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Nuclear Techniques in Food and Agriculture

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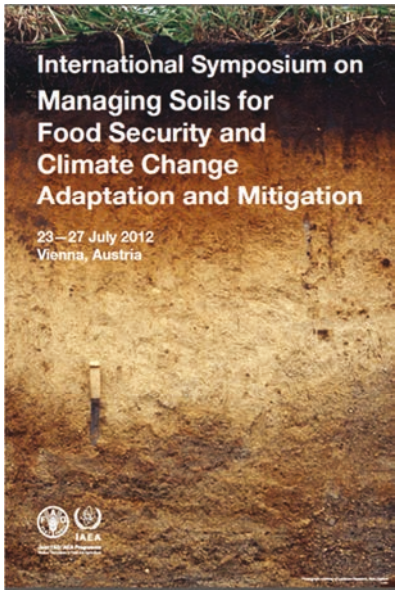

FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation

To Our Readers

The end of 2012 is fast approaching and I wish you all, our readers, a very successful 2013. May you enjoy good health and happiness. Looking ahead to the New Year, there will be many new challenges and opportunities, which I will mention later in this Soils Newsletter and I would like to thank you all for your support in 2012. Without your support and the dedication of our Soil and Water Management & Crop Nutrition colleagues (both Section and Laboratory), consultants and interns, we as a team, would not have been able to successfully accomplish all of our 2012 objectives, thus a big *thank you* to all for your contributions.

One of the notable successes of the SWMCN Subprogramme in 2012 was the FAO/IAEA Symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation". This International Symposium was held from 23-27 July, with the participation of over 400 scientists and policy makers from 80 Member States. There were 85 oral papers and 136 poster papers covering a wide range of topics, including managing soils for crop production and ecosystem services, preserving and protecting soil resources, soil and water conservation for pollution control, managing soils for climate change adaptation and mitigation, managing agricultural water for climate change adaptation, recent advances in nuclear techniques and applications and the Global Soil Partnership. The Joint FAO/IAEA Division joined forces with the FAO-Land and Water Division to promote awareness of the FAO Global Soil Partnership. Mr. Alexander Mueller, Assistant Director General of the FAO Natural Resources Department, delivered an exciting opening address on the importance of soil and land management for sustainable agriculture.

IAEA International Atomic Energy Agency

Following on the heels of the FAO/IAEA Symposium was the 2012 IAEA Scientific Forum (18-19 September) entitled "Food for the Future: Meeting the Challenges with Nuclear Applications". This Forum brought together distinguished scientists and policy makers from different countries, highlighting the successful applications of nuclear techniques in plant breeding and genetics, animal production and health, insect pest control, food and environmental protection and soil and water management & crop nutrition. Further details of the FAO/IAEA Symposium and the 2012 Scientific Forum can be found in the Feature Article Section of this Newsletter. After September, the following three Consultants Meetings (CM) were held at IAEA in Vienna, with contributions from FAO colleagues and international experts:

(i) "Area-wide water salinity management for improving agricultural productivity and food security in arid and semi-arid regions";
(ii) "Agro-ecosystem carbon and nutrient budgeting to assess land resource sustainability for food and biofuel production in marginal lands"; and
(iii) "Optimizing soil and water resource efficiency in integrated cropping – livestock production systems".

These CMs will act as major springboards for the development of three Coordinated Research Projects (CRPs) in 2013, which aim to address major soil, water and nutrient management issues for climate smart agriculture, sustainable multifunctional food/biofuel production systems and integrated cropping – livestock agriculture. Currently there are five ongoing CRPs in the SWMCN Subprogramme, with the CRP D1.20.09 entitled: "Managing Irrigation Water to Enhance Crop Productivity under Water-Limiting Conditions: a Role for Isotopic Techniques (D1.20.09)" concluding in July 2012. The technical document (TECDOC) summarizing the results of this 5-year CRP is in the initial stage of preparation.

In addition to the CRPs, the SWMCN Subprogramme also provided technical support to 52 Technical Cooperation Projects (TCPs) throughout the world in 2012. Of these TCPs, ten are regional projects, which include (a) four in Latin America on soil erosion – soil fertility – soil nutrient management, (b) four in the Asia-Pacific region on soil fertility, land productivity and land degradation and (c) two in Africa on small scale irrigation for high value crops and conservation agriculture practices. The SWMCN Laboratory of the SWMCN Subprogramme has also provided support to CRPs through research and development in soil carbon sequestration, greenhouse gas emissions and agricultural water management. In addition, 43 fellows were trained in the SWMCN Laboratory during 2012. This required incredible support from all team members of the SWMCN Subprogramme and in particular staff at the SWMCN Laboratory, who provided training materials as well as technical and operational support to fellows during an extremely busy time of the year, as we prepared for the FAO/IAEA International Symposium. I greatly appreciate the dedicated effort of each team member and the coordinating effort of my colleague, Mr. Joseph Adu-Gyamfi. This collective support also provided the unique opportunity for the participating fellows to attend the FAO/IAEA International Symposium and to exchange ideas with scientists and experts from around the world. Joseph also successfully led the SWMCN Laboratory through a transitional period when there were so many demands on our resources. In September Gerd Dercon was appointed as Head of the SWMCN Laboratory. Congratulations to Gerd and my sincere thanks and appreciation to Joseph.

The challenges and opportunities of the SWMCN Subprogramme are entering a very exciting phase, with increasing focus and awareness of policy makers and farming communities around the world on the management of land and agricultural water resources for sustainable agriculture, which is resilient to climate change and variability. In addition, there is mounting pressure on the agricultural sector to reduce greenhouse gas emissions. Land and water management tools and technologies are in increasing demand by cropping and livestock farmers to improve soil and water quality, reduce soil erosion and land degradation, minimize greenhouse gases from farmlands, improve soil fertility and produce more food per drop of water in both rainfed and irrigated lands.

In looking forward to these new challenges and opportunities in 2013, I would like to thank you all again for your help and encouragements. I wish you and your families all the best for the New Year and I look forward to receiving your continuing support.

Wishing you all the best,

Long Nguyen
Head
Soil and Water Management and
Crop Nutrition Section

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Staff News

Mr. Lionel Mabit former Technical Officer of the SWMCNL (2005-2012) and **Mr. Gerd Dercon**, SMWCN Laboratory Head, received in 2012, together with other scientists from NAEL/NAFA/NAHU, a Team Award for their Support Provided Following the Accident in Fukushima NPP.

Mr. Gerd Dercon was appointed Head of the Soil and Water Management and Crop Nutrition Laboratory in August 2012 following the retirement of former Head Mr. Gudni Hardarson in December 2010.

Mr. Dexi Lin joined the SWMCN Subprogramme as a consultant for 6 months on 2 July. Dexi is working with Mr. Joseph Adu-Gyamfi, Mrs. Martina Aigner and Mrs. Federica Tamburini (ETH, Switzerland) on the use of a new stable isotope-based technique (the oxygen isotope composition of phosphate) to trace phosphorus (P) in soils. Together with Mrs. Maria Heiling, Ms. Andra-Rada Iurian and Mr. Gerd Dercon, he is also involved in the development and adaptation of isotopic and nuclear techniques for assessing soil organic carbon sequestration and estimating short-term soil erosion. Dexi is a Professor at the Department of Resources and Environmental Sciences of the Fujian Agriculture and Forestry University.

Mr. Basil C. Gonsalves joined the Soil and Water Management and Crop Nutrition Laboratory (SWMCNL) on 19 September 2012 as a consultant. Basil will be working on fallout radionuclide-(FRN) based techniques to estimate soil erosion and sedimentation at landscape level. He will also be evaluating *in situ* measurements of FRNs as a rapid semi-quantitative tool to assess soil erosion and deposition. Basil is currently completing his MSc programme in the Physics and Technology of Nuclear Reactors (PTNR) at the University of Birmingham, United Kingdom of Great Britain and Northern Ireland. He holds two undergraduate degrees: in Physics from the University of St Andrews, United Kingdom of Great Britain and Northern Ireland and in Chemistry from the University of York, United Kingdom of Great Britain and Northern Ireland. Basil is from the United States of America, but grew up in Ethiopia, India and Switzerland. He has undertaken internships at UNEP (Addis Ababa) and the IAEA in Vienna.

Mr. Phillip Chalk, former Section Head (August 1997 to August 2004), left the SWMCN Section in August 2012 after working as a consultant for 18 months. Phil provided invaluable support to the Section by helping to organize the FAO/IAEA International Symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation" in Vienna. He has also helped to edit and compile the 252 extended synopses for the symposium. In addition, Phil assisted with the formulation and setup of new CRPs and TCPs and many of the administrative tasks. We wish Phil all the best.

Ms. Jordana Antal also left the SWMCN Section in August 2012 after 10 months as a team assistant, during which time she provided tremendous administrative support to the FAO/IAEA symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation". Together with Phil, Jordana helped the Section Head in all matters relating to the Symposium.

Ms. Andra-Rada Iurian, an intern with the SWMCN Laboratory, Seibersdorf from June – September 2012, has concluded her assignment and started a follow-up internship at the Terrestrial Environment Laboratory. Ms. Iurian underwent training in the use of fallout radionuclide-based techniques for assessing soil erosion and redistribution, with a major focus on the use of ^{7}Be. We thank Andra-Rada for her inputs to the laboratory activities and wish her all the best for the future.

Both **Mr. Sereyvirak Dy (Virak) (**from Cambodia) and **Ms. Lina Shakhashiro** (from Syria), concluded their interships with the Soil and Water Management and Crop Nutrition (SWMCN) Subprogramme in December 2012, after working with us for eight and six months, respectively. They provided tremendous help to the Subprogramme in a range of project management issues relating to soil and water management in agricultural production, technical cooperation projects and especially to the FAO/IAEA International Symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation" which took place in Vienna, from 23 to 27 July 2012. We wish both of them the best in their future careers.

Feature Articles

Quantifying the Components of Evapotranspiration from Plant Communities, Soil Evaporation and Plant Transpiration, with Oxygen-18 Isotopes and Micrometeorology

Tom Denmead[1], Lee Heng[2], Matthias Zeeman[3], Leo Mayr[4], Peter Cepuder[5], Jose Luis Arrillaga[4], Long Nguyen[2]
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The Keeling plot (Keeling, 1961) approach has been shown to provide an estimate of the relative proportions of water vapour emanating from evaporation (E) from soil, and transpiration (T) from the plant canopy (Moreira et. al., 1997; Williams et al., 2004). This estimate can be used in conjunction with measurements of the net water vapour flux and evapotranspiration (ET), to quantify the E and T components using an Inverse Lagrangian (IL) approach based on canopy turbulence (Raupach, 1989), which allows the identification of water vapour in the different canopy layers (Denmead et al., 2005).

A study was carried out on a wheat crop over a 3-day period in April (daily temperatures ranged from 14-23 ^{o}C) at the BOKU experimental field outside Vienna to provide an independent check of the relative proportions of soil evaporation (E) and plant transpiration (T) estimated by the Keeling plot $\delta^{18}O$ isotope analysis and by the application of the IL model of water vapour transport in plant canopies. The eddy covariance instrumentation to measure ET was provided by the Karlsruhe Institute of Technology at Garmisch-Partenkirchen, Germany (Plate 1).

Photo 1: Experimental setup with the Picarro laser analyser (front, covered in case of rain), eddy covariance and water vapour samplers behind

Transpiration rates, estimated by the $\delta^{18}O$ isotopic technique were similar to those derived from Inverse Lagrangian analyses (Fig. 1) indicating that the IL and isotopic analyses gave essentially the same partitioning of evapotranspiration into E and T.

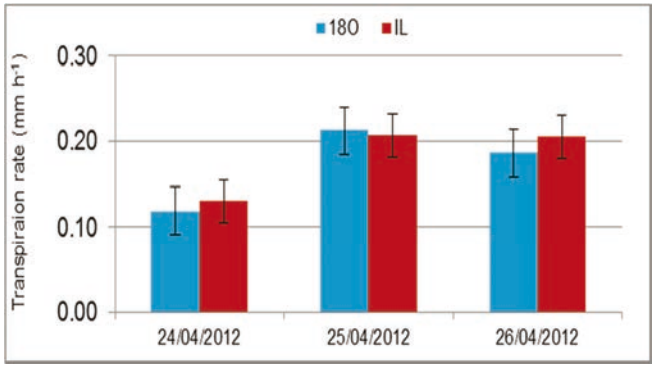

Fig. 1. Average daytime transpiration rates determined by $\delta^{18}O$ and IL analyses.

The use of the IL analysis to determine water vapour in different segments of the canopy is illustrated in Fig. 2. In these observations the soil was dry (9-12 %) and soil evaporation was small.

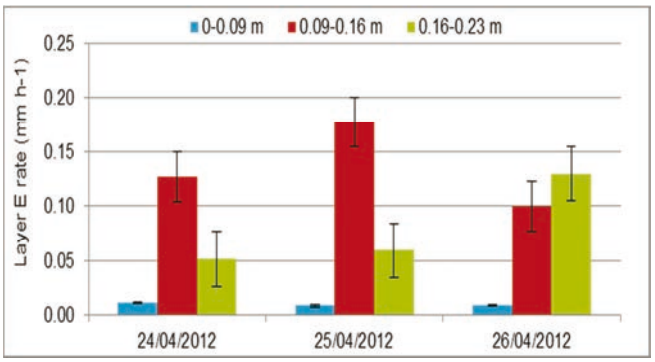

Fig. 2. Daytime means and standard errors of evaporation rates from canopy layers using IL analysis.

The eddy covariance approach confirmed the correctness of the IL analysis for the total water loss from the canopy (to within 6%) (data not shown). The IL and the isotopic analyses gave essentially the same partitioning of ET into E and T for 3 days on a dry soil. The isotopic analysis using $\delta^{18}O$ gave E/ET ~ 4% and T/ET ~ 96%, while IL analysis gave corresponding figures of 6% and 94%.

References

Denmead, O.T., et al. 2005. Inverse lagrangian analysis of heat, vapour and gas exhange in plant canopies. In: Hatfield, J., and Baker, J. Micrometeorology in Agricultural Systems Agronomy Monograph No. 47, Madison, WI: American Society of Agronomy, Crop Science Society of America, Soil Science Society of America: 485-511.

Keeling, C.D. 1961. The concentration and isotopic abundances of carbon dioxide and marine air. Geochim. Cosmochim Acta 24**:** 277-298.

Moreira, M.Z. et al. 1997. Contribution of transpiration to forest ambient vapour based on isotopic measurements. Global Change Biol. 3: 439-450.

Raupach, M.R. 1989. Applying Lagrangian fluid mechanics to infer scalar source distributions from concentrations in plant canopies. Agricultural and Forest Meteorology 47: 85-108.

Williams, D.G. et al. 2004. Evapotranspiration components determined by stable isotope, sap flow and eddy covariance techniques. Agricultural and Forest Meteorology 125: 241–258.

Understanding the Role of Microorganisms in Soil Quality and Fertility under changing Climatic Conditions

Gerd Dercon[1], Joseph Adu-Gyamfi[1], Egbert Schwartz[2], Dexin Lin[1,3], Maria Heiling[1], Martina Aigner[1], Minh-Long Nguyen[1]
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The Soil and Water Management and Crop Nutrition (SWMCN) Subprogramme (Section and Laboratory) assists FAO and IAEA Member States in the development, validation and dissemination of a range of soil, water and crop management technology packages using nuclear and nuclear-related techniques.

In the coming years, SWMCN aims to (i) improve soil quality and soil resilience against the impacts of climate change and variability and (ii) reduce greenhouse gas emissions and increase soil carbon sequestration in both productive and marginal lands.

To achieve these aims, the SWMCN Subprogramme is planning to put major emphasis on applied microbial ecology. Microbial communities play a major role in soil fertility improvement through the decomposition of crop residues, livestock manure and soil organic matter. These microbes are often affected by variations in rainfall and temperature patterns caused by climate change. Recent advances in the use of stable isotopes like carbon-13, nitrogen-15 and oxygen-18 as biomarkers to characterize microbial communities and their interactions with soil nutrient and organic matter processes, known as stable isotope probing (SIP), are important for soil–water–nutrient management.

