IAEA

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

Soils Newsletter

Vol. 31, No. 1 July 2008

http://www-naweb.iaea.org/nafa/index.html
http://www.fao.org/ag/portal/index_en.html

ISSN 1011-2650

Improving soil quality and enhancing land carbon sequestration: Growing soybean under conservation agriculture in Brazil (Courtesy of Bruno Alves, Embrapa Soybean Research Centre, Brazil)

Contents

- To Our Readers 1
- Staff 3
- Staff News 5
- Feature Articles 5
- Technical Cooperation Projects 10
- Forthcoming Events 12
- Past Events 13
- Status of Coordinated Research Projects 17
- Laboratory Activities 18
- Publications 24

To Our Readers

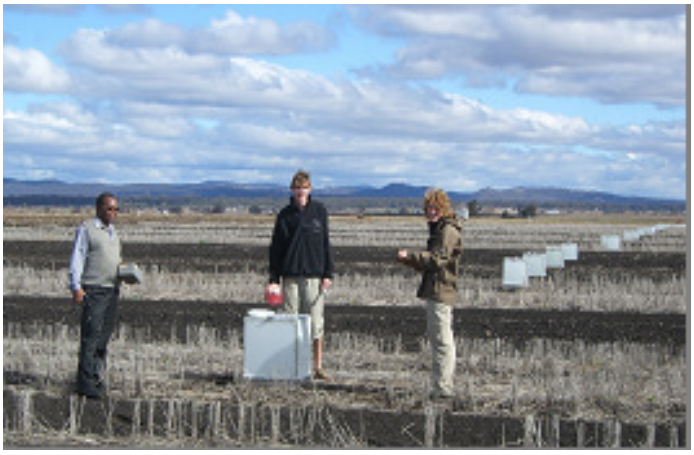
January 2008 saw us embarking on the new programme of work for the 2008-2009 biennium, with three major projects, namely (i) Soil Management and Conservation for Sustainable Agriculture and the Environment, (ii) Technologies and Practices for Sustainable Use and Management of Water in Agriculture and (iii) Integrated Soil-Plant Approaches to Increase Crop Productivity in Harsh Environments. The third project is jointly implemented with the IAEA Plant Breeding and Genetics Section.

The Soils Subprogramme has been involved in the evaluation and modification of 27 concept notes (including four regional projects) for national and regional technical cooperation projects which aim to address the conservation and management of land and water for crop production and environmental protection in Member States to enhance food security, crop productivity and the conservation of soil and water resources for sustainable agricultural systems and their environments in Africa, Asia, Latin America and Europe. Currently the Team in the Soils Subprogramme collectively provides technical support to 45 technical cooperation projects (TCPs) in a range of areas described above. It is so pleasing to receive articles from our counterparts, who inform us of the success of their projects through the involvement with IAEA under coordinated research projects (CRPs) or technical cooperation projects (TCPs).

IAEA International Atomic Energy Agency

The work of the Soils Subprogramme in land and water management will play an important role in addressing food security in the months ahead. The recent soaring food prices and food crisis has focussed attention worldwide on a range of issues including the impact of land use activities and climate change with high variability and extreme events on soil quality, land degradation and agricultural water use efficiency and their subsequent effects on food production and sustainable agriculture.

The need to improve soil quality, arrest land degradation, in particular desertification in agro-ecosystems and to protect land and water resources for food production and sustainable agricultural and socio-economic development is expected to increase in the next 50 years as a result of continuing global population growth and the increased reliance on limited natural resource-based economies. World-wide soil and land degradation is currently estimated at 1.9 billion hectares and this is increasing at a rate of 5 to 7 million hectares each year. At the same time, the 'food insecure' population is approximately 800 million. Soil degradation and food insecurity are intricately linked with long-term social, economic and environmental impacts resulting in human migration within and between Member States and social unrest. By 2020, 60 million people are likely to migrate from desertified areas of sub Sub-Sahara towards North Africa and Europe. Improved soil health and its constituents, such as soil fertility, soil organic matter and plant-available soil moisture storage for food security and natural resource sustainability, will help to stem human migration, enhance sustainable economic development and improve the livelihoods of the poor. Poor land-water management practices can lead not only to land and water degradation, but also to increased greenhouse gases (GHG) emissions (e.g. CO_2, N_2O and CH_4) and thus ultimately contribute to climate change.



Mitigating greenhouse gas (GHG) emissions through improved land management: Assessment of GHG emissions under conservation agriculture in Australia (Courtesy of Dr. Weijin Wang, Department of Natural Resources and Water, Queensland, Australia)

In this Newsletter and also via our 'revamped' webpage (http://www-naweb.iaea.org/nafa/swmn/index.html), you will find interesting information on Soils Subprogramme activities relating to land and water management, including conservation agriculture, soil conservation measures, management of tropical acid soils, soil nitrogen and irrigation management and agroforestry for enhancing soil carbon storage and resource use (soil nutrients and water storage) recovery. Please contact us if you require further information about any of these activities.

There are many challenges ahead to address the issues outlined above. Your feedback and support is vital to our work and activities. I look forward to receiving your continuing support. The Team at both IAEA Headquarters and the Seibersdorf Soil Science Unit (SSU) join me in expressing our appreciation for your invaluable contributions.

Best wishes,

Long Nguyen

Staff

Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture, Vienna International Centre, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria; Telephone (43-1) 2600 + ext.; Fax (43-1) 2600 7; E-mail: Official.Mail@iaea.org

Name	Title	E-Mail Address	Extension
Qu LIANG	Director	Q.Liang@iaea.org	21610

Soil and Water Management and Crop Nutrition Section

Name	Title	E-Mail Address	Extension
Long NGUYEN	Section Head	M.Nguyen@iaea.org	21648
Lee Kheng HENG	Technical Officer	L.Heng@iaea.org	26847
Gerd DERCON	Technical Officer	G.Dercon@iaea.org	21693
Felipe ZAPATA	Consultant	F.Zapata@iaea.org	26844
Peggy MACAIGNE	Consultant	P.Macaigne@iaea.org	21645
Rosario LEON DE MÜLLNER	Secretary	R.Leon-De-Muellner@iaea.org	21647
Eveline KOPEJTKA	Secretary	E.Kopejtka@iaea.org	21646

FAO/IAEA Agriculture and Biotechnology Laboratory, A-2444 Seibersdorf, Austria

Name	Title	E-Mail Address	Extension
Erik BUSCH-PETERSEN	Head, FAO/IAEA Agriculture and Biotechnology Laboratory	E.Busch.Petersen@iaea.org	28267

Soil Science Unit

Name	Title	E-Mail Address	Extension
Gudni HARDARSON	Unit Head	G.Hardarson@iaea.org	28277
Joseph ADU-GYAMFI	Soil Scientist/Plant Nutritionist	J.Adu-Gyamfi@iaea.org	28263
Lionel MABIT	Soil Scientist	L.Mabit@iaea.org	28271
Leopold MAYR	Senior Laboratory Technician	L.Mayr@iaea.org	28305
José Luis ARRILLAGA	Senior Laboratory Technician	J.L.Arrillaga@iaea.org	28306
Martina AIGNER	Senior Laboratory Technician	M.Aigner@iaea.org	28212
Maria HEILING	Senior Laboratory Technician	M.Heiling@iaea.org	28272
Doris GLUDOVACZ	Laboratory Technician	D.Gludovacz@iaea.org	28272
Arsenio TOLOZA	Laboratory Technician	A.Toloza@iaea.org	28403
Norbert JAGODITSCH	Laboratory Assistant	N.Jagoditsch@iaea.org	28422
Kyoko MAKOVICKY	Secretary	K.Makovicky@iaea.org	28362

Soil and Water Management & Crop Nutrition Section (SWMCN)


L. Nguyen


L. Heng


G. Dercon


F. Zapata


E. Kopejtka


R. Leon de Müllner


P. Macaigne

Soil and Water Management & Crop Nutrition (SWMCN) Subprogramme


K. Makovicky


G. Hardarson


J. Adu-Gyamfi


L. Mayr


L. Mabit


J. Arrillaga

Soil Science Unit (SSU)


M. Aigner

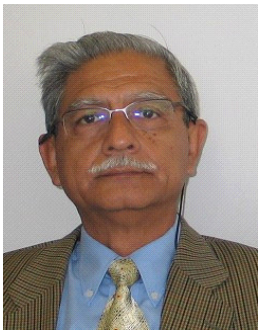

D. Gludovacz


M. Heiling


A. Toloza


N. Jagoditsch

Staff News



Mr. Felipe Zapata, a former staff member, re-joined the section on 17 March 2008 as a Consultant on a 3-month contract. Felipe's duties are to assist with matters relating to the OIOS evaluation review of the Soils Subprogramme in Sustainable Intensification of Crop Production Systems and to provide assistance to the Section Head with other issues, as the needs arise.

Congratulations to Ms. Eveline Kopejtka. Eveline is seen here to receiving her Merit Award from the Deputy Director General and Head of the Department of Nuclear Applications (Mr. W. Burkart) for her inputs and dedication to the Soils Subprogramme.

