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The role of nuclear techniques in developing mitigation options for agricultural derived greenhouse gases

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The world is facing a rapid change in climate and an increasing frequency and severity of extreme weather events. A major cause of this is the rising temperature in the Earth's atmosphere, triggered by soaring emissions of greenhouse gases (GHGs) that trap heat in the atmosphere. Carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O) are among the most important GHGs. More than 24% of these GHGs are emitted by agriculture and land use changes and they continue to increase due to excessive use of nitrogen (N) fertilizers, increasing numbers of ruminants and deforestation. Of special importance is N2O which is 300 times more powerful than CO_2 in causing global warming and stays in the atmosphere for more than 120 years. Nitrous oxide is emitted into the atmosphere when microbial processes in the soil convert N fertilizers and animal manure into N2O.
To reduce N2O emissions from agriculture, we need to know the exact microbial processes and sources (soil N or fertilizer N) that produce N2O and N gas (N2). The stable isotope of nitrogen-15 is currently the only technique which precisely quantifies the pathways of N2O and N2 under field conditions. The International Atomic Energy Agency (IAEA), in partnership with FAO through the Joint FAO/IAEA Division, assists the Member States of IAEA in developing best farm practices to mitigate N2O as well as carbon (C) storage (sequestration) in soil to make it resilient against climate change, and they do this through the use of nuclear techniques. In an IAEA funded Coordinated Research Project (CRP), 9 Member States including Brazil, Chile, China, Costa Rica, Ethiopia, Germany, Iran, Pakistan, and Spain are working together to reduce N2O emissions and enhance C sequestration. Field data of Brazil, China, Chile, Iran and Pakistan showed that N2O emissions from different N inputs were reduced by approximately 50% by adopting best soil nutrient management practices. In Ethiopia, the soil C and N stocks decreased by 23% and 40%, respectively, in conversion of natural forest to crop field. However, after 17 years of afforestation, the crop field showed no changes of C or N stocks. The 15N technique identified 2 more microbial processes of N2O production which include co-denitrification and conversion of organ N to mineral N. This information provides the backbone for the development of climate smart agricultural practices to reduce agriculture derived GHGs while agricultural crop productivity is increased. Moreover, countries worldwide will be in a much better position to determine their specific GHGs emission factors, establish effective mitigation measures and thus meeting their international commitments.