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Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf

# Soils Newsletter

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## Contents

- To Our Readers 1
- Staff 4
- Staff News 5
- Feature Articles 5
- SWMCN Seminar Series 13
- Technical Cooperation Projects 15
- Forthcoming Events 18
- Past Events 20
- Status of Coordinated Research Projects (CRPs) 25
- Activities of the Soil and Water Management and Crop Nutrition Laboratory 28
- Publications 39
- Websites 39



*Study site in Son La Province, Vietnam investigating appropriate soil-water-plant management practices for sustainable crop and livestock production (CRP project DI.20.11; Picture courtesy: Petra Schmitter).*

## To Our Readers

The Soil and Water Management and Crop Nutrition (SWMCN) Section and the SWMCN Laboratory (formerly known as Soil Science Unit until January 2010) have made significant progress within the last 6 months implementing activities for the IAEA 2010-2011 biennium and formulating the 2012-2013 programme with other FAO Divisions through result-based activities relating to soil and water management for sustainable intensification of agricultural production systems and conservation of agricultural and natural resource bases.

Improving soil and water management is a critical issue for enhancing agricultural production and at the same time minimizing greenhouse gas emissions from farmland ([www.unccd.int/knowledge/docs/UNCCDPolicyBrief-Mitigation-02.pdf](http://www.unccd.int/knowledge/docs/UNCCDPolicyBrief-Mitigation-02.pdf)). With a projected increase in the global population to 9.1 billion by 2050 and the mounting pressure of climate change and variability on soil degradation and uneven water distribution, the quest to conserve soil and water resources for agricultural production is becoming increasingly urgent. Having better seeds will not lead to higher crop yields unless soil fertility constraints are addressed and soil health is improved ([www.ifdc.org/](http://www.ifdc.org/); [www.agra-alliance.org/section/work/soils;](http://www.agra-alliance.org/section/work/soils;)



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[www.scidev.net/en/news](http://www.scidev.net/en/news)). The importance of this interaction is increasingly evident in the number of technical cooperation projects (TCPs) jointly managed by the SWMCN and Plant Breeding and Genetics Subprogrammes (see under *Technical Cooperation Projects* heading). The FAO/IAEA/IFDC website (<http://www-iswam.iaea.org/dapr/srv/en/home>) of the Phosphate Rock Decision Support System (PRDSS) has recently been revamped. This aims to provide farmers, extension workers and policy makers with a decision-making tool to determine the appropriate type and amount of phosphate fertiliser required to provide phosphorus for plant growth for both immediate and long-term requirements (e.g. for a growing season and subsequent crops).

The SWMCN Subprogramme is continually working with scientists in Member States (MS) to find ways to sequester carbon dioxide in soils and reduce GHG emissions through conservation tillage and appropriate nitrate fertiliser and crop residue applications. Some of this information and exciting developments in this area can be viewed in the *Status of Coordinated Research Projects (CRPs)* and *Publications* sections of this Newsletter.

With regard to agricultural water management, the SWMCN Subprogramme focuses not only on enhancing the efficient use of irrigation for crop production in irrigated agricultural systems but also on the improvement of soil health, a critical factor in improving the retention of every drop of rain or irrigation water within the plant root zone under both irrigated and rainfed production systems. Since 60% of world food production comes from rainfed agriculture, the SWMCN Subprogramme continues to work with MS in the search for improved soil and crop management packages that will enhance soil capacity to retain and conserve every drop of rainwater for plant growth.

Knowledge of soil-water-crop-livestock interactions is essential to assess how irrigation or rainwater is retained or moved through the plant root zone and how it can be effectively used by crops without creating soil salinity and water pollution. To this end, the SWMCN Subprogramme has provided training for trainers in agricultural water management on all aspects of soil-water-crop interactions at the SWMCN Laboratory in Seibersdorf or in collaboration with national research centres in countries such as China and Turkey. Our field campaign in China has yielded exciting results on the use of isotopic techniques in agricultural water management (see *Feature Articles*). A similar field campaign is being planned in Vietnam later this year with the support of the Vietnamese Government and FAO. The IAEA Division of Public Information and its staff (Louise Potterton, Petr Pavlicek and Misha Kidambi) have successfully developed a range of promotional materials to disseminate information on drip

irrigation for crop production to Member States via UN Radio and the IAEA website (see *Past Events*).

With this Newsletter I would like to share with you my excitement that soil is now being globally recognised as the basis for sustainable agriculture. The following conclusions and recommendation at a recent FAO Committee on Agriculture (COAG) (22<sup>nd</sup> COAG Session, Rome, 16 – 19 June 2010) sum up well the importance of soils in food productivity and agricultural water management:

- (i) Soils underpin the food systems that support human lives and livelihoods – providing the support base and nutrients for plant and animal life and the means for the capture and retention of rainwater and irrigation water.
- (ii) Soils also perform many vital functions in terms of nutrient cycling, soil carbon sequestration, climate regulation, and rainfall infiltration.
- (iii) Agricultural water management involves improved soil and crop management practices to reduce soil evaporation and enhance more crop production per drop through fertilizer applications, improved varieties and weed and pest management.
- (iv) FAO as a global knowledge organization in agriculture should take the leadership in establishing a Global Soil Partnership to strengthen soil, land and crop and animal-based production systems-related networks and capacities at national, regional and global levels to address soil-related problems in specific soil types and ecosystems, as well as the interrelations between soil management, food and livelihood security and climate change.

Let us strengthen our collaboration to improve soil and water management for food production and the conservation of agricultural resources. I look forward to receiving your continuing support in this important crusade.

**Long Nguyen**  
**Head**  
**Soil and Water Management and**  
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## Staff News



**Ms. Ksenija Ajvazi** joined the SWMCN Section on 15 February 2010 to fill the vacant secretarial position following the departure of Ms Eveline Kopejtka. Ksenija was previously working with the Department of Legal and External Relations, Comprehensive Test Ban Treaty Organisation (CTBTO) as well as with the Department of Nuclear Energy, IAEA as a temporary secretarial staff. We welcome Ksenija as a fulltime staff member in the SWMCN Section.



**Ms. Brigitte Liepold** after working as a temporary secretarial assistant for nearly 10 months for the SWMCN Section since 1 March 2009 has joined the IAEA Department of Technical Cooperation, Division of Programme Support and Coordination, Quality Assurance Section as of 4 January 2010. We thank Brigitte for her inputs and wish her well for the future.

## Feature Articles

### Building partnerships for sustainable land management and food security in Cuba

by <sup>1</sup>R.G. Castillo

<sup>1</sup>*Centro de Protección e Higiene de las Radiaciones (CPHR), Havana, Cuba*

Soil erosion and the associated land degradation have long been recognized as major environmental concerns and a constraint to food security and sustainable development. The United Nations has highlighted soil degradation as one of the most significant challenges for sustainable food production in the 21st century (World Summit on Sustainable Development, 2002 Johannesburg, South Africa).

The ARCAL (Regional Cooperative Agreement for the Advancement of Nuclear Science and Technology in Latin America and the Caribbean) Regional Strategy Profile identified the inefficient use of soil resources and the resulting permanent loss of productive agricultural land as major limitations to achieving food security in the Latin American and Caribbean region. Currently, about 300 million hectares of land have been affected by degradation.

Indicators of the present soil conservation status and probable environmental consequences are essential for an assessment of national economic potential and evaluation of political and social consequences. Large-scale soil erosion assessments, for example in a watershed, cannot be based on direct conventional measurements because of methodological restrictions and excessively high temporal and spatial variability. This can be addressed through the use of fallout radionuclides (caesium-137, lead-210 and beryllium-7), which are widely distributed in the environment, adsorbed by soil

particles and hence transported in the landscape in a similar way to soil particles. Therefore the monitoring of their redistribution provides an excellent fingerprint for soil redistribution by erosion or sedimentation. These radionuclide techniques also offer an advantage over the conventional methods, by being much less laborious and pinpointing the sources of soil loss.

In 2009, a regional technical cooperation project (RLA/5/051 – ARCAL) was initiated for Latin America, with 15 countries (Argentina, Bolivia, Brazil, Chile, Cuba, El Salvador, Haiti, Jamaica, Mexico, Nicaragua, Peru, Dominican Republic, Uruguay and Venezuela) participating in the use of radionuclide techniques (<http://arc.unsl.edu.ar>) to address soil erosion resulting from deforestation, overgrazing and inappropriate soil cultivation.

In several countries the RLA/5/051 project has been linked with complementary national and international initiatives. For example, in September 2009 the Republic of Cuba implemented the Country Partnership Programme (CPP) supported by the Global Environment Facility (GEF, <http://www.theGEF.org>). The CPP comprises a package of interventions to address land degradation, including policy, regulatory and institutional reforms and capacity building. The CPP priorities are consistent with Cuba's national action programmes on desertification, sustainable land and water management, and agricultural production. This partnership between the RLA/5/051 and the CPP in Cuba has enhanced the

optimization of skills in the use of radionuclide techniques to improve soil management and promote sustainable agriculture. The two RLA/5/051 participants (Centre for Radiation Protection and Hygiene of the Ministry of Science, Technology and Environment, and the Soil Science Institute of the Ministry of Agriculture) are associated with the CPP to assess soil erosion rates for two pilot project sites located in Western and

South-Eastern Cuba (Llanura sur-occidental de Pinar del Río and Franja costera Guantanamo-Maisi, respectively) through the use of radionuclides. Both sites with a total area of around 2400 hectares, represent typical subhumid and semi-arid agroecosystems in Cuba, which are characterized by severe soil erosion and soils of poor health.

## Exciting Development: Real-Time Carbon Isotope Measurements for Quantifying Soil Carbon – A Strategic Asset in Combating Greenhouse Gas Emissions and Mitigating Climate Change

By <sup>1</sup>D. Risk, <sup>1</sup>N. Nickerson, and <sup>2</sup>Aron Van Pelt

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### Introduction and Motivation

Measurements of  $\delta^{13}\text{C}$  in soil organic matter and soil-respired  $\delta^{13}\text{C}\text{-CO}_2$  are an important tool used to determine rates of processes and fates of carbon (C) compounds on a variety of scales and for understanding the C cycle in soils. In near-surface soils where diffusion is the dominant mechanism of gas transport, it must be recognized that these systems rarely in isotopic steady state. Simple changes, such as variation in respiration rate or infiltration of rainwater alter the soil gas diffusion regime and cause transient isotopic disequilibrium. These transient fractionations can persist for hours or days, and decay as the system approaches a new steady state.

Stable isotopes are increasingly being used in understanding the early stages of fractionation in soil systems. However, there is a clear divergence between the true and measured isotopic signatures at the onset of this fractionation (Nickerson and Risk, 2009a). Further, the actual measurement methodologies themselves can affect the isotopic signatures being measured and so care must be taken in experimental design to avoid such effects (Nickerson and Risk, 2009b). The growing awareness of these effects, in tandem with new instrumentation for observing them in real time, has allowed better modeling and more accurate quantification of these soil gas processes (Phillips et al. *in press*; Subke et al. 2009).

### Materials and Method

Recent advancements in instrumentation have enabled continuous, real-time, in-situ measurements of  $\text{CO}_2$  concentrations and carbon isotopes (specifically  $^{13}\text{C}$  in  $\text{CO}_2$ ) using Cavity Ring Down Spectroscopy (CRDS) and other similar technologies. As they become increasingly field-portable, they can be coupled to soil respiration measurement chambers or other sampling devices where signatures can be measured in real time, and with

improved precision. The temporally dense CRDS time-series measurement allows us to observe dynamic fractionation more easily than traditional sampling techniques, and more importantly, enhances the potential of extracting true signatures using gas transport mechanisms.

An example of soil  $\delta^{13}\text{C}\text{-CO}_2$  dynamic fractionation as measured by CRDS is shown in the following set of measurements using a straightforward synthetic sand-rice “soil” plot in a growth chamber environment. Here, soil air was sampled using a continuous loop between the CRDS analyser and a porous (1 mm perforations) tube buried at 5cm depth below the soil surface.

Figure 1 shows the dynamic isotopic response to changes in temperature (constant moisture), and Figure 2 shows a time-series measurement after a simulated small rain event (constant temperature). The data in Figure 1 and Figure 2 shows how  $\delta^{13}\text{C}\text{-CO}_2$  concentrations changes due to changes in temperature and moisture. In contrast, the signature of  $\delta^{13}\text{C}\text{-CO}_2$  from the rice substrate has been reported (Nickerson and Risk, 2009a) to be nearly constant at both constant moisture and temperature.

Variations in soil temperature and moisture affect microbial activity and respiration rate, causing large changes in  $\text{CO}_2$  production rate and concurrent changes in the observed isotope ratio. These changes in the isotope ratio are largely due to gas transport dynamics rather than to changes in the actual isotopic content of  $\text{CO}_2$  being produced. In both cases, the magnitude of dynamic fractionation is large relative to the typical short-term variation that would be expected from the biogenic source. This type of variability is often masked with traditional discrete sampling done on a fixed schedule, where researchers might return at a similar time each day to perform measurements, because only a sliver of actual isotopic variability is observed. Notice that the impact of the simulated rain

event is much longer lasting than for diurnal production, because percolation and other vadose zone processes delay the re-establishment of a stable regime of gas diffusivity. In these examples, the signature of soil efflux would also be expected to vary alongside changes in soil gas signatures, by roughly 1 permil.

Being able to measure these gas transport dynamics in real time is valuable in validating and extending existing theories of non-equilibrium isotope dynamics. Most of this work is based on the premise that the different isotopologues of  $\text{CO}_2$  ( $^{12}\text{CO}_2$  and  $^{13}\text{CO}_2$ ) behave as though they were altogether different gases, with different diffusivities, concentration gradients and equilibration rates. The differential equilibration rates of these two isotopologues give rise to these short-lived fractionations in the measured gas. Luckily, many researchers have had good initial successes using these assumptions for extracting source signatures (or the 'signal') from this physical 'noise'. Three-dimensional models have been shown to be superior for this purpose, particularly for correcting for methodological biases (Nickerson and Risk, 2009c).

With the advent of gas analysers capable of measuring real-time concentration of isotope of soil gases, the disequilibrium effects can be investigated easily and with much higher time resolution than the conventional techniques.

### Discussion

Among the challenges of interpreting insitu isotopic signatures in environments is the ability to discriminate between the isotopic signal in question and the noise on this signal in fast-changing systems of most natural environments. The duration of most natural systems' state of isotopic fractionation is often longer than the amount of time that natural system (including soils) actually sits in steady-state. Consequently, most natural systems are often in a state of constant isotopic fractionation.

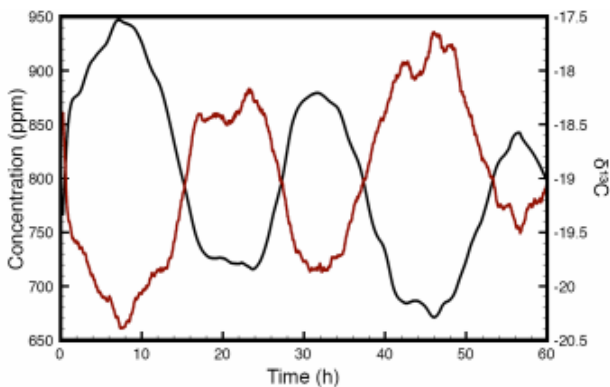


Figure 1. Transient soil  $\delta^{13}\text{CO}_2$  fluctuations (red) as a result of changes in soil  $\text{CO}_2$  production rate (proxied by concentration, shown in black). Day to night respiration ratio is  $\sim 2:1$ . (diurnal temperature fluctuation of  $\sim 10^\circ\text{C}$ ).

