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Fellowship training on soil sampling techniques to monitor soil organiccarbon sequestration.

To Our Readers

The Soil and Water Management & Crop Nutrition (SWMCN) Subprogramme, including the SWMCN Section and the SWMCN Laboratory have been through a period of significant change during the past six months. February–March 2013 saw the retirement of two long serving staff members; Rosario Leon De Müllner (after almost 22 years with the IAEA, including nearly 12 years with the SWMCN Subprogramme) and José Luis Arrillaga (30 years). During this period, we also bid farewell to Joseph Adu-Gyamfi who had been with the SWMCN Laboratory for seven years. The contributions and expertise that Rosario, José and Joseph provided to the SWMCN Subprogramme have been enormous and I am grateful for their dedication and support.

It has been a pleasant surprise and an honour to receive notification from the Agricultural Research Services (ARS) of the United States Department of Agriculture (USDA) that both Lee Heng and I are to be recipients of the 2012 Agricultural Research Services (ARS) Outstanding Sustained Effort Technology Transfer Awards for our contribution towards transferring technologies and practices to end users. Lee Heng will travel to the USA to receive these prestigious awards and to celebrate the occasion with Steve Evett of USDA who is also a recipient of this award. Steve is a strong supporter of the SWMCN Subprogramme and has been working with us on soil moisture sensors using both nuclear and conventional techniques.

IAEA International Atomic Energy Agency

The SWMCN Subprogramme is planning to publish the proceedings of approximately 60 papers that were successfully presented at the FAO/IAEA International Symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation" in Vienna, 23–27 July 2012. With the valuable editorial assistance of Jim Dargie, the previous Director of the Joint FAO/IAEA Division, these papers are currently being reviewed and will be published in December 2013 or early 2014. These proceedings will provide valuable information to Member States on the advances in both nuclear and related techniques used in sustainable land management studies and innovative soil-water-nutrient management practices for climate smart agriculture.

Two new coordinated research projects (CRPs) are being launched this year, one titled "Landscape Salinity and Water Management for Improving Agricultural Productivity" and the second titled "Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping-Livestock Production Systems". The first research coordination meeting (RCM) for the salinity CRP will be held in Vienna from 15–19 July 2013, while the RCM for the integrated cropping-livestock CRP will be held from 22–26 July 2013. The salinity CRP will address an increasing concern in Member States, namely to reduce the impacts of climate change and variability on the widespread increase in landscape water and soil salinity on food production. The integrated cropping-livestock CRP aims to optimize land and water management practices for sustainable food production and conservation of agricultural resources and to mitigate greenhouse gas emissions from these integrated systems.

Besides coordinating seven CRPs (including two new projects as mentioned above), the SWMCN Subprogramme provides technical support to 51 technical cooperation (TC) projects, including ten regional TC projects and conducts/organizes 12 training courses either in the SWMCN Laboratory in Seibersdorf or in Member States on a range of topics, including agricultural water management, fertilizer and nutrient use efficiency, soil organic carbon management, soil erosion and soil conservation measures. All these courses aim to generate the capacity necessary for Member States to improve land productivity and increase soil resilience to climate change and variability.

With increasing global concern on the impacts of climate change and variability on food production and security, the conservation of finite resources such as soil and water for basic needs and the increasing global population and demand for food quantity and quality, the SWMCN Subprogramme is focusing its activities on supporting Member States to meet new challenges by developing appropriate land-water technology packages for climate smart agriculture. You can read more in this Soils Newsletter about these activities, including the modernization of equipment and infrastructure in the SWMCN Laboratory. I am counting on all of you for your continuing support and guidance.

