production and economic indicators were improved with the adoption of silvopastoral systems both poor and non-poor farmers benefited from PES (Table 2).

For mainstreaming adoption of silvopastoral systems, the project worked with local and national policy-makers to implement policies and develop incentive schemes for investing in silvopastoral systems. For example, before the project was initiated, National Forestry Financing Fund/Fondo Nacional de Financiamiento Forestal (Costa Rica) (FONAFIFO), which is the organization responsible for PES in Costa Rica, compensated farmers only for forest systems (primary forest, secondary forest and forest plantations). However, the project worked with FONAFIFO and the Agroforestry Commission of Costa Rica to develop and implement a regulation for PES for the adoption of agroforestry systems (AF, including silvopastoral systems) and currently FONAFIFO has contracts with farmers which compensates them for each tree planted in AF (USD 1.30/tree paid in five years). In Colombia, Colombian Federation of Cattle/Federación Colombiana de Ganaderos (FEDEGAN) which is the national livestock organization, was supported to develop a programme for sustainable cattle production based on the implementation of silvopastoral systems. FEDEGAN is currently developing a national project with the World bank, CIPAV, the Nature Conservancy/Conservación de la Naturaleza (TNC), CATIE and local organizations to mainstream PES in silvopastoral systems for conservation of biodiversity and mitigation and adaptation to climate change, and it has earmarked credits from government banks, to support the investments in silvopastoral systems. GEF funds were approved for developing the proposal and the project is expected to commence in 2010. The socio-economic studies showed that investment cost in silvopastoral systems (USD 700–1 500/ha) are higher than that of traditional pastures (grass pastures, USD 300-400/ha) and lack of capital is one of the main reasons why farmers have not been adopting silvopastoral systems/sistemas silvopastoriles (SPS). To overcome this barrier, the project worked with the Local Development Fund (FDL) of Nicaragua, to develop a credit package for investing in green practices (e.g. silvopastoral systems) that will contribute to mitigation of climate change and improvement in farm productivity. Over the last years, FDL has allocated credits to more than 1 000 cattle farmers in Nicaragua, and in Colombia a similar credit scheme is being developed to support cattle farmers. FDL plans to increase funding for this credit scheme over the next years and is in the process of negotiating funding from the Central American Bank for Integration (BCIE) in the framework of the Cambio project which is funded by GEF.

Within the Clean Development Mechanism (CDM), reforestation and afforestation projects are being included as eligible projects for the first commitment period of the Kyoto Protocol (2008-2012). Offering financial incentives to promote reforestation and afforestation projects in developing countries is a very positive step.

TABLE 1. Land use change of farms receiving Payment for Environmental Services (PES) in the pilot zones of Esparza, Costa Rica; Matiguas, Nicaragua; and el Quindío, Colombia, 2007.

Country	Costa Rica				Nicaragua				Colombia			
Year	2003	2005	2007	% Diff 2007-2003	2003	2005	2007	% Diff 2007-2003	2003	2005	2007	% Diff 2007-2003
	Ha				ha				ha			
DP	548.9	183.3	123.7	-14.2	823.0	270.5	195.6	-20.4	83.6	16.0	9.1	-2.5
NP-T	243.6	4.3	3.1	-8.0	47.7	83.3	41.0	-0.2	730.8	251.6	239.5	-16.7
IP–T	57.3	22.7	16.2	-1.4	22.1	32.5	27.8	0.2	1 099.3	951.6	895.7	-6.9
NP+LDT	744.9	304.5	199.1	-18.2	322.7	385.2	317.3	-0.1	6.2	23.4	44.0	1.3
NP+HDT	113.1	174.2	146.6	1.1	373.6	444.5	497.1	4.1	0.0	34.9	34.3	1.2
IP+LDT	185.9	746.9	810.4	20.8	152.9	308.8	268.6	3.8	54.8	348.3	371.7	10.8
IP+HDT	48.8	474.5	606.5	18.6	158.5	382.8	532.2	12.2	2.2	187.0	239.8	8.1
FB	13.3	13.0	14.9	0.1	86.6	179.6	250.4	5.4	4.6	31.2	28.4	0.8
F+SV	903.4	929.6	929.2	0.9	751.8	798.7	775.5	0.9	639.0	650.2	667.1	1.0
Others	144.1	149.3	152.8	0.3	336.6	189.6	155.6	-5.9	326.6	452.8	417.5	3.1