The previous examples show that it is critical to understand the system's dynamics, and the importance of responding with appropriate tools. New instrumentation has provided a step change in temporal resolution, which unfortunately highlights the deficiencies of older methods where gas transport dynamics were thought to be of little concern for soil isotopic research. Even where correction of data might not be warranted, researchers should have the capacity to estimate the potential for dynamic fractionation in their system of study and associated with methodologies used for sampling. Particularly prone to dynamic fractionation are: sites where soil gas parameters change rapidly; sites with low respiration rate and high soil gas diffusivity; and closed and open chamber sampling methodologies.

### Conclusions

Continuous in-situ gas concentration and isotopic measurements techniques are increasingly being leveraged to study and understand soil carbon dynamics. Improved understandings of C dynamics in natural environments result in more accurate interpretations of long-term field monitoring data, and in this context, real-time isotopic measurements are emerging as critical research tools. Because most natural systems are in an ever changing state regarding their isotopic signatures, as the two data presented demonstrates that it is important to understand how factors like temperature and moisture can cause significant and abrupt changes in field measurements. When the specifics of the system under study are well-understood, steps can be taken to appropriately design the measurements in such a way so as to avoid biases imposed by the measurement implementation itself, and to avoid conditions that cause significant fractionation events that might overshadow the actual signal in question."

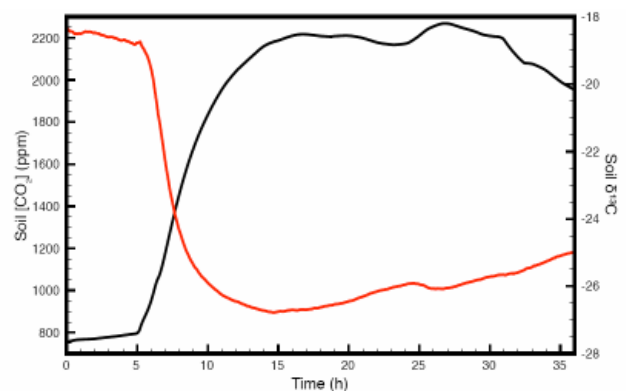


Figure 2. Transient changes in soil  $\delta^{13}\text{CO}_2$  (red) and soil  $\text{CO}_2$  concentration (black) after a rain event.

## References

- Cerling, T. E., D. K. Solomon, J. Quade, and J. R. Bowman, On the isotopic composition of carbon in soil carbon-dioxide, *Geochim. Cosmochim. Acta*, 55, 3403-3405, 1991.
- Nickerson, N., and D. Risk. (2009a) Physical Controls on the Isotopic Composition of Soil Respired and CO<sub>2</sub>. *Journal of Geophysical Research-Biogeosciences*, 114, G01016, doi:10.1029/2008JG000844.
- Nickerson, N., and D. Risk. (2009b) A numerical evaluation of chamber methodologies used in measuring the  $\delta^{13}\text{C}$  of soil respiration. *Rapid Communications in Mass Spectrometry* 23, 2802-2810.
- Nickerson, N., and D. Risk. (2009c) Keeling plots are non-linear in non-steady state diffusive environments. *Geophysical Research Letters*, 36, L08401, doi:10.1029/2008GL036945.
- Phillips, C., N. Nickerson, D. Risk, Z. Kayler, C. Andersen, A. Mix and B. Bond (in press) Soil moisture effects on the carbon isotopic composition of soil respiration. *Rapid Communications in Mass Spectrometry*.
- Subke, J-A., H. Vallack, T. Magnusson, S. Keel, D. Metcalfe, P. Hogberg and P. Ineson (2009) Short-term dynamics of abiotic and biotic soil <sup>13</sup>CO<sub>2</sub> effluxes after in situ <sup>13</sup>CO<sub>2</sub> pulse labelling of a boreal pine forest. *New Phytologist*, 183: 349–357 doi: 10.1111/j.1469-8137.2009.02883.x

## Improving water use efficiency in agriculture: Field campaign in Beijing

by <sup>1</sup>Aaron Van Pelt, and <sup>2</sup>David G. Williams

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### Challenge in improving agricultural water management

Soil evaporation and plant transpiration measurements are important for estimating the amount of water required for plant growth. Stable isotope techniques can be a useful tool for measuring evaporation and transpiration. Evapotranspiration, an important part of the water cycle describes the sum of evaporation (E) and plant transpiration (T) from the land surface to the atmosphere where evaporation accounts for the movement of water to the air from sources such as the soil, canopy interception, and water bodies whereas transpiration accounts for the movement of water within a plant and the subsequent loss of water as vapor through stomata in its leaves. As the amounts of the stable isotope <sup>18</sup>O in soil water and water vapor within the plant canopy can be different, the trapping and analyses of <sup>18</sup>O in soil water and water vapour can help separate evaporation from evapotranspiration (ET). This information allows informed decisions to be made regarding improving irrigation scheduling. For example, recently, Picarro, Inc., a manufacturer of real-time water vapor isotope analysers was invited to participate in a FAO/IAEA field measurement campaign to assess ET from an arable land in Beijing. The data obtained demonstrates the efficacy of using stable isotopes as a means to differentiate evaporation and transpiration with an eye towards improving water use efficiency (WUE).

### Field Measurement Activities

Mr Van Pelt was invited by the IAEA to participate in a meeting and field measurement campaign entitled 'Measurements of Soil Evaporation and Crop Transpiration using Isotopic and Conventional Methods', held

between June 12th and July 1st at China's National Experimental Station for Precision Agriculture in the Xiaotangshan District, Beijing, China, run by the China National Engineering Research Center for Information Technology in Agriculture (NERTICA). This field campaign corresponded with the 2<sup>nd</sup> research coordination meeting (RCM) of the joint FAO/IAEA Coordinated Research Project on "Managing Irrigation Water to Enhance Crop Productivity under Water-Limiting Conditions using Nuclear Techniques." In addition to the international participants of the FAO/IAEA RCM, staff from the China Agricultural University and the Chinese Academy of Agricultural Sciences was invited to participate in the campaign.

The campaign was organized by Dr. Minh Long Nguyen, Section Head and Dr. Lee Heng, Scientific Secretary, Soil and Water Management & Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food & Agriculture, Vienna International Centre with technical support from the following:

Dr. David Williams, University of Wyoming  
 Dr. Ted Hsiao, University of California at Davis  
 Dr. Li Baoguo, China Agricultural University  
 Dr. Xurong Mei, Chinese Academy of Agricultural Sciences  
 Dr. Daozhi Gong, Chinese Academy of Agricultural Sciences  
 Dr. Yong Li, Chinese Academy of Agricultural Sciences  
 Aaron Van Pelt, Picarro, Inc., USA

The focus of the campaign was to conduct a field measurement in which the attendees – over 20 scientists



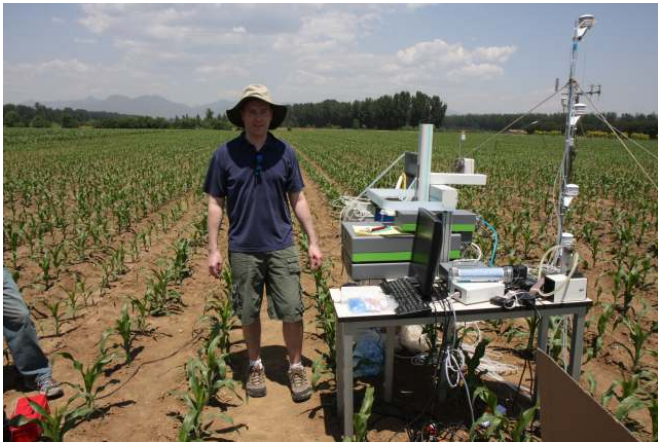
from eight developing countries (Burkina Faso, China, Malawi, Morocco, Pakistan, Turkey, Vietnam and Zambia) could work and learn alongside experts in isotope techniques applied to water management in cropping systems. Mr Van Pelt participated and provided the use of the isotopic water analyser to produce data for the campaign and offered training on the use of continuous water vapor isotope analysers in the field.

### **Quantifying Evapotranspiration**

The field work consisted of measuring soil evaporation and crop transpiration using isotopic and conventional methods. The Picarro water isotope analyser was used to produce real-time water vapor isotope measurements, sampled at five different heights above the experimental corn field in which the campaign took place. Since climate change is causing shifts in local and regional hydrology that influence crop water use and productivity, international organizations like FAO and IAEA are more concerned than ever before in understanding the processes like evapotranspiration. Evapotranspiration is linked to both irrigation efficiency as well as crop productivity. In addition to water isotope data, a variety of measurements were taken to quantify the evapotranspiration of the corn field under study. Such measurements included standard meteorological, eddy covariance and soil moisture data, as well as measurements used to estimate the leaf cover and photosynthesis.

The use of water isotopes in studying evapotranspiration is quite powerful in that the isotopic signature of water vapor in the air arising from evaporation is distinct from that arising from transpiration from plant leaves. Soil evaporation has a different isotopic signature than that of water vapor from transpiration because it is strongly affected by fractionation processes. At steady state, there is no apparent fractionation between the transpired water from leaves and the plant source

water. This means water vapor at different heights above the ground will show different isotope signatures, depending on the relative mixing of evaporated and transpired water with the background air. This information, when combined with soil moisture and other metrological measurements can be used to understand how efficiently the crop is utilizing irrigation water for leaf gas exchange and photosynthesis as opposed to direct evaporation from the soil. The Picarro analyser provided a continuous record of water isotopes during the campaign. Conventional water vapor 'grab samples' from the air were also cryogenically condensed and analyzed by off-line laboratory-based methods to compare to the online Picarro measurements. Liquid water was also cryogenically extracted from the soil in the field and these liquid samples were analyzed at the IAEA Soil and Water Management & Crop Nutrition (SWMCN) Laboratory in Seibersdorf, Austria. A few of these samples, as well as other liquid samples from the home countries of the RCM attendees, were analyzed using the Picarro instrument during the field campaign as well. In contrast to conventional methods for measuring water vapor isotopes by cryogenically trapping the water vapor for subsequent measurement on a lab instrument, the real-time, field-based measurements made with the Picarro analyser avoid issues of sample contamination or fractionation during collection, preparation and transportation to an isotope laboratory for analyses. Further, the ability to make measurements every few seconds allows these transient water vapor isotope signatures to be measured with a high time resolution previously not possible. This field campaign was an important opportunity to further test the field-based approach for measuring water vapor isotopes, as well as an opportunity to compare these data with that from conventional methods.



*Figure 1. Water vapor isotope analyser during Beijing field campaign in June 2009. Water vapor was continuously sampled at five heights above ground (sampling tower in background) in order to discriminate isotopes vertically within the plant canopy for comparison to isotopes from soil water samples.*



*Figure 3. After the water vapor isotope measurements had concluded, the analyser was set up in a building adjacent to the cornfield studied in the Beijing field campaign and was used to quantify the isotopes in liquid water samples provided by the participants from their home countries.*



*Figure 2. Demonstrating to the participants of the Beijing field campaign how the water vapor isotope analyser is used in field measurements.*

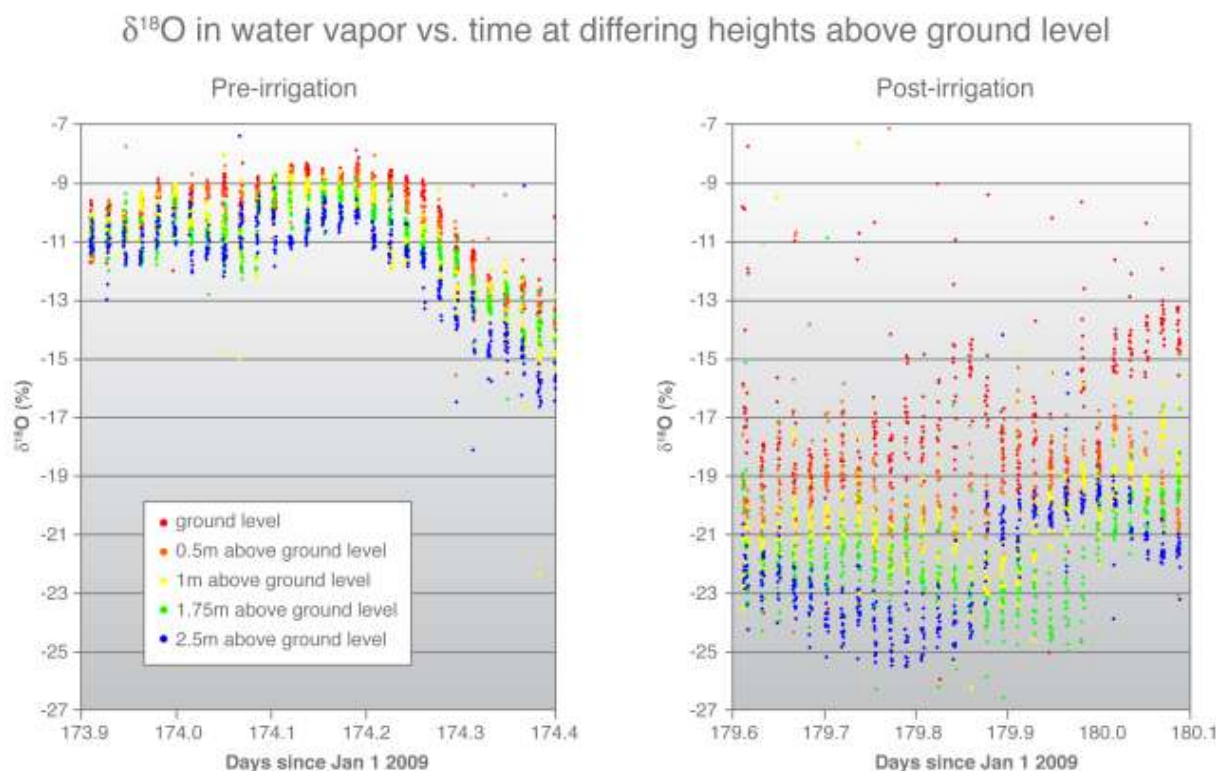


Figure 4. Plot showing the continuous water vapor isotope measurements during the field campaign in Beijing before and after irrigation. The strength of the signals is significantly different before (day 173-4) and after (day 179-80) the field is irrigated.

## NCCR North-South Research Project RP11 ‘Land resource potential and climate change’: Collaboration with Joint Division

by <sup>1</sup>Bettina Wolfgramm

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Centre for Development and Environment,  
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Soil organic carbon content is the key to long-term health of soils, and hence their agricultural productive potential. Worldwide, soils in semi-arid regions are severely affected by land degradation and drastically reduced soil organic carbon. Rainfed agriculture in semi-arid regions is also vulnerable to climate change that causes extreme weather events, further impacting crop yields and accelerating land degradation.

Sustainable land management (SLM) systems (e.g. conservation agriculture, agroforestry, integrated cropping livestock systems) towards enhanced carbon sequestration may offer a way forward in addressing such land degradation. In Tajikistan soil organic carbon has been identified as a key indicator of soil health and resilience against soil erosion and a storehouse of plant nutrient availability (Ergashev et al., 2007; Wolfgramm et al., 2007). A research project was recently initiated in Tajikistan on land resource potential and climate change coordinated by NCCR North-South from Switzerland (<http://NCCR North-South>) in collaboration with the Tajik Soil Institute and the Joint Division. This project aims to develop a comprehensive methodology for assessing the performance of SLM systems, leading to informed decision-making and providing win-win solutions that harmonise human needs and environmental protection under changing climatic conditions.