Feature Articles

Use of ^{7}Be fallout to document soil erosion and soil redistribution within Chilean vineyards

Videla X.[1], Pino I.[1], Nario A.[1], Parada A.M.[1], Walling D. E. [2], Luzio W.[3], Casanova M.[3], Seguel O.[3]
[1]Agriculture Section, Chilean Nuclear Energy Commission, Santiago, Chile
[2]Department of Geography, University of Exeter, United Kingdom
[3]Faculty of Agronomic Science, University of Chile, Santiago, Chile

The IAEA technical cooperation project CHI5048 'Integrated Watershed Management for the Sustainability of Agricultural Lands' was initiated in 2005 with the aim of developing a management model for sustainable agricultural systems through the use of nuclear and chemical techniques to assess the impacts of human practices. The project focuses mainly on pesticides management and modelling, including a test of the use of fallout radionuclides (FRNs) especially ^{7}Be, as a short term erosion/sedimentation soil tracer.

The challenge

Intensive agriculture involves the application of large quantities of agrochemicals (fertilizers and pesticides). The need for an improved understanding of the transport, storage and fate of these substances has highlighted the importance of sediment-associated transport and the key role of soil erosion and associated sediment redistribution in influencing the fate of agrochemicals. Documentation of soil erosion rates is therefore important for the assessment of soil loss and the associated reduction in soil productivity and to understand the transfer and fate of agrochemicals within the environment. In Chile, the total area of agricultural land extends to ca. 1.9 Mha. Within the VIth Region, which lies to the south of Santiago, about 32500 ha are currently planted with vineyards. Wine production now accounts for ca. 11.4% of the Gross National Product and is an increasingly important component of the national economy.

The 1300 ha-Apalta vineyard (34°36'S; 71°16'W) is well known, located in the Colchagua Valley near Santa Cruz in the VIth Region of Chile. Due to agro-environmental conditions, the growers have recently started to plant vines on the steeper slopes (up to 22 degrees), which produce high quality boutique wines, with the rows of vines commonly aligned downslope, rather than on terraces aligned along the contours. The annual rainfall of 600 mm occurs mainly from May to September. The soils have been classified as *La Lajuela Association* (fine loamy, mixed *Thermic Ultic Haploxeralfs*). Even when the vineyards are well managed, the land management practices and weather conditions can result in significant erosion and soil redistribution.

The fallout radionuclide ^{7}Be is being used in the Apalta vineyard, to document short-term soil erosion and soil redistribution rates associated with the establishment of vineyards and to investigate the influence of vineyard management practices and slope steepness on soil redistribution rates.

The study

The study is focusing on two vineyards within the larger Apalta vineyard. In the first, vineyard V, which covers 65 ha and is characterized by slopes within the range of 13 to 22 degrees, the vines have been planted under two contrasting management systems. Vines are planted in rows aligned downslope or on terraces parallel to the contours. In the second vineyard, vineyard N, which covers 32 ha, the slopes are less steep, ranging from 3 to 12 degrees. Here the vines are only planted in rows following the direction of the slope. In vineyard V, two sites, representative of vines planted in rows following the direction of the slope and vines planted on terraces following the contour, were selected for ^{7}Be measurement to document soil redistribution rates.

Preliminary sampling was undertaken between April 2006 and August 2007, in order to obtain background information on ^{7}Be in the soil, to test assumptions of the ^{7}Be technique and to refine the future sampling strategy. Reference sites with similar soil and surface conditions to the study were established close to each of the study sites. Six soil sampling campaigns following a period of heavy rainfall (> 40 mm) were organized. Samples for ^{7}Be activity measurements were analysed in the laboratory of the Agriculture Section of the Chilean Nuclear Energy Commission.

Vineyard V: slope range 14 - 22 degrees

Rows in slope direction

Rows on terraces

Vineyard N: slope range 3 - 12 degrees

Rows in slope direction

Soil Sampling

Preliminary findings

Preliminary estimates of short-term soil redistribution rates obtained for the different study sites emphasize the effectiveness of the terraces in reducing erosion within vineyard V. Net rates of soil loss from the terrace site were typically only about 7% of those from the site where the rows ran downslope. The values of net soil loss obtained for the study site in vineyard N were generally substantially lower than those for the equivalent site in vineyard V, where the rows were aligned downslope, due to the reduced slope gradient.

Problems were encountered in the first year with disturbance of the reference sites by burrowing animals. Since the soil surface at the reference sites is maintained in a bare condition, it is important to standardize the site condition. In this sense, any sparse vegetation cover should be included in the measured inventories for the sampling points within the study sites, in order to establish the total inventory. The soil sampling protocol has been refined to minimize this problem for a future campaign planned for autumn 2008.

Investigation on the interactions between soil water, irrigation and transpiration in the soil-plant-atmosphere continuum with ^{18}O

Peggy Macaigne, consultant, SWMCN Subprogramme

The complex interaction between plant and soil water during the cropping season requires further investigation. How does the plant react in terms of transpiration to water stress during its growth? How is the interaction between the plant, the soil water and irrigation at different levels of water stress? These are the questions to be answered by a pot experiment conducted in a glasshouse at Seibersdorf laboratories involving ^{18}O.
Oxygen 18 is a rare (natural abundance of 0.2 %), natural and stable isotope of water and therefore very useful for tracking water pathways from irrigation or precipitation within the soil-plant-atmosphere continuum. One of the noteworthy properties of ^{18}O is the temperature dependency of its fractionation factor between the liquid phase and the vapour during evaporation, while the plant water uptake does not change the isotopic signature of soil water. These two properties can be exploited to investigate not only soil evaporation and plant transpiration but also the irrigation water pathway within the soil-plant-atmosphere continuum.

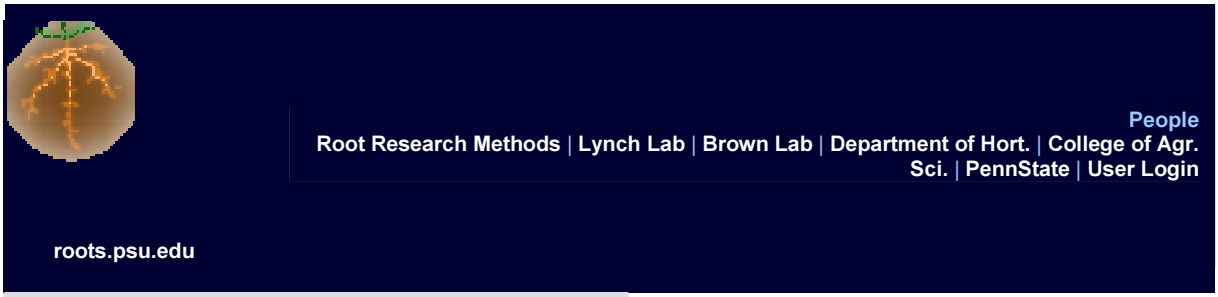
Thirty six large pots (diam. 50 cm) were filled with a 1:1 Seibersdorf soil (diam. 0.5 cm)/quartz sand mixture in a randomised block experiment, consisting of 3 treatments: (i) field capacity + crop, (ii) 60% of field capacity + crop and (iii) 60% of field capacity+ bare soil. The crop used for the experiment is corn (*Zea Mays*).
Climatic data and soil humidity will be monitored during the cropping season. Oxygen 18 in irrigation, soil and plant water (sap and dry organic matter) at different stages of plant growth will be analysed. Soil water and plant sap will need to be extracted before isotopic analyses with the mass-spectrometer can be conducted, involving the construction of a cryodistillation line in the laboratory.

Ms. Peggy Macaigne is preparing a pot experiment

Successful collaboration between IAEA and the Pennsylvania State University (PSU), USA

Jonathan Lynch, (PSU) and Joseph Adu-Gyamfi, (SSU)

The impacts of increased droughts, salinity and nutrient deficiencies are a serious threat to the production of the major world food crops (wheat, rice and maize). Degraded and marginal lands (harsh environments) are the results of nutrient mining, poor land and water management and the inappropriate matching of plants to their environment, particularly with increasing climate variability. Plant roots play an important role in capturing and utilizing soil water and nutrients for plant growth, but the hidden nature of roots below-ground, coupled with the labour cost of assessing a large number of roots in the field has hampered the search for plants with such root characteristics which optimize their adaptability to the environment through an integrated soil-plant approach which matches plants to soil conditions. During the past three years, the IAEA collaborating with Pennsylvania State University (PSU) through a Coordinated Research Project (CRP) D1.50.10 on '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' has developed a field root methodology that is capable of discerning variations for root traits important for efficient nutrient (phosphorus and nitrogen) and water uptake with minimum labour and expense. This methodology which is available at a website sponsored by IAEA has been effectively used to identify multilines (deep and shallow-rooted genotypes) that explore water and nutrients at different soil depths. These multiline genotypes are being assessed for their performance in cropping systems and their long term effects on soil health with the aim of improving the livelihoods of people living in harsh environments. The major achievements of this collaboration is that in addition to the participants of the CRP to using the methodology by to evaluate efficient rice, maize and beans lines tolerant to harsh environments in parts of Cuba, Mozambique, Nigeria and Mexico, the website is user-friendly and available to our member states through http://roots.psu.edu



.1. Contact: Jonathan Lynch

Address
Ph: 814-863-2256
E-mail: JPL4 at psu.edu

.2. Research Methodology

- Analysis of real-time root growth with the KineRoot program
- Cylinders for root evaluation
- Diagnosis of nutritional disorders in beans (Phaseolus vulgaris L.)
- Examining the Fine Anatomy of Roots
- Field Crop Root Crown Sampling and Analysis
- Plant nutrient disorders displayed
- Root anatomy
- Root hairs
- Root Length Determination
- Screening of root whorls
- Simulation Modeling
- Soil Coring for Root Distribution with Depth
- Staining Protocol for Arbuscular Mycorrhizae Colonized Roots

Sponsored by:

IAEA

Research Methodology

Welcome to our new Root Methodology website. Over the coming period, different researchers in our lab will publish their research methodologies. If you have information about root methods to contribute, please contact Jouke Postma.