Wishing you all the best,

Minh-Long Nguyen
Head
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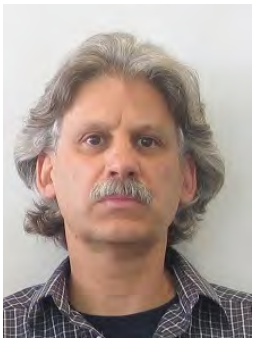
Staff News

Joseph Adu-Gyamfi, Soil Scientist/Plant Nutritionist, SWMCN Laboratory, left the Agency on 14 March 2013 after seven years of service. Joseph, a Ghanaian national, received his PhD in Plant Nutrition and Crop Physiology in 1991 from the University of Hiroshima, Japan. Joseph had 13 years of experience in Africa and Asia working with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) of the Consultative Group on International Agricultural Research (CGIAR) as a Principal Scientist (Physiology), Team Leader of Government of Japan/ICRISAT Collaborative Project, ICRISAT Country Representative in Nigeria and Regional Theme Coordinator for West and Central Africa of the regional research project on integrated genetic and soil fertility management. Previously, Joseph also worked as a Senior Research Scientist with CSIR (Ghana), Expert/Senior Consultant on monitoring and evaluation of agro-and industrial-based projects for USAID and Danida, and as a Senior Lecturer at the University of Ghana. He had considerable experience and knowledge on the use of ^{15}N, ^{13}C, ^{14}C and ^{32}P, before joining the Soil Science Unit of the FAO/IAEA Agriculture & Biotechnology Laboratories in Seibersdorf, Austria, in March 2006.

At Seibersdorf he contributed to the design and implementation of fourteen national TCPs (Asia & Pacific, Africa and Europe) and one CRP (15 participating countries) aimed at improving biomass productivity in nutrient-stressed, drought- and saline-prone environments through the use of isotopes of nitrogen (N), phosphorus (P) and carbon (C). During his time at Seibersdorf he organized one interregional training course (22 fellows), 10 group fellowship training (54 fellows), 45 individual training through fellowships, 50 individual scientific visits and four consultant and intern placements. Joseph also developed several inter-laboratory collaborations with Plant Breeding and Genetics and Food and Environment Program laboratories and Member States. He authored/co-authored nine journal articles, two contributions to IAEA TECDOCs, 14 conference proceedings and completed a TECDOC on "Optimizing productivity of food crop genotypes in low nutrient soils".

The SWMCN subprogramme will remember Joseph for his contributions to developing protocols for (i) evaluation of plant root traits that enhance N and P acquisition and utilization in low nutrient environments (ii) stable isotope probing to elucidate the role of soil microorganisms in nutrient cycling and soil quality, and (iii) the use of oxygen-18 isotopes in phosphate to trace P sources and cycling in soils (a new method). As the Acting Head of the SWMCNL from April 2011 to August 2012 Joseph successfully implemented the activities of the Laboratory and produced four banners and six success stories that explained the main activities and achievements of the SWMCNL.

We thank Joseph for his contribution to the SWMCN Subprogramme and wish him well in his future career.



José Luis Arrillaga, Senior Laboratory Technician retired in March 2013 after 30 years of service to the SWMCN Subprogramme, particularly to the SWMCN Laboratory. On behalf of the Section and the Laboratory, Minh-Long Nguyen and Gerd Dercon thanked José for his long service.

Over all these years José played a key role in the development of research and training activities in the field of water management at the SWMCN Laboratory. José helped hundreds of scientists and technicians from across the world to discover the secrets of water in the soil and use basic and advanced soil water monitoring devices. His training skills were continuously praised by participants from Member States.

In the coming months José will assist the SWMCN Laboratory as short term consultant in group trainings in the field of agricultural water management (3 June–2 August 2013).

We wish José well in his retirement!

Rosario Leon De Müllner, Team Assistant in the SWMCN Section, retired in late February 2013 after nearly 10 years of dedication and support to the activities of the SWMCN Subprogramme. She joined the SWMCN Section in July 2003 after 12 years (July 1991–July 2003) with the Animal Production and Health Section and nearly seven years with UNIDO (January 1985–July 1991). Her institutional knowledge and hard-working attributes have been of tremendous help to the Head of the SWMCN Section and all the team members in the Section and the Laboratory.

We miss Rosario's inputs, particularly her attention to detail and her prompt following-up approach. We wish Rosario all the best in her retirement.