The specific objectives of the NCCR North-South RP11 project are (i) the identification of SLM systems, making most effective use of land resource potentials for increased agricultural production, resilience to climate change as well as carbon sequestration, and (ii) extrapolation of the benefits of these SLM systems to regional scales. The project is assessing selected SLM systems by comparing their performance with traditional land management practices (e.g. extensive grazing and conventional tillage). For their evaluation, the WOCAT-LADA questionnaires are being used. WOCAT (World Overview of Conservation Approaches and Technologies) constitutes a framework for documentation, evaluation and dis-

semination of good SLM systems and decision support. The questionnaires and databases on SLM systems can be used at local/ field level for the assessment of case studies, whereas at the national level the WOCAT/LADA (Land Degradation Assessment in Drylands project) mapping tool can be used for the spatial assessment of land degradation and the performance of SLM systems.

For quantifying specific impacts with regards to erosion control and soil health, a combination of methods including conventional (soil reflectance spectrometry) and isotopic techniques (fallout radionuclides) is being applied and coupled with Geographic Information Systems/Remote Sensing (GIS/RS) for regional assessments (Bühlmann et al., 2010). Finally, a comprehensive methodology for SLM impact assessment shall be elaborated and results synthesized for representative agro-ecosystems in Tajikistan (Dushanbe area and the high Pamir Mountains). The Tajik case studies will be the focal area, especially for testing of models and tools. In a later stage the approach shall be applied to other agro-ecological zones in semi-arid tropics of Ethiopia and Kenya to test their performance.



*NCCR North-South Regional Training Course 2009: Field day Faizabad, Tajikistan (photo: Anne Zimmermann, CDE)*

## References

- Bühlmann E, Wolfgramm B, Maselli D, Hurni H, Sanginov SR, Liniger HP. 2010 (forthcoming). GIS-based Decision Support for Soil Conservation Planning in Tajikistan. *Journal of Soil and Water Conservation*.
- Ergashev M, Nekushoeva G, Wolfgramm B. 2007. Conversion of grazing land to fruit and fodder plots, pp 189-196. In Liniger HP, Critchley W (editors). 2007. Where the land is greener. Case studies and analysis of soil and water conservation initiatives worldwide. CTA, Wageningen, <http://www.wocat.net/overviewbookPDF.asp>

In Tajikistan, the project team from both the NCCR North-South and the Tajik Soil Institute has been closely involved since 2005 through IAEA Technical Cooperation projects in the area of soil conservation and soil fertility management. Since 2009, the collaboration between all three partners has been strengthened further through the NCCR North-South project RP11 and a UN led initiative (Sustainable Land Management in the High Pamir and Pamir-Alai Mountains, PALM project) to assess land degradation and develop best land management practices in the Pamir Mountains of Tajikistan using radionuclide techniques and GIS/RS. This collaboration is an example of how built partnerships with national and international stakeholders can be useful for optimizing land resource use to minimize land degradation and alleviate rural poverty.



*Joint case study area, Bodomo Watershed, Tajikistan (photo: Bettina Wolfgramm, 2004)*

- NCCR North-South. 2010. Natural resources: the climate change challenge. NCCR North-South policy brief No. 4. [http://www.nccr-north-south.unibe.ch/publications/Infosystem/On-line\\_Dokumente/Upload/NCCR\\_Policy\\_Brief\\_Climate\\_Change.pdf](http://www.nccr-north-south.unibe.ch/publications/Infosystem/On-line_Dokumente/Upload/NCCR_Policy_Brief_Climate_Change.pdf)
- Wolfgramm B, Seiler S, Kneubühler M, Liniger HP. 2007. Spatial assessment of erosion and its impact on soil fertility in the Tajik foothills. *EARSeL eProceedings* 6 (1):12-25. [http://las.physik.uni-oldenburg.de/eProceedings/vol06\\_1/06\\_1\\_wolfgramm1.html](http://las.physik.uni-oldenburg.de/eProceedings/vol06_1/06_1_wolfgramm1.html)

## SWMCN Seminar Series

### Quick Method for Determining Plant Available Water

By Gaylon S. Campbell

Senior Scientist, Decagon Devices, Inc., Pullman, WA USA

Before joining Decagon Devices, Inc. in 1998 as a Senior Scientist, Dr Campbell was a Professor of Soils at Washington State University, Pullman for nearly 20 years. During his tenure at Washington State University, Dr. Campbell hosted and supervised more than 50 students, postdoctoral researchers, sabbatical scientists, and visiting scientists from numerous disciplines and countries. He also served, often as Chair, on numerous national and international committees and review teams and has served on the editorial boards of many international journals. Dr. Campbell has made major research contributions in the field of soil and environmental physics, where he has led developments in a wide range of areas spanning the soil–plant–atmosphere continuum.

Dr. Campbell is also a disciplined and prolific writer, with an ability to express the complex in ways that are easily understood. He has authored and co-authored more than 250 publications, including three major textbooks (Campbell, 1977, 1985; Campbell and Norman, 1998), more than 100 refereed journal papers, and more than 30 book chapters.

#### ABSTRACT

For the first few days after heavy rain or irrigations, water drains from the soil profile until its water content approaches a relatively stable value called the drained upper limit or field capacity. When plants have extracted all of the water available to them, the root zone water content approaches a lower limit of available water, or permanent wilting water content. The water held by the soil between these two limits is called plant available water. These two limits are often associated with water content values at specific soil water potentials, (a measure of pressure at soil water is extracted). Field capacity is often taken as the water content of a soil at -33 kPa water potential. Permanent wilt is taken as the water content at -1500 kPa. The methods typically used to determine plant available water are slow and inaccurate. We present here (1) a method for measuring field capacity using a tensiometer and an extrapolation technique, and (2) a method for measuring permanent wilting water content with a dew point potentiometer and an extrapolation method which are

much faster and more accurate than traditional methods.

### Prevention and rehabilitation of degraded land to achieve sustainable agriculture

By Patcharin Jankong

SWMCN Laboratory Seibersdorf, Joint FAO/IAEA Division

Patcharin Jankong joined the Soil and Water Management & Crop Nutrition (SWMCN) Subprogramme in June 2009 as an intern from Thailand. She is currently receiving training and provides technical support in the use of Fallout Radionuclides (FRNs) to assess soil erosion and sedimentation rates in agricultural catchments.

#### ABSTRACT

Rapid population growth and the challenge of food security combined with burgeoning urban development have put multiple pressures on land and water resources. Worldwide soil degradation is currently estimated at 1.9 billion hectares and is increasing at a rate of 5 to 7 million hectares each year. Once land resources are degraded, rehabilitation usually requires a long-term effort and is often expensive. To mitigate land and soil degradation, effective soil conservation and suitable rehabilitation practices are required and should be chosen according to the levels and causes of soil degradation. The basic principles of soil conservation and management for preventing land degradation are: (i) to control soil erosion by practices such as terracing, reduced tillage in combination with mulching, intercropping or grass strips, (ii) to improve soil fertility through organic and inorganic fertilizers, and (iii) to prevent accumulation of harmful substances.

Natural rehabilitation of degraded land can be a practical and low-cost alternative. For example, soil stabilization through vegetative measures has been used to control wind and water erosion and simultaneously improve soil health by increasing soil organic matter and nutrient availability. Nevertheless, if land has been degraded by mining and/or contaminated by heavy metals or organic pollutants, the surrounding farmlands can also be affected through surface runoff from the contaminated site, thereby rendering them unfit for cultivation. In this case, phytoremediation technologies, defined as the use of plants and trees to remove, immobilize, transform or degrade contaminants in polluted soil or water, in combination with for instance constructed wetlands and/or microbial interactions can be used to remediate polluted land as well as to prevent contami-

nation of farmlands. Therefore both on-farm management and off-site remediation are important to protect and improve agricultural land resources, hence improve crop productivity and environmental quality.

During this seminar, case studies using some of the techniques mentioned above to prevent and rehabilitate degraded land were presented.

# Technical Cooperation Projects

## Operational Projects and Technical Officers responsible for implementation

Project Number	Title	Technical Officer
AFG5003	Sustainable Increase in Crop Production in Afghanistan	Nguyen, Minh-Long in collaboration with the Plant Breeding and Genetics Section
ALG5021	Optimizing Irrigation Systems and Surface Water Management	Heng, Lee Kheng
ALG5022	Nuclear Techniques for Sustainable Use of Saline Groundwater and Wastelands for Plant Production	Heng, Lee Kheng
ANG5005	Effect of Biofertilizer and Inorganic Fertilizer Uses on the Growth and Yield of Maize and Bean in Ferralitic Soils of Huambo	Hardarson, Gudni
BEN5005	Improving Maize and Yam-Based Cropping Systems and Soil Fertility	Adu-Gyamfi, Joseph Jackson
BGD5026	Increasing Agricultural Production in the Coastal Area through Improved Crop, Water and Soil Management	Adu-Gyamfi, Joseph Jackson in collaboration with the Plant Breeding and Genetics Section
BKF5007	Improving Voandzou and Sesame Based Cropping Systems Through the Use of Integrated Isotopic and Nuclear Techniques	Sakadevan, Karuppan in collaboration with the Plant Breeding and Genetics Section
CHI5048	Integrated Watershed Management for the Sustainability of Agricultural Lands	Mabit, Lionel in collaboration with the Food and Environmental Protection Section
CMR5016	Development of N and P fertilizer management for Sustainable Intensification of Agricultural Production in Cameroon	Heng, Lee Kheng
ECU5024	Improving Productivity of the African Palm through Better Fertilization and Water Management Practices	Dercon, Gerd
ECU5026	Improving the Efficiency of Irrigation in the Rio Chota Sub-Basin	Sakadevan, Karuppan
ELS8009	Study of Sedimentation in the Reservoirs of the Four CEL Hydroelectric Power Stations	Dercon, Gerd
ERI5004	Improving Crop Productivity and Combating Desertification	Adu-Gyamfi, Joseph Jackson/ Nguyen, Minh-Long in collaboration with the Plant Breeding and Genetics Section
HAI5003	Enhancing Crop Productivity through the Application of Isotope Nuclear Techniques	Sakadevan, Karuppan in collaboration with the Food and Environmental Protection Section
INS5035	Application of Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands	Dercon, Gerd in collaboration with the Plant Breeding and Genetics Section
INS5037	Applying Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands	Sakadevan, Karuppan in collaboration with the Plant Breeding and Genetics Section
IRQ5017	Optimization of Land Productivity through the Application of Nuclear Techniques and Combined Technologies	Nguyen, Minh-Long in collaboration with the Plant Breeding and Genetics Section
IVC5031	Improving Plantain and Cassava Yields through the Use of Legume Cover Crops	Hardarson, Gudni
KEN5030	Assessing Nutrient and Moisture Use in Major Cropping Systems	Heng, Lee Kheng

<b>Project Number</b>	<b>Title</b>	<b>Technical Officer</b>
MAG5014	Use of Environmental Radioisotopes for the Assessment of Soil Erosion and Sedimentation and for Supporting Land Management in the Province of Antananarivo, Madagascar	Mabit, Lionel
MAG5015	Optimization of Phosphate Fertilization of Ferralsols (classically deeply weathered red or yellow soils found in humid east Madagascar) in the Highland Areas of Madagascar	Nguyen, Minh-Long Dercon, Gerd
MAR5017	Investigating the N Dynamics in the Crop-Soil System of a Multiple Cropping System to Optimize Fertilizer Use	Nguyen, Minh-Long
MLI5021	Sustainable Intensification and Diversification of Sorghum Production Systems in the Southern Zone of Mali, Phase-1	Heng, Lee Kheng
MLI5022	Assessment of Erosion and Sedimentation in the Niger Watershed with the Use of Radioisotopes, Phase-1	Mabit, Lionel
MLW4002	Supporting Capacity Building in Nuclear Science and Technology	Heng, Lee Kheng
MON5015	Implementation of the Fallout Radionuclide Technique for Erosion Measurement	Dercon, Gerd
MOZ5003	Sustaining the Management of Soil Fertility	Dercon, Gerd
NAM5009	Using Mutation Breeding and Integrated Soil Plant Management Techniques to Develop Sustainable, High Yielding and Drought Resistant Crops	Heng, Lee Kheng in collaboration with the 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
QAT5002	Developing Biosaline Agriculture in Salt-affected Areas in Qatar	Nguyen, Minh-Long in collaboration with the Plant Breeding and Genetics Section
RAF5058	Enhancing the Productivity of High Value Crops and Income Generation with Small-Scale Irrigation Technologies	Heng, Lee Kheng
RLA5051	Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems (ARCAL C)	Dercon, Gerd in collaboration with Terrestrial Environment Laboratory (Chemistry Unit)
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 the Food and Environmental Protection Section
SAU5003	Improving Fertilization under Saline Conditions for Sustainable Crop Production	Nguyen, Minh-Long in collaboration with the Plant Breeding and Genetics Section
SEN5030	Integrated Approach to Develop Sustainable Agriculture in Senegal	Dercon, Gerd in collaboration with the Plant Breeding and Genetics Section
SEY5004	Developing Improved Nutrient Management Practices Using Nuclear and Related Techniques for Enhancing Sustainable Agricultural Productivity	Heng, Lee Kheng
SIL5008	Contribution of Nitrogen Fixing Legumes to Soil Fertility in Rice-based Cropping Systems	Hardarson, Gudni
SIL5012	Managing Irrigation Water for a Dry Season Sorghum/Legume Intercropping System for Income Generation and Soil Health	Adu-Gyamfi, Joseph Jackson
SRL5040	Study on Nitrogen Balance in Coconut-Based Agroforestry Systems Using Nitrogen-15 Isotope Dilution Technique	Hardarson, Gudni



<b>Project Number</b>	<b>Title</b>	<b>Technical Officer</b>
SUD5030	Increasing Productivity of Selected Crops Using Nuclear Related Techniques	Adu-Gyamfi, Joseph Jackson in collaboration with the Plant Breeding and Genetics Section
TAD5005	Developing Soil Conservation Strategies for Improved Soil Health	Dercon, Gerd
ZAI5017	Use of Isotope Techniques in Relation with the Nitrogen Dynamic and the Quality of Organic Plant Material in Agricultural Soil Management	Nguyen, Minh-Long/Dercon, Gerd
ZAM5026	Improving Crop Varieties Through Use of Nuclear Techniques	Heng, Lee Kheng in collaboration with the Plant Breeding and Genetics Section
ZIM5011	Combating Desertification in Agricultural Drylands	Heng, Lee Kheng
ZIM5014	Developing and Promoting Strategies for Improved Crop Production	Heng, Lee Kheng

# Forthcoming Events

## FAO/IAEA Events

**Second Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) on 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) 27 September – 1 October 2010, Rabat, Morocco**

*Scientific Secretaries: Gerd Dercon and Minh-Long Nguyen*

Participants from thirteen countries (eight research contract holders, four technical contract holders and three agreement holders) are expected to participate in this RCM. Mr. Moncef Benmansour from the Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN), Morocco, will be the local organizer. The participants will report on the major results and conclusions of their research since the start of the project in June 2009. The data presented will be discussed in line with the objectives of the project. The individual experimental plans of the research and technical contract holders will be reviewed and adjustments made where needed. Experimental and sampling protocols for identifying hot spot areas of land degradation in agricultural catchments requiring effective soil conservation measures (precision conservation) will be discussed and further developed.