SIP helps us to understand the interactions between soil microbial communities and their specific functions in soil carbon sequestration, soil organic matter stabilization, soil fertility and soil resilience, as well as the soil productive capacity for sustainable intensification of cropping and livestock production. SIP involves the introduction of a stable isotope labelled substrate into a soil microbial community to trace the fate of the substrate. This allows direct observations of

substrate assimilation to be made in minimally disturbed communities of microorganisms. Microorganisms that are actively involved in specific metabolic processes can be identified under in-situ conditions.

SIP is most developed for carbon-13 probing, but studies using nitrogen-15 and oxygen-18 probing are scarce. Nevertheless, the use of nitrogen-15 SIP is proving to be useful for assessing functional soil microbial activity that is linked with N substrates and for labelling soil DNA with $H_2{}^{18}O$, to identify newly grown cells for better understanding of the role of soil microbial dynamics in soil quality and fertility.

Some interesting references dealing with Stable Isotope Probing include:

Cadisch, G., M. España, R. Causey, M. Richter, E.J. Shaw, A.W. Morgan, C. Rahn, and G.D. Bending. 2005. Technical considerations for the use of ^{15}N-DNA stable-isotope probing for functional microbial activity in soils. Rapid Communications in Mass Spectrometry 19:1424–1428.

Kreuzer-Martin, H.W. 2007. Stable isotope probing: linking functional activity to specific members of microbial communities. Soil Science Society of America Journal 71:611-619.

Radajewski, S., P. Ineson, N.R. Parekh, and J.C. Murrell. 2000. Stable-isotope probing as a tool in microbial ecology. Nature 403:646-649.

Rangel-Castro, J.I., K. Killham, N. Ostle, G.W. Nicol, I.C. Anderson, C.M. Scrimgeour, P. Ineson, A. Meharg, and J.I. Prosser. 2005. Stable isotope probing analysis of the influence of liming on root exudate utilization by soil microorganisms. Environmental Microbiology 7:828-838.

Schwartz, E. 2007. Characterization of Growing Microorganisms in Soil by Stable Isotope Probing with $H_2{}^{18}O$. Applied and Environmental Microbiology 73:2541-2546.

2012 IAEA Scientific Forum on Food for the Future: Meeting the Challenges with Nuclear Applications

The annual Scientific Forum (SF) was held during the IAEA General Conference on 18-19 September 2012 in Vienna. This year, the focus was on nuclear applications relating to food. The Forum brought together scientists and experts to discuss food production, food protection and food safety issues.

The opening highlight was the performance of the Men's Choir of the Russian National Research Nuclear University, followed by the Inaugural Address from IAEA Director General Mr. Yukiya Amano. Speeches were also given by Mr. Steven Chu, Secretary of Energy, United States of America, Mr. Jose Graziano da Silva, Director General, Food and Agriculture Organization (video message), Mr. Gusti Muhammad Hatta, Minister of Research and Technology, Indonesia, Ms. Margaret Kamar, Minister of Higher Education, Science and Technology, Kenya, and Mr. Nguyen Quan, Minister of Science and Technology, Vietnam.

Director General Mr. Yukiya Amano noted in his speech that the IAEA is actively supporting Member States in their quest to improve global food security through the provision of safe and wholesome food supplies for rapidly expanding populations. He stated that the IAEA is in a unique position to make nuclear technology available to developing countries, by helping them to grow more food, fight animal and plant pests and diseases and ensure the safety of food products.

All five Sections and Laboratories in the Joint Division of Nuclear Techniques in Food and Agriculture participated in the Forum. Ms. Naga Munchetty, a presenter from BBC News, chaired all of the sessions. The Forum showed how sustainable nuclear technologies are helping smallholder farmers in developing countries to meet these challenges. In the session on "Increasing Food Production", it was noted that the world will need to produce 70 % more food between now and 2050 to satisfy the demand of a global population in excess of 9 billion people. In this regard, the intensification and diversification of more and higher quality food in a climate-smart and sustainable manner whilst protecting the environment is critical to smallholder farmers and the key to poverty reduction and increased food security.

The Forum noted that increasing global populations face the challenge of substantially increasing food production under conditions of severe land degradation which have led to a significant reduction in the productive capacity of agricultural lands. Sustainable soil management is therefore critical to the improvement of agricultural productivity. The panellists also highlighted the fact that education and extension play a key role in providing agricultural producers with the knowledge and incentive for the management of soil productivity.

Relating to the importance of soil and water management for food production, a film on "More Food with Better Soil: Using Isotope Techniques" was shown. It showcased research activities from the SWMCN Laboratory which provides critical information that will help farmers in developing countries to grow more and better crops. An interview was also

conducted with Mr. Minh-Long Nguyen, the SH of SWMCN on the importance of soil management in food security and climate-smart agriculture. Mr. Steven Chu, Secretary of Energy, United States of America and Mr. Winfried Blum, Professor Emeritus of Soil Science of the Universität für Bodenkultur (BOKU), Vienna spoke separately about the effects of desertification, erosion and droughts on soil and water resources, and climate-smart soil and water management for optimizing sustainable food production. This was followed by a lively discussion between the audience and the panel on the use of nuclear and isotopic techniques in land management for food production and sustainable agriculture.

FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation, 23-27 July 2012, Vienna, Austria

Minh-Long Nguyen

Soil and Water Management and Crop Nutrition Section, IAEA, Austria

The FAO/IAEA International Symposium was successfully held over a 5-day period with the participation of FAO colleagues from Rome and over 400 scientists, policy makers and technical staff from 81 Member States. All team members from the SWMCN Section and SWMCN Laboratory provided tremendous support and assistance to ensure that the event ran smoothly and to man the SWMCN publication display. Both Phil Chalk and Ms. Jordana Antal of the SWMCN Subprogramme and Ms. Karen Morrison and her team from the IAEA Conference Services Section played a major role in ensuring that the Symposium was a success. There were 85 oral papers and 136 poster papers presented at the Symposium. Participants have subsequently been approached by the Scientific Secretary (M. L. Nguyen) and his FAO/IAEA International Symposium team to submit their full papers. To date, the response to this request has been modest, with 38 oral papers and 45 poster papers submitted. These papers are currently under review. Authors will be notified in due course. In the meantime, if you are one of the participants who have not responded to our previous requests, I wish to invite you again to submit your oral or poster papers for publication consideration in the FAO/IAEA Proceedings. Please send them to: m.nguyen@iaea.org.

The Symposium comprised 7 Sessions, covering a range of topics relating to soil and water management issues, including a session dedicated to recent advances in nuclear techniques and applications in soil and water-related research. A specific session relating to the Global Soil Partnership on the final day of the Symposium generated great interest from the Symposium participants, since this GSP initiated by FAO provides an exciting opportunity and platform for interactions between providers, decision makers and farming communities.

IAEA Peaceful Uses Initiative (PUI) awarded to IAEA Technical Cooperation Regional project RAF/5/058 - Enhancing the Productivity of High Value Crops and Income Generation with Smallscale Irrigation Technologies, 2012-2013

L.K. Heng

Soil and Water Management and Crop Nutrition Section, IAEA, Austria

The RAF5058 project entitled Enhancing the Productivity of High Value Crops and Income Generation with Smallscale Irrigation Technologies, involving 19 African countries (Algeria, Benin, Botswana, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Libya, Mali, Mauritius, Morocco, Niger, Nigeria, Sudan, Uganda, United Republic of Tanzania, Zambia, and Zimbabwe), recently received a total of US$181 900 from the IAEA Peaceful Uses Initiative (PUI) for two years (2012-2013).

The project deals with nuclear and isotopic applications in soil moisture measurement and fertilizer use by high-value crops for sound deployment of smallscale irrigation systems and best practice in water use and management. The field experiments and socio-economic studies carried out so far by participating Member States show that drip irrigation increases yield while saving irrigation water by up to 30% compared to traditional methods of application. The project has generated tremendous interest from smallholder farmers who are eager to adopt the technology. Several Field Days, which further create awareness and enhance technology transfer to local smallholder farmers, have been held in different countries. The project received wide coverage and was showcased during the 2011 IAEA Scientific Forum on Water Matters - Making a Difference with Nuclear Techniques http://www.iaea.org/newscenter/focus/water/.

The PUI fund aims at developing and pilottesting new interactive irrigation tool kits developed within modern communication technologies (i.e. mobile phones), using sitespecific water management packages and precision irrigation information. This information, developed by scientists using isotopic-nuclear techniques and smallscale irrigation technology, helps farmers to access irrigation scheduling information, to cope with water scarcity and to improve crop productivity through precision irrigation. This PUI initiative is built as a result of the increasing use of mobile phones in Africa over the last decade to assist farmers to gain information about everything from markets to weather (http://allafrica.com/stories/201204160805.html; http://allafrica.com/stories/printable/201207160458.html).

The planned activities of the PUI include:

1. Developing interactive irrigation tool kits within mobile phone systems using site-specific water management packages and precision irrigation information.
2. Organizing Farmers Field Days to transfer technology packages to farmers and the wider community.
3. Organizing regional training courses to disseminate information and technology.

Project outcomes/outputs:

1. Member State institutes will be equipped and trained in the use of modern soil water monitoring systems, irrigation management and crop water use efficiency.
2. Interactive irrigation tool kits developed within mobile phone systems, using site-specific water management packages and precision irrigation information.
3. Technology packages transferred to farmers and the wider community through Farmers Field Day events.

NEW VACANCIES

- IAEA Soil Scientist/Plant Nutritionist: P4

https://recruitment.iaea.org/vacancies/p/2012/2012_128.html

- IAEA Soil Scientist: P4

https://recruitment.iaea.org/vacancies/p/2012/2012_131.html

- Technical Officer (Soil and Water): P4

http://www.fao.org/fileadmin/user_upload/VA/pdf/IRC2208e%20.pdf

Technical Cooperation Projects

Operational Projects and Technical Officers responsible for implementation

Project Number	Title	Technical Officer(s)
ALG5026	Increasing the Genetic Variability for the Improvement of Strategic Crops (Wheat, Barley, Chickpeas and Dates) for Enhanced Tolerance to Biotic and Abiotic Stresses and the Development of Biotechnology Capacities	Adu-Gyamfi, Joseph in collaboration with Plant Breeding and Genetics Section
ALG5028	Preserving Arid and Semi-Arid Agro-Ecosystems and Combating Desertification by Using Advanced Isotopic Techniques, Developing Decision Making Tools and Supporting Sensitisation of the Local Population on the Needs of Desertification Control	Dercon, Gerd
ANG5011	Monitoring Soil Fertility in Pasture Areas for Their Improvement and Maintenance	Heng, Lee
BGD5028	Assessing Crop Mutant Varieties in Saline and Drought Prone Areas Using Nuclear Techniques	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
BEN5007	Soil, Crop and Livestock Integration for Sustainable Agriculture Development Through the Establishment of a National Laboratory Network	Adu-Gyamfi Joseph in collaboration with Animal Production and Health Section
BKF5009	Improving Voandzou and Sesame Based Cropping Systems Through the Use of Integrated Isotopic and Nuclear Techniques for Food Security and Poverty Alleviation	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
BKF5010	Enhancing Crop Productivity through Small Scale Irrigation Technologies for Peri-Urban Agriculture to Improve the Income and Livelihood of Farmers	Heng, Lee
BOT5007	Using Isotopic, Nuclear and Other Conventional Techniques to Support the Development of Improved Soil and Water Management Techniques to Increase Crop Production	Sakadevan, Karuppan; Nguyen, Minh-Long
CAF5006	Improving Cassava Production through High-Yielding Varieties and Sustainable Soil Fertility Management by Using Isotopic and Nuclear Techniques to Ensure Sustainable Farming	Dercon, Gerd in collaboration with Plant Breeding and Genetics Section
COS5029	Strengthening of Good Agricultural Practices (GAP) for Food Safety and Security and Environmental Protection	Dercon, Gerd in collaboration with Food and Environmental Protection Section
ECU5026	Improving the Efficiency of Irrigation in the Rio Chota Sub-Basin	Sakadevan, Karuppan
GUA5018	Evaluating the Impact of Anthropogenic Contamination on Aquatic Ecosystems	Sakadevan, Karuppan in collaboration with Isotope Hydrology Section
HAI5003	Enhancing Crop Productivity through the Application of Isotope Nuclear Techniques	Sakadevan, Karuppan
HON5007	Evaluating Nutrient Pollution and Heavy Metals in Lake Yojoa to Determine the Impact on the Environment and Human Health	Sakadevan, Karuppan in collaboration with Isotope Hydrology Section
INS5039	Enhancing Food Crop Production Using Induced Mutation, Improved Soil and Water Management and Climate Change Adaptation	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
IRQ5018	Using Fallout Radionuclides and Stable Isotope Techniques to Assess Soil Quality and Dust Production for Enhanced Agricultural Land Productivity	Dercon, Gerd
IVC5033	Contributing to Food Security and Combating Poverty by Improving the Productivity of the Coconut Palm, Plaintain and Leafy Vegetables by Means of Studying the Effects of Organic and Mineral Fertilisers	Nguyen, Minh-Long
KAM5001	Improving Soil Fertility and Crop Management Strategies in Diversified Rice-Based Farming Systems	Nguyen, Minh-Long and Heng, Lee
KAZ5003	Increasing Micronutrient Content and Bioavailability in Wheat Germplasm by Means of an Integrated Approach	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
KEN5031	Improving Agricultural Productivity in Mixed Cropping Systems through Application of Knowledge Based Technologies Generated with the Aid of Nuclear Techniques	Heng, Lee and Sakadevan, Karuppan

MAG5019	Improving the Use of Agricultural Resources and Combating Soil Erosion by Optimising Conservation Agriculture and Developing Strategies for its Dissemination	Nguyen, Minh-Long; Dercon, Gerd
MLI5024	Enhancing Sustainable Intensification and Diversification of Sorghum Production Systems in the Southern Zone by an Integrated and Participatory Approach, Phase 2	Heng, Lee
MLI7003	Assessing Erosion, Sedimentation and Water Resources in River Basins by Using Isotope Techniques	Dercon, Gerd
MOZ5003	Sustaining the Management of Soil Fertility	Dercon, Gerd
MOZ5004	Improving Nitrogen and Water use Efficiency of Maize Varieties in Conservation Agriculture under Smallholder Farming Systems	Dercon, Gerd
MYA5020	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	Dercon, Gerd in collaboration with Plant Breeding and Genetics Section
NEP5001	Improving Nepalese Cardamom Using Nuclear and Molecular Techniques	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
NER5015	Improving Productivity of the Millet-Cowpea Cropping System through Development and Dissemination of Improved Varieties and New Water and Fertiliser Management Techniques	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
NIC8012	Applying Nuclear Techniques for the Development of a Management Plan for the Watershed of the Great Lakes	Dercon, Gerd
OMA5001	Producing Forage Crops Tolerant to Salinity and Drought	Adu-Gyamfi, Joseph
QAT5003	Improving Agricultural Productivity in Saline Land/Areas	Sakadevan, Karuppan
RAF5058	Enhancing the Productivity of High Value Crops and Income Generation with Small Scale Irrigation Technologies	Heng, Lee
RAF5063	Supporting Innovative Conservation Agriculture Practices to Combat Land Degradation and Enhance Soil Productivity for Improved Food Security	Dercon, Gerd
RAS5055	Improving Soil Fertility, Land Productivity and Land Degradation Mitigation	Nguyen, Minh-Long
RAS5056	Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
RAS5064	Enhancing Productivity of Locally-underused Crops through Dissemination of Mutated Germplasm and Evaluation of Soil, Nutrient and Water Management Practices	Sakadevan, Karuppan in collaboration with Plant Breeding and Genetics Section
RAS5065	Climate-Proofing Rice Production Systems (CRiPS) based on Nuclear Applications	Heng, Lee in collaboration with Plant Breeding and Genetics Section
RLA5051	Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems (ARCAL C)	Dercon, Gerd
RLA5052	Improving Soil Fertility and Crop Management for Sustainable Food Security and Enhanced Income of Resource-Poor Farmers (ARCAL CI)	Sakadevan, Karuppan
RLA5053	Implementing a Diagnosis System to Assess the Impact of Pesticide Contamination in Food and Environmental Compartments at a Catchment Scale in the Latin American and Caribbean (LAC) Region (ARCAL CII)	Dercon, Gerd in collaboration with Food and Environmental Protection Section
RLA5062	Applying Stable Isotopes to Assess the Impacts of Natural Zeolite to Increase Nitrogenous Fertilizer Use Efficiency, to Improve Soil Fertility and to Reduce Soil Degradation (ARCAL CXXV)	Nguyen, Minh-Long
SEN5034	Using an Integrated Approach to Develop Sustainable Agriculture in a Context of Degrading Soil Fertility, Climate Change and Crop Diversification	Dercon, Gerd in collaboration with Plant Breeding and Genetics Section
SEY5006	Implementing Nutrient and Water Management Practices Using Nuclear and Related Techniques to Enhance National Vegetable Production through Sustainable Agricultural Management	Heng, Lee
SLO5003	Developing the Optimum Combination of Soil Quality and Nutrient Management for Sustainable Food Production and Pollution Prevention	Sakadevan, Karuppan
SUD5033	Enhancing Productivity of Major Food Crops (Sorghum, Wheat, Groundnut and Tomato) under Stress Environment Using Nuclear Techniques and Related Biotechnologies to Ensure Sustainable Food Security and Well Being of Farmers	Adu-Gyamfi, Joseph in collaboration with Plant Breeding and Genetics Section