Béatrice Brenier, joined the SWMCN Section as a temporary Team Assistant after Rosario's retirement. Béatrice has been working with the IAEA over the past five years, including 2.5 years in the Research Contracts Administration Section and 15 months in the Technical Cooperation Department. Béatrice is assisting the SWMCN Subprogramme in organizing research coordination meetings and updating all papers that are submitted for review and publishing in the FAO/IAEA International Symposium Proceedings. We welcome Béatrice to the SWMCN Subprogramme.

Feature Articles

Managing Irrigation Water to Enhance Crop Productivity under Water Limiting Conditions: A Role for Isotopic Techniques

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Agriculture consumes about 75% of all freshwater withdrawals. This amount is predicted to increase by 50% by 2025 in developing countries, and by 18% in developed countries to feed the growing population (WWAP, 2006). However, crop water productivity (the amount of water per unit of production, CWP) is less than 40% in many coutries. This was due to sparse vegetation cover as a result of sub-optimal or inefficient soil and irrigation management practices. One of the main losses of water is soil evaporation. By knowing the proportion of water loss as soil evaporation (E) and crop transpiration (T) allows management practices to be implemented to minimize the E component. This article summarizes results obtained from Malawi (maize), China (maize) and Vietnam (coffee) from an IAEA coordinated research project (CRP) on Managing Irrigation Water to Enhance Crop Productivity under Water Limiting Conditions: A Role for Isotopic Techniques, implemented from 2007 to 2012. Both isotopic and conventional techniques have been used at these two field sites to separate E and T from ET. The isotopic data obtained was analysed for E and T using the isotopic mixing relationship (Keeling plot) and the isotopic mass balance approaches (Keeling plot, Keeling, 1961; Williams et al., 2004; Hsieh et al., 1998). Results of maize from Malawi showed that increasing nitrogen (N) application rates from 50 kg N ha^{-1} to 150 kg N ha^{-1} reduced the proportion of E under both crop water requirement (ETc) treatments, with the proportion of E the least in treatment receiving 150 kg N ha^{-1} and 100% ETc (Table 1), attributed to the combination of both adequate N and water for crop growth.

In China, covering the soil surface with plastic film reduced E component of the maize crop to 12% from 31% under conventional practices (Table 2).

Soil E losses of a 10 year old coffee tree plantation in central Vietnam for the period from flowering to bean development are shown in Table 3. When the ground was mulched with branches and leaves of coffee plants and drip irrigated, the T component was as high as 92–95% compared to non-covered ground, furrow irrigated where total water loss through E was three times more (Table 4).

Table 1. Separation of E from ET for maize crop in Malawi at different crop water requirement (ETc) and nitrogen (N) levels

Malawi		
Irrigation (% ET_C)	N (kg N ha^{-1})	E/ET
50	50	0.92
	150	0.87
100	50	0.83
	150	0.80

Table 2. Separation of E from ET in maize crop in China

China	E/ET
Conventional	0.31
Filming	0.12
Mulching	0.24
Bare soil	0.38

Table 3. The E component of coffee plants at the different stages (mature, budding and flowering, and bean development) as determined by the isotopic technique

Stage	δ_{ET}‰	δ_E‰	δ_T‰	F_E%
Mature and canopy reforming (September–November)	-11.6	-12.7	-10.4	53
Budding and flowering (December–February)	-9.7	-11.8	-10.5	15
Bean development (April–August)	-10.9	-13.8	-10.3	16

Note: δ_{ET}, δ_E $\alpha\nu\delta$ δ_T, denote $\delta^{18}O$ values of ET, E and T, respectively. F_E denotes percent of ET as E.

Table 4. The E and T components of coffee plants in the flowering stage under different management practices

Irrigation practice	T (%)	E (%)
Furrow, no mulch	83	17
Drip, no mulch	87	13
Drip, with mulch	94	6

The E and T results for maize obtained from the Malawi and China field sites were also used to validate FAO's AquaCrop model for improving irrigation scheduling and agronomic practices. For example, in North China Plain, the long term simulation from AquaCrop showed that in the wet years no irrigation is needed for maize. However, in the normal and wet years, one irrigation at planting of maize is needed (Heng et al., 2013).