**Third Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) on Managing Irrigation Water to Enhance Crop Productivity under Water-Limiting Conditions: a Role for Isotopic Techniques (D1.20.09), 6–10 December 2010, Hanoi, Vietnam**

*Scientific Secretaries: LeeHeng and Minh-Long Nguyen*

Eight contract holders, one technical contract holder and three agreement holders are expected to participate in this RCM in Vietnam. Drs. Hai Sinh Duong and Nhan Dang from the Institute for Nuclear Science and Technology at the Vietnam Atomic Energy Commission in Hanoi will be the local organizers. The main objective of the third RCM is to review research results obtained during the reporting period in accordance with the project workplan to assess overall progress in the implementation of the CRP and to draw up an activity plan for completion of the project, in particular formulating strategies for summarizing, publishing and disseminating the results.

**Third Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) Selection and Evaluation of Food (Cereal and Legume) Crop Genotypes Tolerant to Low Nitrogen and Phosphorus Soils Through the Use of Isotopic and Nuclear related Techniques (D1.50.10) 23-27 August 2010, Maputo, Mozambique**

*Scientific Secretaries: Joseph Adu-Gyamfi and Gerd Dercon*

Nine contract holders, one technical contract holder and five agreement holders are expected to participate in this RCM in Mozambique. Mr Miguel Magalhalles from the Agricultural Research Institute of Mozambique will be the local organizer. Participants will present the major results, conclusions and outputs of their research work since the 2nd RCM which was held in Mexico in April 2008. The results presented will be discussed in line with the final project outputs.

## Non-FAO/IAEA Meetings

- 19th World Congress of Soil Science. Soil Solutions for a Changing World. Dates: 1–6 August 2010. Place: Brisbane, Australia. Website: <http://www.19wcss.org.au/index.html>
- 5th International Nitrogen Conference on: N2010 Reactive Nitrogen Management for Sustainable Development - Science, Technology and Policy. 5th International Nitrogen Conference, 3 -7 December 2010, New Delhi, India. The N2010 Conference is organized by Indian Nitrogen Group and International Nitrogen Initiative. The International Nitrogen Initiative is a global effort to optimize nitrogen's beneficial role in sustainable food production and to minimize nitrogen's negative effects on human health and the environment. The themes of the N2010 Conference include food security, energy security/industry, human health & environmental degradation, ecosystem health and biodiversity, climate change and integration. Additional information on the conference themes and registration is available at: <http://www.n2010.org/>
- International symposium "Sustainable Land Use and Rural Development in Mountainous Regions of Southeast Asia. 21-23 July 2010, Hanoi, Vietnam Website: <https://www.uni-hohenheim.de/sfb564/uplands2010/> This symposium is organized by the Collaborative Research Centre "The Uplands Program" SFB 564, Hohenheim University (Germany) and Hanoi University of Agriculture (Vietnam). The objective of

this symposium is to bring together scholars and practitioners so that they can share innovative methods of studying upland development, present multidisciplinary and integrated research outcomes, and discuss successful policy measures and development approaches which focus on balanced resource use, natural resource conservation and poverty reduction in tropical and subtropical upland agro-ecosystems.

- XIth ESA Congress Agro2010 Montpellier. The International Scientific Week Around Agronomy. 29 August to 3 September 2010, Montpellier, France.

Website: <http://www.agropolis.fr/agro2010>

This event is organized by the European Society of Agronomy. The objective is demonstrate the scientific coherence of Agronomy as a science; work with other disciplines on the definition of new frontiers in interdisciplinary research; make a scientific contribution to the burning questions of 2010 with regards to agriculture and its contribution to sustainable development and natural resource management; discuss with farm advisors, technical institutes, stakeholders and decision makers how Agronomic Research can be made more operational to contribute to sustainable development; and attract more students and young scientists to work on the type of questions and with the type of approaches we develop in our research.

- Global Forum on Salinization and Climate Change. 25 to 29 October 2010, Valencia, Spain.

Website: <http://www.uv.es/jorba/GFSCC2010>

The Food and Agriculture Organization of the United Nations, International Atomic Energy Agency and the Universidad de Valencia, together with several sponsors are convening this global forum. The Forum will be hosted by the Universidad

de Valencia and Spanish authorities in Valencia. The Forum will constitute an opportunity to discuss, from a multi-disciplinary perspective, the problems associated with salinization and climate change and will strengthen the dialogue between policy makers, scientists and field experts. We are calling for soil, water, agriculture and biodiversity experts and institutions, environment and agriculture ministries, private sector and regional and international organizations dealing with salinization or climate change.

The forum will have a mixed format: the scientific basis for different thematic areas will be presented and discussed during the mornings, while there will be time for economic and policy considerations during the afternoons, providing opportunities for interaction between policy makers, scientists and field experts.

- 15th World Fertilizer Congress of the International Scientific Centre for Fertilizers (CIEC).

Meeting the Fertilizer Demand on a Changing Globe: Biofuels, Climate Change & Contaminants. 29 August to 2 September 2010, Bucharest, Romania.

Website: <http://www.icpa.ro/ciec/index.htm>

The 15th World Fertilizer Congress, jointly organized by CIEC and Romanian Academy of Agricultural and Forestry Sciences (AAFS) will provide a forum to exchange the latest detailed information and achievements on fertilizer research, development, production and application since the 14th World Fertilizer Congress of CIEC (Chiang Mai, Thailand, January 2006), and will also fully discuss future developments.

# Past Events

## FAO/IAEA Events

### World Water Day

*Technical Officers: Long Nguyen, Lee Heng and Joseph Adu-Gyamfi*

The World Water Day (WWD) is observed annually on 22 March. This year's theme is 'Clean Water for a Healthy World'. The goal is to raise the profile of water quality at a political level so that water quality considerations are made alongside those of water quantity. The Soils Subprogramme contributed a series of articles, audios, videos and photo essays as part of the event (see the links below):

<http://www.iaea.org/NewsCenter/News/2010/dripirrigation.html>

<http://www.iaea.org/NewsCenter/News/2010/morewater.html>

<http://www.iaea.org/NewsCenter/Multimedia/PhotoEssays/DripIrrigation/index.html>

### **Second Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) on Strategic Placement and Area-Wide Evaluation of Water Conservation Zones in Agricultural Catchments for Biomass Production, Water Quality and Food Security (D1.20.10) 10-14 May 2010, Tartu, Estonia**

*Technical Officers: Karuppan Sakadevan and Lee Heng*

Participants from twelve countries (eight research contract holders, two technical contract holders and two agreement holders) have attended this RCM. Mr. Ulo Mander from the Institute of Ecology and Earth Sciences, University of Tartu was the local organiser for this Meeting. The participants presented the major results and outputs of their research since the start of the project in December 2008. The data collected as part of the individual projects has been discussed. The work plan for the next 18 months has been reviewed to identify critical gaps between the CRP objectives and the individual project objectives. A readjustment to the work plan was suggested and agreed to by the participants. The impending mid-term review for the CRP was also discussed.

### **General Assembly of the European Geosciences Union, 2-7 May 2010, Vienna, Austria**

*Technical Officers: Lionel Mabit and Patcharin Jankong (SWMCN Laboratory)*

This year, the General Assembly of the European Geosciences Union (EGU) took place in Vienna, from 2 - 7 May 2010. During this meeting, the SWMCN

Laboratory provided an update of the R&D investigation in the field of fallout radionuclides (FRNs).

The following four presentations were made at the EGU meeting: (i) recent development on FRN research activities ( $^{137}\text{Cs}$ ) carried out in collaboration with the Department of Agronomy, Biotechnical Faculty, Ljubljana University, Slovenia, (ii) the potential for using radionuclide techniques in Africa to assess the impact of major land use on soil erosion and the effectiveness of specific soil conservation technologies to control this erosion, (iii) the joint use of  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}$  and geostatistical approaches to establish sediment budgets in Morocco through collaboration with the Centre National de l'Énergie, des Sciences et des Techniques Nucléaires (CNESTEN), Rabat, Morocco, and (iv) radiological survey in an abandoned uranium mining area in Madagascar implemented in the framework of a past TCP (MAG7/002) and the current TCP (MAG5/014) by the local team of the Institut National des Sciences et Techniques Nucléaires (INSTN), Antananarivo, Madagascar.

## Duty Travel

### **Cuba for Regional TC project RLA/5/051 on Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems**

*Technical Officer: Gerd Dercon*

In the context of the regional project RLA/5/051, started in May 2009, Mr. Gerd Dercon participated in the first Regional Training Course on "the Use of Fallout Radionuclides (FRN) for Estimating Soil Erosion and Assessing the Effectiveness of Soil Conservation Measures". This course was conducted in La Habana, Cuba, from 16 to 27 November 2009 to provide basic knowledge and skills to participants on the use of Fallout Radionuclide (Caesium-137, Lead-210 and Beryllium-7) techniques.

The course focussed on soil sampling strategies and techniques in the first week, and the use of gamma spectroscopy and basic data interpretation of FRN datasets in the second week, and was targeted at participants with an academic background equivalent to a Bachelor's degree in soil science, environmental chemistry, agricultural or related sciences, and with experience in soil erosion or land degradation studies. The participants were all directly involved in the RLA/5/051 project activities. In total there were 21 participants in the training course, which came from the following countries: Argentina, Bolivia, Brazil, Chile,

Cuba, El Salvador, Haiti, Mexico, Nicaragua, Peru, the Dominican Republic, Uruguay and Venezuela.

The regional Technical Cooperation project RLA/5/051 aims to enhance soil conservation and environmental protection in Latin American, Caribbean and Antarctic environments in order to ensure sustainable agricultural production and reduce the on and off-site impacts of land degradation. The expected outcome of this project is to enhance the regional capacity for sound assessment of land degradation and developing improved national and regional policies. Soil redistribution rates will be determined through the measurement of fallout radionuclide inventories to assess erosion/sedimentation rates and the effect of human intervention on soil ecosystems in selected areas of 14 countries in the region (Argentina, Bolivia, Brazil, Chile, Cuba, El Salvador, Haiti, Jamaica, Mexico, Nicaragua, Peru, the Dominican Republic, Uruguay and Venezuela).



*Participants of the first training course of the regional project RLA/5/051 on the use of radionuclides for assessing land degradation.*

**Haiti to review progress and develop a 2010 and 2011 project work plan for TC project HAI/5/003 on Enhancing Crop Productivity through the Application of Isotopic and Nuclear Techniques.**

*Technical Officer: Karuppan Sakadevan*

The TC project HAI/5/003 aims to enhance N use efficiency in cropping systems through reducing fertilizer N losses and improving N input to soil through biological nitrogen fixation. The expected outcomes of the project should result in a substantial increase in food production and provide greater protection for the environment. In the context of this national project, Mr Karuppan Sakadevan visited Port-au-Prince to review project progress, to identify human resource, infrastructure, potential field study sites and procurement requirements, and to develop a detailed work plan for 2010 and 2011.

In consultation with national counterparts, the following activities were prioritised: (1) enhancing biological nitrogen fixation to improve soil fertility in upland cropping systems, (2) improving water use efficiency in rice cropping, and (3) developing the opportunity for collaborative work with FAO, IAEA, UNDP, IDB (Interamerican Development Bank) and USAID. During these consultations it was emphasized that IAEA's technical support is required in the following three key areas: (1) to establish soil fertility status for different agro-ecological zones in the Artibonite Valley, the main agricultural production area, (2) to improve soil N fertility in the uplands of this area, and (3) to improve irrigation water management under rice cropping.

It is with regret that we inform our readers that in January 2010, a powerful earthquake struck Port-au-Prince and killed thousands of people. A number of UN staff and colleagues from the FAO country office were also killed. In the context of this devastation, the IAEA is currently reviewing all Technical Cooperation Projects in Haiti to prioritise which human resource and capacity building activities are most urgently required to improve food security.



*Participants at the HAI/5/003 project progress meeting.*

**Brazil to attend the first coordination meeting of the Technical Cooperation project RLA/5/052 on Improving Soil Fertility and Crop Management for Sustainable Food Security and Enhanced Income of Resource-Poor Farmers**

*Technical Officer: Karuppan Sakadevan*

This Technical Cooperation project was approved by IAEA for implementation in 2010 and in the context of this project Mr Karuppan Sakadevan travelled to Piracicaba, Sao Paulo, Brazil to the first coordination meeting from 1 to 5 March 2010. The meeting was held at the University of Sao Paulo, Piracicaba. The objective of the meeting was to discuss the details for project activities and implementation strategies to improve technical capabilities, including the development of human resources through training and the enhancement of laboratory facilities in the region.

The meeting was attended by representatives of the academic, nuclear, agricultural and environmental sectors from the following countries: Argentina, Bolivia, Brazil, Cuba, the Dominican Republic, El Salvador, Venezuela, Mexico and the International Atomic Energy Agency (IAEA). At the conclusion of the coordination meeting, participants reviewed the project work plan for 3 years from 2010-2012 as well as its target outputs and strategies for implementation.

During the meeting, challenges for improving crop production in small farm holdings in Latin America and the Caribbean were reviewed and discussed, and programmes to address such challenges were proposed. The participants visited three small farms to learn how they are managed, in particular how they enhance soil fertility through the use of inorganic and organic fertilizers, cover crops and crop rotation. These three farms comprised: (1) a mixed dairy and sugarcane farm, (2) a sugarcane farm with potential use for ethanol production, and (3) an organic farm specialize in vegetable production. At all three farms the farmers provided useful information to the participants on managing nutrients for crop productivity. The role of agricultural extension services in farm management, including field demonstrations of soil and nutrient management, farmers' involvement in farm management decision making, and the use of new technologies for improving crop productivity was reiterated



*Participants at the first coordination meeting of RLA/5/052.*

**Switzerland to study neutron radiography (NR) techniques for in-situ quantification of root development and architecture, and in-situ measurements of soil water content.**

*Technical officers: Josef Adu-Gyamfi and Sasa Linic*

Neutron Radiography (NR) is a non-destructive technique used to measure in-situ root development in soils

and to quantify soil water content. Mr Joseph Adu-Gyamfi and Mr Sasa Linic undertook a scientific visit to the Institute for Terrestrial Ecosystems, Swiss Federal Institute of Technology, Eidgenössische Technische Hochschule, ETH, Zurich, Switzerland from 16 to 18 February 2010 to learn more about the new technique and to explore possible collaboration with the Institute.

Prof Schulin and his team (Mr Bernd Felderer and Mr Rees Rainer), met Mr Adu-Gyamfi and Mr Linic to discuss the objectives of the two-day visit and to explore future collaboration between the Institute for Terrestrial Ecosystems and the Soil and Water Management and Crop Nutrition Laboratory (SWMCNL). Prof Schulin outlined some of the current research activities at the Institute which include: (i) biofortification of zinc in wheat by improving bioavailability and uptake efficiency, (ii) environmental monitoring and management strategies for remediation of contaminated soils and (iii) the use of Neutron Radiography as a non-destructive method to study in-situ root development, and to quantify the water content in the rhizosphere.

Mr Adu-Gyamfi discussed with Prof Schulin and his ETH team about some of the on-going activities at the SWMCNL, and the possibility for future collaboration with ETH on the use of (i) Neutron Radiography (NR), to quantify soil water content in the rhizosphere and (ii) zinc and boron isotopes to understand the mechanisms of bioavailability and the uptake efficiency of these trace elements by crops. Prof Schulin stressed that NR has been used successfully to study the dynamics of root development and architecture in soybeans, wheat and rice and future research will seek to validate the methodology in different soil types, with a range of soil moisture regimes. Mr Adu-Gyamfi and Mr Linic, accompanied by Mr Felderer, travelled about 38 km to the Paul Scherrer Institute (PSI), a multi-disciplinary research centre where the neutron imaging facility is located. Mr Peter Vontobel guided us on a tour of the facility and explained the principles of operation, methods and detectors and their applications in root research. We were later briefed on the advantage of the NR compared to X-ray methodology when studying in-situ root development and root architecture in crops.

