Towards sustainable land management for enhancing food security while mitigating climate change impacts:

The Role of Nuclear and Isotopic Techniques

Long Nguyen
Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture
Corporate Mission

Atomic energy for peace, health and prosperity

Sustainable agricultural development, improved nutrition and food security

To contribute to sustainable food security and safety by use of nuclear techniques and biotechnology

1964: 48 Years of Successful Partnership
Our Goals:

- Food Security
- Sustainable Agriculture
- Resource conservation
Key Issues

• An increase in global population from 7 billion to 9 billion by 2050
• 70% increase in food production and 50% increase in water demand for agriculture needed by 2050.
• 1.9 billion ha of land degraded with an annual rate of 5-7 million ha.
• Agriculture emits 14-30% of global greenhouse gas (GHG) emissions:
An overview on approaches and relevant nuclear and isotopic techniques used by the SMNCSN
1. Managing soils for enhancing crop production and ecosystem services

Soil moisture neutron probe
1. Integrated soil-water-nutrient management in:
   - Agroforestry,
   - Dryland and irrigated agriculture.
   - Cropping systems in tropical high P fixing soils.

2. Evaluation of crop genotypes with increased WUE using carbon isotope discrimination technique.

3. Identification of food crop genotypes tolerant to soils of low N and P status.
2. Preserving and protecting soil resources through the use of Fallout Radionuclides (FRN)

- FRN with precipitation (P)

- Erosion site: $^{137}\text{Cs} < P$

- Deposition site: $^{137}\text{Cs} > P$

- Resulting soil level

Original soil level
1. Erosion:

- Extent of soil erosion: 7Be, 137Cs and 210Pb for short-term (<30 days), medium-term (~40 years) and long-term (~100 years).

- Sources: Compound specific stable isotope (CSSI).

2. Salinization
3. Managing soils for climate change

- Increasing soil quality and productivity
  - Soil fertility
  - Conservation agriculture
  - Mulching
  - Bio-fertilisers
4. Managing soil water storage for climate change

- Improving water use efficiency in rainfed and irrigated agriculture
  - Agroforestry
  - Mulching
  - Irrigation scheduling
  - On-farm water storage
The Way Forward
Soil Carbon and GHG Management

- Increasing soil carbon storage (C sequestration in soil and crops)
  - Soil fertility
  - Conservation agriculture
  - Mulching/cover crops
  - Bio-fertilisers

- Reducing GHG
  - N fertilisers
  - Animal manure
  - Irrigation scheduling
Area-wide/catchment WQQ

- A more holistic system approach:
  - Integrated cropping-livestock.
  - Non-point source pollution control.
  - Water recycling through constructed wetlands and riparian zones.
  - Alternative land uses.

- Increasing soil and agricultural resilience against drought and flooding events:
  Climate smart agriculture.
CONCLUSIONS

- Nuclear and isotopic techniques (NIT) offer comparative advantages of high specificity, accuracy and sensitivity.
- Multi-disciplinary approaches.
- Capacity building, networking, coordination and information exchange are important in NIT applications.
- Partnerships and innovative collaboration modalities important.
CONCLUSIONS

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Food Biomass Production

Water Resource, Quality & Availability, Climate Change, Adaptation

Nuclear & Isotopic Technologies in Soil-Plant-Animal Systems

Soil Resource, Quality & Availability, Climate Change, Mitigation

Nutrient/Elemental Cycling

Food Biomass Production

Identifying Niches for Species

Biodiversity

Deep Root System & Recalcitrant Compound

Economic Issues

Social, Ethnic & Policy Issues

Societal & Human Dimensions

14C, 15N

2H, 18O

12C, 13C, 14C

15N, 32P

Carbon Sequestration in Agro-ecosystems

Water Recycling & Purification

Improving WUE & NUE