The results obtained showed that isotopic techniques ($\delta^{18}O$ or $\delta^{2}H$) using the Keeling plot and the isotopic mass balance methods were able to provide improved estimates of soil E and T components. Together with the conventional method (e.g. the eddy covariance method), the transpiration efficiency of a range of crop species in different agro-climatic conditions can be estimated. This inforrmation allows appropriate soil and water management practices to be devised and implemented. The FAO's AquaCrop model was able to provide the means to develop deficit irrigation schedules to save water while minimizing reductions in yield through saving unnecessary soil E and improving water use efficiency.

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Assessment of Soil Organic Carbon Stability in Agricultural Systems by Using Natural Abundance Signals of Stable Carbon and Nitrogen Isotopes

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Information on the stability and age of soil organic matter (SOM) pools is of vital importance for assessing the impact of soil management and environmental factors on SOM, an important part of the global carbon (C) cycle. The terrestrial soil organic C pool, up to a depth of 1 m, contains about 1500 Pg C (Batjes, 1996). This is about 2.5 times more organic C than the vegetation (650 Pg C) and about twice as much as in the atmosphere (750 Pg C) (Batjes, 1998), but the assessment of the stability and age of SOM using ^{14}C radio carbon technique are expensive. Conen et al. (2008) developed a model to estimate the SOM stability based on the isotopic discrimination of ^{15}N natural abundance by soil micro-organisms and the change in C/N ratio during organic matter decomposition, for steady state, Alpine and permanent grasslands.

In the framework of the IAEA funded coordinated research project (CRP) on Soil Quality and Nutrient Management for Sustainable Food Production in Mulch based Cropping Systems in sub-Saharan Africa, research was initiated to use this model in agricultural systems for developing a cost effective and affordable technique for Member States to determine the stability of SOM.

As part of this research, soil samples were taken and analysed in four long term field experiments, established on soils with low and high SOM, in Austria and Belgium. The participating institutions are the Austrian Agency for Health and Food Safety (AGES), the University of Natural Resources and Life Sciences in Vienna (BOKU), the University of Leuven (KUL), the Soil Service of Belgium (BDB) and the Centre Wallon de Recherches Agronomiques (CRA-W).

In 2012, all Austrian samples were prepared for analysis through fractionation according to the method described by Conen et al. (2008). Only the labile particulate organic matter (POM) fraction was isolated. The protected organic matter fraction (mOM) was calculated as the difference between the bulk soil and POM fraction. For the Belgian soils, an additional and more detailed fractionation scheme was used based on Six et al. (2002). The soil was divided into POM, free micro-aggregates, micro-aggregates occluded within macro-aggregates and a silt and clay fraction smaller than 53 µm.

In February and March 2013 a collaborative visit from Tim De Clercq, University of Leuven, took place at the SWMCN Laboratory in Seibersdorf. During this visit all soil fractions of the Belgian samples were analysed and a subset of the Belgian soil was fractionated according to the method described by Zimmermann et al. (2007). The results for both soil and fractionation schemes were compared with the Austrian soil samples. All results were then implemented in the model developed by Conen et al. (2008). At the same time general knowledge of SOM stability and experience with different fractionation schemes and isolation techniques were exchanged between the KU Leuven and IAEA researchers (Figs. 1 and 2).

Fig. 1: Using the low-cost micro-aggregate isolator to extract soil fractions according to Six et al., 2002.

Fig. 2: Wet sieving of soil for separating soil fractions.

The preliminary results (not shown) of the research indicated that the model developed for grasslands by Conen et al. (2008) can be used to determine the stability of SOM in agricultural systems. The C/N ratio and $\delta^{15}N$ signature of the POM and mOM fraction follow the pattern of this model (Fig. 3). The modelled stability values still have to be validated by ^{14}C measurements. For the measurement of ^{14}C and interpretation (occurrence of bomb ^{14}C and black carbon) the teams of Steier and Leifeld have been involved in the project.