The SWMCN Subprogramme should explore the possibilities for collaboration with the Institute, in the use of neutron radiography for in-situ quantification of root development and architecture, and in-situ measurements of soil water content. Future collaboration on the use of zinc and boron isotopes to quantify crop uptake and use efficiency were also discussed with Prof. Schulin.

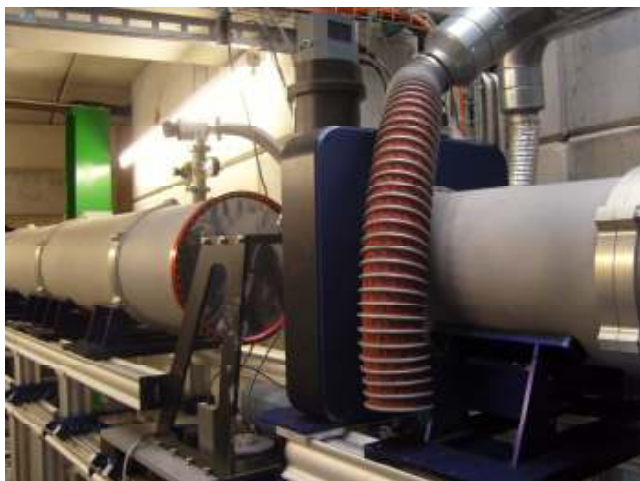


Photo 1 (a) The cold-neutron imaging set-up for studying in-situ root development.

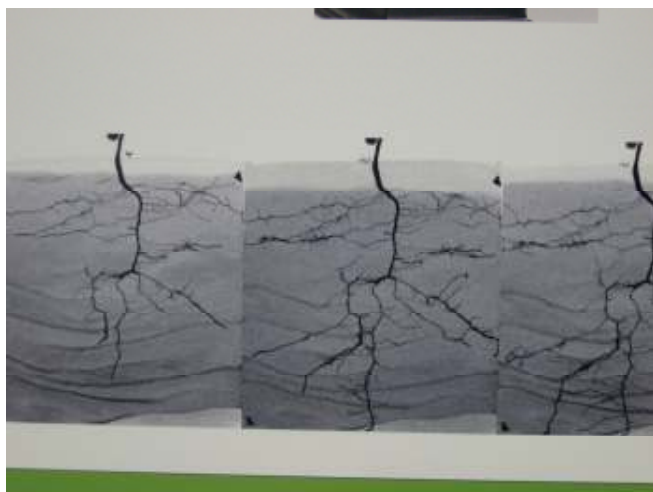


Photo 1 (b) Neutron radiograph of roots in Aluminium containers.

### **Austria, Petzenkirchen to learn more about ongoing activities on land and water management and explore opportunities for future collaboration**

*Technical Officers: Josef Adu-Gyamfi and Sasa Linic*

Mr Joseph Adu-Gyamfi and Mr Sasa Linic travelled to Petzenkirchen (Institute for Land and Water Management Research, Federal Agency for Water Management, Austria) on 12 March 2010. Mr Adu-Gyamfi briefed Dr Peter Strauss and Mr Franz Feichtinger the purpose of the visit. Dr Strauss and Mr Feichtinger stressed that the main focus of the Institute is to do research at both the field and area-wide scale on the management of soil and agricultural water. The three main sub-programme activities are (i) watershed management (ii) quantification of groundwater recharge in relation to management and (iii) quantification of nutrient fluxes and soil pollutants (nitrogen and phosphorus) to groundwater and surface water. Dr Strauss highlighted on a new on-line system to monitor nutrient and water fluxes in the fields in the Eastern and Upper Austria where soil water dynamics is monitored through the

internet system. It was further explained that the Institute develops models for water and nitrogen dynamics in unsaturated soils.

The possibility of using stable isotopes of nitrogen ( $^{15}\text{N}$ , and  $^{18}\text{O}$ ) to help understand water and nutrient dynamics and to trace the source and pathways of nitrate into drainages was discussed. Dr Strauss remarked that collaboration with the Soil Water Management and Crop Nutrition Section (SWMCN) on the use of stable isotopes to better understand the water and N fluxes will be very fruitful. Mr Adu-Gyamfi explained that the visit is a fact finding mission and that the outcome of the visit will be discussed with Mr Nguyen, Section Head, SWMCN Subprogramme. A request to bring trainee fellows from SWMCN Laboratory for a scientific visit to the institute was accepted. It was agreed that the subprogramme explore possibilities for collaboration with the institute in the area of the use of nuclear and isotopic techniques to monitor water and nutrient dynamics in agro-ecosystems at area-wide scale

## **Non FAO/IAEA Events**

### **Visitors**

- Dr. Ren Wang, Director CGIAR Secretariat (CGIAR, Consultative Group on International Agriculture Research) visited the NAFA Programme and presented two seminars on the CGIAR reform, one at the IAEA Headquarters and one in Seibersdorf Agriculture Biotechnology Laboratories. The meetings were useful in identifying opportunities between the SWMCN Subprogramme and the CGIAR.
- Dr. Jose Luis Peralta Vital, Centro de Protección e Higiene de las Radiaciones, Cuba, 17 March 2010, to discuss potential collaboration with the SWMCN subprogramme and plan activities in the context of the Regional Project RLA/5/051 on Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems.
- Dr. Reinaldo Honorio Gil Castillo, Centro de Protección e Higiene de las Radiaciones, Cuba, 14 April 2010, to discuss capacity building in the context of the Regional Project RLA/5/051 on Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems.
- Mr Kalaluka L Munyinda from Zambia visited the SWMCN Section as a part of the his visit to both the Plant Breeding and Genetics and the Soil Water Management and Crop Nutrition Laboratories 8-15 April 2010) to acquire further information on "*Developments and trends*

*in screening and analysis of mutants for biotic and abiotic stress using molecular markers and carbon isotope discrimination".*

- Mr. Samuel Bodé, Mr. Dries Roobroeck and Mrs. Dongmei Xue from the Department of Applied Analytical and Physical Chemistry, Faculty of Bioscience Engineering, Ghent University (Belgium) visited the SWMCN Subprogramme on 4 May 2010 to discuss the preliminary results on the Use of the Stable Isotopic Signals of Amino Sugars as Tracers for Soil Organic Matter Translocations from Critical Land Degradation Areas, which is linked to the 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.
- Prof. W. Blum of the University of Natural Resources and Applied Life Sciences (BOKU University, Vienna, Austria) visited the SWMCN Section on 5 May to discuss joint collaboration.
- Prof. Dr. Jan Diels, Department of Earth and Environmental Sciences, K.U. Leuven, Belgium, 5 May 2010, to explore potential collaboration with the SWMCN subprogramme.
- Professor Dr. Mikhail Makarov, Faculty of Pedology, Lomonosov Moscow State University, Russia, 5 May 2010, to discuss further involvement in helping Tajikistan use isotopic techniques for improving soil quality.
- Gaylon S. Campbell, Senior Scientist, Decagon Devices, Inc., Pullman, WA, USA, 4 May 2010 and presented a seminar on "Quick Method for Determining, Plant Available Water" which was jointly hosted by SWMCN and BOKU University.
- Dr. Luca Montanarella of the European Commission - DG JRC (Joint Research Centre, Italy) visited the SWMCN Section on 5 May to discuss potential collaboration.
- Mr. Boubacar Traore from Institute d'Economie Rurale (IER) 26-29 April 2010, to finalize results relating to MLI/5/021 TC project on Sustainable Intensification and Diversification of Sorghum Production Systems in the Southern Zone of Mali and to discuss future project planning.
- Dr. Peter Cepuder and Dr. Gernot Bodner from BOKU University, Vienna on 10 May 2010 to attend a seminar and discuss potential collaboration with SWMCN.
- Dr. Pasquale Steduto, Service Chief, Natural Resource Land and Water, FAO, 10-14 May

2010, attended a consultants meeting with Plant Breeding Section and visited the SWMCN Section to discuss progress on AquaCrop model development which the Section is involved.



# Status of Coordinated Research Projects (CRPs)

## 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: Gerd Dercon and Minh-Long Nguyen*

The first RCM was successfully held at IAEA headquarters in Vienna from 8 - 12 June 2009. As agreed in the RCM, the first draft of a harmonized protocol for the application of CSSI techniques on a catchment scale in a range of environments and land use systems was developed and sent to the CRP participants in October for further testing.

The objective of the CRP is to develop integrated isotopic approaches to identify hot spot areas of land degradation in agricultural catchments for effective soil conservation measures (precision conservation). Specific research objectives are: (i) to use the FRN with conventional techniques and spatial analysis to establish soil redistribution patterns and rates over several temporal scales on an area-wide basis (catchment), (ii) to develop and validate protocols for the application of compound specific stable isotope (CSSI) techniques to identify sources of pollution (eg. cropland, grassland and forestland) in the catchment, (iii) to 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) to develop decision support tools for implementing precision conservation and contributing to sustainable land management.

The expected outputs from this CRP include:

1. Better understanding of the land use/management impacts on soil redistribution and the location of hot spot diffuse pollution areas on an area-wide scale.
2. Enhanced capacity in Member States to conduct applied research on comprehensive soil redistribution studies with the aid of nuclear and related techniques.
3. Validated methods for establishing soil redistribution patterns and rates over several temporal scales on an area-wide basis (catchment) using FRNs.
4. Harmonized protocols for the application of CSSI techniques on a catchment scale in a range of environments and land use systems.
5. Development of models and other approaches for the integrated application of FRNs and CSSI techniques to establish comprehensive soil redistribution studies in the catchment, including the identification of soil sources and hot spot diffuse pollution areas.

There are eight research contract holders (Chile, China (two), Morocco, Poland, the Russian Federation, the Syrian Arab Republic and Vietnam), three technical contract holders (Germany, New Zealand and the United Kingdom) and three agreement holders (Australia, Canada and the United Kingdom).

The second RCM will be held at the *Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN)*, Morocco, from 27 September to 1 October 2010.

## Conservation measures for sustainable watershed management using fallout radionuclides (D1.50.08)

*Technical Officer: Gerd Dercon*

All nineteen manuscripts prepared as part of this project have been edited by Gerd Dercon for the production of an IAEA-TECDOC. They have also been reviewed by an independent reviewer (Gary Hancock). It is expected that the IAEA-TECDOC will be published shortly.

The overall objective of this CRP was to develop diagnostic tools for assessing soil erosion and sedimentation processes and effective soil conservation measures for sustainable watershed management. In this context, the participants developed fallout radionuclide methodologies with particular emphasis on the combined use of  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}$  and  $^7\text{Be}$  for measuring soil erosion and sedimentation over several spatial and temporal scales.

A wealth of information on soil redistribution and the effectiveness of soil conservation has been generated by the CRP using several fallout radionuclides and conventional techniques in a wide range of environments. In total, over 150 scientific papers (peer-reviewed journals) have been published by the CRP participants. Presentations have also been made at national and international scientific meetings.

Eleven contract holders from Brazil, Chile, China (2), Morocco, Pakistan, Poland, Romania, the Russian Federation, Turkey and Vietnam, two technical contractors (Austria and the UK) and five agreement holders (Australia, Canada, Japan, Switzerland and the USA) have participated in this CRP.

The IAEA TECDOC of this CRP has been finalized and will be published soon. Currently all CRP participants are collaborating to summarize the results obtained from this CRP as an overview paper.

### **Integrated Soil, Water and Nutrient Management in Conservation Agriculture (D1.50.09)**

*Technical Officer: Gerd Dercon*

The fourth and final Research Coordination Meeting (RCM) of this CRP was held in October 2009 at IAEA Headquarters in Vienna. This CRP had a total of ten participants comprising seven research contractors from Argentina, Brazil, India, Morocco, Pakistan, Turkey and Uzbekistan, two technical contractors (Australia and Chile) and one agreement holder (CIMMYT-Mexico). In addition, one individual contractor (Mr. Bernard Vanlauwe) conducted research on the evaluation of C and N dynamics in long-term trials in Sub-Saharan Africa focussing on tillage, residue management and rotational effects.

The overall objective of this CRP was to enhance the productivity and sustainability of farming systems through a better understanding of the principles and practice of conservation agriculture. This goal can be achieved through specific objectives, such as quantifying the individual and interactive effects of conservation tillage practices, residue management, crop rotations, nutrient and water inputs to increase soil organic matter, resource use efficiency, agricultural productivity and environmental quality.

The CRP commenced in June 2005 with the first RCM held in Vienna. The second RCM was organized in September 2006 by the team of Mr. Mohammed Ismaeli from Morocco. Mr. Mahmut Basri Halitligil from the Sarayköy Nuclear Research and Training Center was the host of the third RCM in Ankara (Turkey) in April 2008. The CRP has created an interesting database on soil-water-plant relationships in conservation agriculture. New methodologies and research protocols based on isotopic and related techniques were introduced into the research schemes. Integration of the different results from many diverse agro-ecological areas made it possible to gain insights into processes related to conservation agriculture and also supports and assists with the interpretation and explanation of site-specific results. This understanding will help to improve conservation agriculture systems across the world through implementation of projects under IAEA's Technical Cooperation Programme.

The CRP was also linked to several PhD and MSc dissertations and will form the basis for joint group publications at national and regional levels. Manuscripts for the IAEA-TECDOC of this CRP are now under review. The CRP participants have been also collaborating in summarizing the results obtained

from this CRP which will be published as an overview paper for the XI<sup>th</sup> ESA Congress Agro2010 Montpellier to be held in Montpellier, France from 29 August to 3 September 2010.

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

*Technical Officer: Lee Heng and Minh-Long Nguyen*

The overall objective of this CRP is to improve water productivity (production per unit of water input) of crops under water-limiting conditions, and specific objectives are as follows: i) to quantify and develop the means to manage soil evaporative losses to maximise the beneficial use of water through improving the transpiration component of evapotranspiration, ii) to quantify and develop a means of improving the amount of biomass produced per unit of transpiration, and iii) to devise irrigation and related management techniques to enhance the yield component of biomass production (Harvest Index).

This CRP has a total of 12 participants comprising eight research contractors from Malawi, Morocco, China (2 participants), Pakistan, Turkey, Vietnam and Zambia, one technical contractor (Mr. D. Williams, University of Wyoming-Laramie, USA) and three agreement holders (Mr. T. Hsiao, UC Davis; Mr. P. Cepuder, Universität für Bodenkultur, Vienna and Mr. E. Fereres, IAS-CSIC and University of Cordoba, Spain). So far, the Moroccan, Pakistan and Vietnam participants have separately developed innovative air moisture trapping devices to sample air samples in very simple ways and separated E and T from the isotopic signature of <sup>2</sup>H, <sup>18</sup>O using the Keeling Plot approach in wheat fields and coffee plantations respectively. The CRP will undergo a mid-term review in the second half of this year for its extension to five years. The third RCM will be held in Hanoi, Vietnam from 6 to 10 December 2010. The local organizers of that meeting will be Drs. Hai Sinh Duong and Nhan Dang from the Institute for Nuclear Science and Technology at the Vietnam Atomic Energy Commission in Hanoi.

