Agricultural cropland, forest, rangeland, wetlands, and urban ecosystems have significant potential to offset large amounts of greenhouse gases (GHGs) through improved land management and increased productivity. To fully realize this potential, we must understand how to implement the proper management practices and technologies to mitigate carbon dioxide (CO$_2$), nitrous oxide (N$_2$O), and methane (CH$_4$); conduct appropriate national, regional, and local inventories of soil carbon levels; develop sound measurements and monitoring techniques; and apply the appropriate practices and technologies within economic constraints. Considerable research is currently ongoing in these areas and is the subject of this special section.

AGRICULTURE AND FORESTRY CONTRIBUTION TO GREENHOUSE GASES

The atmospheric concentration of three GHGs—O$_2$, CH$_4$, and N$_2$O—has increased during the past 100 to 150 yr (IPCC, 2001). Since the late 1800s fossil fuel use, expansion of cultivated agriculture, and forest clearing have led to an increase in atmospheric CO$_2$ from 260 µL L$^{-1}$ (260 ppmv) to current levels > 370 µL L$^{-1}$ (370 ppmv) (IPCC, 1995). Most of the recent increase in CO$_2$ has been attributed to combustion of fossil fuels for energy and transportation. This increase in atmospheric CO$_2$ potentially impacts climate, as it is a greenhouse gas. In 1992, the USA signed and ratified the United Nations Framework Convention on Climate Change (UNFCCC) with the provision that stabilization of GHG concentrations allow ecosystems time to adapt to climate change, ensure food production, and enable sustainable economic development. In 2004, total U.S. GHG emissions were 7074 Tg CO$_2$ equivalent (eq.), a 15% increase since 1990 (USEPA, 2006). In the USA, emissions from agriculture and forestry represented approximately 447 Tg CO$_2$ eq., 6% of the U.S. total GHG emissions. Globally, agriculture accounts for about 14% of the total GHG emissions.

Agriculture contributes to GHG emissions through enteric fermentation, livestock manure management, rice cultivation, agricultural soil management of crop residues. Methane and N$_2$O are greenhouse gases from agriculture. Agriculture in the USA represented 27% of the anthropogenic CH$_4$ emissions of 7074 Tg CO$_2$ eq., and 68% of the N$_2$O emissions in 2004 and 68% of the N$_2$O emissions in 2000. Methane and N$_2$O agriculture accounts for 47% of the CH$_4$, 84% of the N$_2$O (USEPA, 2006). Forests contribute approximately 2% to the overall N$_2$O emissions and N fertilization of forests.

At the same time agriculture and forestry are contributing to the overall U.S. greenhouse gas emissions, land use, land use change, and forestry are major mitigation options for reducing GHG emissions in the short term. Forests in the USA represented net carbon accumulation by forest and agricultural soils.

AGRICULTURE AND FORESTRY CONTRIBUTION TO MITIGATION

Contributions of agriculture and forestry to mitigation of greenhouse gases can be achieved by (i) abatement from atmospheric CO$_2$, within the ecosystem, and (ii) sequestering C, within the ecosystem. Effective mitigation strategies involve approaches that decrease emissions while enhancing sequestration of C in biomass and in soil. Recent models of terrestrial systems can mitigate the increase in atmospheric CO$_2$ by sequestering C into surfaces and soils. The estimated amount of C stored in vegetation (560 Pg) or in the atmosphere (750 Pg) is twice the C in living vegetation (560 Pg) or in the atmosphere (Sundquist, 1993). Carbon sequestration in vegetation (560 Pg) or in the atmosphere (750 Pg) is one of the mitigation technologies (IPCC, 2001). Caldeira et al. (2004) categorized mitigation options. Those options that were immediately deployable with major contributions (>0.5 Gt C yr$^{-1}$) mitigation included agricultural soil C, soil and crop residue abatement from agriculture (soils and litter), and land restoration. Options with significant mitigation contribution but not immediately deployable included geologic storage, coal technology, and hydrogen fuels. Thus, agriculture and forestry, whether currently contributing to emissions or offering opportunities to sequester C, are essential to meeting global climate goals.