ELSEVIER

Geoderma 79 (1997) 261–276

GEODERMA

Developing policies for soil carbon management in tropical regions [1]

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Revised 28 November 1995; accepted 9 April 1997

Abstract

It is argued in this paper that two fundamental economic processes prevent resource-poor farmers in tropical countries from managing soil carbon in a sustainable manner. The first process is related to the fact that soil carbon and tropical forests are part of the natural capital of these countries and of the world community. As a consequence, the interests of resource-poor farmers in tropical countries, of these countries themselves and of the world community conflict. This implies that levels of adoption of sustainable soil carbon management practices which are optimal from the perspective of resource-poor farmers are sub-optimal from a regional and global perspective.

The second process regards the nature of sustainable soil management practices. These practices are investments in natural capital which bring about net benefits to farmers only after four to six years. Absolute poverty levels in tropical countries make it very difficult for farmers to undertake such investments. It follows that even perfectly informed and rational resource-poor farmers will not voluntarily adopt socially optimal levels of soil carbon management in tropical countries.

Policy interventions are a means of ensuring that soil carbon is managed in such a socially optimal and sustainable fashion in these countries. Two principles are proposed for developing effective, equitable and appropriate policy options. The first is the beneficiary-compensates principle, which requires that society in tropical countries and in industrialized countries should compensate resource-poor farmers in tropical countries for adopting soil carbon management practices. The second principle is that international and national policy options need to be well articulated and that sets of complementary policies should be put in place for greater effectiveness.

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[1] An earlier version of this paper was presented at the International Workshop on the Management of Carbon in Tropical Soils under Global Change, Nairobi, Kenya, February 7–11, 1994.

PII S0016-7061(97)00044-X

Policies alleviating rural poverty and pressures to deforest are as necessary as policies specifically targeted at soil carbon management.

Finally, research priorities for soil and biological scientists are derived from the analysis. These priorities necessitate the creation of interdisciplinary teams of soil, biological and social scientists. This is perhaps an even greater challenge for the scientific community than the achievement of the research agenda itself. © 1997 Elsevier Science B.V.

Keywords: soil carbon management; economic policy

1. Introduction

The carbon cycle, that is, the exchange of carbon dioxide among the biosphere, geosphere (including soils) and the atmosphere, has been affected by human activities over the centuries. One of these activities, landuse, has a direct bearing on soil carbon and soil carbon management. There are specifically two landuse processes in tropical countries which negatively affect the carbon cycle by contributing to CO_2 emissions and global warming. These processes are deforestation, 60% of which occurs through slash-and-burn agriculture (World Bank, 1991, p. 36), and progressive change in soil carbon under cultivation by resource-poor farmers who cannot afford to maintain or manage the carbon content of their soils.

Tropical forests have a large carbon pool in their soils and litter as long as the forest canopy remains intact. This soil carbon pool is estimated at over half the total carbon stored in tropical forests (Dixon et al., 1993). Tropical deforestation affects the carbon cycle directly by burning of branches and also leads to a more gradual loss in this soil carbon pool by oxidation to CO_2. Cultivation of tropical soils results in further losses in soil carbon through erosion and oxidation of surface organic matter, unless carbon management practices are used by farmers as a means of replenishing the soil carbon pool. Tropical deforestation and cultivation in developing countries thus contribute to greenhouse gas emissions and deplete soil carbon. Soil carbon depletion, in turn, leads to a decline in soil quality and, in the long-term, to ecologically unsustainable agriculture. Trends in soil carbon losses in tropical countries, though not well documented on a large scale, are raising concerns about agricultural sustainability in these countries and about global climate change (Bolin, 1977; Brown and Pearce, 1994a). At the same time, various technological solutions which soil and biological scientists have designed for managing soil carbon in a sustainable manner (Table 1) are rarely adopted by farmers in tropical countries. This is a manifestation of the fact that sustainable soil carbon management (like other sustainable land management practices) is, in the words of Agenda 21 and the Rio Declaration, ''the responsibility of governments'' (Earth Summit, 1993, p. 1). That is to say, in the absence of government intervention and of policies for promoting adoption, most farmers will not voluntarily adopt these practices. Soil erosion control