TAD5005	Developing Soil Conservation Strategies for Improved Soil Health	Dercon, Gerd
URT5027	Improving Livestock Production and Productivity through Sustainable Application of Nuclear and Related Techniques	Heng, Lee in collaboration with APH and IPC Sections
URT5028	Improving Crop Production and Productivity through the Use of Nuclear and Nuclear-Related Techniques	Heng, Lee in collaboration with IPC Section
VEN7004	Use of Agro-Environmental Radioactive Soil Tracers (i.e. 137Cs and 2010Pb) for Assessing and Managing Sedimentation Processes Impacting Reservoirs	Nguyen, Minh-Long
ZAI5020	Assessing and Improving the Assimilability of Natural Phosphates Composted with Organic Matter in Marginal Soils through the Use of Isotope and Nuclear Techniques for Improved Crop Nutrition	Dercon, Gerd
ZAM5027	Developing Maize Genotypes for Drought and Low Soil Fertility Tolerance	Heng, Lee in collaboration with Plant Breeding and Genetics Section
ZIM5015	Developing Drought Tolerant and Disease/Pest Resistant Grain Legume Varieties with Enhanced Nutritional Content Using Mutation Breeding and Novel Techniques, Phase II	Heng, Lee in collaboration with Plant Breeding and Genetics Section
ZIM5018	Optimising Water Use and Soil Productivity for Increased Food Security in Drylands through Farmer Participation in Sustainable Technologies	Heng, Lee

Forthcoming Events

FAO/IAEA Events

Training course on Soil Organic Carbon Dynamics and Management: The use of innovative isotope and conventional techniques, 15 April - 10 May 2013, Seibersdorf, Austria

Technical Officers: Gerd Dercon, Maria Heiling and Martina Aigner

The purpose of this training course is to provide basic knowledge and skills in how to use isotope and conventional techniques to improve soil organic carbon management. The training course will address the following topics: (a) The importance of soil organic carbon for improving soil quality and mitigating climate change; (b) Soil sampling techniques for estimating soil organic carbon at plot and landscape level; (c) The use of isotope and conventional techniques for assessing soil organic carbon dynamics; and (d) Modelling soil organic carbon dynamics.

Approximately 15 participants from Benin, Iraq, Madagascar, Mozambique and Zimbabwe will attend this training course. The course is organized by the Soil and Water Management & Crop Nutrition Laboratory, in close collaboration with the University of Natural Resources and Life Sciences, Vienna (BOKU).

Training course on Agricultural water management: The use of innovative isotope and conventional techniques, 24 June - 5 July 2013, Seibersdorf, Austria

Technical Officers: Lee Heng, Leo Mayr and Jose Luis Arrillaga

The purpose of this training course is to provide basic knowledge and expertise on the use of isotope and conventional techniques for managing agricultural water for food security. The training course will cover the following topics: (a) Methods of separating soil evaporation and crop transpiration to improve water use efficiency, (b) FAO's AquaCrop model for maximizing yield response to water; and (c) Carbon isotopic discrimination - basic and advanced techniques.

Approximately 10 participants from various TC projects will attend this training course. The course is organized by the Soil and Water Management & Crop Nutrition Section and Laboratory, in collaboration with the University of Natural Resources and Life Sciences, Vienna (BOKU).

Regional Training Course for TC project RLA5051 on Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems, 12 - 23 November 2012, Irapuato Guanajuato, Mexico

Technical Officer: Gerd Dercon

The purpose of the training course is to provide basic knowledge and skills on how to disseminate and promote the work and research carried out under the regional project RLA5051, entitled Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems, through the use of innovative internet-based advanced geospatial information visualization and dissemination platforms (Google Earth, MapBox, among others). By disseminating this information, our RLA5051 network and partners can reach target audiences and have an impact on policy and programming in the region. These internet-based tools can serve as an invaluable aid in this effort to exchange and communicate information on soil erosion and conservation to a wide audience. Approximately 28 participants from across Latin America and the Caribbean (Argentina, Bolivia, Brazil, Chile, Cuba, Dominican Republic, El Salvador, Haiti, Jamaica, Mexico, Nicaragua, Peru, Uruguay and Venezuela) will attend this training course. The local organizer is the *Centro de Investigación y de Estudios Avanzados*, Irapuato Guanajuato, Mexico. Trainers are Franck Albinet (France), Diego Valladares (Argentina), Francisco Cisneros (Mexico) and David Cruz Gomez (Mexico).

Regional Training Course for TC project RAF5063 on "Supporting Innovative Conservation Agriculture Practices to Combat Land Degradation and Enhance Soil Productivity for Improved Food Security", 26 November - 7 December 2012, Sidi Thabet, Tunisia

Technical Officer: Gerd Dercon

The purpose of the training course is to provide basic knowledge and skills on the use of Fallout Radionuclide (FRN) techniques for estimating soil erosion and assessing the effectiveness of soil conservation measures. The course will focus on the theoretical basis of FRN techniques, soil sampling strategies and techniques and the use of radiometric techniques, particularly gamma spectrometry. Approximately 17 participants from across Africa (Algeria, Benin, Côte d'Ivoire, Mali, Madagascar, Morocco, Tunisia, Uganda and Zimbabwe) will attend this training course. The local organizer is the *Centre National des Sciences et Technologies Nucléaires (CNSTN)*, Sidi Thabet, Tunisia. Trainers are Wahid Abdelli (Tunisia), Foued Gharbi (Tunisia), Mansour Oueslati (Tunisia), Mohamed Samaali (Tunisia), Moncef Benmansour (Morocco) and Naivo Rabesiranana (Madagascar).

Training course on "The use of Internet-based geospatial information visualization tools in disseminating & promoting the work carried out in the Joint FAO/IAEA Division (NAFA)", 3 - 14 December 2012, Seibersdorf, Austria

Technical Officer: Gerd Dercon

The purpose of this training course is to provide basic knowledge and skills on how to disseminate and promote the work and research of the Joint FAO/IAEA Division through the use of innovative Internet-based advanced geospatial information visualization and dissemination platforms.

Approximately 15 participants from the Joint FAO/IAEA Division will attend this training course, focusing on training-the-trainers. The course is organized by the Joint FAO/IAEA Division, in close collaboration with the Soil and Water Management & Crop Nutrition Laboratory. The trainer is Franck Albinet from France.

Non-FAO/IAEA Events

Asia Water Week 2013
Dates: 13-15 March 2013; Place: Manila, Philippines.
Website: http://www.adb.org/news/events/asia-water-week-2013

Phosphates 2013
Dates: 25-27 March 2013; Place: Monte Carlo, Principality of Monaco
Website: http://www.crugroup.com/events/phosphates/

European Geosciences Union General Assembly
Dates: 7 - 12 April 2013; Place: Vienna, Austria.
Website: http://www.egu2013.eu/

13th ISSPA (International Symposium on Soil and Plant Analysis)
Dates: 7-12 April 2013; Place: Queenstown, New Zealand.
Website: http://www.isspa2013.com/

4th International Symposium on Soil Organic Matter 2013
Dates: 5-10 May 2013; Place: Nanjing, People's Republic of China.
Website: http://www.ireea.cn/som2013/

World Association of Soil and Water Conservation Conference
Dates: 13-18 May 2013; Place: Bangkok (Krung Thep), Thailand.
Website: http://www.ldd.go.th/web_waswac2/index.htm

AGU Meeting of the Americas
Dates: 14-17 May 2013; Place: Cancun, Mexico.
Website: http://moa.agu.org/2013/

Soil Carbon Sequestration: for Climate, Food Security and Ecosystem Services
Dates: 26-29 May 2013; Place: Reykjavík, Iceland.
Website: http://scs2013.land.is/

IMPACTS WORLD 2013 - The International Conference on Climate Change Effects
Dates: 27-30 May 2013; Place: Potsdam, Germany.
Website: http://www.climate-impacts-2013.org/

IUSS Global Soil Carbon Workshop
Dates: 3-6 June 2013; Place: Madison, Wisconsin, United States of America.
Website:
http://www.iuss.org/index.php?option=com_content&view=article&id=407&Itemid=31

LuWQ2013 International Interdisciplinary Conference on Land Use and Water Quality: Reducing Effects of Agriculture
Dates: 10-13 June 2013; Place: The Hague, The Netherlands.
Website: http://www.luwq2013.nl/

International Conference: Four Decades of Progress in Monitoring and Modeling of Processes in the Soil-Plant-Atmosphere System: Applications and Challenges
Dates: 19-20 June 2013; Place: Naples, Italy.
Website: www.spa-conference-naples2013.org

9th European Conference of Precision Agriculture (ECPA)
Dates: 7-11 July 2013; Place: Lleida, Spain.
Website: http://www.ecpa2013.udl.cat/

Utilization and protection of halophytes and salt-affected landscapes
Dates: 4-6 September 2013; Place: Kecskemét, Hungary.
Website:
http://members.iif.hu/tot3700/salinityconferencehungary2013.html

7th Int. Conference on Urban Soils, SUITMA7
Dates: 16-20 September 2013; Place: Torun, Poland.
Website: www.suitma7.umk.pl

First International Conference on Global Food Security
Dates: 29 September - 2 October 2013; Place: Noordwijkerhout, The Netherlands.
Website: http://www.globalfoodsecurityconference.com/

First World Irrigation Forum
Dates: 29 September - 5 October 2013; Place: Mardin, Turkey.
Website: http://www.icid.org/wif_icid.html

Soils in Space in Time - First Divisional 1 Conference of IUSS
Dates: 30 September - 4 October 2013; Place: Ulm/Danube, Germany.
Website: https://iuss-division1.uni-hohenheim.de/

11th International Conference of the East and Southeast Asia Federation of Soil Science Societies

Dates: 21 - 24 October 2013; Place: Bogor, Indonesia.
Website: http://www.esafs11ina.org/index.php

6th International Nitrogen Conference
Dates: 18 - 22 November 2013; Place: Kampala, Uganda.
Website: www.N2013.org

20th World Congress of Soil Science
Dates: 8 - 13 June 2014; Place: Seoul, Republic of Korea.
Website: http://www.20wcss.org/

Past Events

Duty Travel

Oman: National Workshop on the Use of Isotopic Techniques in Soil and Water Management and Crop Nutrition, 12 - 16 May 2012.

Technical Officer: Joseph Adu-Gyamfi

The national training course was conducted at the Ministry of Agriculture and Fisheries, Directorate General of Agriculture and Livestock Research, Muscat, Oman. The programme was aimed at improving the skills, knowledge and technical competence of scientific and technical personnel in the use of isotopic and conventional techniques to monitor the dynamics of soil water and nutrients in saline environments and experimental procedures to evaluate crop plants for their tolerance to drought and saline environments. Two resource personnel, Dr. A. A. Al-Hakimi (Yemen) and Mr A Wabhi (Syrian Arab Republic) assisted the Technical Officer (TO) in the training. Eighteen scientific and technical personnel from the Peaceful Nuclear Technology Office (PNTO), Ministry of Agriculture and Fisheries, and the Sultan Qaboos University in Muscat participated in the training.

The following topics were covered during the training programme: (1) New developments in soil water and monitoring technology, evapotranspiration, and water use efficiency, (2) Field estimation of soil water, crop-water productivity and irrigation efficiency using isotopic techniques, (3) Installation of soil moisture monitoring equipment (nuclear and conventional), (4) Soil moisture data processing, (5) The use of carbon isotope discrimination in breeding programmes to improve agronomic water use efficiency by wheat in drought and saline environments. This training will help improve local capacity building in soil, water and crop management in the different regions of Oman, to ensure that future project activities relating to soil and water salinity, crop nutrition and crop production planning will be more effective. The TO later visited the Soils and BioSaline Laboratories. Certificates were presented to the participants by Mr Hadj S. Cherif, Head of PNTO and the IAEA NLO for the project.

Malaysia: To organize the first coordination meeting for the technical cooperation project RAS5064 on "Enhancing productivity of locally-underused crops through dissemination of mutated germplasm and evaluation of soil, nutrient and water management practices", Malaysian Nuclear Institute, Kajang, 18 - 22 June 2012.

Technical Officer: Karuppan Sakadevan

The purpose of the first regional coordination meeting was to develop detailed country work plans for the regional technical cooperation project RAS5064 started in January 2012. The project is approved for four years. The meeting was attended by national counterparts from Bangladesh, Cambodia, China, Indonesia, Malaysia, Myanmar, Philippines, Thailand and Vietnam specialized in both plant breeding and soil and water management. Sri Lanka did not attend the meeting. The objectives of the meeting were to: (1) review the current status of best fit soil and water management practices in the participating countries, identify and address gaps and needs for the application of integrated soil and water management, together with improved under used crop varieties adaptable to biotic and abiotic stress, (2) review the current status of the availability of improved under used crop varieties, and (3) discuss and finalize the details of the activities stipulated in the work plan to be implemented under the project.

The initial focus of the meeting was to discuss the importance of under used crops for income diversification, opportunities to improve productivity through improved soil, water and crop management practices, crop improvement through breeding and the role of isotopic and nuclear techniques for optimizing water and nutrient use by these crops in counterpart countries.

National work plans and regional activities with a focus on

critical issues in crop, soil and water management were agreed by the counterparts. The need for distributing improved seeds of underused crops was emphasized. Exchanging knowledge and information on underused crops and soil, water and nutrient management practices among the participants was one of the key outcomes of the meet-

ing. Participants agreed to establish field studies for evaluating the performance of improved crop varieties under existing soil and climatic conditions.

Switzerland: International Workshop on Development of Isotopic Tracers for a Better Understanding of the Phosphorus Cycle, Ascona, 24 - 29 June 2012.

Technical Officer: Joseph Adu-Gyamfi

The workshop was held at Monte Verità, Ascona, Switzerland. The objective of this workshop was to bring together scientists and researchers to further explore the potential use of oxygen isotopes in both inorganic and organic P compounds ($\delta^{18}O$-PO_4) to study and understand P dynamics in both cropping and livestock production systems for the improvement of soil fertility and food productivity. The specific goals of the workshop included: (1) assessing our current knowledge of P cycling in the environment and identifying how isotopic techniques may be used to address these deficiencies, (2) identifying novel avenues for cross-disciplinary research, data sharing and ways of applying stable isotope approaches to shed light on P cycling, and (3) providing an opportunity for young scientists to interact with leaders in the field and establish networks and international collaborations and contacts. Comparisons of the methods of oxygen isotope analysis of phosphates and of standards used were discussed. The need for the IAEA to develop a standard for global use as it has done in the past for C-13 and O-18 was emphasized. The TO explored collaboration with the Swiss Federal Institute of Technology (Eidgenössische Technische Hochschule, ETH, Switzerland) to develop protocols for extraction and estimation of $\delta^{18}O$-PO_4 for soils with different soil P status and plant-availability. The output of the travel is an on-going collaboration between China, Switzerland and the IAEA that will help strengthen the dissemination of land-based technologies to improve land management in FAO and IAEA Member States.