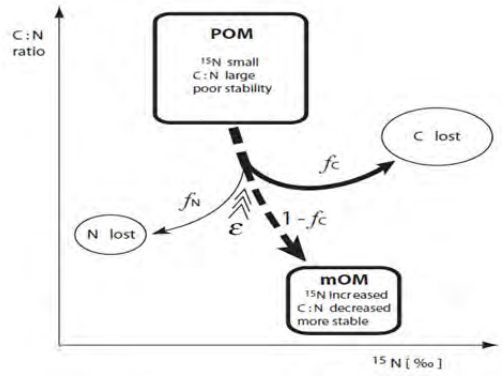

Fig. 3: Conceptual model of the transition of organic matter from POM to mOM developed by Conen et al. (2008).

For the Belgian soil we tried to adapt the model for the use of above mentioned fractionation scheme of Six et al. (2002). The preliminary results are shown in Fig. 4.

The SOM stability increases in the following order: POM < occluded micro-aggregates < free micro-aggregates < silt and clay. These findings support the aggregate hierarchy theory described by Tisdall and Oades (1982) which states that micro-aggregates are formed within macro-aggregates and become free micro-aggregates after macro-aggregates are broken up. The stability values for all these SOM fractions calculated with the adapted Conen Model will also be validated with ^{14}C measurements in 2013.

The model developed by Conen et al. (2008) shows promise for use in agricultural systems and will be improved and validated for more soil and climatic

conditions in 2013. This will lead to a reliable and cost effective technique to determine the relative stability and age of SOM fractions.

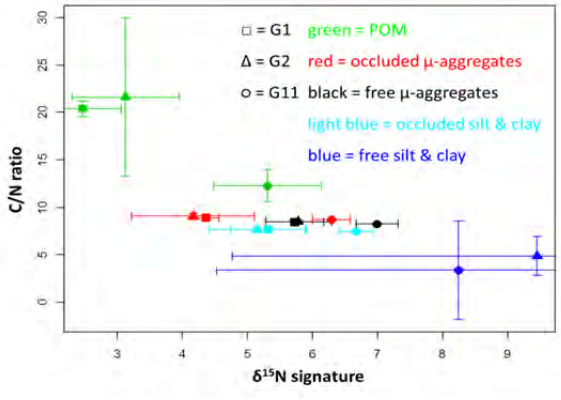

Fig. 4: C/N ratio and $\delta^{15}N$ for five fractions of three treatments from long term mulch trial in Boutersem, Belgium. (G1 = no fertilizer, G2 = only mineral fertilizer, G11 = 45 ton/ha yearly compost fertilizer, µ-aggregate = micro-aggregate).

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Biological Nitrogen Fixation by Cowpea Using Nitrogen 15-isotope: The Role of Water and Improved Crop Varieties

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Agriculture in sub-Saharan Africa is characterized by low productivity and is associated with variable and irregular rainfall, infertile soils, and inadequate application of organic and inorganic fertilizers (Fatokun et al., 2002). Cowpea (*Vigna unguiculata [L.] Walp.*) is a major source of dietary protein for the people, and occupies about eight million hectares of agricultural land, a majority being in Niger and Nigeria (Singh et al., 1997). The major uses include (1) food grain, (2) animal feed, and (3) source of organic N fertilizer.

In Niger, cowpea production increased from 4 000 tons $year^{-1}$ in the mid-fifties to a maximum of 775 000 tons $year^{-1}$ in 1997, and its cultivated area is still increasing. Despite its importance, cowpea yields in Niger are very low (approximately 300 kg ha^{-1}) relative to the production potential of between 1.5-3.0 t ha^{-1} (Ball et al., 2000). Yield can be substantially increased by using improved cowpea varieties and overcoming water stress. With adequate soil moisture cowpea flowers over a long period produce more seeds and yield loss is limited. On the contrary, under water deficit conditions the flowering period is cut short and the seed matures earlier, reducing yield. Overcoming water stress can also improve nutrient use efficiency of cowpea.