Analysis of real-time root growth with the KineRoot program

Cylinders for root evaluation

Diagnosis of nutritional disorders in beans (Phaseolus vulgaris L.)

Examining the Fine Anatomy of Roots

Field Crop Root Crown Sampling and Analysis

Plant nutrient disorders displayed

Root anatomy

Root hairs

Root Length Determination

Screening of root whorls

Simulation Modeling

Soil Coring for Root Distribution with Depth

Staining Protocol for Arbuscular Mycorrhizae Colonized Roots

Analysis of real-time root growth with the KineRoot program ›

» printer-friendly version | add new comment | Portuguese | French | Spanish | Array

Submitted by Jouke Postma on Thu, 2007-02-08 15:52.

A Penn State University Laboratory

Photo: *A Website on laboratory and field validated protocols for evaluation of root traits contributing to enhanced phosphorus and nitrogen acquisition from low fertility soils*

SWMCN Subprogramme's Seminar Series

Soil morphology: a key to discovering and understanding the structure and dynamics of soil covers

By Alain Ruellan

Professor M. Ruellan, Professor Emeritus in Pedology at AgroCampus Rennes, France, visited the SWMCN Subprogramme at IAEA Headquarters on 18 April and presented a seminar on soil morphology, a branch of soil science, studying the forms and arrangement of soil features including soil structures in each soil layer (soil horizon). His presentation reviewed the relationships between soil morphology and physical, chemical and biological processes such as soil biological activities, watershed hydrology and geochemistry, rock weathering, soil formation and erosion, human activities and climatic conditions. The sustainable use of soil resources requires the understanding of soil functions, not only in terms of their physical, chemical and biological properties but also the soil history (i.e. the evolution and functioning of soils), its interaction with nature and its position in the landscape. This understanding is necessary because the spatial diversity of soil structures within a landscape is governed by years of soil evolution and development.

Wine quality: the answer is partly in the soil

By Robert White

Professor Robert White, the Foundation Professor of Soil Science and Professor Emeritus at the University of Melbourne, Australia, visited the SWMCN Subprogramme at IAEA Headquarters on 29 May and provided an exciting seminar on 'The soil component of terroir'. Terroir is an important concept in the wine industry that expresses the complex interaction of soil, climate, landscape, variety, and human perceptions on the flavours and aromas of wine from particular sites. His talk reviewed the role of soil properties in determining the terroir of a particular site and showed that the effect of soil variation on terroir should be evaluated on the scale of metres rather than kilometres. High density real-time measurements of relevant soil properties enables digital soil mapping that can then be used to guide site selection and vineyard management.

One of the most important soil factors influencing vine performance and wine quality is the supply of nitrogen (N). The availability of soil mineral N at several high vigour sites in cool climate regions of southern Australia is being assessed. A manager's ability to control soil N mineralization and N uptake by Sauvignon Blanc vines at a high fertility site by withholding irrigation and using different inter-row cover crops was discussed. The results confirm the importance of a regulated supply of water and N at critical stages of vine phenology to achieve optimum fruit quality.

Technical Cooperation Projects

Operational Projects and Technical Officers responsible for implementation

Project Number	Title	Technical Officer
AFG5003	Sustainable increase in crop production in Afghanistan	L. Nguyen/P. Lagoda
ALG5020	Combating desertification	G. Dercon
ALG5021	Optimising irrigation systems and surface water management	L. Heng
ALG5022	Nuclear techniques for sustainable use of saline groundwater and wastelands for plant production	L. Heng
ANG5005	Effect of biofertilizer and inorganic fertilizer use on the growth and yield of maize and bean in Ferralitic soils of Huambo	G. Hardarson
BGD5026	Increasing agricultural production in the coastal area through improved crop, water and soil management	Q. Shu /J. Adu-Gyamfi
CHI5048	Integrated watershed management for the sustainability of agricultural lands	I. Ferris/ L. Mabit
CMR5016	Development of N and P fertilizer management for Sustainable Intensification of agricultural production in Cameroon	L. Heng
CPR5015	Assessment of soil erosion and effectiveness of soil conservation	G. Dercon
ECU5022	Efficient use of nitrogen fertilizers in flower production	L. Heng
ECU5024	Improving Productivity of the African Palm through Better Fertilization and Water Management Practices	G. Dercon
ELS8009	Study of sedimentation in the reservoirs of four CEL hydroelectric power stations	T. Vitvar/G. Dercon
ERI5004	Improving crop productivity and combating desertification	P. Lagoda/J. Adu-Gyamfi
GHA5032	Enhancing production and use of cassava	L. Heng
HAI5003	Enhancing crop productivity through the application of isotope nuclear techniques	L. Heng
INS5035	Application of Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands	Q. Shu/G. Dercon
IVC5029	Improvement of yield in plantain and cassava through the use of legume cover crops	G. Hardarson
KEN5026	Isotope techniques for assessment of water and nitrogen use efficiency in cowpea/maize intercropping systems	J. Adu-Gyamfi
MAG5014	Use of environmental radioisotopes for the assessment of soil erosion and sedimentation in the province of Antananarivo, Madagascar	L. Mabit
MAG5015	Optimization of phosphate fertilization of Ferralsols (classically deeply weathered red or yellow soils found in humid east Madagascar) in the highlands of Madagascar	G. Dercon
MAR5014	Management Practices for Increased Efficiency of Fertilizers and Improved Productivity of Saline Soils	L. Nguyen
MAR5017	Investigating the N dynamics in the crop-soil system of a multiple cropping system to optimize fertilizer use	L. Nguyen
MLI5021	Sustainable intensification and diversification of sorghum production systems in the southern zone of Mali, Phase I	L. Heng

Project Number	Title	Technical Officer
MLI5022	Assessment of soil erosion and sedimentation in the Niger watershed with the use of radioisotopes, Phase I	L. Mabit
MON5014	Application of Isotopes in soil and plant studies	G. Hardarson
MON5015	Implementation of the fallout radionuclide technique for erosion measurement	G. Dercon
NAM5008	Increasing crop productivity and resource use efficiency in the northern communal areas	L. Heng
NER5012	Improvement of the productivity and sustainability of cowpea with finger millet	G. Dercon/M. Spencer
PHI5031	Assessment of erosion and sedimentation processes for effective formulation of soil conservation and water quality protection measures	G. Dercon
QAT5002	Developing Biosaline Agriculture in Salt-affected Areas in Qatar	P. Lagoda/L. Nguyen
RAS5043	Sustainable land use and management strategies for controlling soil erosion and improving soil and water quality	G. Dercon
RLA5050	Strengthening laboratory capacity to assess the implementation of good agricultural practices in the production of fruit and vegetables in Latin America	I. Ferris/G. Dercon
SAU5003	Improving Fertilization under Saline Conditions for Sustainable Crop Production	P. Lagoda/L. Nguyen
SEN5030	Integrated approach to develop sustainable agriculture in Senegal	G. Dercon/M. Spencer
SEY5002	Nutrient and Moisture Determination in the Soils of Seychelles to Establish a Programme of Fertilization and Irrigation in the Face of Limited Water Supply and Low Soil Fertility	L. Heng
SIL5008	Contribution of nitrogen fixing legumes to soil fertility in rice-based cropping systems	G. Hardarson
SLO5002	Protecting groundwater and soil against pollutants using nuclear techniques	J. Adu-Gyamfi/ I. Ferris
SRL5038	Application of isotopes for soil erosion studies	G. Dercon
SUD5030	Increasing productivity of selected crops using nuclear related techniques	Q. Shu/J. Adu-Gyamfi
TAD5002	Assessment of soil erosion and sedimentation for Land Use	G. Dercon
TUR5024	Improving crop productivity through nuclear and related techniques	L. Nguyen
UGA5029	Developing soil conservation strategies	G. Dercon
YEM5002	Drip Irrigation and Fertigation for Improved Agricultural Productivity	J. Adu-Gyamfi
ZAI5017	Use of isotope techniques in relation with the nitrogen dynamics and the quality of organic plant material in agricultural soil management	G. Dercon
ZIM5011	Combating desertification in agricultural lands	L. Heng

Forthcoming Events

FAO/IAEA Events

A mid-term Review of the 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)

Technical Officers: Joseph Adu-Gyamfi and Gerd Dercon

The mid term review of the 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' is planned for the third quarter of 2008 after a second RCM in Morelia, Mexico from 21 to 25 April 2008. The aim of the review is to critically assess the progress achieved in line with the specific objectives of the CRP, identify gaps and make suggestions to improvement of work plans. No coordination meeting will be held but the outputs and outcomes achieved by each individual contract holder from the project progress reports will be evaluated against the expected achievements. The third RCM is proposed to be held during the third quarter of 2009 in one of the following African countries (Ghana, Cameroon, or Mozambique).