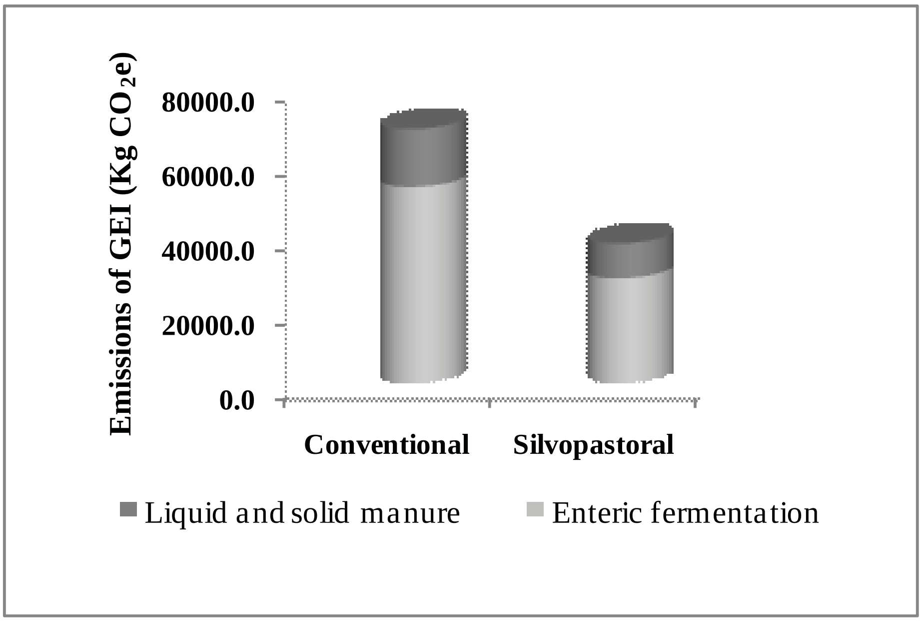
DP: Degraded Pasture; NP-T: Natural Pasture without Trees; IP-T: Improved Pasture without Trees; NP+LDT: Natural Pasture with Low Density Trees; NP+HDT: Natural Pasture with High Density Trees; IP+LDT: Improved Pasture with Low Density Trees; IP+HDT: Improved Pasture with High Density Trees; FB: Fodder Bank; F+SV: Forest and Secondary Vegetation.

TABLE 2. Socio-economic indicators with Payment for Environmental Services (PES) and different poverty levels.

Indicators	Poverty level	Base line (2003)	2006	% change
Milk production (kg ha^{-1} year^{1})	Noon poor	617.4 + 94.5 a*	662.9 + 56.0 a	7.4
	Poor	657.8 + 84.7 a	864.3 + 75.2 b	31.7
	Very poor	637.4 + 58.8 a	878.3 + 54.7 b	37.8
Family income per capita (USD year^{-1})	Noon poor	3188.0 + 475.5	5005.7 + 555.0 a	57.0
	Poor	1258.0 + 166.4 b	2606.7 + 378.1 b	107.2
	Very poor	802.5 + 109.5 c	1371.4 + 163.0 c	70.9

* Different letters indicate significant difference according to Duncan test ($p < 0.05$).

FIGURE 1. Composition of emissions of greenhouse gases emissions/emisión de gases de efecto de invernadero (GEI) (Kg CO2e) in 2 livestock systems



However, the CDM does not include compensation for the adoption of good practices (e.g. silvopastoral systems) in grasslands ecosystems although these ecosystems occupy vast areas and have good potential for mitigation and adaptation to climate change. In the implementation of reduction of emissions from deforestation, forest degradation (REDD), it is expected that funds will be allocated in the agricultural sector, as there are many drivers in the agricultural sector related to deforestation. For example, establishment of silvopastoral will lead to more sustainable production reduced pastureland degradation, and expansion of cattle in the forest reserves.

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