### **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 in the second year of implementation. There are eight contract holders (China, Estonia, the Islamic Republic of Iran, Lesotho, Nigeria, Romania, Tunisia and Uganda), two technical contractors (USA and UK) and two agreement holders (France and USA)

in the CRP. The overall objective is to assess and improve the performance of water conservation zones in agricultural catchments for biomass production, water quality and food security. The specific objectives are: (i) to determine the capacity of wetlands, ponds and riparian zones in agricultural catchments for water conservation, (ii) to assess the nutrient/pollutant attenuation capacity of wetlands, ponds and riparian zones to improve water quality, (iii) to better understand the link between water and nutrient dynamics in wetlands, ponds and riparian zones and biomass production and (iv) to optimize the system of wetlands, ponds and riparian zones for improved water conservation and quality in agricultural catchments.

The CRP started in December 2008 and the first RCM was held at the IAEA Headquarters in Vienna. The participants have submitted progress reports for the first year and contract renewal requests which have been evaluated and renewed. The second RCM was held in Tartu, Estonia from 10 - 14 May 2010 to review project progress and outputs, lessons learnt, identify gaps between output and CRP objectives and future work plans. Professor Ulo Mander was the local coordinator for the RCM. The mid term review for the CRP will be carried out at the beginning of 2011 for its extension to five years. This CRP has been linked to a number of national research projects through which Master and Doctoral students are currently being trained. The third RCM will be held in Jinja, Uganda.

### **Selection and Evaluation of Food (Cereal and Legume) Crop Genotypes Tolerant to Low Nitrogen and Phosphorus Soils Through the Use of Isotopic and Nuclear related Techniques (D1.50.10)**

*Technical Officers: Joseph Adu-Gyamfi and Gerd Dercon*

The CRP is in its fourth year of implementation and is expected to be completed in 2011. Over the next eighteen months the mechanisms at which tolerant genotypes acquire nitrogen (N) and phosphorus (P) from different soil N and P pools, and the long term effects of crops with enhanced N and P on soil

productivity are being investigated. The third RCM will be held in Maputo, Mozambique from 23-27 August 2010 to discuss the work done and results obtained since April 2008. The first RCM was held at the IAEA head quarters in Vienna during 16-20 October 2006. The second RCM was held in Morelia, Mexico during 21-25 April 2008. The project has a total of 16 participants with nine research contract holders (Burkina Faso, Brazil, Cameroon, China, Cuba, Ghana, Malaysia, Mexico, and Mozambique), five agreement holders (Australia, Benin, Kenya, Nigeria, and France) and two technical contractors (Germany and USA). The overall objective of this CRP is to develop integrated crop, soil

and nutrient management practices to increase crop production in marginal lands by identifying and promoting the development of food (cereal and legume) crop genotypes with enhanced nitrogen (N) and phosphorus (P) use efficiency and greater productivity in marginal lands.

To date, 150-200 crop genotypes of rice, maize, soybean and common bean have been successfully tested in 17 countries. Preliminary results indicates that the percentage of roots with a specified branching angle interval could be a suitable selection parameter for soil N use efficiency while adventitious rooting and root hair formation would be suitable plant parameters for selecting P use efficiency.

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

## **Training manual on the use of fallout radionuclides (FRNs) to assess erosion and sedimentation processes**

*Lionel Mabit (SWMCN Laboratory)*

A practical training manual on the use of FRNs ( $^{137}\text{Cs}$ ,  $^7\text{Be}$ , and  $^{210}\text{Pb}$ ) to investigate soil erosion and sedimentation is being written. The objective of this IAEA training course series publication, which includes contributions from IAEA staff and 20 authors from 8 different Member States (Austria, Canada, Chile, Hun-

gary, Morocco, Slovakia, Switzerland and the United Kingdom), is to provide IAEA Member States with the basic training and manuals required to use FRNs. A draft of the training manual was completed at the end of 2009. The final editing and compilation of contributions from individual authors is being carried out during the first half of 2010. The final manual will be ready by the end of 2010 and should be published in 2011. The contents of the manual are provided below:

- Chapter 1.** Assessment of soil erosion and sedimentation: the role of fallout radionuclides.
- Chapter 2.**  $^{137}\text{Cs}$ : a widely used and validated medium-term soil tracer.
- Chapter 3.** The use of excess  $^{210}\text{Pb}$  ( $^{210}\text{Pb}_{\text{ex}}$ ) as a soil tracer.
- Chapter 4.** The use of  $^7\text{Be}$  as a short term soil redistribution tracer: State of the art and guidelines based on existing experience.
- Chapter 5.** Conversion models and related software.
- Chapter 6.** Case studies.
  - 6.1.** Combined use of  $^{137}\text{Cs}$  and  $^{210}\text{Pb}_{\text{ex}}$  to assess long term soil redistribution in a small agricultural field in Morocco.
  - 6.2.** Using  $^7\text{Be}$  and  $^{137}\text{Cs}$  to evaluate soil redistribution in South America – Chile.
  - 6.3.** Soil erosion measurements in a sub-alpine catchment of the Central Swiss Alps –Information gained through isotope analysis.
- Chapter 7.** Trends in the use of  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}_{\text{ex}}$  and  $^7\text{Be}$  to document soil redistribution.

## **An overview of recent activities carried out by an international network using fallout radionuclides to assess soil erosion and sedimentation processes coordinated by the SWMCN Laboratory.**

*Lionel Mabit, Patcharin Jankong, Arsenio Toloza (SWMCN Laboratory)*

In 2010, the SWMCN Laboratory strengthened the existing network and established a new collaboration with Member States on the use of fallout radionuclides as listed and presented below:

**(1) Austria**

The SWMCN Laboratory team, after completing the study on using  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}_{\text{ex}}$  and erosion plot measurements in the Mistelbach watershed (collaboration with BOKU University - Vienna), initiated the field validation of the Fine Soil Increment Collector which was developed in 2008. Depth distribution of  $^7\text{Be}$  in soil and its link to rain events is currently being investigated in agricultural lands.

**(2) Canada**

Estimation of soil movement using residual radio-caesium may overestimate net loss and underestimate net deposition if the selectivity of the erosion process (e.g. on soil texture) is not taken into consideration. To investigate this aspect, an experiment to assess soil erosion was carried out in a glasshouse under controlled conditions using  $^{134}\text{Cs}$ -labelled soil and a rainfall simulator. Analysis of data from the experiment has been initiated in collaboration with Dr. Bernard from the Ministère de l'Agriculture, des Pêcheries et de l'Alimentation du Québec, Québec, Canada (MAPAQ).

**(3) Chile**

With technical support and advice from the SWMCN Laboratory, the local TCP team (CHI/5/048) led by Dr. Nairo from the Chilean Nuclear Energy Commission (CCHEN), The Ministry of Agriculture, through the Agriculture and Livestock Service (SAG) and the Soils Department of the Agronomic Science Faculty, University of Chile has carried out  $^7\text{Be}$  measurements to evaluate short-term erosion rates in the Chilean vineyards of the Apalta catchment. The main results of this preliminary study were disseminated to the wine farmers and the media.

**(4) China**

The SWMCN Laboratory is collaborating with the Institute of Mountain Hazards and Environment, Chinese Academy of Sciences and Ministry of Water Resources, Chengdu, Sichuan, China to assess the sedimentation rate and sediment dating in the central part of the largest Qinghai Lake using  $^{210}\text{Pb}_{\text{ex}}$  and  $^{137}\text{Cs}$ . This provided an opportunity to investigate whether low sedimentation rates could be overestimated by using  $^{137}\text{Cs}$  and  $^{210}\text{Pb}_{\text{ex}}$  classical sedimentation models. This project was led by Prof. Zhang and is supported by the Chinese National Natural Science Foundation.

**(5) Madagascar**

In addition to the on-going technical activities related to the test of  $^{137}\text{Cs}$  as a soil tracer in Madagascar (TCP: MAG/5/014), a survey to assess soil radioactivity background has been finalised for the Vinaninkarena region located in central Madagascar where uranium ore was previously extracted. The main result of the study,

which was initiated within the framework of the national project on '*Assessment of the environmental pollution by multidisciplinary approach*', and the previous TCP MAG/7/002 entitled: '*Effects of air and water pollution on human health*' was presented in May 2010 during the EGU meeting in Vienna.

**(6) Mali**

The SWMCN Laboratory is providing technical support to Mali to evaluate soil erosion and sedimentation in the Niger watershed. Analytical support to ensure the accuracy of FRN measurements carried out by the local team was provided under TCP MLI/5/022. After calibration of their gamma detector which is ready to be installed through MLI/5/022, the local teams which also gained experience from the fellowship training will be able to work with full autonomy on the use of FRNs for soil erosion and sedimentation research in Mali.

**(7) Morocco**

Dr. Benmansour from the Centre National de l'Énergie, des Sciences et des Techniques Nucléaires (CNESTEN), Rabat, Morocco, in collaboration with the SWMCN Laboratory, investigated the combined use of  $^{137}\text{Cs}$ ,  $^{210}\text{Pb}_{\text{ex}}$ , conventional techniques and geostatistical tools to assess soil redistribution and to develop a sediment budget in an agricultural field in Morocco. The main results of this study have been written as a joint paper and presented at the EGU meeting in May 2010.

**(8) Nigeria**

A paper entitled: 'First use of the  $^{137}\text{Cs}$  technique in the derived savanna of Nigeria, West Africa, for estimating medium-term soil redistribution rates' has been submitted by Dr. Junge from the Bundesanstalt für Geowissenschaften und Rohstoffe in Hannover, Germany (previously working for the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria). This paper demonstrates the usefulness of nuclear techniques to improve natural resource management in West Africa. Both SWMCN Laboratory and Section staff were involved in the data analysis and writing of this manuscript.

**(9) Slovenia**

The first objective of the collaborative research project with the Department of Agronomy, Biotechnical Faculty, Ljubljana University, Slovenia, was to establish a reference site and its soil characteristics for the use of FRNs in soil erosion studies in Slovenia. In the agricultural area of Goričko, Eastern Slovenia, an undisturbed forest situated in Šalamenci, a few meters away from a proposed agricultural field research site, was selected to establish the  $^{137}\text{Cs}$  inventory [ $7300 \pm 2500 \text{ Bq m}^{-2}$  ( $n=20$ )] and to establish a baseline level of multi-

elemental fingerprints and naturally occurring radionuclides (NORs) in soils.

This study introduces a new approach to the establishment of NORs and elemental fingerprint baseline levels in a reference site, which can provide comparative data to that collected from neighbouring agricultural fields for the assessment of soil redistribution magnitude using FRN techniques. In addition, this information will also be used to determine the impact of soil erosion processes and agricultural practices on soil quality and redistribution within agricultural landscapes in Slovenia.

The second aim of this joint project is to evaluate the erosion and sedimentation rates in one representative Slovenian agricultural field. Soil sampling has already been carried out by the Slovenian local team led by Dr. Zupanc, and they are being analysed in Seibersdorf by the SWMCN Laboratory team.

#### (10) Syrian Arab Republic

As part of the 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*' and in agreement with the Technical Officer of the CRP, it was decided to support the CRP participant, Dr. Asfary, Department of Agricultural Applications, Atomic Energy Commission of Syria in FRN analyses of soil samples and the interpretation of data.

## A proposal for up-scaling the use of FRNs at the watershed level

Lionel Mabit (SWMCN Laboratory)

Assessing the severity and spatial extent of soil erosion in large areas is not an easy task. Mapping soil movement beyond a field scale is complex. Up scaling the use of FRNs to document soil and sediment redistribution at the watershed or catchment scale is one of the new concepts investigated by the FAO/IAEA Soil Sub-programme through the new CRP D1.20.11.

The study of small areas (a few hectares) with  $^{137}\text{Cs}$  and other FRNs generally involves soil sampling on a more or less regular grid or transect basis along the landscape, however for large watersheds, one or both of the following approaches has to be adopted:

- For a large area with variable annual precipitation, there is a clear need to select additional reference sites to integrate the variability of the initial fallout as closely as possible to the investigated agricultural fields.
- The area under investigation should be subdivided into isosectors (based on topographic, geomorphological, pedological and land use maps) in order to facilitate the sampling strat-

This is one of the main priorities of the SWMCN Laboratory team for FRN analytical and supportive activities in 2010.

#### (11) Tunisia

A new partnership has been established with Dr. Gharbi Foued from the Centre National des Sciences et Technologies Nucléaires (CNSTN), Tunis, Tunisia with the support of the CNESTEN in Morocco. The main goal of this challenging new partnership is to date sediment in the Ichkeul Lake located in North Tunisia (using  $^{137}\text{Cs}$  records) to establish sedimentation rates.

#### (12) Yemen

With the technical support of the SWMCN Laboratory, a joint project led by Dr. Dana Pietsch from the Institute of Geography of Tübingen University in Germany, was started in 2009 to quantify soil degradation caused by erosion in tropical highland terraces in Yemen. A preliminary test in a reference site (top terrace) has been completed. The top terrace was used as a reference site as it has not been affected by other terraces. The background level of  $^{232}\text{Th}$ ,  $^{40}\text{K}$ ,  $^{226}\text{Ra}$ ,  $^{235}\text{U}$ , and  $^{238}\text{U}$  has been established and the initial fallout of  $^{137}\text{Cs}$  has been estimated at  $3435 \pm 1306 \text{ Bq m}^{-2}$  ( $n = 10$ ) confirming the potential use of this radionuclide as a soil tracer in this area to establish soil erosion and sedimentation rates.

egy. The watershed can then be divided into isosectors according to different combinations of parameters or classes that represent more than 90% of the surface of the isosector. Using this approach, forest on flat land can be considered as a stable area with nil soil redistribution budget.

- The next step is to select at least one to three representative agricultural fields for FRN soil sampling in each isosector on a variable grid or multi-transect basis. The information provided by representative fields will be extended to the area of each relevant isosector.

With this new approach, the following information can be obtained:

- (i) The overall production of sediment (net erosion) from each isosector and then from the watershed.
- (ii) The comparison between different isosectors which were identified using GIS (land use, topography, soil texture etc.)

The net erosion of an entire watershed using the isosector and representative field concept can be calculated by the following equation:

$$E_w = \frac{\sum_{i=1}^n S_i E_i}{S_{tot}}$$

Where  $E_w$  = Net erosion for the entire watershed or area in tonnes  $ha^{-1} yr^{-1}$ ,  $n$  = number of isosectors,  $S_{tot}$  = Surface area of the watershed in ha,  $S_i$  = Surface area of the isosector  $i$  in ha, and  $E_i$  = Average net erosion of the representative field(s) of the isosector  $i$  in tonnes  $ha^{-1} yr^{-1}$ .