Final RCM of CRP on "Selection for Greater Agronomic Water Use Efficiency in Wheat and Rice using Carbon Isotope Discrimination", 3 to 7 November 2008, Vienna, Austria (D1.20.08)

Technical Officer: Lee Heng

The fourth and final RCM of this CRP will be held from 3 to 7 November 2008 at IAEA Headquarters in Vienna. All chief scientific investigators (both contract and agreement holders) are expected to attend the meeting.

The objective of the meeting is to: 1) present and discuss the results obtained for the whole duration of the CRP, 2) evaluate achievements in accordance with project objectives and expected outputs, 3) review manuscripts prepared for the production of the IAEA-TECDOC publication.

The participants will be requested to present an overview of their results which should be in line with the expected outputs and specific objectives of the project. A circular has been sent to the participants informing them of the upcoming meeting. Further information about administrative arrangements will be communicated later.

A full manuscript which will be published subsequently in the IAEA's TECDOC series is expected from each participant prior to the meeting.

TC Development

Regional Africa

Lee Heng has been involved in developing a new regional TC project on "Small-scale irrigation technologies for enhancing productivity of high value crops and income generation in African States" for the 2009-2011 cycles. The focus of the project will be pilot testing, scaling-up technologies and developing mechanisms for dissemination by working with National Irrigation /Crop Research and Technology Multiplication Centres, focusing on the identification and transferring of innovative technologies from participating and collaborating countries and institutions.

Regional Latin America

The ARCAL (Regional Cooperative Agreement for the Advancement of Nuclear Science and Technology in Latin America and the Caribbean) agreement provides a framework for Member States in Latin America and the Caribbean to intensify their collaboration through programmes and projects focused on the specific shared needs of its members. It was established in 1984 and became a formal inter-governmental agreement in 1998. The ARCAL acronym stems from its Spanish name ('Acuerdo Regional de Cooperación para la Promoción de la Ciencia y la Tecnología Nucleares en América Latina y el Caribe').

As part of the 2009-2011 Technical Cooperation Project cycle, approximately 24 ARCAL project proposals are currently being fine-tuned and finalized by different Latin American teams in close collaboration with several departments and divisions from IAEA. The deadline for finalization is 15 July 2008. The final discussion with Member States on these projects will be carried out during the General Conference in autumn of this year.

Two project designs are supported by technical officers at the Soil and Water Management & Crop Nutrition Subprogramme of the Joint FAO/IAEA Division, working in close collaboration with other IAEA teams:

(i) The first project design, followed-up jointly with the Agency's laboratories in Seibersdorf, addresses important environmental issues related to soil degradation by erosion. The project will generate regional capacity to provide reliable erosion data for different natural, forest and agro-ecosystems through the measurement of environmental radionuclide inventories. Soil redistribution rates will be measured using various theoretical approaches in order to assess erosion/sedimentation rates and the effect on soil ecosystems due to human intervention in selected areas of 14 countries in the region. This will lead to the development of more sustainable land management practices and soil conservation measures. The nuclear techniques, which would be used in this regional project, are developed through Coordinated Research Project D1.50.08 (Conservation Measures for Sustainable Watershed Management using Fallout Radionuclides).

(ii) The second project design is developed in collaboration with the Food and Environmental Protection Subprogramme of the same Joint FAO/IAEA Division. This project will target the implementation of a diagnostic system to assess the impact of pesticide contamination in food and environmental compartments at a catchment scale in the region (In total 13 countries are listed to participate). The project is based on results of a previous regional project.

A specific strategy is designed for the additional five countries that join this proposal in the second phase. In addition, as the former phase emphasized the development of analytical capacity in the laboratory, the next phase will focus as well on the issues of pesticide contamination at catchment scale. Therefore the collaboration between both Subprogrammes is of uttermost importance. Some of the basins are: Alto Valle del Rio Negro and Neuquén in Argentina, valleys of the Ribeira river in Brazil and the Apalta in Chile, Lake Tota in Colombia, the Machuca-Jesús María river in Costa Rica, Ariguanabo in Cuba, Jambeli and Saquimala rivers in Ecuador, Chapare in Bolivia, Salto in Uruguay and Artibonite Valley in Haiti.

Non-FAO/IAEA Meetings

- Eurosoil 2008, 25 to 29 August, Vienna, Austria. http://www.ecsss.net
- Agriculture Development through Human Capacity Building, 4 to 22 September, Galillee College, Nahalal, Israel. http://www.galilcol.ac.il/
- 5th International Conference on Land Degradation, 18 to 22 September, Bari, Italy. http://www.iamb.it/5ICLD/
- soilACE 2008 (II International Conference on Soil and Compost Eco-Biology), 26 to 29 November, Puerto de la Cruz, Tenerife, Spain. http://www.soilace.com/en_01_index.htm

Past Events

Duty Travels

Duty travel to Namibia for TC project NAM/5/008

Lee Heng recently travelled to Namibia (23 to 29 March 2008) as the technical officer of a TC project 'Increasing Crop Productivity and Resource Use Efficiency in the Northern Communal Areas'. The purpose of this travel was to: (1) Monitor TC project NAM5008 on 'Increasing Crop Productivity and Resource Use Efficiency in the Northern Communal Areas' implementation and progress, (2) Assess local capabilities and needs and to refine/update the work plan, (3) Provide training on soil water measurement and data analysis and interpretation, (4) Draft a technical report on outcomes and recommendations to TC Africa for follow up action, and (5) Assist the counterparts to develop the project design for 2009-2011 TCP in consultation with FAO.

Besides backstopping the project, Lee visited the FAO Office in Windhoek and met Mr. Louis Muhigirwa, the FAO Programme Officer in Namibia, to discuss possible collaboration. She also made a day trip to the field site in the northern communal region, 800 km from Windhoek, where the experiment of this project is being carried out.

Duty travel to Eritrea for TC project ERI/5/004

Joseph Adu-Gyamfi, Technical Officer (TO) for the TC project ERI5004 on 'Improving crop productivity and combating desertification' travelled to Eritrea (8 to 15 March 2008) to review the progress on an expert report, and to make technical adjustments to the work plans. Besides the technical consultations with Project Counterparts which resulted in identifying nominations for fellowship training and scientific visits anticipated in 2008 and 2009, the TO successfully organized a training course on the use of the carbon isotope discrimination technique to select crops for greater water use efficiency in water limited environments. A visit to the UNDP office helped the TO to streamline the process for the future delivery and clearance of equipment items for the project.

Duty travel to Mexico for a research coordination meeting (RCM) of CRP D1.50.10

Joseph Adu-Gyamfi travelled to Morelia, Mexico (21 to 25 April 2008) to act as Scientific Secretary for the second RCM of the CRP D1.50.10. Details of discussions and proposed recommendations during the RCM are highlighted in this Newsletter.

FAO/IAEA Events

Third Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) on Soil, Water and Nutrient Management for Conservation Agriculture (D1.50.09)

Scientific Secretary: Gerd Dercon

The third research coordinating meeting (RCM) of this CRP was held in Ankara, Turkey from 14 to 18 April with Gerd Dercon as the Scientific Secretary.

The main purpose of this RCM was: (i) to review and discuss the results of the research obtained since the second RCM, (ii) to evaluate the main achievements in accordance with project objectives and the agreed work plan (iii) to discuss further issues for implementing the last phase of the CRP and (iv) to plan strategies for collecting and analyzing the information and disseminating research results.

Seven research contractors from Argentina, Brazil, India, Morocco, Pakistan, Turkey and Uzbekistan; two technical contractors from Australia and Chile and one agreement holder from Mexico (also the individual contract holder from Kenya, linked to this CRP) attended the third RCM of this CRP. In addition, there were two observers: Dr. Jérôme Balesdent, INRA, France, and Mrs. Dumur Rajeswaree, IAEA fellow from Mauritius.

