



چهارمین همایش ملی کاربرد فناوری هسته‌ای در علوم کشاورزی و منابع طبیعی
(۲۹-۳۰ اردیبهشت، ۱۳۹۴، پژوهشکده کشاورزی هسته‌ای)

The 4th National Congress on Nuclear Technology Application in Agricultural &
Natural Resource Sciences (19-20 May, 2015, Nuclear Agriculture Research School)

Nuclear techniques in soil water and nutrient management

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Abstract

Sustainable agricultural development require the combined use of soil, nutrient, and water management strategies that enhance crop productivity and at the same time promote environmental sustainability. In this context, there is a strong need for high-quality innovative research and soil-water-specific technologies that will address the most strategically important issues of soil/land and water management and conservation in agro ecosystems. Nuclear and Isotopic Techniques (NITs) comprise the use of stable (natural abundance and enrichment by artificial labelling) and radioactive (radiation-emitting) isotopes as well as radiation sources such as neutron and gamma density probes. Isotopes are utilized as tracers that provide unique, precise, and quantitative data on nutrient and water pools and fluxes in the soil-plant-water systems, to assess the relative value of selected soil-water management technologies tailored to specific agroecosystems for improving soil fertility, crop productivity, mitigation of greenhouse gases and water use efficiency in crop and livestock production systems. Specific chemical sources and pollutants from these systems can also be traced using NITs. For example, ¹⁵N-stable isotopic techniques can be used to measure rates of nitrogen (N) processes such as N mineralization-immobilization, nitrification and denitrification, biological N fixation, N use efficiency, and sources of N pollution in ground- and surface waters. Nuclear-based techniques are a complement and not a substitute to nonnuclear conventional techniques. They are applied in the context of agricultural research under field and greenhouse conditions when they offer comparative advantages over conventional techniques. However, they demand skilled and trained personnel and adequate laboratory facilities, in particular measurement equipment/techniques or alternatively financial resources for analytical services. In the case of radioactive isotopes, strict compliance with safety regulations and radiation protection procedures are required