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Reconciling Sustainability Issues and Environmental Implications of Tropical Cropping Systems

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Abstract

Forest conversion and land-use change in the tropics are considered the major factors leading to environmental degradation, pollution and greenhouse gas (CO_2, N_2O, CH_4) emissions. The Kyoto protocol promotes a reduction in the emissions of greenhouse gases by about 5 % from 1990 levels by the period 2008 to 2012 in an attempt to mitigate the threat of global warming. Following the green revolution with its emphasis on high fertilizer inputs the development of sustainable cropping systems nowadays is increasingly based on the use of organic residues (alone or in combination with mineral fertilizers) to improve crop production and the soil resource base. In particular the use of legumes has obtained much interest although there has been a shift away from green manures towards leguminous grain legumes in order to increase the impact on farmers' livelihoods. Grain legumes with a low N harvest are particularly beneficial, e.g. promiscuous soybeans, and pose interesting challenges for plant breeders. However, resource use efficiency of legume residues is usually low ($10-30$ %) and considerable losses occur ($20-60$ %) associated with their high quality, poor nutrient release-demand synchrony and high rainfall in humid and sub-humid tropical areas. Although few studies have distinguished between leaching and gaseous losses, investigations from fertilized cropping systems in the humid and sub-humid tropics have shown that N_2O fluxes can be as much as ten times that of natural systems. N_2O emissions are linked to N availability (particularly nitrification) and hence increasing N-rich fast decomposing legumes in cropping systems will contribute to N_2O emissions (e.g. around $0.3-2$ % of applied residue N can be emitted as N_2O). On the other hand improved soil structure will reduce water-filled pore space and thereby mitigate some of the emission potentials. Zero-till systems, which are being promoted successfully in the Brazilian Cerrados, provide opportunities for carbon sequestration but also a high C availability in the mulch layer favouring N_2O emissions. Thus, the link between sustainability and greenhouse gas emissions is a complex one and the balance between C sequestration, leaching losses and greenhouse gas emission needs to be considered.

Keywords: Cropping system, green house gases, Kyoto protocol, N_2O emission

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