The meeting was opened by Mr. Tsukasa Kimoto, FAO Representative in Turkey (and also Officer-in-Charge, FAO Sub-regional Office for Central Asia). Dr. İlksen Hilal Dara, Director of the Saraykoy Nuclear Research and Training Centre, welcomed the participants of this RCM. Mr. Tsukasa Kimoto emphasized that the use of nuclear techniques and related conventional technologies provides a tremendous opportunity to contribute to the challenges of agriculture, globally and nationally, by developing improved management practices for food security and environmental sustainability. He recognized that conservation agriculture (CA), the core theme of the meeting, plays a major role in improving land management, as demonstrated in many countries. It was also indicated that almost 100 million hectares worldwide are currently under conservation agriculture. Dr. İlksen Hilal Dara presented the activities and impressive facilities of the Saraykoy Nuclear Research and Training Centre, the venue of this RCM meeting.

Data acquired so far by the CRP team indicates that CA conserves soil moisture, reduces soil organic matter mineralization, and improves biological nitrogen (N) fixation. The team further improved protocols to assess soil organic carbon dynamics. Finally, dissemination of the results was planned, with the team targeting common publications which will bring the datasets from the different participants together and cover topics such as carbon dynamics, biological N fixation and N-water interaction under CA management.

Participants of the third RCM of the CRP D1.50.09

Second RCM of the CRP on 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)

Scientific Secretaries: Joseph Adu-Gyamfi and Gerd Dercon

The second RCM of this CRP was held in Morelia, Mexico from 21 to 25 April with Joseph Adu-Gyamfi as the Scientific Secretary. The RCM was attended by ten participants including six research contract holders, two technical contractors and two agreement holders. Four of the research contract holders could not attend because of visa-related issues and three of the agreement holders failed to attend. The participants were welcomed by Dr. Silvia Figueroa Zamidio, President, Universidad Michoacana de San Nicolás de Hidalgo, who acknowledged the valuable collaboration between her University and the IAEA through this CRP. The FAO Representative in Mexico, Dr. Norman Bellino, in his opening address, stressed that low available soil nutrients and severe nutrient depletion is a threat to food security and environmental sustainability. He was confident that this CRP, funded by the Joint FAO/IAEA programme, will go a long way to help developing innovative crop and nutrient management strategies that will enhance the adaptability of crops to low nutrient environments using nuclear and related techniques. Ms. Leonel Godoy Rangel, Constitutional Governor, State of Michoacan de Ocampo, opened the meeting.

The Scientific Secretary (SC) outlined the objectives of the meeting which were to review, evaluate and discuss the achievements in accordance with the project objectives and agreed work plans, to discuss issues for implementing the second half of the CRP, and outline priorities, identify gaps and adjust work plans to achieve the overall objectives of the CRP. During an opening lecture on 'Integrated soil-plant approaches to increase crop productivity in harsh environment', the SC stressed the need to identify nutrient (nitrogen and phosphorus) sources and pools available to crop plants in low nutrient available soils.

The SC presented a framework for the CRP outlining the three pillars, i.e. screening, evaluation (2006-2008) and adaptation mechanisms (2008-2010). Protocols for determining soil P pools using unlabelled and labelled phosphorus were presented and discussed, and laboratories (China, Brazil, Cuba, Mali) which could use the protocols were identified The results presented by the participants at the RCM demonstrated the advances made in the CRP since the first RCM, especially the progress made by the participants in the implementation of their respective work plans.

The meeting agreed on the following:

(1) germplasm used should be classified based on the nature (landrace/local, improved material, breeding line or recombinant inbred lines), maturity duration (early, medium and late),

(2) standard definitions of low N and P,

(3) uniform definitions of uptake and utilization efficiencies of N and P,

(4) evaluation should be carried out under single-stress conditions and eliminate nutrient deficiencies other than N or P by adequate fertilizer additions, or acidity-related stresses (aluminium or manganese toxicity) by liming (or preferably using non-acid soils without acidity problems in deeper soil layers),

(5) varieties should always be compared and grouped using graphs presenting yield under high P conditions (P-sufficient) versus yield under low P conditions (P-stressed),

(6) phenology must always be taken into account. Sampling times should be systematically conducted at specific growing stages (e.g. flowering – R5, podding). correlation analysis between root characteristics and yield or P uptake should take into account size-independent measures (root angle, numbers of roots, allometric partitioning coefficients),

(7) when roots are sampled (shovelometrics) for root morphological characteristics, nodulation could be measured without much additional effort. A standard protocol could be shared, with some optional steps for scoring nodule activity.

The need to look at the mobilization of phosphorus in the soil rhizosphere by root exudates from plants through a technical contract was realized and discussed.

The meeting attracted media attention with three newspapers in Mexico reporting on the meeting. Ghana, Cameroon and Mozambique were proposed as candidates for the venue of the third RCM.

.

Opening Ceremony (from right, Dr. N. Bellino, FAO Representative, J. Adu-Gyamfi, IAEA, Ms. L.G. Rangel, Constitutional Governor, Dr. S.F.Zamudio, President, Universidad Michoacana de San Nicolás de Hidalgo, and the host Dr. J. Bayuelo-Jimenez

Participants at the second RCM

More Crops per Drop-Involvement in AquaCrop Model Development

Lee Heng attended a meeting on the development of FAO's AquaCrop model for predicting yield response to water, at the Headquarter in Rome in April (5 to April). This is an on-going collaboration with FAO in their crop water productivity programme to revise their document on 'Yield Response to Water', Irrigation and Drainage Paper No. 33 (Doorenbos and Kassam, 1979). Significant progress has been made on model development; the results have been presented at the 100th International Annual Meeting of the American Society of Agronomy (ASA), Crop Science Society of America (CSSA), and Soil Science Society of America (SSSA) in New Orleans, last November. The Agronomy Journal has also agreed to publish the results of this work in a special section on 'Modeling Water Use Efficiency'. The outcome of this collaboration is a more user-friendly model which can be used by scientists and land managers in Member States to manage scarce water for crop production under both rainfed and irrigated conditions.

Non FAO/IAEA Events

General Assembly of the European Geosciences Union (EGU), 13 to 18 April 2008, Vienna, Austria

Lionel Mabit (SSU) and Andreas Klik (Boku University)

The meeting brought together several thousand researchers from all around the world. The following paper from the Soils Subprogramme was presented under the programme group schedule *Soil System Sciences* during the Soil erosion and degradation on Mediterranean type ecosystems session: Erosion and sedimentation evaluation in a small agricultural Austrian watershed using Caesium-137, Lead-210 and traditional approaches. This contribution by L. Mabit and A. Klik, based on the use of fallout radionuclides and conventional water erosion measurements, was an opportunity to present to the EGU participants the results of a fruitful collaboration established two years ago between the Soil Science Unit and Boku University.

Status of Coordinated Research Projects (CRPs)

Selection for Greater Agronomic Water Use Efficiency in Wheat and Rice Using Carbon Isotope Discrimination (D1.20.08)

Technical Officer: Lee Heng

The objective of this project is to contribute to increasing the agronomic water use efficiency of rice and wheat production and to increase wheat productivity under drought and rice in salt-affected areas. Nine research contract holders from Algeria, Bangladesh, China (two), India, Morocco, Pakistan, Syrian Arab Republic and Yemen, two technical contractors (CSIRO-Australia and IRRI-Philippines) and one agreement holder (CIMMYT-Mexico) participated in this CRP. So far, three RCMs have been held with the last one held in Yinchuan, China in June 2007. All contracts have been renewed and the final RCM is scheduled to be held from 3 to 7 November 2008 in Vienna, Austria.

Assess the Effectiveness of Soil Conservation Techniques for Sustainable Watershed Management Using Fallout Radionuclides (D1.50.08)

Technical Officer: Gerd Dercon

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 are further developing fallout radionuclide methodologies, with particular emphasis on the combined use of ^{137}Cs, $^{210}Pb_{exc}$ and ^{7}Be for measuring soil erosion and sedimentation over several spatial and temporal scales.

The fourth and final research coordination meeting (RCM) of the CRP was successfully held in Vienna, Austria, in October 2007, with Felipe Zapata acting as Scientific Secretary. The report of the last RCM held at the IAEA was finalized and sent to the participants. Current efforts are focused on the preparation of manuscripts for the production of an IAEA TECDOC.

A wealth of valuable 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 143 scientific papers (peer-reviewed journals) have been published by the CRP participants. A further 43 papers are in preparation. Presentations have also been made at national and international scientific meetings.

Eleven contract holders from Brazil, Chile, China (two), 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) participated in this CRP.

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

Technical Officer: Gerd Dercon

The overall objective of this CRP is to enhance the productivity and sustainability of farming systems through a better understanding of the principles and practice of conservation agriculture. This should be achieved through the specific objective, which is to quantify the individual and interactive effects of conservation tillage practices, residue management, crop rotation, nutrient and water inputs to increase soil organic matter, resource use efficiency, agricultural productivity and environmental quality.