Philippines: for the First Coordination Meeting of the regional TC project RAS5065 on "Supporting Climate-Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications", Manila, 25 - 29 June 2012.

Technical Officer: Lee Heng

The First Coordination Meeting for this RAS5065 project was conducted in Manila, the Philippines, and hosted by the Philippines Nuclear Research Institute (PNRI) from 25-29 June, 2012. The purpose of meeting was to integrate the individual work plans of RAS5065 participants based on the country presentations and to discuss and finalize details of project activities. The meeting was also to review the current status of mutants and advanced rice varieties available, to identify and address gaps and needs for selecting advanced, new rice crop varieties adaptable to climate change, to review the current status of best fit soil and water management practices, identify the roles of nuclear and isotopic techniques and to address gaps and needs for the application of integrated mutation/soil and water management technology packages, tailored to fit the local socio-economic and agro-ecological conditions, and adaptable to climate change in participating Member States.

The meeting was attended by participants from Bangladesh, China, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Thailand, and Vietnam (two from each country to reflect both mutation breeding and soil and water management and crop nutrition components). Vietnam sent only a plant breeder, while Cambodia was absent. Both the Project Managing Officer (PMO) Mr. Ho-Seung Lee and the two Technical Officers (TO) (Ms. Lee Heng and Mr. Pierre Lagoda, Section Head of Joint FAO/IAEA Plant Breeding and Genetics Section) attended this meeting. International organizations including the Asian Development Bank (ADB), Food and Agriculture Organization and the International Rice Research Institute were also represented.

Dr. Alumanda dela Rosa, Director of the Host Institution, the Philippines Nuclear Research Institute (PNRI), gave the opening remarks. Mr. Ho Seung Lee, the PMO for this project, outlined the meeting objectives and the expected outcomes. Mr. Pierre Lagoda (TO) presented the new challenges for food security and sustainability in the face of climate change. Ms. Lee Heng (TO) presented information on the potential use of nuclear and isotopic techniques under best fit soil and water management and crop nutrition practices.

The roles of nuclear and isotopic techniques were discussed during the meeting. There is a need to enhance the synergy and cooperation among Member States, since there is a different level of expertise relating to nuclear and isotopic techniques. Short training courses to focus on the use of nuclear and isotopic techniques to assess soil and water efficiency techniques (neutron probe, N15 and C-13) will be organized. Modern or traditional varieties already used by farmers and new mutant or breeding lines will be the starting point. It was agreed that not only mutants can be used in this project. In the absence of mutant varieties, any variety adapting to adverse ecosystems can be used, or any advanced breeding or mutant lines.

Participants at the 1st coordination meeting in the Philippines

Sri Lanka: the First Coordination Meeting of technical cooperation project RAS5055 on "Improving Soil Fertility, Land Productivity and Land Degradation Mitigation", Colombo, 27-31 August 2012.

Technical Officer: Minh-Long Nguyen

The First Coordination Meeting of this RAS 5055 project was conducted in Colombo, Sri Lanka, 27-31 August and hosted by the Sri Lankan Atomic Energy Authority. The main objective of this RAS 5055 project is to assist Member States in the use nuclear and isotopic techniques to develop and effectively implement area-wide precision conservation measures to control the impact of land-use practices on land degradation.

The meeting was attended by scientists from Australia, Bangladesh, China, India, Indonesia, Malaysia, Myanmar, New Zealand, Pakistan, Philippines, the Republic of Korea, Sri Lanka, Thailand and Vietnam. The purpose of this meeting was to review the work plan and outputs of the RAS 5055 project, to discuss the protocol and experimental design of each counterpart's project and to identify training courses and expert missions required to support the needs of participating countries in the use of isotopic and nuclear techniques to achieve the main RAS 5055 objective as outlined above.

Seychelles: TC project SEY5006 on "Nutrient and Water Management Practices Using Nuclear and Related Techniques to Enhance National Vegetable Production through Sustainable Agricultural Management", Victoria, 3 - 5 September 2012.

Technical Officer: Lee Heng

Lee Heng travelled to the Seychelles to review progress in the SEY5006 project and to discuss the 2013 work plan with project team. This project is an extension of two previous TC projects, SEY5002 (Nutrient and Moisture Determination in the Soils of Seychelles) and SEY5004 (Development of Improved Nutrient and Management Practices Using Nuclear and related Techniques for Enhancing Sustainable Agricultural Productivity). The objective of SEY5006 is to strengthen national capacities and services for the implementation of nutrient and water management practices using nuclear and related techniques to enhance vegetable production through sustainable agricultural management. The trip involved meeting the CEO of the Seychelles Agricultural Agency and the Principal Secretary of the Ministry of Natural Resources and Industry, who stressed the importance of the IAEA project, as water and soil availability are becoming scarce due to competition from other sectors and the changing climate is affecting crop production due to prolonged drought.

A visit was made to the UNDP office to discuss with Ms. Veronique Bonnelame, the National Coordinator of the Global Environment Facility (GEF) Small Grant Programme (SGP), and the partnership between the UNDP/GEF, the Seychelles and the IAEA in a salinity project which aims to improve the salinity situation due to sea water intrusion. The work will involve real time monitoring of soil moisture and soil salinity levels and the training of the local farming community. The UNDP/GEF work will compliment IAEA Technical Cooperation cycle project (2014-2015) on Increasing crop production through effective management of soil salinity in the Coastal area in the Seychelles. A visit was also made to the Anse Boileau Research Station, where the IAEA's irrigation and nutrient management experiments were carried out. A presentation on soil water measurement and the use of nuclear and isotopic techniques was given to all staff at the Anse Boileau Research Station and the visiting extension workers. Project results were reviewed and the work plan was revised. Finally a trip was made to meet farmers and to listen to their problems. Two farms growing high-value crops (vegetables) were visited and both farmers expressed major concerns about prolonged drought, lack of fresh water for irrigation and the increasing salinity level in the soil and water. They are looking forward to solving the salinity problem through IAEA project.

Vietnam: to attend the 2nd Global Conference on Agriculture, Food Security and Climate Change: Hungerfor Action, 3-7 September, Ha Noi, Vietnam and to co-chair a side event on Managing Soils for Food Security and Climate Change Adaptation and Mitigation: Making a Contribution via Nuclear Techniques on 4 September, 2012.

Technical Officer: Minh-Long Nguyen

At the invitation of the Ministry of Agriculture and Rural Development (MARD) of Vietnam, I attended the 2nd Global Conference on Agriculture, Food Security and Climate Change: Hunger for Action. This Global Conference, which was organized by the Ministry of Agriculture and Rural Development of Vietnam, the Ministry of Economic Affairs, Agriculture and Innovation of the Netherlands, the UN Food and Agriculture Organization (FAO) and the World Bank, was held at the Melia Hotel - Hanoi, Vietnam.

The main theme of the Conference was climate smart agriculture and it comprised four interesting sessions:

- Climate Smart Agriculture as a Driver for Green Growth-Water/Energy/Agriculture Linkages;
- Agriculture-Forest Linkages- Towards a Landscape Approach;
- Scenario for Policy: Transforming Food Systems, Landscapes and Farming for the 21 Century;
- Climate Smart Agriculture and the Role of the Private Sector.

Each of these Sessions touched on Stocktaking of Best Practices Lessons Learned and Presentations of best practices from several countries followed by discussion.

The side event on the second day of the Conference (Time: 13:00-15:00 on 4 September, 2012*)* was organized at the invitation of Prof. Dr Nguyen Van Bo, the President of the Vietnam Academy of Agricultural Sciences (VAAS), since Prof. Nguyen van Bo and the VAAS are placing increasing importance on role of isotopic and nuclear techniques to develop/improve soil and water management practices for food productivity and sustainable agriculture.

The side event was chaired by the TO and by Prof. Dr Nguyen Van Bo. The TO gave a presentation on the topic as outlined in the side event title with emphasis not only on soil and water management for crop production but also on other areas relating to food and agriculture, such as crop improvement-plant mutation. Over 70 Vietnamese and international scientists and policy makers attended the side event. The conclusion of the side event was that atoms are important in food and agriculture.

Italy: To attend the Global Annual Workshop and the wheat group meeting organized by the Agricultural Model Inter-comparison and Improvement (AgMIP) Project, FAO, Rome, 9 - 12 October 2012.

Technical Officer: Lee Heng

Lee Heng attended the AgMIP Wheat meeting (9th October) and the 3rd Global Annual AgMIP Workshop (10-12th October) held at the FAO, Rome. AgMIP (WWW.AgMIP.org) is a distributed climate-scenario simulation exercise for model intercomparison, with the participation of multiple crops and agricultural economics modelling groups from around the world. The goals of AgMIP are to improve characterization of the risk of hunger and world food security due to climate change and to enhance adaptation capacity in both developing and developed countries through the estimation of regional yields for global applications and to make them available for wider utilization with the aim of producing results on future (2050 —2100) productivity of the main agricultural regions in the world for major crops (wheat, maize, rice, sorghum, soybean, sugarcane).

The SWMCN Section has been supporting the FAO Natural Resources and Environment (NRL) Division in the AgMIP Wheat Pilot project using the FAO AquaCrop model for an inter-comparison of climate change impacts on wheat production since the initiative started in April 2011. Twenty-seven wheat crop models were included in this exercise, where wheat grain yields under diverse environments were simulated and compared, and sensitivity analysis was carried out with a combination of changes in rainfall, temperature, and atmospheric CO_2 concentration in relation to the baseline in four contrasting locations, based on location specific late-century climate projections. The meeting in Rome was to report results and progress on the wheat activities and to plan the next 12 months' activities. The results of this work can be used to validate and strengthen IAEA's work on evaporation and transpiration separation due to the extra data available.

The Global Annual Workshop brought together some 180 participants from climate, crop modelling, economics and information technology communities around the world to:

- Review progress and present results for AgMIP regional and global research programmes;
- Refine AgMIP protocols for model inter-comparisons to include uncertainty and scaling;
- Advance AgMIP regional and global integrated assessments of food security;
- Build trans-disciplinary collaborations.

Over the three days, Crop Model Inter-comparison Pilots and the regional (Sub-Saharan Africa, South Asian, North America, South America, Australia and Oceania and Europe) work done were presented. Various cross-cutting themes and future research plans were discussed. For example, what approaches are needed to enable agricultural sector analysis across relevant scales and disciplines to compare climate impact studies across regions? These topics are very relevant for extending the work of the IAEA to regional-scales.

National Training Course in Malaysia on the Application of Advanced Isotopic and Nuclear Techniques for the Improvement of Soil Quality and Crop Productivity, 29 October - 2 November 2012.

Technical Officer: Long Nguyen

The National Training Course on the Application of Advanced Isotopic and Nuclear Techniques for the Improvement of Soil Quality and Crop Productivity was held 29 October 2 November, 2012 at the Malaysian Nuclear Agency, Selangor, Malaysia and implemented as part of IAEA Project MAL5029 on Applying Mutation Breeding and Optimized Soil, Nutrient and Water Management for Enhanced and Sustainable Rice Production. The course was attended by 22 participants from four national institutes.

The training course was opened on Monday 29 October by the Course Advisor, Dr. Rusli Ibrahim, followed by the introduction of participants and lecturers by the Course Director Dr. Khairuddin Abdul Rahim, from the Division of Agrotechnology and Biosciences, Malaysian Nuclear Agency (Nuclear Malaysia), Ministry of Science, Technology and Innovation Malaysia (MOSTI).

Lectures were given by Dr. Gudni Hardarson, with the main emphasis on the use of stable isotopes in crop nutrition, by Professor Zaharah A. Rahman on radioactive isotopes and their use in soil and nutrient management and by Dr Peter Buss on soil water and irrigation management.

Scientific visits were made during the course to the gamma greenhouse operated by the Malaysian Nuclear

Agency and to the analytical facilities of the soils programme, where the participants were shown the NOI-7 emission spectrometer and the liquid scintillation counter.

This training event will certainly provide major motivation for participating young scientists to use isotopic and nuclear techniques for the improvement of soil management in Malaysia.

Participants at the training course in Malaysia

Kenya: International Symposium on Integrated Soil Fertility Management in Africa: from Microbes to Markets, Nairobi, 22 - 26 October 2012.

Technical Officer: Joseph Adu-Gyamfi

The Symposium was held at the Safari Park Hotel in Nairobi, Kenya. The purpose of the Symposium was to assemble the strengths of several organizations and collaborative research projects committed to designing, refining and delivering potent solutions to food insecurity and agricultural resource degradation in sub-Saharan Africa. A particular focus of the Symposium was the comparison and scaling-up of candidate breakthrough technologies, monitoring and evaluation of impacts within rural settings and along agricultural value chains and strategies to increase human and institutional capacities understanding on how biological, organic and mineral resources are best integrated in the management of agricultural soils by African small scale farmers. The specific themes included: (1) Advancing plant-microbe interactions in crop nutrition; (2) Enhancing biological nitrogen fixation for African smallholders; (3) Exploring options for sustainable intensification and diversification of farming systems; (4) Identifying bottlenecks and opportunities for the implementation of Integrated Soil Fertility Management (ISFM); (5) Commercializing breakthrough technologies; and (6) Building capacity in ISFM. This theme explores how best to develop capacities among farmers, development agents, researchers and educators in Africa to better manage soil fertility and agricultural resources. The TO gave a presentation on "Atoms for food and agriculture: Nuclear and isotopic techniques for understanding soil-water-nutrient-crop management". Representatives from FAO, CGIAR Centres, the African Union, international NGOs, regional and national research and policy bodies attended the meeting. The need for excellent science, building linkages and networks to respond to societal challenges, and drawing science into policies was emphasized. Scientists and policy makers were encouraged to "walk the talk."

Mexico: to conduct a training course on the use of AquaCrop model for crop adaptation to drought and high temperatures for the CRP D2.30.29 on "Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas and Beyond", 3 to 5 December 2012.

Technical Officer: Lee Heng

Lee Heng assisted the FAO/IAEA Joint Division Plant Breeding and Genetics Section in their CRP on "Climate Proofing of Food Crops: Genetic Improvement for Adaptation to High Temperatures in Drought Prone Areas and Beyond" (for which Ms. Madeleine Spencer is the scientific secretary) to conduct a 3-day training course on the use of the AquaCrop model on the response of rice and the common bean to drought and temperature. The training was held after the second research coordination meeting, which was held from 26-30 November 2012. Mr Federico Sanchez, from Universidad Nacional Autónoma de México; Instituto de Biotecnología-UNAM is the local organizer.

Consultants Meeting on "Area-Wide Water Salinity Management for improving Agricultural Productivity and Food Security in Arid and Semi-Arid Regions", Vienna, Austria, 1-4 October 2012.

Technical Officers: Lee Heng, Karuppan Sakadevan and Long Nguyen

A four-day Consultants Meeting (CM) on "Area-wide water salinity management for improving agricultural productivity and food security in arid and semi-arid regions" was held at the IAEA Headquarters in Vienna, from 1-4 October, 2012 for the formulation of a coordinated research project (CRP) on salinity and water management.

The meeting involved four consultants from Australia, Austria, Pakistan and Spain, plus a representative from the FAO and staff members from IAEA HQ and the Laboratory at Seibersdorf. The meeting aimed to identify ways of improving crop productivity and sustainability through water and salinity management at field and landscape scales, and to define approaches and technologies to assess and monitor soil water content and salinity at field and area-wide scales. In addition, the CM explored nuclear, isotopic and conventional techniques used to assess the impact of on-farm practices on regional crop productivity, water and salt stores and fluxes under current and future climates. The consultants, in collaboration with the IAEA/FAO team from the Soil and Water Management and Crop Nutrition (SWMCN) Section, decided on a CRP entitled Landscape Salinity and Water Management for Improving Agricultural Productivity.