This article summarizes the results of a field study carried out in Niger to assess the use of improved cowpea varieties and water management on yield and nitrogen use efficiency of cowpea using stable isotopes of nitrogen-15 (^{15}N).

The field experiment was carried out in the Sahelian zone of Sadore located 45 km south of Niamey, capital of Niger. Six varieties of cowpea cultivars including three widely used varieties in Niger (TN3-78, TN5-78 and KVX) improved the variety obtained from IATA, Nigeria (V499). One variety imported from Ghana (Ghana) and a non-fixing variety obtained from ICRISAAT, Niger (IC10), were used in the study. The water application includes: (a) control in which the treatment is irrigated at field capacity (I1), (b) irrigation every three days (I2), (c) irrigation every five days (I3), and (d) irrigation every seven days (I4). Each treatment received a basal application of 10 kg ha^{-1} as ^{15}N-labelled urea and 30 kg P_2O_5 ha^{-1}

as single superphosphate. Crop yield, N uptake and ^{15}N in plant were measured and fertilizer N use and biological nitrogen fixation were estimated.

Results showed that keeping the soil water content at field capacity through regular application of water increased cowpea grain yield in all five varieties (Fig. 1, treatment I1)

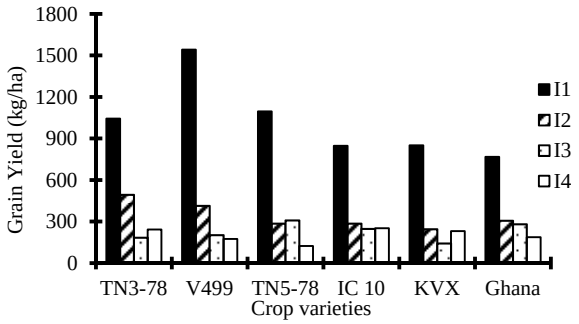

Fig. 1: Cowpea grain yield under different varieties and water management.

Grain yields increased from 174 to 1540 kg ha^{-1} (nine fold) in the high yielding V499 variety and from 186 to 767 kg ha^{-1} (four fold) in the Ghana variety. Continuous water application increased grain nitrogen (N) uptake in all crop varieties (Table 1) with maximum observed in V499.

The ^{15}N isotopic mass excess in grain was used to estimate the proportion of N in grain derived from soil, fertilizer and by biological N fixation. The amount of N in grain obtained through biological N fixation is provided in Fig. 2.

The results showed that with sufficient soil moisture, cowpea can capture up to 35 kg N ha^{-1} of the grain N from the atmosphere through biological N fixation. Cowpea grain normally acquired about 25% of the biologically fixed N and the remaining 75% is returned to the soil as crop residues and root, thus providing a significant source of N for subsequent crops.

Table 1. Effect of water management on N uptake by different cowpea varieties

Water management	TN3-78	V499	TN5-78	IC 10	KVX	Ghana
			kg N ha^{-1}			
I1	37.22	58.22	35.14	31.30	30.05	30.17
I2	21.20	31.17	15.27	13.53	23.21	17.17
I3	6.52	7.59	11.88	9.48	5.85	12.30
I4	8.06	6.65	4.91	9.39	8.70	8.13

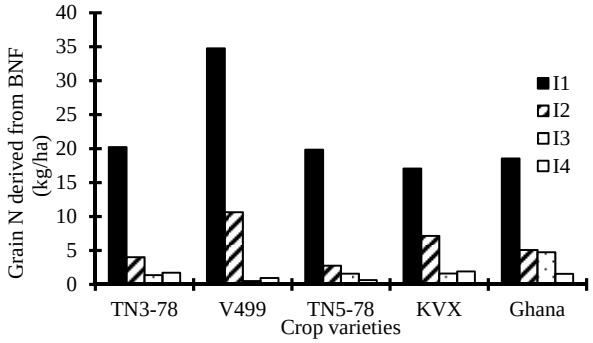

Fig. 2: Grain N derived from biological N fixation under different water management.