This CRP has 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) is conducting 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. Ms. Mirjam Pulleman represented CIMMYT until April 2008. As Mirjam has now taken up a research/academic position in the field of conservation agriculture at Wageningen University (The Netherlands) and, Mr. Bram Govaerts will replace her as the CIMMYT representative. Bram is a scientist well-known for his research in conservation agriculture in South America and Africa. On behalf of the CRP team, we would like to welcome Bram to our group and thank Mirjam for sharing her knowledge and her efforts to make this CRP a success.

The first, second and third RCMs were held in Vienna (Austria, June 2005), Rabat (Morocco, September 2006) and Ankara (Turkey, April 2008) respectively.

The CRP is entering its final phase, and has created an interesting database on soil-water-plant interrelationships in conservation agriculture. This database, which will be expanded within the next 15 months of the CRP, will provide valuable information on the long-term impact of conservation agriculture.

Progress reports and requests for contract renewal in 2008 will be evaluated in November-December this year. The fourth and final RCM is scheduled to be held in the second semester of 2009 at the IAEA headquarters in Vienna.

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

Technical Officers: Long Nguyen and Lee Heng

The first RCM of this CRP was held from 26 to 30 November 2007 at the IAEA Headquarters in Vienna, Austria. Thirteen participants consisting of nine research contractors, two technical contractors and two agreement holders attended the meeting.

The overall objective of this CRP is to improve the water productivity (production per unit of water input) of crops under water-limiting conditions. The standardized methodology and protocols to be used by all participants have been sent to each of them. The next RCM will be held in 2009 in China.

Laboratory Activities

Research

Assessment of erosion and sedimentation rates using ^{137}Cs, $^{210}Pb_{ex}$ and conventional erosion measurements within an Austrian watershed (Mistelbach)

L. Mabit (Soil Science Unit), A. Klik [(1)], Moncef Benmansour [(2)], A. Toloza (Soil Science Unit), A. Geisler [(3)] and U.C Gerstmann [(3)]

[(1)] Universität für Bodenkultur (BOKU), Department für Wasser-Atmosphäre-Umwelt, Institute of Hydraulics and Rural Water Management, Vienna, Austria
[(2)] Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN), Rabat, Morocco
[(3)] GSF-National Research Center for Environment and Health, Institute of Radiation Protection, Neuherberg, Germany

The magnitude of sedimentation processes was evaluated using Fallout RadioNuclides 'FRNs' (^{137}Cs and $^{210}Pb_{ex}$) and the mid-term (13 years) magnitude of erosion rates was quantified through conventional runoff plot measurements in a small Austrian watershed. Our objectives were to measure the magnitude of soil erosion under conventional and conservation cropping practices using runoff plots and to test and validate the potential use of FRNs as soil tracers to assess sedimentation rates under Austrian field conditions.

In Mistelbach, during 1994 and 2006, runoff and erosion rates were measured by BOKU University using erosion plots to investigate the impacts of different tillage practices. Three tillage treatments were compared: conventional tillage system (CT); conservational tillage (CS) with cover crops during winter; and direct seeding (DS) with cover crops during winter. The study design consists of a 3x15 m runoff plot for each treatment. The soil erosion results obtained are presented in Table 1.

Table 1. Soil erosion rates obtained from the erosion plots (1994-2006)

Year	*crop*	*Soil loss (t^{-1} ha^{-1} yr^{-1})*		
		CT	*CS*	*DS*
1994	corn	317.20	43.8	26.00
1995	w-wheat	0.12	0.06	0.04
1996	sugar beet	3.25	0.60	0.41
1997	s-barley	0.00	0.00	0.00
1998	sunflower	19.75	5.92	5.43
1999	w-wheat	0.00	0.00	0.00
2000	corn	0.00	0.00	0.00
2001	w-wheat	0.00	0.00	0.00
2002	corn	11.98	0.16	0.38
2003	w-wheat	0.03	0.04	0.02
2004	sunflower	0.05	0.03	0.04
2005	w-wheat	n.m	n.m	n.m
2006	corn	0.34	0.08	0.07
Average erosion rate (t^{-1} ha^{-1} y^{-1})		*29.38*	*4.22*	*2.70*

CT = conventional tillage system; CS = conservational tillage with cover crops during winter; DS = direct seeding with cover crops during winter; n.m = not measured

As presented in the previous Soils Newsletter (Vol. 30, No. 2), the initial ^{137}Cs fallout was evaluated in an undisturbed forest within the watershed at 1954 ± 91 Bq m^{-2} (n = 76).

In addition, in the sedimentation area of the watershed, soil profiles were collected to a depth of 1m using a soil column cylinder auger with a gasoline-powered hammer (Figure 1).

Among the 76 samples collected from the reference site, 11 samples were randomly selected to be analyzed later in the laboratory for the determination of the $^{210}Pb_{ex}$ reference level.

$^{210}Pb_{ex}$ activities were calculated by measuring both total ^{210}Pb and ^{226}Ra and subtracting the supported ^{210}Pb in equilibrium with ^{226}Ra from the ^{210}Pb total activity. Also for the samples collected in the sedimentation area, the ^{137}Cs, the total ^{210}Pb, the ^{226}Ra and the $^{210}Pb_{ex}$ activity were measured.

In the deposition area, the areal activities of ^{137}Cs were converted into sedimentation rates (t ha^{-1} yr^{-1}) based on the ^{137}Cs depth information provided by the soil profiles and taking into account the reference value inventory (1954 ± 91 Bq m^{-2}).

Figure 1: Soil samples collection in the sedimentation area in Mistelbach watershed

Evaluation of soil deposition magnitude using ^{210}Pb and ^{137}Cs methods.

(i) In the reference site (n=11) the total ^{210}Pb activity ranged from 30.5 to 43 Bq kg^{-1} for a mean value of 37.9 Bq kg^{-1}± 11% (mean ± CV), the ^{226}Ra ranged from 33.1 to 40.4 Bq kg^{-1} for a mean value of 36.3 Bq kg-1 ± 7% (mean ± CV) and the ^{210}Pb$_{ex}$ ranged from 0 to 9.15 Bq kg^{-1} for a mean value of 2.7 Bq kg^{-1} ± 115% (mean ± CV).
The average measurement error for the reference site and the sedimentation area samples at 2 sigma for total ^{210}Pb, ^{226}Ra, ^{210}Pb$_{ex}$ (n=40) were 11.3±1.6%, 5.5±1.1% and 377±210%, respectively at 95% confidence level. The measurement error of total ^{210}Pb and ^{226}Ra was acceptable. The measured values of total ^{210}Pb and ^{226}Ra were similar and the bias concerning the value of ^{210}Pb$_{ex}$ can be as high as the measured value itself.
Due to a similar activity of total ^{210}Pb and ^{226}Ra reflected by a very low level of ^{210}Pb$_{ex}$ coupled with a high variability of the initial fallout inventory and a high measurement error, it was not possible to use the ^{210}Pb$_{ex}$ as a soil tracer to obtain sedimentation rate values in the study area.

Similar limitations have already been reported in New Zealand, France and Russia.

(ii) In the sedimentation area ^{137}Cs was present until a depth of 50 cm and the maximum areal activity of the soil profiles was 4776 Bq m^{-2} with a maximum activity at a 10-20 cm depth of 1344 Bq m^{-2}.
The conversion of the ^{137}Cs data into soil movement was based on the ^{137}Cs depth profile information which can provide directly the deposition. It was estimated that during the 54-year period, the sedimentation rates were 50.5 t ha^{-1} yr^{-1} corresponding to an average layer sedimentation of 3.7 mm yr^{-1} equivalent to a total material accumulation of 20 cm during the 1954-2007 period.

This study demonstrates the complementarities between the FRNs and the conventional soil erosion measurements using runoff plots. In order to better understand and quantify sediment transfer and storage, our future investigations will focus on the comparison of the magnitude and spatial distribution of soil erosion/deposition using FRNs, particularly ^{137}Cs (laboratory and in-situ measurements) and conventional measurements. Also interpolation tools will be used to evaluate the spatial variability of the initial ^{137}Cs fallout at the reference site.

Bringing hope to marginal and harsh environments: The use of carbon-13 isotope discrimination technique to evaluate and select food crops adapted to water and salt stress environments

Joseph Adu-Gyamfi, SSU

Introduction

Many countries have weather patterns and soil characteristics that place major constraints on food production systems over large tracts of land. Thus a major challenge for making better use of these marginal lands is not only to select appropriate crops but also to evaluate and optimize their adaptability and crop productivity under extreme climatic conditions (high temperatures and low rainfall) or where soils suffer from salinity, acidity or low plant nutrient status. The carbon isotope discrimination technique (using the ratios of different carbon isotopes [^{12}C/^{13}C] in plants) commonly referred to as CID, has been proposed as a possible selection criterion for greater water use efficiency in breeding programmes for water limited and salt stress environments because it provides an integrative assessment of genotypic variation in leaf transpiration efficiency. Although the relationship between CID and water and/or salt stress have been well studied and documented for many crop plants, few studies have looked at the combined effects of salt, water and nutrient stresses on the potential use of this technique to select and evaluate crop plants adapted to harsh environments.