Consultants Meeting on "Agro-ecosystem carbon and nutrient budgeting to assess land resource sustainability for food and biofuel production in marginal lands", Vienna, Austria, 19-20 November 2012.

Technical Officers: Gerd Dercon and Long Nguyen

A four-day Consultants Meeting (CM) on "Agro-ecosystem carbon and nutrient budgeting to assess land resource sustainability for food and biofuel production in marginal lands" was held at the IAEA in Vienna, 19-22 November 2012.

The meeting involved four consultants from Australia, Germany, New Zealand and Senegal, plus a representative from FAO, an observer from the Quinvita NV company and staff members from IAEA HQ and the Laboratory at Seibersdorf.

The objectives of this Consultants Meeting were to:

- Review and discuss issues and options to: (1) enhance soil fertility, soil quality and biofuel productivity on marginal land in tropical and subtropical regions, (2) assess soil, water, crop and nutrient management practices on water and nutrient use efficiencies, nutrient losses and greenhouse gas emissions, and (3) examine options to assess the energy balance and reduce on and off-site environmental and economic footprints of biofuel cropping systems on marginal lands.
- Assess the potential role of nuclear, isotopic and related techniques to understand the interaction between soil, water and crops relating to (1) and (2) above and to improve soil, water and crop management practices for optimizing economic and environmental benefits of biofuel systems.
- Formulate a CRP to address relevant issues identified as part of the CM.

The consultants have decided that the CRP should focus on multi-functional biofuel production systems and that these systems should not be restricted to only marginal lands but can also be applied to a range of lands depending on socio-economic factors.

Consultants Meeting on "Optimizing soil and water resource efficiency in integrated cropping-livestock production systems", Vienna, Austria, 26-29 November 2012.

Technical Officers: Karuppan Sakadevan and Long Nguyen

A four-day Consultants Meeting (CM) on "Optimizing soil and water resource efficiency in integrated cropping-livestock production systems'" was held at the IAEA Headquarters in Vienna, from 26-29 November, 2012.

The meeting involved four consultants from Australia, Brazil, France and New Zealand, plus a representative from the FAO and staff members from IAEA and the Laboratory at Seibersdorf.

The objectives of this CM were to:

- Review and discuss issues and options to: (1) enhance soil fertility, soil quality and productivity of integrated cropping-livestock production (ICLP) systems, (2) assess water and nutrient use efficiencies and greenhouse gas emissions, and (3) reduce on and off-site environmental footprints of livestock on ICLP systems.
- Assess the role of nuclear, isotopic and related techniques to optimise soil-water-nutrient resource use efficiency and minimize environmental impacts.
- Formulate a CRP to address relevant issues identified as part of the CM.

The consultants have concluded that the CRP on ICLP systems is timely because of increasing interest in the potential benefits that mixed cropping-livestock systems may bring in terms of economic and market flexibility, nutrient cycling and soil carbon sequestration.

Sixth training course for the Regional TC project RAF5058 on "Enhancing the Productivity of High Value Crops and Income Generation with Smallscale Irrigation Technologies", 10 -14 December 2012, Addis Ababa, Ethiopia.

Technical Officer: Lee Heng

The objectives of the training course are to introduce interactive irrigation tool to be developed within mobile phones systems using sitespecific water management data collected from the RAF5058 project, to help farmers access irrigation scheduling information to improve crop productivity and minimize water watsage. The RAF5058 project recently received US$181,900 from the IAEA Peaceful Uses Initiative (PUI) fund to develop and pilot-test the interactive irrigation tool within mobile phones. This initiative was built as a result of the increasing use of mobile phones in Africa over the last decade to assist farmers in gaining information from markets to weather. The interactive technology packages developed will be transferred to farmers and the wider community through Farmers Field Day events. The training course will also synthesize nitrogen-15 results from field trials carried out in individual countries to determine fertilizer use efficiency of high-value crops under small-scale drip irrigation systems. Project participants from the following countries are expected to attend this meeting: Algeria, Benin, Botswana, Cameroon, Ethiopia, Ghana, Kenya, Mauritius, Morocco, Niger, Nigeria, Sudan, Uganda, Zambia and Zimbabwe. An expert on mobile technology, Dr Peter Okoth from CIAT will be conducting the training. The local organizer is the Ministry of Agriculture and Rural Development, Addis Ababa, Ethiopia. Mr. Hune Nega Tessema from the RAF5058 project is the course director.

Status of Coordinated Research Projects (CRPs)

Managing Irrigation Water to Enhance Crop Productivity under Water-Limiting Conditions: a Role for Isotopic Techniques (D1.20.09)

Technical Officers: Lee Heng and Minh-Long Nguyen

The fourth and final Research Coordination Meeting (RCM) of this CRP was held 23-27 July 2012, at IAEA in Vienna, coinciding with the FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation.

All 13 participants in the CRP, which included seven research contractors from China (2 participants), Morocco, Pakistan, Turkey, Vietnam and Zambia; five agreement holders from Austria, Spain, United States of America (2 participants) and Kenya, and a technical contractor from Australia, presented their work at the RCM and in the Symposium, as both oral and poster papers. This research generated tremendous interest from the Symposium participants. The results obtained over the entire duration of the CRP and the publication of the TECDOC was discussed during the RCM.

The overall objective of this CRP was to improve crop water productivity (production per unit of water input) under water-limiting conditions. The specific research objectives were to: (1) Quantify and develop means to manage soil evaporative losses to maximise the beneficial use of water - the transpirational component of evapotranspiration, (2) Quantify and develop means to improve the amount of biomass produced per unit of transpiration, (3) Devise irrigation and related management techniques to enhance the yield component of biomass production (Harvest Index).

Over the past five years, stable isotopes of water ($\delta^{18}O$ and $\delta^{2}H$), soil moisture neutron probes (SMNP) and conventional approaches (e.g. micro-lysimetry, sap flow) were successfully used to quantify soil evaporation and transpiration fluxes in different crops, stages of canopy development and the soil surface. FAO's Aquacrop model was also used to validate data generated to improve irrigation scheduling and agronomic practices for efficient agricultural water use and conservation.

Key outputs:

- Significant amounts of water were lost through soil evaporation, ranging from 15 to 85% of the total water from rainfall and irrigation for annual (maize, winter wheat, pepper) and perennial crops (coffee and orange trees). These losses mainly occurred immediately after irrigation or rainfall events, as well as during early seedling development and in the senescent stages. By mulching the soil surface with maize straw, evaporation was reduced by 50 mm out of a total of 400 mm of water loss in China, and water use efficiency (WUE) improved from 1.30 to 1.48 kg m^{-3}. Similarly, regulated deficit irrigation reduced water loss through evaporation by 70 mm in winter wheat compared to full irrigation, while yield was maintained (7.6 tonnes ha^{-1}) and WUE improved from 1.7 to 2.1 kg m^{-3}.
- In Malawi, adequate soil fertility and irrigation are both needed to increase maize yield and WUE in the semi-arid southern part of the country. Grain yield was less than 0.25 tonnes ha^{-1} under rainfed cultivation (seasonal rainfall 247 mm) irrespective of N application and the proportion of water lost through evaporation was approximately 70% of total water use. However, when 240 mm of irrigation and 50 kg N ha^{-1} were added, a grain yield of 2.7 t ha^{-1} was obtained and the proportion of evaporation loss was reduced by 20%.
- Mulching during bud development and flowering stages for a 12-15 year-old coffee stand in Vietnam effectively reduced evaporation by 10% compared to trees without mulching.
- A field campaign to partition ET using isotopic and conventional techniques carried out in a maize crop at the Chinese National Experimental Station for Precision Agriculture showed that before irrigation, soil E was a small portion of ET. However, immediately after irrigation, soil E was essentially the same as total ET, indicating there was essentially no transpiration. This result is implausible, since the crop canopy cover was only about 20% and the soil was not short of water, therefore it should be transpiring a substantial amount of water.
- The magnitude of water vapour in the different canopy layers was also calculated using an Inverse Lagrangian (IL) approach based on canopy turbulence, in addition to determining its proportion using the Keeling Plot approach. A study carried out in Vienna on a drying soil (θ of 9-12%), supporting a small wheat crop of 23 cm high with an LAI near 1, showed that both the IL and isotopic analyses gave essentially the same partitioning of ET into E and T ($\delta^{18}O$ gave E/ET ~ 4% and T/ET ~ 96%, and IL analysis gave corresponding values of 6% and 94%), with the majority of the evaporation coming from the middle canopy layer of between 9 and 16 cm.
- A novel, fast, simple, affordable and portable vacuum distillation method for extracting plant and soil samples for isotopic analysis was developed as part of the CRP by the SWMCN Laboratory in Seibersdorf. The fast recovery and reproducibility of the new methodology is valuable for quantifying the removal of water from the soil around crop roots through soil evaporation and transpiration. This information will be used

to identify soil and water management practices that minimize water losses via soil evaporation.
- Data generated in the CRP are used to validate the FAO's AquaCrop model, which is being used in Member States to develop soil and water management recommendations for water productivity improvements.

Strategic Placement and Area-Wide Evaluation of Water Conservation Zones in Agricultural Catchments for Biomass Production, Water Quality and Food Security (D1.20.10)

Technical Officers: Karuppan Sakadevan and Lee Heng

This CRP is now in its fifth and final year and the third RCM was held 23-27 July 2012 in Vienna, along with the FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Eight research contract holders from China, Estonia, Islamic Republic of Iran, Lesotho, Nigeria, Romania, Tunisia and Uganda, and three agreement holders from United States of America (University of Florida and University of Rhode Island) and France (University of Renne) attended the RCM. All participants presented progress reports made since 2010. In addition, five participants presented oral papers and six presented posters at the FAO/IAEA International Symposium.

Since the second RCM which was held 10-14 May 2010, all research contract holders have collected field data on ^{15}N, ^{18}O and ^{2}H from water and vegetation from water conservation zones and catchments to identify their sources and the interaction between water conservation zones and the catchment.

The overall objective of this CRP is to assess and enhance services provided by water conservation zones (farm ponds, wetlands and riparian buffer zones) to optimize water and nutrient storage, biomass production and food security within agricultural catchments. The specific objectives of the project are: (1) to optimize water storage in water conservation zones for downstream irrigation use, (2) to regulate nutrient cycling in water conservation zones to improve bio-fuel crops and fuel wood production and downstream water quality and (3) to optimize the use of water conservation zones for crop production.

Key outputs:

- O-18, H-2 signatures and Na, Cl, Mg, K, NO_3, EC and pH measurements in water samples were collected from water conservation zones, streams, runoff water from farmlands, rainfall and unsaturated zones from upslopes in: (1) Kamech Catchment, Tunisia, (2) Sanjiang Plains, China (3) Ab-Bandons, Islamic Republic of Iran, and (4) Manafwa catchment, Uganda. Results showed that: (1) more than 90% of the water captured by water conservation zones within farmlands originates from rainfall and surface runoff during the rainy season, (2) capillary rise of water from the unsaturated zones and subsurface flow from upslopes contributed less than 10% of water in the water conservation zones, which occurred during the dry period, and (3) water conservation zones are the main source of water for recharging the unsaturated zones beneath them.
- Field investigations in Uganda have shown that rice production in riverine wetlands provides a net benefit of between US $1300 and $1800/ha/cropping season. With three rice harvests, the potential benefits of rice cropping in Uganda can be as high as US $5400. The use of N-15 labelled urea as fertilizer in the study further showed that only 30% of the fertilizer N was used for rice uptake. N balance in soil, crop and water are currently being investigated to determine the fate of the remaining fertilizer N in riparian rice wetlands.
- Field studies in Romania have shown that an average of 6 tonnes/ha wheat is produced in riparian buffer zones with an above ground biomass of 13 tonnes/ha, and the biomass removed 270 kg N/ha. However, woody biomass in riparian buffer zones used as wood for fuel, removed as much as 445 kg N/ha. The use of N-15 labelled urea fertilizer in the study showed that about 35%, 27% and 28% of fertilizer N was accounted for in above and below ground biomass and in soil, respectively.
- Water from the Ab-Bandon water conservation areas in Iran is used for irrigating rice fields, providing about 5,000 cubic meters/ha of water and producing an average of 3.2 tonnes/ha of rice. The water also provides 54% of the N and 92% of the P requirements of the rice crop.

Integrated Isotopic Approaches for an Area-wide Precision Conservation to Control the Impacts of Agricultural Practices on Land Degradation and Soil Erosion (D1.20.11)

Technical Officers: Long Nguyen and Gerd Dercon

The overall objective of this CRP is to develop integrated isotopic approaches to identify hot spots or critical areas of land degradation in agricultural catchments so that effective soil conservation measures (precision conservation) can be implemented. Specific objectives are to: (i) develop the combined use of fallout radionuclide (FRN) and conventional techniques with spatial analysis to establish soil redistribution patterns and rates over several temporal scales on an area-wide (catchment) basis, (ii) develop and validate protocols for the application of compound specific stable isotope (CSSI) techniques to identify and apportion the amount of source soils (land

degraded areas) from main land uses or land management (cropland, grassland and forestland) in the catchment, (iii) integrate nuclear based approaches with other non-nuclear techniques through modelling and other tools to establish comprehensive soil redistribution studies on an area-wide basis, and (iv) create a basis for developing decision support tools to implement precision conservation and contribute to sustainable land management.

This CRP, which was formulated on the basis of a recommendation from a Consultants Meeting held at IAEA, Vienna, 5-7 November 2007, is in its third year. The first RCM was held at IAEA in Vienna from 8-12 June 2009. The second RCM was held at the National Centre for Atomic Energy, Nuclear Sciences and Applications (Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN)) in Rabat, Morocco, from 27 September-1 October 2010. A Mid-Term Review of the CRP was successfully carried out in November 2011.

The third RCM was held in Vienna from 23-27 July 2012 at the same time as the FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Seven research contract holders from Chile, China, Morocco, Poland, the Russian Federation and the Syrian Arab Republic, four technical contract holders from Belgium (University of Ghent), China (Chinese Academy of Agricultural Sciences) and Germany (University of Hohenheim) and five agreement holders from Australia (CSIRO), Canada (University of Manitoba), New Zealand (National Institute of Water & Atmospheric Research) and the United Kingdom (University of Exeter and University of Plymouth) attended the third RCM. By linking this RCM to the Symposium, the results of this successful CRP were effectively disseminated to a much wider scientific audience.

In 2012, the protocol for the application of CSSI techniques to identify critical areas of land degradation at the catchment scale is being validated under different agro-ecological conditions and land use systems (i.e. Chile, China, Morocco, Poland, the Russian Federation, Syrian Arab Republic and Vietnam).

One staff member from the Soil and Water Management & Crop Nutrition Laboratory (Mr. Christian Resch) has been trained in the use of the CSSI technique at the University of Hohenheim, Stuttgart (3-14 December). This training will support the project through facilitating the rapid identification of increased land degradation in Member States, particularly in tropical and subtropical regions, and will also enable Mr Resch to "train-the-trainers," so that he can provide expertise and training in this technology to other SWMCNL staff, allowing them to start the next step of disseminating this novel analytical technique to Member States through group or individual fellowship trainings to be conducted in the Seibersdorf laboratories.

Approaches to Improvement of Crop Genotypes with High Water and Nutrient Use Efficiency for Water Scarce Environments (D1.50.13)

Technical Officers: Karuppan Sakadevan and Pierre Lagoda

This CRP has a total of 12 research contract holders from Bangladesh, China, Indonesia, Kenya, Malaysia (two contracts), Mexico, Pakistan, Peru (two contracts), Uganda and Vietnam, and one agreement holder from South Africa. The first RCM of the CRP was held from 12-16 December 2011 in Vienna, Austria and eleven participants attended the meeting. During the first RCM, country work plans were developed for all research contract holders. Since the first RCM, field studies have been established in different agro-ecological zones and initial soil samples from the field have been collected and analysed to identify the chemical and physical characteristics of soils. The first year progress report and renewals are currently being evaluated.