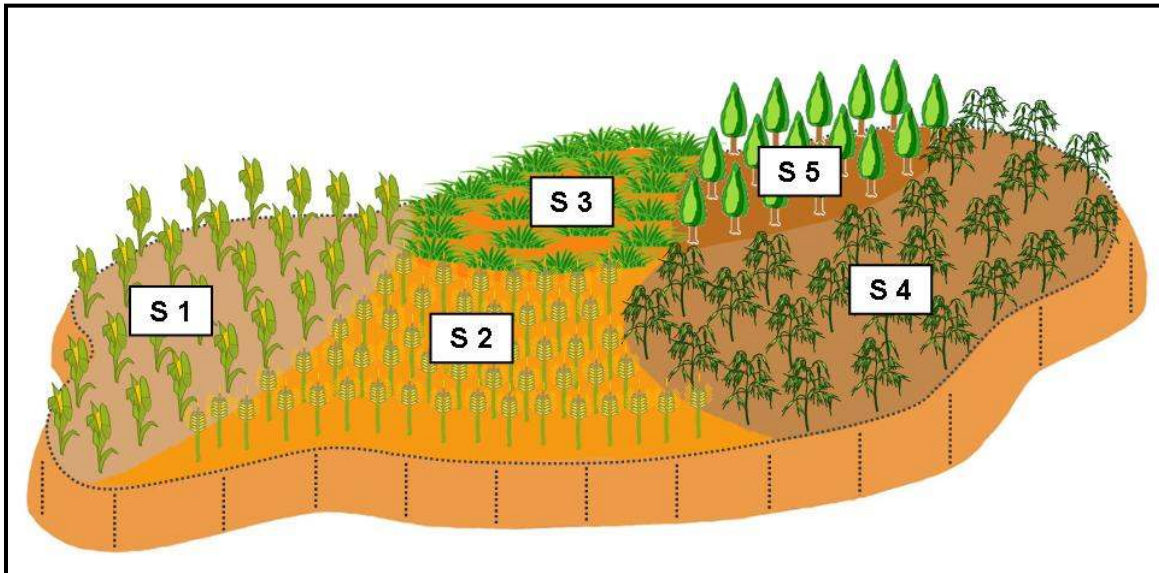


Figure 1 Fictive watershed divided into 5 isosectors based on land use

For the example provided in Figure 1, the  $E_w$  of the catchment divided into 5 different isosectors can be estimated as follows:

$$E_w = [(S_1 \cdot E_1) + (S_2 \cdot E_2) + (S_3 \cdot E_3) + (S_4 \cdot E_4) + (S_5 \cdot E_5)] / (S_{tot})$$

$$S_{tot} = S_1 + S_2 + S_3 + S_4 + S_5$$

It is proposed to use this approach in large watersheds of up to several  $km^2$ .

## Preliminary evaluation of oxygen isotope composition and carbon isotope discrimination for evaluating wheat lines for tolerance to pre- and post-anthesis water stress

Joseph Adu-Gyamfi, Sasa Linic, José Arrillaga and Lee Heng

### Introduction

Identifying wheat genotypes with increased water use efficiency (WUE) and high biomass production in water scarce environment is the ultimate goal of enhancing wheat yields under drought conditions. The two drought scenarios that affect wheat yields are (1) plants were stressed till flowering and thereafter received adequate irrigation (pre-anthesis) and (2) plants received adequate water till flowering and thereafter stressed till maturity (post-anthesis). The carbon isotope discrimination ( $\Delta^{13}\text{C}$ ) technique in plant tissues is increasingly being used as a surrogate of water use efficiency and has emerged as a powerful tool to evaluate  $\text{C}_3$  plants with increased WUE in drought prone environments, examining the balance between net photosynthesis ( $A$ ) and stomatal conductance to water vapour ( $g_s$ )

Although the relationship between  $\Delta^{13}\text{C}$  and water use efficiency is well documented, it has been suggested that the ratios of  $^{18}\text{O}$  to  $^{16}\text{O}$  ( $\delta^{18}\text{O}$ ) varies with transpiration rate, which is closely related to stomatal conductance ( $g_s$ ) and could therefore be used as an additional indicator (besides  $\Delta^{13}\text{C}$ ) of crop tolerance to drought. Changes in plant photosynthesis associated with increased atmospheric  $\text{CO}_2$  concentrations can be detected in the  $^{13}\text{C}$  and  $^{18}\text{O}$  isotope compositions in plant organic matter and therefore can be used as long-term integrators of plant response to photosynthesis.

A preliminary evaluation of the use of oxygen isotope composition ( $\delta^{18}\text{O}$ ) and  $\Delta^{13}\text{C}$  in selecting for tolerance to water stress in wheat was investigated. Detailed experimental set up and the comparative results on the performance of the nuclear and capacitance-based soil water sensors to evaluate the performance of two wheat varieties under pre-anthesis and post-anthesis water-stressed environments were reported in the previous Soils Newsletter (Vol. 32, No. 2, January 2010).

### Measurements

#### Plant sampling and analysis

Two spring wheat varieties, namely, S W Kronjet ( $V_1$ ) and Xenos ( $V_2$ ) were sowed on 11 May 2009 in 3 x 5 meter plots in a randomized split-plot design with two water regimes and three replications (12 plots). Water stress was imposed to the two treatments however irrigation was supplemented when the moisture was down

to 30% plant available water (PAW) and maintained at 50% PAW.

Plants were harvested at 17 (beginning of water treatment), 28, 38, 50 (tillering) and 87 (maturity) days after sowing. Soil water content was measured to a depth of 70 cm (at 10 cm intervals) using the Diviner 2000, EnvironScan, time-domain reflectometer (TDR) and neutron moisture probes (Troxler 4300 and CPN) on a weekly basis for managing irrigation scheduling and estimating water uptake by the plant root system. Grain samples were oven-dried at 70°C to a constant weight, finely ground and analyzed for carbon isotope composition ( $\delta^{13}\text{C}$ ) using an Isotope Ratio Mass Spectrometer (Isoprime GV Instruments). Values of carbon isotope discrimination ( $\Delta^{13}\text{C}$ ) were calculated assuming the carbon isotopic composition ( $\delta^{13}\text{C}$ ) of air is -8‰. The same samples were analyzed for oxygen isotope composition ( $\delta^{18}\text{O}$ ) using the Finnigan TC/EA coupled to the Finnigan Delta Plus XP Isotope Ratio Mass Spectrometer.



Photo 1. Estimating the soil water in the wheat field using the neutron moisture sensor.

### Results

#### Weather conditions, crop growth and yield

The total rainfall during the growing season (May to August 2009, Figure 1) was 582.2 mm (with the highest rainfall of 80 mm recorded in July) and average temperature was 18.7°C, ranging from 10°C in May to 28°C in July during the crop growing season. The solar radiation was highest in July with an average of 319.9  $\text{W}/\text{m}^2$  and the soil water content at 20 cm soil depth ranging from 11-29%. Figure 1 showed that most of the rainfall came in the later part of June, with very little rainfall during the pre-anthesis stage of the crop.



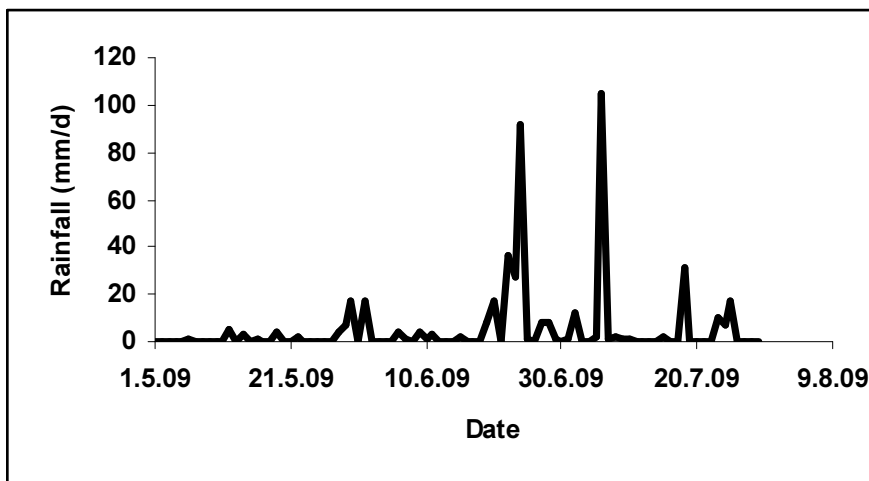


Figure 1. Rainfall distribution during the study period.

Biomass increased steadily from 17 days after sowing (DAS) (first sampling) to 87 DAS (final sampling). Due to low rainfall distribution, pre-anthesis water stress had more effect on biomass than the post anthesis water stress (Figure 2). Total above ground biomass ( $\text{Mg ha}^{-1}$ ) was 7.2 for  $V_1$  and 6.6 for  $V_2$  in the post anthesis, while 5.3 for  $V_1$  and 4.6 for  $V_2$  in the pre-anthesis treatments, compared to the control (10.4). Grain yields ( $\text{Mg ha}^{-1}$ ) were 3.04 for  $V_1$  and 3.06 for  $V_2$

in the post anthesis and 2.4 for  $V_1$  and 1.94 for  $V_2$  for pre anthesis. No significant differences in grain yield was observed for  $V_1$  and  $V_2$  in the post anthesis treatment, however the difference in grain yield between  $V_1$  and  $V_2$  for the pre-anthesis treatment was significant. The harvest index (ratio of grain yield to biomass) ranged from 0.46–0.50 for the water stressed treatments and 0.59 for the control plants.

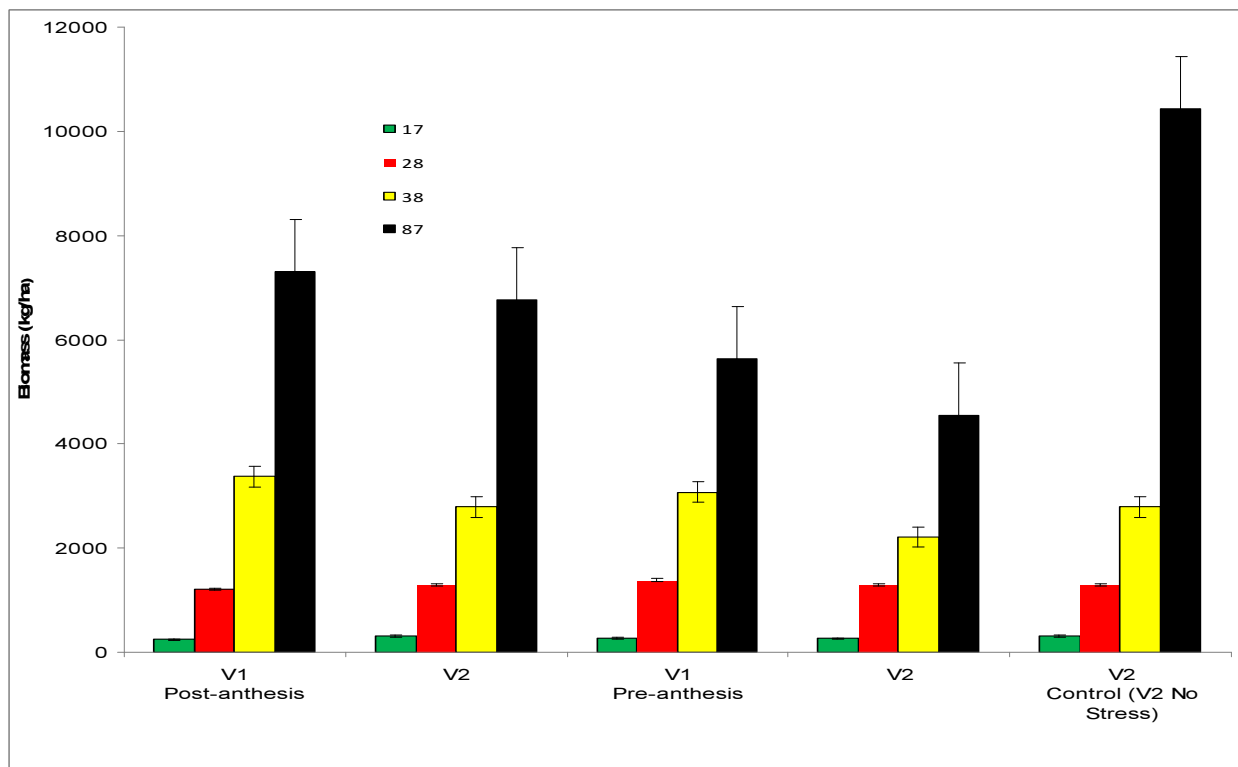


Figure 2. Aboveground biomass at 17, 28, 38 and 87 days after sowing (DAS) for two wheat varieties ( $V_1$ —SW Kronjet and  $V_2$ —Xenos) subjected to pre-anthesis and post anthesis water stress. The control plants ( $V_2$ ) were not subjected to water stress during the experimental period.

## Variation in carbon and oxygen isotope composition

Figure 3 shows the influence of the water-stress on  $\Delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  in grain. The pre-anthesis water-stress resulted in less  $\Delta^{13}\text{C}$  (17.79–17.99‰) compared with post anthesis water-stress (18.07–18.59 ‰). The  $\Delta^{13}\text{C}$  values of grain were lower for  $V_1$  than for  $V_2$  irrespective of water stress. For  $\delta^{18}\text{O}$ , the values in grain were higher (10.2 ‰) in the post anthesis than the pre-anthesis water stress (9.53 ‰).

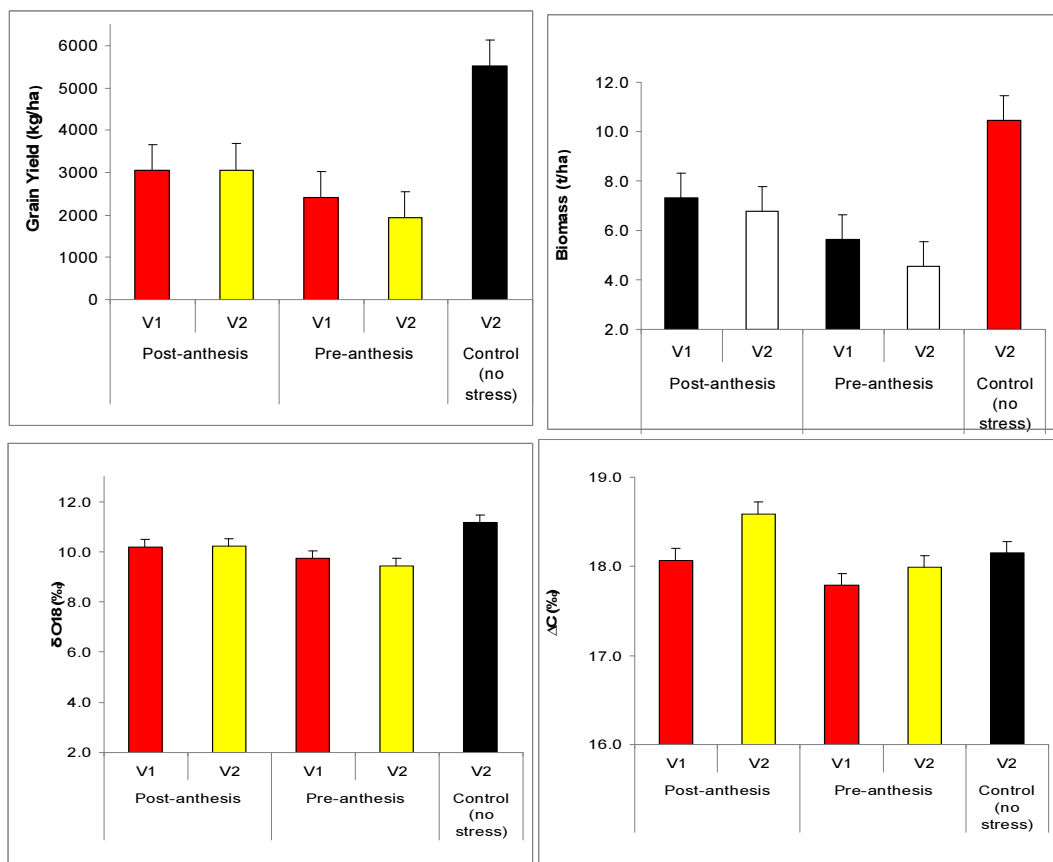


Figure 3. Grain yield, biomass carbon-13 and oxygen-18 in grain samples of the two wheat varieties ( $V_1$  and  $V_2$ ) under pre-anthesis and post anthesis water stress.