Basic Principles

Carbon, the major building block of carbohydrate and proteins in plant tissues, contains both light and heavy carbon stable isotopes (^{12}C and ^{13}C). The measurement of natural variations in the abundance of ^{13}C and ^{12}C in plant materials is increasingly being used to select and evaluate plant cultivars which can withstand drought and salt stress. Under drought, less carbon (in the form of carbon dioxide), particularly ^{13}C from the atmosphere is taken up by plants for growth because of plant stress, thus creating a major variation in the natural isotopic ratios of ^{13}C and ^{12}C in plant materials. A plant cultivar, which is resistant to water scarcity, should display less depletion in ^{13}C than a susceptible cultivar. Such discrimination against ^{13}C (i.e. difference between ^{13}C and ^{13}C, expressed as delta δ^{13}C) in plant tissues (leaves and grains) has been successfully used in the selection of drought-resistant species. Under saline conditions, it has been hypothesized that high delta values (maximum discrimination) are positively correlated with increased salt tolerance in rice varieties. In addition, a reduction in δ^{13}C as salinity

increases suggests that salinity induces a greater degree of stomata resistance which provides less opportunity for discrimination against the heavier ^{13}C isotope, indicating that $\delta^{13}C$ (^{13}C /^{12}C isotopic ratio) could be used as a selection criterion in breeding efforts to develop salt tolerant crops. The $\delta^{13}C$ in plant leaves and grain have been shown to be negatively related to water use efficiency (WUE).

Experiments and results

Two separate experiments were conducted in the glasshouse to fine-tune the CID methodology. The first experiment aimed at examining the combined effects of salt and drought on the effectiveness of the CID technique using wheat, rice and maize and the second experiment was to assess the use of the CID technique to select wheat varieties tolerant to water stress under phosphorus deficient soils. In the first experiment, the soil used was a fertile alkaline soil [total N (2.27 g.kg^{-1}), C (32 g. kg^{-1}), total P (1115 mg. kg^{-1}), available P (382 mg.kg^{-1} Bray P2), pH KCl (7.5)]. The pots used contained 4 kg soil: sand mixture (1:1) and six treatments including (i) control (ii) salt (50mM or 10 dSm-1 applied 8 days after planting) (iii) drought 1 (30% field capacity [FC] 8 d after planting) (iv) drought 2 (30% FC at 50% booting) (v) drought 1 x salt (vi) drought 2 x salt. The soil moisture was monitored with time domain reflectometers (TDR). Four spring wheat varieties from Kazakhstan (*Saratovskaya, Severyanka, Stepnaya-15 and Otan-1*), two upland rice varieties (WAB 5650 and ROK 3) from Sierra Leone, and two maize varieties from Austria (*ES Beatle, and DK 375*) were arranged in a randomized complete block design with 3 replications. In all there were 72 pots for the wheat, 36 each for the rice and maize varieties. Each pot contained 3 plants and received fertilizers equivalent to 100 kg N (N-15 ammonium sulphate at 2% atom excess) in two split applications, 40 kg P (as triple superphosphate) and 50 kg K (muriate of potash) per ha.

For the second set of experiments to assess the effectiveness of the CID technique under low soil nitrogen and phosphorus conditions, wheat, maize and rice varieties were used.

The soil used was acidic and very low in fertility [total N (0.83 g. kg^{-1}), C (7.91 g. kg^{-1}), total P (233 mg. kg^{-1}), available P (6.5 mg. kg^{-1} Bray P2), pH KCl (5.4)]. Four wheat varieties (*Saratovskaya, Severyanka, Stepnaya-15 and Otan-1*) from Kazakstan were grown in pots containing 4 kg soil with 4 P levels (0, 20, 40 and 60 kg ha^{-1} P) which received basal fertilizer application equivalent to 100 kg N/ha (N-15 ammonium sulphate at 2% atom excess) and 50 kg K/ha. A rice cultivar (*Oryza savita L.,TDS 5*) from Vietnam and a maize cultivar NP-7 from Venezuela, were grown with four P levels (0, 20, 40 and 60 kg ha^{-1} P), three N levels (0, 50 and 100 kg ha^{-1} N) and two salt treatments (1 and 10 dSm^{-1}). The CO_2 in the glasshouse was monitored and compared with the ambient CO_2. A soil water monitoring device, the time domain reflectometer (TDR), was installed in all the pots and water was supplied to the pots based on the TDR readings. All of the plants were harvested at physiological maturity, separated into spikes (if any), shoot and roots, oven dried to a constant temperature of 70^{o}C, weighed and ground. A portion of the ground samples was analysed for $\delta^{13}C$, total carbon, total nitrogen and atom % ^{15}N using the Europa Scientific ANCA 20-20/GSL and GV Instruments Isoprime stable isotope mass spectrometers.

The combined effects of water stress and salinity resulted in less negative ^{12}C /^{13}C ($\delta^{13}C$) values as compared to the other treatments. The method was successfully used to evaluate and select wheat and rice genotypes from Kazakhstan and Vietnam tolerant to drought and salinity conditions. However, increasing P supply resulted in less negative values of δ in wheat but not in rice, indicating that low P availability favours high negative $\delta^{13}C$ values. This shows that the CID technique is influenced by soil phosphorus and nitrogen availability, suggesting that the use of this technique to evaluate drought and salt tolerant genotypes in nutrient-stressed environments requires further investigation. Details of experimental results and discussions are available in the Soil Science Unit Activity Report 2007.

Fellowships

Name	Country	Area of Training	Period
Mr. Asivelo Fanantenansoa Solonjara (MAG/07007)	Madagascar	Use of Fallout radionuclides (FRNs) – especially ^{137}Cs and ^{7}Be – to assess erosion and sedimentation processes	3 March to 2 June
Mr. Trilock Ram (MAR/07005)	Mauritius	Field estimation of soil water content and water balance using different soil water monitoring equipment under two irrigation regimes	3 March to 2 August
Mr. Burhanuddin Rasyid (INS/07006)	Indonesia	Comparing soil water moisture equipment (installation, measurements, data collection, analysis and data interpretation)	3 March to 2 July
Mr. Mohammad Ubaidulla Shirazi (PAK/05047)	Pakistan	Use of combined isotopes of carbon and oxygen to evaluate wheat and *Brassica* genotypes for their tolerance to drought and salinity	3 March to 2 August
Mr. Hamid Bachiri (ALG/07029)	Algeria	The use of carbon isotope discrimination to evaluate wheat lines tolerant to drought and salinity	1 April to 30 June
Mr. Mohammad Ashiqur Rahman (BGD/07017)	Bangladesh	Field estimation of crop-water balance under irrigated and non-irrigated conditions	14 April to 13 August

Soil Science Unit (SSU) staff members are involved in field and laboratory training as well as lecturing to fellows in the areas outlined above. In addition, staff members from IAEA Headquarters, particularly Ms. Lee Heng, have also assisted fellows in the use of conventional, isotopic and nuclear techniques to determine soil water measurement and evapotranspiration.

Scientific Visitors

Name	Country	Area of Training	Period
Mr. Keven Selwin Nancy (SEY/07001)	Seychelles	Use of isotopes in soil science	12 to 16 November 2007 (*addition to last Newsletter issue)
Mr. Boubacar Traore (MLI /8001)	Mali	Use of nuclear techniques in crop nutrition and water management	14 to 18 January
Ms. Indoomatee Ramma (MAR/07004)	Mauritius	Use of nuclear techniques in crop nutrition and water management	3 to 7 March
Mr. Almoustapha Fofana (MLI/08004)	Mali	Use of fallout radionuclides in measurement of erosion and sedimentation	3 to 14 March
Mr. Mohammad Qasem Obaidi (AFG/08012)	Afghanistan	Use of nuclear techniques in crop nutrition and water management	31 March to 4 April

Other visitors to the SSU

Ms. Tigist Oicha, a PhD student of Prof Klik, BOKU University, to discuss possible collaboration on the use of isotopes in Conservation Agriculture on 30 April 2008.

Mr. Martin Parcher, a staff member of BOKU University in Tulln, to study sample preparation for C-13 analysis as part of the collaboration with the University on the use of carbon isotope discrimination to evaluate wheat lines tolerant to drought.

Mr. Thomas Momber, from E.N.T.P.E (Ecole Nationale des Travaux Publics de l'Etat), France, visited the SSU on 22 April 2008 and received information on the use of Fallout Radionuclides to assess erosion and sedimentation processes.

Mr. Tahir Diop and **Mr. Ibrahim Ndoye** from the Université Cheikh Anta Diop de Dakar (Senegal) visited the Unit and Section from 22 to 25 April 2008 for a planning workshop for the TC project SEN5030 (Integrated approach to develop sustainable agriculture in Senegal). This planning workshop was organized by the Department of Technical Cooperation (Division for Africa) in collaboration with the Soil and Water Management & Crop Nutrition and Plant Breeding and Genetics Subprogrammes of the Joint FAO/IAEA Division.