This CRP aims to increase crop productivity and resource use efficiency in harsh environments by using best fit soil and water management practices and improved crop varieties through demonstrations in small farmers' fields. The overall objective of this CRP is to increase crop productivity and food security by developing and extending to farmers, technology packages which include information about improved crop varieties and best-fit soil, water, nutrient and crop management practices that make cropping systems resilient to environmental stresses. The specific objectives are: (1) to increase the productivity of improved mutant varieties of crops tolerant to environmental stresses under existing soil and climatic conditions, and (2) to enhance nitrogen and water use efficiencies of crops tolerant to environmental stresses through best practice involving soil, water, crop and fertilizer management.

Soil Quality and Nutrient Management for Sustainable Food Production in Mulch-based Cropping Systems in Sub-Saharan Africa (D1.50.12)

Technical Officers: Gerd Dercon and Long Nguyen

The objective of this CRP is to improve the livelihoods of low socio-economic farmers and rural communities in a region that is dominated by a savannah ecosystem in its natural state.

The CRP seeks to address four key issues relating to soil quality and nutrient management for sustainable food production in mulch based cropping systems in sub-Saharan Africa in order to:

- improve soil fertility and soil health by promoting carbon sequestration through the replacement of ex-

ported nutrients (especially N, but also P and S to a lesser extent) and by applying the principles of conservation agriculture;
- increase productivity in integrated crop-livestock systems across different spatial scales in the moist and dry savannahs of sub-Saharan Africa;
- increase on-farm and area-wide ecosystem service efficiency (e.g. nutrients, water, labour and energy use efficiency);
- assess economic feasibility and conduct socio-economic and environmental impact assessments of mulch-based farming systems in sub-Saharan Africa.

In mulch-based farming systems, it is critical to adopt soil management practices that can potentially increase soil organic matter content (carbon sequestration) and maximize the efficient utilization of soil nutrients (synthetic and organic fertilizers) and water storage for crop growth. Soil organic matter improves soil fertility, stabilizes soil aggregates, increases soil water holding capacity to provide more water for crop growth and provides carbon as an energy source for the soil fauna and flora, which in turn enhances the soil chemical and physical properties.

The use of stable isotopic techniques (C-13 and N-15), at both enriched or natural abundance levels, will facilitate in-depth analyses and understanding of the basic soil biophysical processes, including soil carbon and nutrient cycling in mulch-based systems. The CRP will provide a platform for the extrapolation of the recommended soil management practices to many agro-ecological regions of sub-Saharan Africa because of the selection of benchmark sites in diverse and representative environmental conditions.

This CRP was formulated on the basis of the recommendations of a consultants' meeting held at IAEA, Vienna 5- 8 July 2010. The first Research Coordination Meeting was held in Vienna, 30 January–3 February 2012. Fifteen participants, with seven research contract holders from Benin, Kenya, Madagascar, Mauritius, Mozambique, Pakistan and Zimbabwe, three technical contract holders from China, the Czech Republic and the United Kingdom and five agreement holders from Austria, Belgium, Kenya, New Zealand and United States of America attended the first RCM. The expected duration of the CRP is five years (2012-2016).

In spring 2012, a common field trial protocol was developed and sent to the CRP participants for implementation. The SWMCN Laboratory team has also started a series of research activities to support this CRP. Currently, a longterm field experiment of over 15 years in Gross-Enzersdorf (BOKU Research Station, 8 km east of Vienna) is being used to adapt stable isotope techniques (C-13 and N-15) for the assessment of soil organic carbon sequestration and stability under different agro-ecological conditions. Two additional experiments were initiated to validate these techniques: (i) a longterm field experiment in Grabenegg, at the experimental research station of the Austrian Agency for Health and Food Safety (AGES), west of Vienna, and (ii) a greenhouse column experiment in the SWMCN Laboratory. Guidelines for using these stable isotope techniques are expected to be ready by July 2013 for further testing by the CRP participants.

A video has been made on the CRP activities at the Grabenegg site. This video was published on the IAEA website during the IAEA Scientific Forum on "Food for the Future: Meeting the Challenges with Nuclear Applications", held during the IAEA General Conference in September. (See video: http://www.iaea.org/newscenter/multimedia/videos/gc56/180912/bettersoil/index.html).

Activities of the Soil and Water Management and Crop Nutrition Laboratory, Seibersdorf

Research and Development

Assessing soil erosion at landscape level by means of the fallout radionuclides method via insitu gammaray spectrometry

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Iain G. Darby, Roman P. Alvarez, Efrain R. Trujillo and Ralf B. Kaiser
Nuclear Spectrometry and Applications Laboratory (NSAL), Division of Physical and Chemical Sciences

Measuring Fallout Radionuclides (FRNs) is a well-established method to estimate soil erosion and deposition in agricultural landscapes (Dercon *et al.*, 2012). While extremely sensitive, laboratory based gamma-ray spectrometry requires careful handling and preparation of measurement samples with a lengthy measuring time (~1 day) due to a small sample mass. *In-situ* gamma-ray spectrometry can give near instantaneous results, allowing prompt decisions to be made and identification of critical spots of soil erosion, while the equipment is in the field (Tyler *et al.*, 2001).

The aim of this investigation is to compare the precision of the *in-situ* FRN measurements, made by a lanthanum bromide ($LaBr_3$ (Ce)) scintillation detector of ^{137}Cs against those from conventional (high-purity germanium HPGe detector) laboratory based gamma-ray spectrometry for assessing soil erosion. We aim to establish the strength of correlation between *in-situ* field and laboratory-based measurements, and to develop new strategies for landscape based soil erosion assessment. The potential advantage of *in-situ* measurements is their ability to perform a higher frequency of sampling measurements per geographical area, thereby providing a greater sample density for soil erosion models. By sampling in the field we maximize the volume of FRN measured per location, compensating for poorer spectroscopic background conditions compared to the laboratory approach. In the current study we used a LaBr scintillator detector in order to optimise our detection efficiency (determining the sampling time) and detector resolution (affecting the uncertainty on the activity of FRN).

This investigation is conducted as part of Coordinated Research Project (CRP) D1.20.11 on Integrated Isotopic Approaches for an Area-wide Precision Conservation to Control the Impacts of Agricultural Practices on Land Degradation and Soil Erosion.

The study was carried out in Grabenegg, at the experimental research station of the Austrian Agency for Health and Food Safety (AGES), west of Vienna. It is at an altitude of 260 m a.s.l., with an annual average temperature of 8.4°C and annual precipitation of 686 mm. The soil is classified as *Gleyic* or *Eutric Cambisol*.

Fifty FRN data were taken over the field site and at two reference sites. Each measurement was for 900 seconds with the detector being placed on the ground. The data was taken in two parts: (i) 15 measurements in a 6 hour period, (ii) 35 measurements taken 1 week later over a 12 hour period. Core soil samples were collected in part (ii) from 3 measurement locations and 1 reference site (see Fig. 1).

Fig. 1: Left: In-situ measurements being made. Right: Core soil sampling.

Critical to the success of applying the FRN method is the knowledge of the deposition of the FRN at a local reference site. This site is used to estimate the total ^{137}Cs fallout input or reference inventory and is a key component of the conversion models used to estimate erosion and sedimentation rates from assembled data. Therefore great care was taken to find a plot of land undisturbed for the last 40-50 years and two orchards adjacent to farmhouses in the vicinity of the field were selected. It is important to note all conclusions about ^{137}Cs measurements from our test site will be made relative to the reference inventory (Bq/ m^2).

Preliminary results show that radionuclides measured *in-situ* are a promising tool for improving the usefulness of the FRN method to assess erosion at landscape level. Initial results (Fig. 2) showed that changes in the measured ^{137}Cs level correspond to geomorphological features beyond the uncertainties of our measurements. These data demonstrate our ability to measure the distribution of ^{137}Cs as a function of positions enabling us to draw useful conclusions. This technique will allow Member States without traditional gamma spectroscopy facilities to apply the FRN method to improve soil conservation strate-

gies at landscape level. Further testing is planned with the Nuclear Spectrometry and Applications Laboratory on additional sites around Vienna in the coming months.

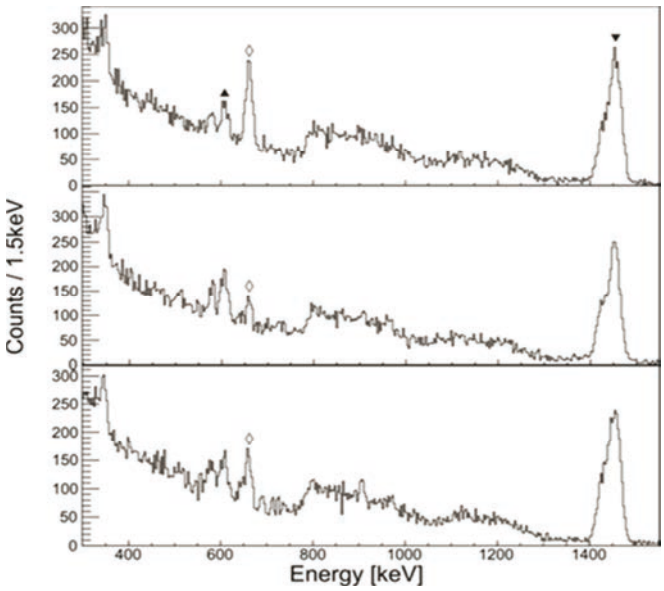

Fig. 2: 900 second gamma-ray spectra collected by the LaBr detector at two measuring sites (top and middle) and at one reference site (bottom). The 662keV gamma-ray indicating the decay of ^{137}Cs is marked with an open diamond. Background activity from ^{40}K and the intrinsic activity of the detector are marked with an inverted filled triangle. Activity from ^{214}Bi at 609keV, a Uranium decay series product, is marked with an upright filled triangle. The LaBr detector clearly resolves the ^{137}Cs and ^{214}Bi peaks.

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Validation of ^{7}Be as a tracer for short-term soil erosion events in eastern Austria

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As part of Coordinated Research Project (CRP) D1.20.11, on "Integrated Isotopic Approaches for an Area-wide Precision Conservation to Control the Impacts of Agricultural Practices on Land Degradation and Soil Erosion", a study was conducted, which aimed at understanding the use of fallout ^{7}Be in shortterm (between 1-2 months) erosion studies for agricultural land, in particular on Central European Typic Eutrocrepts, a typical soil rich in soil organic carbon, found in the Eastern part of Austria. The following experiments were carried out:

1. Assessing the influence of heavy rains on ^{7}Be distribution in soils under field conditions

The uniformly distributed pre-existing ^{7}Be and their inputs associated with heavy rains represent key assumptions for short-term soil erosion studies using ^{7}Be. Due to the limited number of samples that can be measured in a relatively short time, these assumptions are often not verified for the reference site. Also, the degree of variation in ^{7}Be inventories within the reference area is commonly not established. As a result, groups of soil profiles, sectioned into 2 or 3-mm slices, are bulked in distinctive depth increments and measured as a single sample (Schuller et al., 2006; Shi et al., 2011). The objective of the research was to assess the influence of two consecutive heavy rainfalls (producing 81 mm rains in the period 20-25 July, 2012) on ^{7}Be spatial distribution in the IAEA Seibersdorf Laboratory experimental field and to establish the coefficient of variation for the ^{7}Be areal activity (Bq m^{-2}) within a small plot (8x8 m^{2}).

One incremental and nine additional bulk soil cores were collected from a previously cultivated flat site with no evidence of erosion or deposition, after the occurrence of heavy rains (> 20 mm d^{-1}). Cores were taken to a depth of 4 cm in order to collect all detectable ^{7}Be. All soil cores were sampled using a fine soil increment collector, developed by the SWMCNL (SWMCNL Activity Report, 2008) (Figure 1). The gamma-spectrometric measurements were performed using a P-type high-purity germanium detector (HpGe), with 110% relative efficiency. The activity concentrations of ^{7}Be were corrected for decay with respect to the time of sample collection. The ^{7}Be depth profile in the Seibersdorf soil showed an exponential decrease as expected, since the field was ploughed more than 6 months before the sampling and the soil was not disturbed by human activity during this period. Figure

2 shows the characteristic soil depth profile of ^{7}Be for the studied area. Other depth distribution profiles of ^{7}Be, as presented in the literature for other sites, showed the same exponentially shape (Blake et al., 1999; Schuller et al, 2006). ^{7}Be activity concentrations (Bq kg^{-1}) higher than the detection limit were measured only for the upper 25 mm of soil. Based on total ^{7}Be inventories (Bq m^{-2}) measured in 10 different points within the selected area, an average inventory of 312±37 Bq m^{2} was calculated. The resulting Coefficient of Variation (CV) of 19.21% could be considered as acceptable for a flat field without evidence of soil movement after the occurrence of heavy rainfalls. The experimental site from Seibersdorf can thus be considered a suitable reference site for further investigation on soil erosion using ^{7}Be in the surrounding fields.

Fig.1. Collecting 2.5 mm incremental soil samples for 7Be gamma measurements.

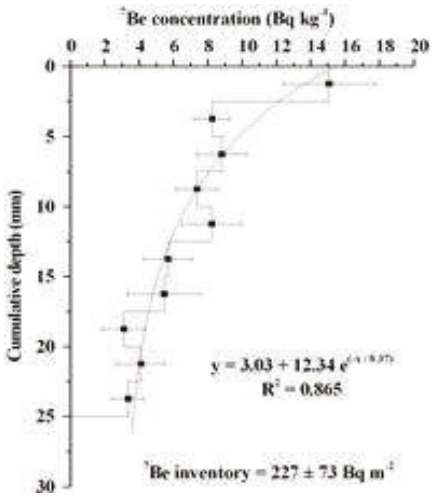

Fig.2. The vertical distribution of ^{7}Be

2. Using ^{7}Be in soil erosion assessments in partially covered soils

In agro-ecosystems, soils are most susceptible to erosion when they are not or only partially covered by crops. As a proportion of ^{7}Be fallout is rapidly fixed by a crop's above-ground biomass and thus the amount of fallout associated with the soil varies according to the density and the nature of biomass, the application of this radiotracer for estimating the soil erosion rates has been limited to bare soils, without any vegetation.

To investigate the validity of this technique in areas covered by crops, a study is currently being conducted in the Seibersdorf area to better understand how aboveground biomass influences the use of ^{7}Be for short-term soil erosion studies in agricultural land, and to assess to what extent ^{7}Be can still be used to assess erosion. This research represents a collaborative action between both the IAEA Soil Science Laboratory and the Terrestrial Environmental Laboratory of Seibersdorf.

The objectives of the study are:

- To determine ^{7}Be interception fraction and the accumulation process of bean leaves in the early growing stage (15 days after seeding) (Figure 3).

- To determine the ^{7}Be root-foliar transfer

Preliminary results will be available at the end of 2012 and the findings of this research will be reported in the next issue of the SWMCN Newsletter.

Fig.3. Sampling common bean leaves in the greenhouse for 7Be gamma measurements.

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The use of oxygen-18 isotopes in phosphate to trace phosphorus sources and cycling in soils

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Recognizing the importance of increasing phosphorus (P) use efficiency to improve land productivity in tropical and subtropical regions, particularly with rapid reduction of global P reserves, the Soil and Water Management & Crop Nutrition Laboratory (SWMCNL) is currently collaborating with scientists from China and Switzerland to test a new stable isotope-based technique (the oxygen isotope composition of phosphate, $\delta^{18}O\text{-}PO_4$) (Photo 1), to trace P in soils and plants under on-farm conditions (O'Neil et al., 2003; McLaughlin, 2006; Elsbury et al., 2009; Angert et al., 2011).

Phosphorus is a key nutrient essential for all living organisms. Soils with low P status are widespread in many regions of the world and their P deficiency limits plant growth and reduces crop production and food quality. Phosphorus has one stable isotope (31P) and several radioisotopes (from ^{26}P to ^{30}P and from ^{32}P to ^{38}P), but the only two isotopes (^{32}P and ^{33}P) that are suitable for agronomic studies have a very short half-life, making it difficult for any long term study. Because P has only one stable isotope, researchers have started to explore the potential of oxygen isotopes in inorganic P compounds to study and understand P dynamics in both cropping and livestock production systems to improve soil P fertility and food productivity.