Figure 4 shows the relationships between grain yield and  $\delta^{18}\text{O}$  and  $\Delta^{13}\text{C}$  in grains. There was a strong and positive correlation between grain yield and  $\delta^{18}\text{O}$  ( $R^2=0.958$ ) compared to that between  $\Delta^{13}\text{C}$  and grain yield. ( $R^2=0.071$ ). Similar results were observed for biomass. Our data showed that there was a weak, but

positive correlation ( $R^2=0.17$ ) between  $\delta^{18}\text{O}$  and  $\Delta^{13}\text{C}$ . The data clearly support the hypothesis that the ratios of  $^{18}\text{O}$  to  $^{16}\text{O}$  ( $\delta^{18}\text{O}$ ) in grains could be a better indicator to evaluate the tolerance of wheat plants to water stress than the  $\Delta^{13}\text{C}$ .

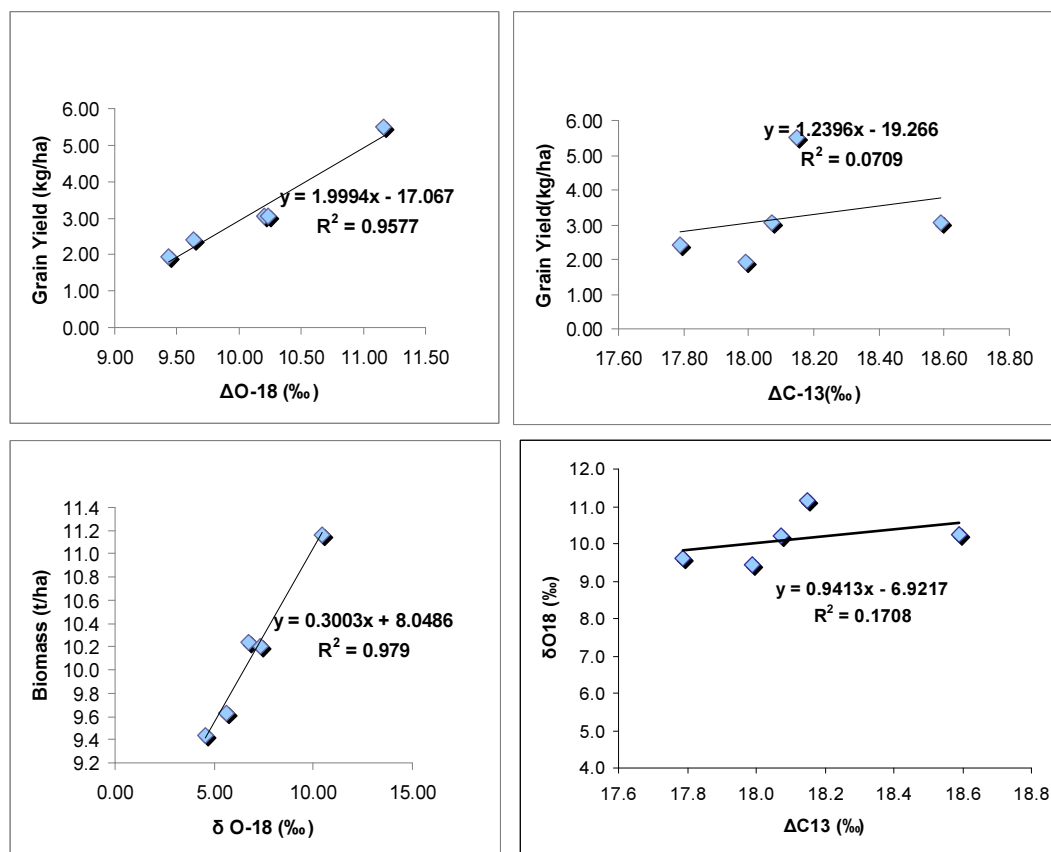


Figure 4. Relationship between grain yield, O-18 and C-13

### Tentative Conclusions

- (1) Pre-anthesis water-stress significantly affected wheat biomass and grain yield more than the post-anthesis water-stress. The wheat genotype SW Kronjet ( $V_1$ ) was more tolerant to water stress than Xenos ( $V_2$ ).

- (2) The ratios of  $^{18}\text{O}$  to  $^{16}\text{O}$  ( $\delta^{18}\text{O}$ ) in grains which is directly related to biomass and grain yield could be a better indicator to evaluate wheat plants to water stress than the  $\Delta^{13}\text{C}$ .

### Results from Collaborative activities with the Plant Breeding Unit

Joseph Adu-Gyamfi and Souleymane Bado

Carbon isotope discrimination for evaluating rice varieties tolerant to different salinity levels in soil and solution culture

### The Experiment

A collaborative study between the Plant Breeding and Genetics and the Soil Water Management and Crop Nutrition Laboratories was initiated to use the carbon isotope discrimination technique to evaluate rice varieties for the tolerance to salinity using soil and hydroponics cultures. Seeds of four different rice varieties (Pokkali, salt and drought tolerant; Bicol, moderately tolerant, IR29, salt susceptible from International Rice Research

Institute (IRRI) and STDV, moderately tolerant mutant developed in the Plant Breeding and Genetics Laboratory, Seibersdorf) varying in their level of salt tolerance were pre-germinated in Petri dish for a week with distilled water. The one month old seedlings were transplanted either in to soil (Seibersdorf classified as Dystic Eutrocrepts) or hydroponic culture. Aluminium tank (200 × 100 × 9 cm) was filled with 160 kg of soil that received fertilizer application of 100 N and 40 P kg ha<sup>-1</sup> and puddle before transplanting the seedlings. Three salinity treatments (0, 6, and 12 dsm<sup>-1</sup>) using NaCl were initiated in the 3 tanks. The plants were kept submerged by adding tap water or Yoshida nutrient solution daily. In hydroponic system, the pre-germinated seeds were transplanted in plastic-plugged equidistant holes trays with a piece of sponge in hydroponic systems. A nutrient (Yoshida) solution was used and, the plants were exposed to different concentrations of salinity using NaCl (0, 6 and 12 dsm<sup>-1</sup>) after two weeks after transplanting. The pH was maintained at 5.0 and the nutrient solution was renewed every 2 d.

### Sampling and Analysis

Plants in both solution and soil cultures were sampled at 8, 16, and 32 days after salinity treatment (DAT),

washed with water (1-2 minutes), and the fresh weight and plant height were recorded. Samples were then oven-dried at 70°C, weighed, and a portion of the dry weight was analyzed for C, N, and <sup>13</sup>C concentrations with an Isotope Ratio Mass Spectrometer (Isoprime GV Instruments).

### Results

The above-ground biomass of the 4 rice varieties was higher when grown under hydroponic system than the soil culture. The salinity effect was more severe at 16 DAT than at 8 days. In the Hydroponic culture dry matter (g plant<sup>-1</sup>) decreased from 1.4–0.9 (Pokkali), 0.8–0.4 (Bicol), 0.6–0.3 (STDV) and 0.5–0.2 (IR29). Similar results were observed for the soil culture, confirming the tolerance of Pokkali and IR29 under saline environments compared to the other varieties (Figure 1). Salinity caused a reduction in  $\Delta^{13}\text{C}$  values compared to the control with the reduction being more severe in Pokkali (23.4–21.9‰) and less severe in IR 29 (23.4–22.7‰) suggesting that IR 29 is the most sensitive to salinity whilst Pokkali is tolerant to salinity (Figure 1, Photo 1).

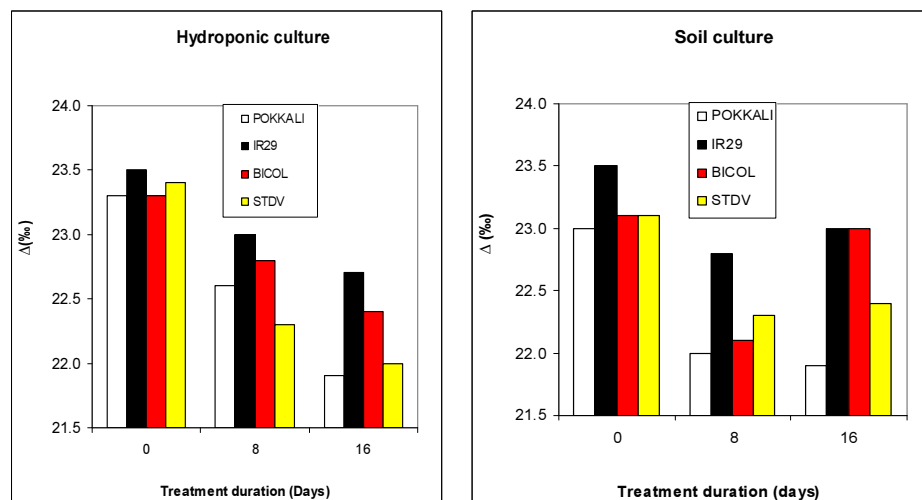


Figure 1. Carbon isotope discrimination in the aboveground biomass by 4 rice varieties (Pokkali, Bicol, IR29 and STDV) grown in soil culture and hydroponic conditions under 3 salinity treatments (0, 6 and 12 dSm<sup>-1</sup>).

### Tentative Conclusions

Evaluating for salt tolerance in rice using soil culture (rather than hydroponics) was well established. Results from the carbon isotope discrimination confirm the tolerance of Pokkali to salinity at 16 days after salinity

treatment in both hydroponics and in soil culture conditions. The mechanism of salt tolerance is being investigated by analyzing the Na, K and Cl content in shoots and roots.



Photo 1. Evaluating rice varieties for their tolerance to salinity in soil culture and hydroponics.

### Summary of the radionuclide analyses performed by the SWMCN Laboratory in 2009

*Arsenio Toloza, Lionel Mabit, Patcharin Jankong (SWMCN Laboratory)*

In 2009, using the SSU  $\gamma$ -detector (HPGe coaxial detector, relative efficiency of 115%, Minimum Detectable Activity for  $^{137}\text{Cs}$  of  $0.2 \text{ Bq kg}^{-1}$ ), the SWMCN Laboratory team performed 360 radioisotopic measurements to support the research activities of our Member States. The counting time ranged between 10,000 and 50,000 seconds (for an average of 30,000 seconds) per sample. The SWMCN Laboratory analysed: 90 samples as part of our collaboration with the Center for Agricultural Land Management and Agrohydrology, Department for Agronomy, Biotechnical Faculty (Ljubljana, Slovenia), 20 samples to support the Syrian participant of the CRP D1.20.11 (IAEA contract No.: 15532), 30 samples to

support the local team of the Ministère de l'Énergie et de l'Eau & Direction Nationale de l'Énergie (Bamako, Mali) according to the work plan of the TCP MLI 5022, and 160 sample analyses of  $^{137}\text{Cs}$  and geogenic radioisotope contents for our collaborative project in Yemen with the University of Tübingen (Germany).

Out of this external network support, 60 additional measurements were also conducted for calibration, background and quality control purposes. Table 1 summarizes the radioisotopic analytical services provided by the SWMCN Laboratory.

In 2009, the gamma spectrums of samples measured for  $^{7}\text{Be}$  content in 2008 were also reanalysed and updated with a new calibration procedure (mixed gamma containing:  $^{241}\text{Am}$ ,  $^{109}\text{Cd}$ ,  $^{57}\text{Co}$ ,  $^{139}\text{Ce}$ ,  $^{203}\text{Hg}$ ,  $^{113}\text{Sn}$ ,  $^{85}\text{Sr}$ ,  $^{137}\text{Cs}$ ,  $^{60}\text{Co}$ ,  $^{88}\text{Y}$ . Total activity 40 kBq) using three different Petri dish geometries (80, 100, and 120 ml).

**Table 1.** Number of FRN and geogenic radioisotope analyses performed in 2009

Radioisotopes (Matrix)	<sup>137</sup> Cs	<sup>40</sup> K	<sup>226</sup> Ra	<sup>232</sup> Th	<b>Total</b>
	<i>soil</i>	<i>soil</i>	<i>soil</i>	<i>soil</i>	
External Networks	180	40	40	40	<b>300</b>
Seibersdorf	30	10	10	10	<b>60</b>
Total					<b>360</b>

### Scientific Visitors

<b>Name</b>	<b>Country</b>	<b>Area of Training</b>	<b>Period</b>
Mr Rabesiranana, Nairo (MAG/10001V)	Madagascar	Use of nuclear techniques in crop nutrition and water management	4 to 15 January 2010
Mr. Munyinda Kalaluka L. (ZAM/09033V)	Zambia	Use of nuclear techniques in crop nutrition and water management	8 to 15 April 2010

# Publications

## List of Publications

- Cobo, J.G., Dercon, G., Cadisch, G. (2010). Nutrient balances in African land use systems across different spatial scales: a review of approaches, challenges and progress. *Agriculture Ecosystems and Environment*, 136, 1-15.
- Iqbal, M. A., Bodner, G., Heng, L.K., Eitzinger, J., Hassan, A. (2010). Assessing yield optimization and water reduction potential for summer-sown and spring-sown maize in Pakistan. *Agricultural Water Management*, 97, 731-737.
- Jankong, P., Mabit, L., Toloza, A., Zupanc, V. (2010). Anthropogenic and geogenic radionuclides content in an undisturbed Slovenian forest soil. In: *Geophysical Research Abstracts*, Volume 12, European Geosciences Union – General Assembly 2010. Abstract EGU2010-3124.pdf.
- Mabit, L. (2010). Measurement of soil water erosion in Africa: the potential support provided by nuclear techniques. In: *Geophysical Research Abstracts*, Volume 12, European Geosciences Union – General Assembly 2010. Abstract EGU2010-3098.pdf.
- Mabit, L., Benmansour, M., Nouira, A. (2010). A case study of soil erosion and sedimentation magnitudes in Morocco using  $^{137}\text{Cs}$  &  $^{210}\text{Pb}_{\text{ex}}$ . In: *Geophysical Research Abstracts*, Volume 12, European Geosciences Union – General Assembly 2010. Abstract EGU2010-3105.pdf.
- Mabit, L., Bernard, C. (2010). Spatial distribution and content of soil organic matter in an agricultural field in Eastern Canada, as estimated from geostatistical tools. *Earth Surface Processes and Landforms*, 35, 278-283.
- Rabesiranana, N., Rasolonirina, M., Solonjara, A.F, Raelina Andriambololona, Mabit, L. (2010) Preliminary study of a radiological survey in an abandoned uranium mining area in Madagascar. In: *Geophysical Research Abstracts*, Volume 12, European Geosciences Union – General Assembly 2010. Abstract EGU2010-3155.pdf.
- Schmitter, P., Dercon, G., Hilger, T., Le Ha T.T., Than, N.H., Lam, N., Vien T.D., Cadisch, G. (2010). Sediment induced soil spatial variation in paddy fields of Northwest Vietnam. *Geoderma*, 155, 298-307.
- Suwa, R., Hakata, H., Hara, H., El-Shemy, H A., Adu-Gyamfi, J.J., Nguyen, N T., Kanai, S., Fujita, K. (2010). High temperature effects on photosynthate partitioning and sugar metabolism during ear expansion in maize (*Zea mays* L.) genotypes. *Plant Physiology and Biochemistry* 48:124-2010.
- Zaman, M., Nguyen, M. L. (2010). Effect of lime or zeolite on  $\text{N}_2\text{O}$  and  $\text{N}_2$  emissions from a pastoral soil treated with urine or nitrate-N fertilizer under field conditions. *Agriculture, Ecosystems and Environment*: In press.

## 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>
- FAO website: <http://www.fao.org/waicent/FAOINFO/AGRICULT/Default.htm>
- FAO/AGL (Land and Water Development Division):  
<http://www.fao.org/ag/agl/default.stm>

## Impressum

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