Analytical services

Leo Mayr and Doris Gludovacz

The Soil Science Unit provides stable isotope analyses for CRPs, TCPs, individual technical contracts (TC) and for FAO/IAEA regular research and training activities. The following table is a summary of the analytical work provided during 2007.

Samples measured:

	^{15}N enriched	^{15}N nat. ab.	^{13}C nat. ab.	^{18}O nat. ab.	Total
D1-2008	0	0	1502	0	1502
D1-5009	344	33	196	0	573
TC (URU-12845)	61	0	0	0	61
TCPs	226	253	0	0	479
Seibersdorf	1289	173	1135	0	2597
Total	**1920**	**459**	**2833**	**0**	**5212**

Measurements carried out:

	^{15}N enriched	^{15}N nat. ab.	^{13}C nat. ab.	^{18}O nat. ab.	Total
D1-2008	0	0	2335	0	2335
D1-5009	634	53	343	0	1030
TC (URU-12845)	113	0	0	0	113
TCPs	292	542	0	0	834
Seibersdorf	2685	530	2889	264	6368
Total	**3724**	**1125**	**5567**	**264**	**10680**

Publications

Recent Titles

Guidelines on Nitrogen Management in Agricultural Systems. Training Course Series No. 29. IAEA, Vienna, Austria (2008). Link to http://www-pub.iaea.org/mtcd/publications/PubDetails.asp?pubId=7612.

This publication deals with the topic of nitrogen management in agroecosystems. Nitrogen (N) is an essential plant nutrient and N deficiency severely restricts crop yields in most cultivated soils. Therefore, substantial N inputs are required for optimum plant growth and adequate food, feed and fibre production. Developing countries use more than 55 million metric tons (MT) of N fertilizers at an estimated value of 16 billion US$ annually of which approximately 2 million MT are used in Africa, 5 in Latin America and 50 in Asia. It is estimated that adequate production of food (in particular cereals) for present and future populations will not be achieved without external inputs of fertilizer N. However, management practices involving fertilizer N should be efficient in order to optimize crop production while minimizing adverse effects on the environment. Moreover, the use of alternative N sources such as organic residues and biological nitrogen fixation should be increased within the context of Integrated Soil Fertility Management to ensure food security in areas of the world where fertilizer N is too expensive or simply not available. At the present legumes such as soybean, common bean, groundnuts, chickpeas, cowpeas etc are fixing approximately 11 million MT of N in developing countries. This publication covers, concisely and comprehensively, key topics dealing with the utilization of all sources of N in farming systems, and in particular to demonstrate to scientists in developing countries how isotopic tracer technologies can be used in research to improve overall N-use efficiency in agricultural systems while increasing crop yields in a sustainable manner, i.e. conserving the natural resource-base and protecting the environment. It is a timely publication; increasing attention is being paid to N management in food production, energy consumption and environmental protection.

Field Estimation of Soil Water Content. Training Course Series No. 30. IAEA, Vienna, Austria (2008), 132 p. Link to: http://www-pub.iaea.org/mtcd/publications/PubDetails.asp?pubId=7801.

This Guideline is the product of an international study conducted by IAEA comparing the advantages and disadvantages inherent in the various soil water measuring techniques under laboratory and field conditions. These techniques include electromagnetic (EM), soil moisture neutron probe (SMNP), electrical resistance and gravimetric methods). The Guideline shows that the field-calibrated SMNP remains the most accurate and precise method for soil profile water content determination thus assisting in the provision of accurate soil water balance data for improving crop water use efficiency and irrigation water use efficiency. The capacitance EM sensors exhibit much more variability in the field than the SMNP or direct soil water measurements; they are not recommended for soil water balance studies as they are less accurate and are more prone to soil salinity and temperature fluctuation which often occur in irrigated soils.

Publications - Papers in Scientific Journals and Conference Proceedings

Dercon G., Poesen, J., Deckers, J., Govers, G., Tacuri, E., Villavicencio, A., Iglesias, C., Loaiza, G., 2008. Non-linear behaviour of soil translocation in response to slope gradient by mechanised tillage in steepland agriculture: The role of tillage speed and field surface form. Catena (Accepted).

Evett, S.R., Heng, L.K., Moutonnet, P., Nguyen, M.L. 2008. Field Estimation of Soil Water Content: A Practical Guide to Methods, Instrumentation and Sensor Technology. IAEA-TCS-30. International Atomic Energy Agency, Vienna, Austria. ISSN 1018-5518. 131 p.

Evett, S.R., Hignett, C., Heng, L. 2008. Electrical resistance sensors for soil water tension estimates. In: Evett, S.R., Heng, L.K., Moutonnet, P., Nguyen, M.L., editors. Field Estimation of Soil Water Content: A Practical Guide to Methods, Instrumentation, and Sensor Technology. IAEA-TCS-30. International Atomic Energy Agency, Vienna, Austria. ISSN 1018-5518. p. 123-129.

Heng, L.K., Evett, S.R. 2008. Tensiometers. In: Evett, S.R., Heng, L.K., Moutonnet, P., Nguyen, M.L., editors. Field Estimation of Soil Water Content: A Practical Guide to Methods, Instrumentation, and Sensor Technology. IAEA-TCS-30. International Atomic Energy Agency, Vienna, Austria. ISSN 1018-5518. p. 113-121.

Heng, L.K., S.R. Evett, T.A. Howell and T.C. Hsiao. 2007. Calibration and testing of FAO AquaCrop model for rainfed and irrigated maize. [abstract]. ASA-CSSA-SSSA Annual Meeting, November 4-8, 2007, New Orleans, Louisiana. 2007 CDROM.

Hsiao, Theodore C., Heng, Lee, Steduto, Pasquale, Raes, Dirk, and Elias Fereres. 2007. AquaCrop – Model parameterization and testing for maize. [abstract]. ASA-CSSA-SSSA Annual Meeting, November 4-8, 2007, New Orleans, Louisiana. 2007 CDROM.

Mabit, L**.,** Bernard, C., Makhlouf, M., Laverdière M.R. (2008). Spatial variability of erosion and soil organic matter content estimated from ^{137}Cs measurements and geostatistics. Geoderma (Accepted).

Mabit, L., Klik, A. (2008). Erosion and sedimentation evaluation in a small agricultural Austrian watershed using Caesium-137, Lead-210 and traditional approaches. In: Geophysical Research Abstracts (CD-Rom), Volume 10, European Geosciences Union - General Assembly 2008, ISSN: 1029-7006. Abstract EGU2008-A-01651.pdf, 2 pages. http://www.cosis.net/abstracts/EGU2008/01651/EGU2008-A-01651-2.pdf.

Pansak, W., Hilger, T., Dercon, G., Kongkaew, T., Cadisch, G., 2008. Changes in the Relationship between Soil Erosion and N Loss Pathways after Establishing Soil Conservation Systems in Uplands of Northeast Thailand. Accepted in Agriculture Ecosystems and Environment (In press).

Schmitter, P., Hertel, M., Dercon, G., Hilger, T., Thi Le Ha, T., Huu Thanh, N., Duc Vien, T., Van Dung, N. and Cadisch, G. (2008) Linkage between sediment induced spatial variability in soil quality and rice performance in paddy fields in mountainous regions of Vietnam. International Conference of the Society for Tropical Ecology. Consequences of climate change on tropical ecosystems, Stuttgart, February 2008.

Tiessen, K.H.D., Dercon, G., Sancho, F., Lobb, D.A. and Mehuys, G.R. (2008) Tillage erosion – A different way to look at soil erosion and conservation within steepland potato production in the Americas. Potato science for the Poor - Challenges for the new Millennium. Cuzco, Peru. March 2008.

Wani, S., L. Heng, A. Facchi, P. Singh, P. Steduto. 2007. Productivity of soybean-based systems in semi-arid tropics. Testing with AquaCrop. [abstract]. ASA-CSSA-SSSA Annual Meeting, November 4-8, 2007, New Orleans, Louisiana. 2007 CDROM.

Zaman, M., Nguyen, M.L., and Saggar, S. N_2O and N_2 emissions from pasture and wetland soils with and without amendments of nitrate, lime and zeolite under laboratory conditions. Australian Journal of Soil Research 46. (In Press).

Zaman, M., Nguyen, M.L., J. D. Blennerhassett, J.D., Quin, B.F. Reducing NH_3, N_2O and NO_3-N losses from a pasture soil with urease or nitrification inhibitors and elemental S-amended nitrogenous fertilizers. Biol Fertil Soils (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

IAEA
International Atomic Energy Agency

Soils Newsletter
Vol. 31, No. 1
July 2008

The Soils Newsletter is prepared twice per year by the Soil and Water Management & Crop Nutrition Section, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture and FAO/IAEA Agriculture and Biotechnology Laboratory, Seibersdorf.

International Atomic Energy Agency
Wagramer Strasse 5, P.O. Box 100,
A-1400 Wien, Austria

Printed by the IAEA in Austria,
July 2008

08-22161