In order to analyse $\delta^{18}O\text{-}PO_4$, phosphate in different soil P fractions (e.g., H_3PO_4, $H_2PO_4^-$, HPO_4^{-2} and PO_4^{-3}) must be extracted from the soil, purified and converted to Ag_3PO_4. Tamburini et al (2010) have developed protocols for estimating $\delta^{18}O\text{-}PO_4$ for soils with different soil P status and plant-availability in different countries. Soils receiving different farm management practices (e.g. fertiliser or manure applications) show different δ18O-PO4 signatures, indicating the potential as isotopic tracer for studying P cycling, tracing P sources and ultimately providing a better understanding of soil P dynamics in agro-ecosystems.

The current collaboration between China, Switzerland and IAEA will also help to strengthen the dissemination of land-based technologies to improve land management in FAO and IAEA Member States.

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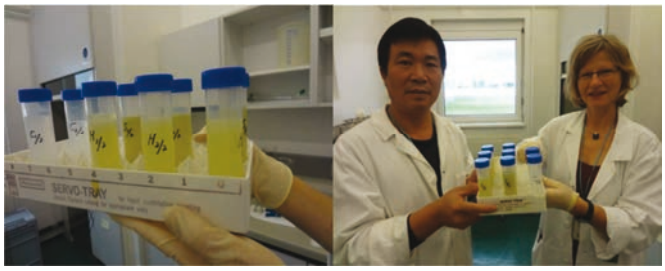

Photo 1. Chinese expert Dr Lin testing a new stable isotope-based technique to trace phosphorus in soils and plants

Geographical decision support system (DSS) design: Back to the basics

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The ARCAL RLA5051 Regional Technical Cooperation project on "Using Environmental Radionuclides as Indicators of Land Degradation in Latin America, Caribbean and Antarctic Ecosystems" brings together researchers from Latin America and the Caribbean in the field of land degradation assessment through the measurement of environmental radionuclide inventories.

In this context, a system offering project participants the opportunity to disseminate their work and datasets, to compile relevant external datasets and to clearly visualize them, provides a critical role in improving decision making as regards national and regional policies for soil conservation and environmental protection in the region. Furthermore, the geographical dimension and cross-cutting nature of issues involved in ecosystem management requires the development of a system focused on strong geospatial visualization capabilities.

System design: The approach

The use of advanced geospatial analytical tools such as the Geographical Information System (GIS) is a long established specialist domain, which often has severe financial implications. Since the launch of Google Earth in 2005 and with the fast-evolving and low-cost web technologies, various geospatial visualization platforms are accessible online to non-specialists, allowing dynamic and interactive visualization of data harvested from various sources (for instance, as in the case of regional project RLA5051, ^{137}Cs, ^{7}Be concentration and spatial distribution, erosion models outputs, land use information and digital elevation models…).

To set up such a system today, a wide spectrum of solutions are available (either proprietary or open source). However, the organizational and technical nature of regional technical cooperation projects considerably challenges traditional solutions in various respects:

- Technical, human and financial resources vary significantly from country to country;
- No full-time and dedicated system administration provided;
- Internet connectivity might be limited in some areas;
- As a technical cooperation initiative, focus must be placed on cutting-edge technologies, skill transfer and capacity building.

Although this set of constraints and requirements is relatively common, they have only been partially addressed by traditional solutions so far. Emerging geospatial technological trends show that innovators have built on lessons learnt and prioritized simplicity, efficiency, flexibility, openness, complementarity, quality and low-costs.

System design: The technical side

Web system architecture relies on client-side (end-user browser) and server-side (remote servers) components. From the birth of the Web, applications used to run online systems have moved from client-side to server-side. Today, it is clear that such systems sometimes bring unnecessary or even irrelevant complexity, especially when internet bandwidth is a scarce resource. At the same time, the Web current trend is towards decentralization of services (for instance DropBox services to share data, YouTube to broadcast video, Amazon S3 to host websites, MapBox to host maps etc.). As a consequence, there is an opposing trend moving design focus back to the client-side components simply delegating specialized tasks to optimized service providers. This type of loosely coupled system proves to be fast, interoperable, expandable, scalable and very easy to maintain and replicate. Most importantly, reducing system complexity and delegating to specialized actors allows for full focus on core capabilities and initial purpose.

The design of the Geographical Decision Support System within the ARCAL RLA5051 project is being based on this approach and relies mainly on a stack of open source technologies and online services such as Quantum GIS (http://qgis.org), TileMill (http://mapbox.com/tilemill/gallery/), MapBox, GitHub, Jekyll, Prose, Git, DropBox and Google Earth. To train the participants in RLA 5/051, a regional training course was held in Mexico, November 2012. Twenty-six participants from Latin America and the Caribbean participated in this course.

An example of Geographical Decision System Support can be seen at: http://sahelresponse.org/, *which has been developed in partnership with a wide platform of international organizations.*

Vacuum extraction of soil and plant water for stable isotope analyses - update

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The simple, fast and portable vacuum distillation setup developed in the SWMCN Laboratory, reported in the July 2011 SNL) for extracting soil and plant water was further improved with the use of an immerse cooler in place of both liquid nitrogen and dryice to prevent loss of water vapour during evacuation, since liquid nitrogen is still not readily available in many countries. The methodology was successfully tested with two soil types (clay and sand), over two water levels (near field capacity and near wilting point) and over a range of extraction times and temperatures. The results showed that the water recovery (extracting more than 98% of the total water) for sandy soil under wet conditions is as low as 15 minutes versus 30 minutes in dry soil, on the other hand in clay soil, the time to extract 98% of water was 30 versus 120 minutes under wet and dry conditions, respectively. The complete setup (see below) costs around €8150. It provides a rapid, low-cost and reliable method that meets a high-throughput of leaf and soil water isotopic analyses.

Photo 1: An improved vacuum distillation method for extracting soil and plant water for stable isotope analyses.

Training Activities

One of pillars of the Soil and Water Management & Crop Nutrition Laboratory (SWMCNL) is training activities to support technology transfer under various technical co-operation projects (TCPs).

Regional Training Course on Soil and Water Management in Agriculture to Support Crop Production in Asia and the Pacific (RAS5064), 23 July - 17 August 2012, Seibersdorf, Austria

Technical Officers: J J Adu-Gyamfi, K Sakadevan, L K Heng, P Cepuder (BOKU, Austria), G Dercon and M L Nguyen

From 23 July to 17 August 2012, the Soil and Water Management & Crop Nutrition Subprogramme brought together twenty scientists and technicians from sixteen countries across the Asia and Pacific region (i.e. Afghanistan, China, Indonesia, Islamic Republic of Iran, Cambodia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Palau, Sri Lanka, Vietnam and Yemen) for a training programme on soil and water management in agriculture. The particular emphasis of the training was the use of isotopic and nuclear techniques to understand soil-water-crop processes and interactions, and identify strategies to improve nutrient and water use efficiency and crop productivity. The training was funded by the Government of Japan under IAEA's Peaceful Uses Initiative (PUI) Programme, and organized within the activity of regional project RAS5064, on *"Enhancing Productivity of Locally-underused Crops through Dissemination of Mutated Germplasm and Evaluation of Soil, Nutrient and Water Management Practices."*

Training was provided by the entire team of scientists and laboratory technicians from the Soil and Water Management & Crop Nutrition Section and Laboratory, in close collaboration with Mr Peter Cepuder from the University of Natural Resources and Life Sciences (BOKU), Vienna, Austria. As part of the training, the participants also attended the FAO/IAEA International Symposium on *"Managing Soils for Food Security and Climate Change Adaptation and Mitigation"*, held at the IAEA in Vienna 23 - 27 July 2012.

Besides the main objective of enhancing skills, knowledge and technical competence in soil, water, crop and nutrient management in agriculture, the training also provided an opportunity to share experiences, establish networks among the trainees and enhance cooperation between their countries. In addition to the technical sessions, presentations by the Research Contract and Administration Section explained the pathways through which participants can become involved in IAEA Coordinated Research Projects. The participants were also privileged to meet and interact with the Director General of the Food and Agricultural Organization (FAO) of the United Nations, Mr. José Graziano da Silva, who was visiting the FAO/IAEA Agriculture and Biotechnology Laboratories.

Feedback from the participants showed that such intensive training programmes have a large impact. They learned to use modern isotopic techniques which can be used to help solve technical problems in their countries relating to drought, water shortage, soil and water salinity or soil erosion (Ms. Rivera, Philippines). They could also discuss these problems with other fellows and find out what others do in their countries to address them (Mr. Eskandari, Islamic Republic of Iran). What was accomplished through the training goes beyond the simple technological and theoretical transfer. Such training courses helped to foster the next generation of agricultural science leaders in the Asia and Pacific region and to establish the networks that we will use during our careers (Mr. Raj Devkota, Nepal).

Photo 1: Participants learning about N-15 methodology to quantify biological nitrogen fixation by legumes

Photo 2: Fellows discussing agriculture and water management and food security issues with the Director-General of the Food and Agriculture Organization (FAO).

Photo 3: Participants and trainers at the Regional Training Course

Individual Fellowship Training

Besides the group training reported above, an additional group of fourteen fellows, six from Afghanistan, and one each from the United Republic of Tanzania, Kenya, Sudan, Oman, Sierra Leone, Mali, Zambia and Bangladesh, received three months intensive training in the application of isotopic and nuclear techniques to improve soil and water management and crop nutrition. Emphasis was placed on how to assess resource use efficiency. In addition, one fellow from the Philippines and one from Malaysia received individual training on the use of isotopic techniques to understand water and nutrient use by crops.

Fellows learned how to conduct laboratory, glasshouse and field experiments for quantifying biological nitrogen fixation and agronomic water use efficiency and theywere also trained in the use of computer models such as the AquaCrop model to assess irrigation efficiency and to improve crop-water productivity.

Photo 4: Monitoring soil moisture to improve irrigation scheduling through the use of soil moisture neutron probe and related conventional techniques (SWMCNL Experimental and Training Site at Seibersdorf, Austria)

Photo 5: Two fellows from Afghanistan measuring soil water in a field experiment using conventional techniques (SWMCNL Experimental and Training Site at Seibersdorf, Austria)

Photo 6: A fellow from Tanzania taking a close look at his experiment on the use of N-15 methodology to quantify biological nitrogen fixation by legumes

External Quality Assurance: Annual Proficiency Test on ^{15}N and ^{13}C isotopic Abundance in Plant Materials

Martina Aigner

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The 2012 Proficiency Test (PT) on ^{15}N and ^{13}C isotopic abundance in plant materials, jointly organized by the University of Wageningen, Netherlands, and the IAEA Soil and Water Management & Crop Nutrition Laboratory (SWMCNL) has been successfully completed. The Wageningen Evaluating Programs for Analytical Laboratories (WEPAL, http://www.wepal.nl) is accredited for the organization of Interlaboratory Studies by the Dutch Accreditation Council. In total, eleven stable isotope laboratories participated in this PT-round "IPE 2012.2".

Every year, one ^{15}N-enriched plant test sample (0.5 to 2.5 atom %, i.e. 370 to 6000 δ ‰ "delta per mille") is included in one round of the WEPAL IPE - (*International Plant-Analytical Exchange*) programme. A bulk quantity of uniformly ^{15}N-enriched plant material is produced by the FAO/IAEA Soil and Water Management & Crop Nutrition Laboratory and sent to WEPAL for milling, homogenization and bottling through the routine test sample production process for PTs. This ^{15}N-enriched material is sent out together with 3 other, non-enriched plant samples. Participants are invited to perform analysis of any determinant offered in the WEPAL IPE scheme including ^{15}N (enriched and/or natural abundance level), total N (N-elementary), Kjeldahl-N, ^{13}C and total C (C-elementary). The participation fee for one round of PTs in 2012 (round IPE2012.2), was covered by the IAEA.

This year, participants who registered in the PTscheme were provided with the WEPAL test sample set IPE 2012.2 consisting of four test samples of 20 g plant material each. Test sample No.2 (WEPAL material code 208) was enriched with ^{15}N and only the results of this test sample were evaluated by the IAEA. In total, eleven laboratories reported isotope abundance data: Africa (1): Morocco; Asia (1): Pakistan; Europe (5): Austria, Belgium, Germany, Italy and Turkey and Latin America (4): Argentina, Brazil, Chile and Uruguay (Fig. 1). The SWMCNL also participated in this round of PTs (Lab code 915, marked in Fig. 2 and 3).

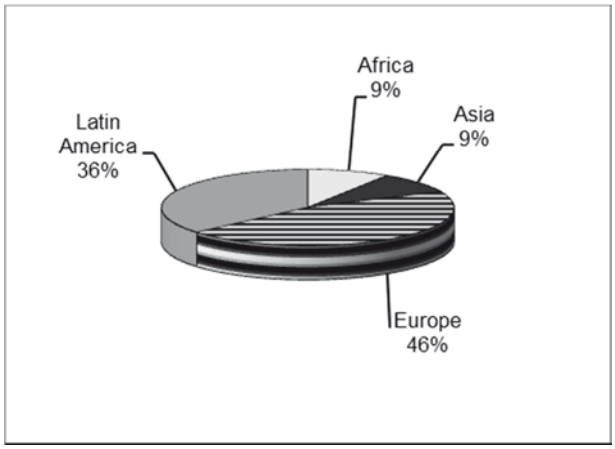

Fig.1. Geographical distribution of participants

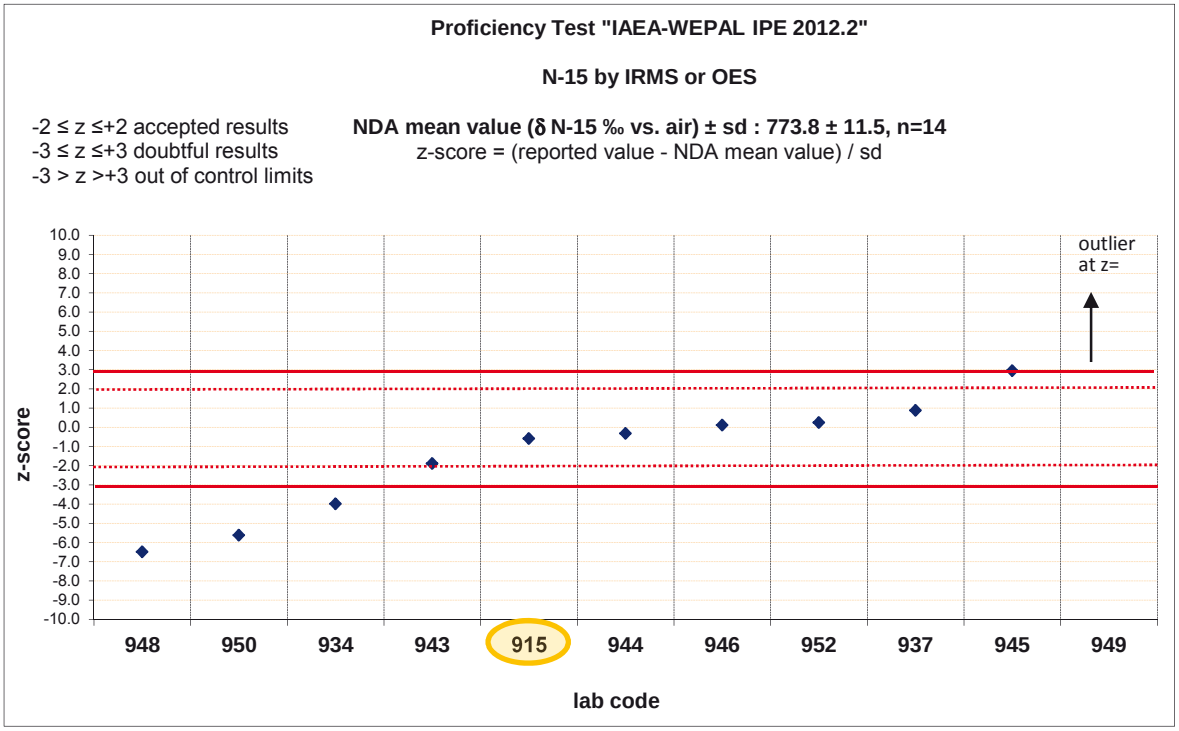

Fig. 2. Z-score evaluation of the ^{15}N analysis of plant material 208 (2)

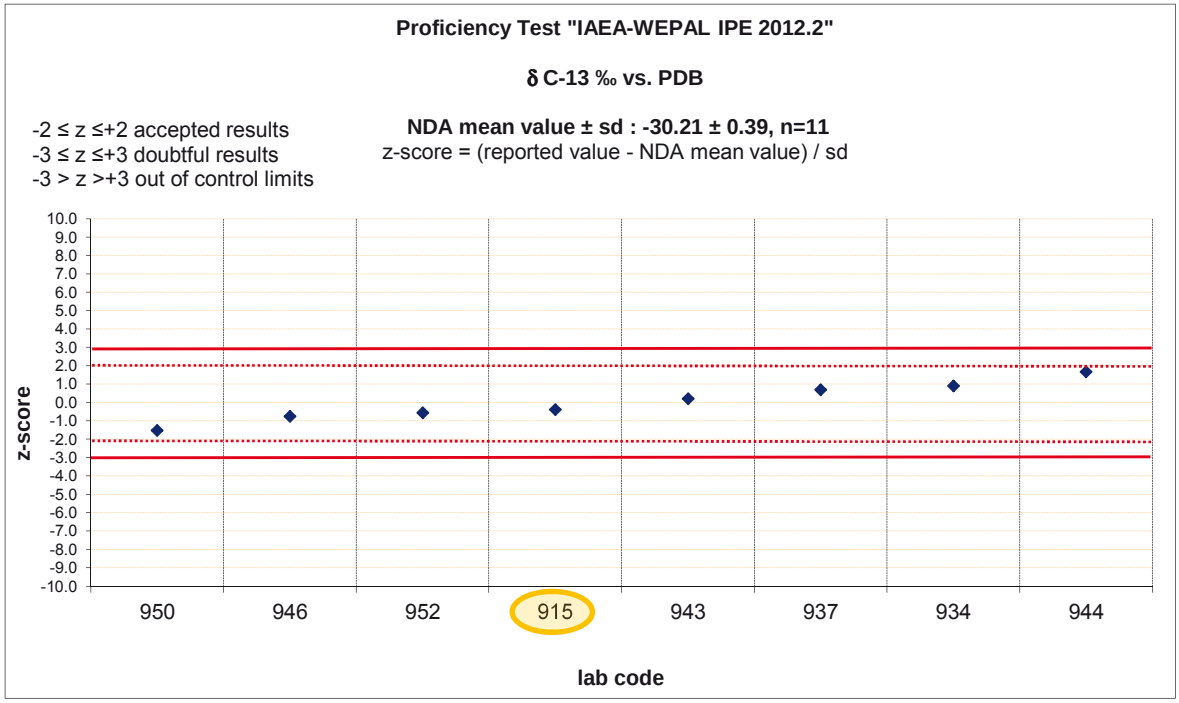

Fig. 3. Z-score evaluation of the ^{13}C analysis of plant material 208 (2)

Table 1 below shows the reported analytical data and WEPAL-evaluation of the ^{15}N enriched plant material produced by the Soil Water Management and Crop Nutrition Laboratory (SWMCNL).

Table 1. Summary of results of plant material 208 (2)

type of analysis	unit	material code	sample no.	remark	Lab no.	reference value (NDA mean)	SD	reported result	Z-score (based on statistics all participants)	* straggler, ** outlier
delta 15N	‰ Air	208	2	^{15}N enriched	915	773.8	11.5	767.00	-0.59	
delta 15N	‰ Air	208	2	^{15}N enriched	934	773.8	11.5	727.93	-3.98	**
delta 15N	‰ Air	208	2	^{15}N enriched	937	773.8	11.5	784.00	0.88	
delta 15N	‰ Air	208	2	^{15}N enriched	943	773.8	11.5	752.14	-1.88	
delta 15N	‰ Air	208	2	^{15}N enriched	944	773.8	11.5	770.20	-0.31	
delta 15N	‰ Air	208	2	^{15}N enriched	945	773.8	11.5	807.79	2.95	*
delta 15N	‰ Air	208	2	^{15}N enriched	946	773.8	11.5	775.07	0.11	
delta 15N	‰ Air	208	2	^{15}N enriched	948	773.8	11.5	699.00	-6.49	**
delta 15N	‰ Air	208	2	^{15}N enriched	949	773.8	11.5	1975.21	104.17	**
delta 15N	‰ Air	208	2	^{15}N enriched	950	773.8	11.5	709.09	-5.61	**
delta 15N	‰ Air	208	2	^{15}N enriched	952	773.8	11.5	776.71	0.25	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	915	-30.21	0.39	-30.36	-0.39	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	934	-30.21	0.39	-29.86	0.91	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	937	-30.21	0.39	-29.94	0.70	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	943	-30.21	0.39	-30.13	0.21	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	944	-30.21	0.39	-29.56	1.68	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	946	-30.21	0.39	-30.50	-0.75	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	950	-30.21	0.39	-30.79	-1.51	
delta 13C	‰ V-PDB	208	2	^{13}C nat.ab.	952	-30.21	0.39	-30.42	-0.55	
N - elementary	g/kg	208	2		158	32.94	1.15	34.45	1.31	
N - elementary	g/kg	208	2		915	32.94	1.15	33.60	0.57	
N - elementary	g/kg	208	2		934	32.94	1.15	30.63	-2.01	*
N - elementary	g/kg	208	2		937	32.94	1.15	28.91	-3.51	**
N - elementary	g/kg	208	2		943	32.94	1.15	34.11	1.01	
N - elementary	g/kg	208	2		945	32.94	1.15	37.76	4.19	**
N - elementary	g/kg	208	2		946	32.94	1.15	32.49	-0.39	
N - elementary	g/kg	208	2		950	32.94	1.15	36.94	3.47	**
N - Kjeldahl (as N)	g/kg	208	2		158	31.24	1.87	31.32	0.04	
N - Kjeldahl (as N)	g/kg	208	2		937	31.24	1.87	27.59	-1.95	
N - Kjeldahl (as N)	g/kg	208	2		948	31.24	1.87	32.50	0.67	
N - Kjeldahl (as N)	g/kg	208	2		949	31.24	1.87	34.22	1.59	
N - Kjeldahl (as N)	g/kg	208	2		950	31.24	1.87	32.90	0.89	
N - Kjeldahl (as N)	g/kg	208	2		952	31.24	1.87	29.78	-0.78	
C - elementary	g/kg	208	2		158	445.8	11.7	436.79	-0.77	
C - elementary	g/kg	208	2		915	445.8	11.7	422.00	-2.03	*
C - elementary	g/kg	208	2		934	445.8	11.7	423.05	-1.94	
C - elementary	g/kg	208	2		937	445.8	11.7	402.81	-3.67	**
C - elementary	g/kg	208	2		943	445.8	11.7	436.03	-0.83	
C - elementary	g/kg	208	2		946	445.8	11.7	450.52	0.40	
C - elementary	g/kg	208	2		950	445.8	11.7	422.31	-2.01	*
C - elementary	g/kg	208	2		952	445.8	11.7	440.02	-0.49	

Conclusions

Six out of eleven laboratories participating in the nitrogen analysis reported ^{15}N-data lie within the control limits for the enriched plant sample (Fig. 1) and all eight laboratories participating in carbon analysis reported ^{13}C isotopic abundance results within the control limits for this test sample (Fig. 2).

Worldwide comparisons of stable ^{15}N and ^{13}C isotope measurements provide confidence in the laboratory's analytical performance and are therefore an invaluable tool for external quality control.

It is expected that in the future more stable isotope laboratories will make use of this unique opportunity to assess their analytical performance and provide evidence of the high quality of their analytical data.

For more information on external quality assurance supported by the SWMCNL, please contact Mrs. Martina Aigner of SWMCNL.

Fellows and Scientific Visitors at the SWMCN Laboratory in 2012

a. Fellows

- Mr S Hazrat, Afghanistan
- Mr M S Salim, Afghanistan
- Mr S A Sadat, Afghanistan
- Mr R Haidiri, Afghanistan
- Mr B Sofezadh, Afghanistan
- Mr S Rohani, Afghanistan
- Mr B Mohammad, United Republic of Tanzania
- Mr S Suliman, Sudan
- Ms E N Njiru, Kenya
- Ms A Doucoure, Mali
- Mr H S Al-Busaidi, Oman
- Mr C. Phiri, Zambia
- Ms N. Sadat, Afganistan
- Ms Y. Zhang, China
- Mr H. Sosiawan, Indonesia
- Mr A. Eskandari, Iran, Islamic Rebpublic of
- Mr A. Phirum, Cambodia
- Mr C. Tan, Cambodia
- Ms T. Silipanyo, Laos
- Ms S. Kingsavanh, Laos
- Mr S. A. Abdul Rahman, Mali
- Ms S.H.M. Oo, Myanmar
- Mr P.R. Devkota, Nepal
- Mr A.R. Muhammad, Pakistan
- Ms M.D. Kalpage, Sri Lanka
- Mr M.H.J.P. Gunarathna, Sri Lanka
- Mr M. T. Tran, Vietnam
- Mr M. Alaamri, Oman
- Mr F. Ikertang, Palau
- Mr T.S. Moroke, Botswana
- Ms F. Rivera, Philippines
- Mr M. Saif Galeb Saeed, Yemen
- Mr R. Rallos, Philippines
- Mr A.W. Ahmad Nazrul, Malaysia

b. Scientific visitors

- Luxemburg Ambassador (HE Mr Hubert Wurth) and Councillor (Mr Robert Lauer), 11 January
- U S Mission (Mr Bill Baton), 17 January
- National Liaison Officer and National Liaison Assistant (Mr Raja J Bin Raja Hedar and Ms Siti Syarina MAT SALI) from Malaysia,18 January
- National Program Team for Inception of New TC cycle for Botswana, 25 January
- Visitors Centre Guides, 6 February
- Nuclear Spectrometry and Application Laboratory Group Fellowship participants, 1 March
- 6th Coordination Meeting of RAS 5048 and RAS 5058, 1 March
- TC Procurement Visit, 7 March
- World Nuclear University SI Alumni Assembly, 28 March
- Minister for Science and Technology, Thailand and entourage, 30 March
- Six scientific visitors (SV) from Cambodia, 12-19 April
- Mr Berhe Tekola, FAO- Animal Production and Health Division (AGAD), 3 May
- Visit by IAEA Deputy Director General, Department of Management, 14 May
- 32 International Engineering students from India, 16 May
- Mr Doğan Yaşar and Mr Muharrem Korkmaz, Turkish Atomic Energy Authority, 21 May
- Dr Hudi Hastowo, Dr As Natio Lasman (Chairman of the Indonesian Regulatory Body) and Dr Syahril (Indonesian Permanent Mission), 7 June
- BBC Filming Team, 8 June
- Standing Advisory Group on Nuclear Applications (SAGNA) Members of IAEA, 12 June
- Visitors (12) from Lesotho, 14 June
- IAEA New Staff Induction Group, 26 June
- HE Mr Pravongviengkham, Laos Vice-Minister of Agriculture, 4 July
- Mr N Rabesiranana, Madagascar
- Ms L Rabeharisoa, Madagascar
- Mr Daniel K Asare, Ghana
- Mr L Fondio, Ivory Coast
- Mr T T Lekadou, Ivory Coast
- Mr C K Kayuki, Uganda
- Mr R Vencatasamy, Mauritius

Publications

List of Publications in 2012

Aulakh, M., Manchanda, J.S., Garg, A., Kumar, S., Dercon, G., Nguyen, M.L. (2012). Crop Production and Nutrient Use Efficiency of Conservation Agriculture for Soybean-Wheat Rotation in the Indo-Gangetic Plains of Northwestern India. Soil and Tillage Research, 120, 50-60.

Bado, S., Adu-Gyamfi, J., Padilla-Alvarez, R., Forster, B. P., Laimer, M. (2012). Ion accumulation in rice genotypes varying in salt tolerance: Development of a simple screen. Plant Abiotic Stress Tolerance II, International Conference, Vienna, Austria, February 22-25, 2012.

Benmansour, M., Mabit, L., Nouira, A., Moussadek, R., Bouksirate, H., Duchemin, M., Benkdad, A. (2013). Assessment of soil erosion and deposition rates in a Moroccan agricultural field using fallout 137Cs and 210Pbex. Journal of Environmental Radioactivity, 115, 97-106.

Dercon, G., Mabit, L., Hancock, G., Nguyen, M.L., Dornhofer, P., Bacchi, O.O.S., Benmansour, M., Bernard, C., Froehlich, W., Golosov, V.N., Haciyakupoglu, S. Hai, P.S., Klik, A., Li, Y., Lobb, D.A., Onda, Y., Popa, N., Rafiq, M., Ritchie, J.C., Schuller, P., Shakhashiro, A., Wallbrink, P., Walling, D.E., Zapata, F., Zhang, X. (2012). Fallout radionuclide based techniques for assessing the impact of soil conservation measures on erosion control and soil quality: An overview of the main lessons learnt under an FAO/IAEA Coordinated Research Project. Journal of Environmental Radioactivity, 107, 78-85.

Henry, A., Mabit, L., Jaramillo, R.E., Cartagena, Y., Lynch, J.P. (2012). Land use effects on erosion and carbon storage of the Río Chimbo watershed, Ecuador. Plant and Soil. DOI 10.1007/s11104-012-1478-y

INTERNATIONAL ATOMIC ENERGY AGENCY, Greater Agronomic Water Use Efficiency in Wheat and Rice Using Carbon Isotope Discrimination, IAEA-TECDOC- 1671, IAEA, Vienna (2012), 292 p.

Jankowicz-Cieslak, J., Scharl, T., Brozynska, M., Adu-Gyamfi, J., Foster, B. P., Rapacz. M. (2012). Diversity in physiological Responses to Drought by Musa Genotypes: Plant Abiotic Stress Tolerance II, International Conference, Vienna, Austria, February 22-25, 2012.

Laso, J.C., Marohn, C., Dercon, G., Dewi, S., Piepho, H.P., Joshi, L., van Noordwijk, M., Cadisch, G. (2012). Coastal vegetation and its influence on the 2004 tsunami event. In: Geophysical Research Abstracts, Volume 14, European Geosciences Union, General Assembly 2012, Vienna, Austria, 22-27 April 202, Abstract. http://meetingorganizer.copernicus.org/EGU2012/EGU2012-12834.pdf

Mabit, L., Chhem-Kieth, S., Toloza, A., Vanwalleghem, T., Bernard, C., Amate J.I., González de Molina, M., Gómez, J.A. (2012). Radioisotopics and physicochemical background indicators to assess soil degradation affecting olive orchards in southern Spain. Agriculture, Ecosystems & Environment, 159, 70-80.

Mabit, L., Dornhofer, P., Martin, P.C., Toloza, A., Zupanc, V. (2012). Depth distribution of selected geogenic radionuclides (40K, 226Ra, 232Th) and anthropogenic 137Cs in an undisturbed forest soil in East Slovenia. Indian Journal of Pure & Applied Physics, 50, 45-48.

Marchetti, A., Piccini, C., Santucci, S., Chiuchiarelli, I., Francaviglia, R., Mabit, L. (2012). Spatial distribution of soil organic matter using geostatistic: a key indicator to assess soil degradation status in Central Italy. Pedosphere, 22(10), 230-242.

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Zaman, M. and Nguyen, M. L. (2012). How application timings of urease and nitrification inhibitors affect N losses from urine patches in pastoral system. Agriculture, Ecosystems and Environment, 156: 37–48.

Websites

- Soil and Water Management and Crop Nutrition Section:
  http://www-naweb.iaea.org/nafa/swmn/index.html

- Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture:
  http://www-naweb.iaea.org/nafa/index.html

- Food and Agriculture Organization FAO website: http://www.fao.org/about/en/

- FAO/AGL (Land and Water Development Division): http://www.fao.org/nr/water/landandwater_what.html

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