An economic analysis of grain yield and biological N fixation showed that at current market price of 0.50 USD kg^{-1}, farmers' income could be increased from less than 100 to 650 USD ha^{-1}.

Further, cowpea provides approximately 45 kg N ha^{-1} (equivalent to 96 kg urea, saving approximately 50 USD ha^{-1} in fertilizer cost) every growing season. This is available for subsequent crops grown in rotation with cowpea, primarily millet, often grown in rotation or intercropped with cowpea. This is an important aspect in improving the fertility of sandy soils in Niger.

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Technical Cooperation Projects

Operational Projects and Technical Officers responsible for implementation

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

KEN5031	Improving Agricultural Productivity in Mixed Cropping Systems through Application of Knowledge Based Technologies Generated with the Aid of Nuclear Techniques	L. Heng and K. Sakadevan
MAG5019	Improving the Use of Agricultural Resources and Combating Soil Erosion by Optimizing Conservation Agriculture and Developing Strategies for Its Dissemination	M.L. Nguyen and G. Dercon
MLI5024	Enhancing Sustainable Intensification and Diversification of Sorghum Production Systems in the Southern Zone by an Integrated and Participatory Approach, Phase 2	L. Heng
MLI7003	Assessing Erosion, Sedimentation and Water Resources in River Basins by Using Isotope Techniques	G. Dercon
MOZ5003	Sustaining the Management of Soil Fertility	G. Dercon
MOZ5004	Improving Nitrogen and Water Use Efficiency of Maize Varieties in Conservation Agriculture under Smallholder Farming Systems	G. Dercon
MYA5020	Strengthening Food Security through Yield Improvement of Local Rice Varieties with Induced Mutation (Phase II)	G. Dercon in collaboration with Plant Breeding and Genetics Section
NER5015	Improving Productivity of the Millet Cowpea Cropping System through Development and Dissemination of Improved Varieties and New Water and Fertilizer Management Techniques	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
NIC8012	Applying Nuclear Techniques for the Development of a Management Plan for the Watershed of the Great Lakes	G. Dercon
OMA5001	Producing Forage Crops Tolerant to Salinity and Drought	J. Adu-Gyamfi
QAT5003	Improving Agricultural Productivity in Saline Land/Areas	K. Sakadevan
RAF5058	Enhancing the Productivity of High Value Crops and Income Generation with Small Scale Irrigation Technologies	L. Heng
RAF5063	Supporting Innovative Conservation Agriculture Practices to Combat Land Degradation and Enhance Soil Productivity for Improved Food Security	G. Dercon
RAS5055	Improving Soil Fertility, Land Productivity and Land Degradation Mitigation	M.L. Nguyen
RAS5056	Supporting Mutation Breeding Approaches to Develop New Crop Varieties Adaptable to Climate Change	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
RAS5064	Enhancing Productivity of Locally Underused Crops through Dissemination of Mutated Germplasm and Evaluation of Soil, Nutrient and Water Management Practices	K. Sakadevan in collaboration with Plant Breeding and Genetics Section
RAS5065	Climate Proofing Rice Production Systems (CRiPS) Based on Nuclear Applications	L. Heng in collaboration with Plant Breeding and Genetics Section
RLA5051	Using Environmental Radionuclides as Indicators of Land Degradation in Latin American, Caribbean and Antarctic Ecosystems (ARCAL C)	G. Dercon
RLA5052	Improving Soil Fertility and Crop Management for Sustainable Food Security and Enhanced Income of Resource Poor Farmers (ARCAL CI)	K. Sakadevan
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)	G. Dercon in collaboration with Food and Environmental Protection Section
RLA5062	Applying Stable Isotopes to Assess the Impacts of Natural Zeolite to Increase Nitrogenous Fertilizer Use Efficiency, to Improve Soil Fertility and to Reduce Soil Degradation (ARCAL CXXV)	M.L. Nguyen
SEN5034	Using an Integrated Approach to Develop Sustainable Agriculture in a Context of Degrading Soil Fertility, Climate Change and Crop Diversification	G. Dercon in collaboration with Plant Breeding and Genetics Section
SEY5006	Implementing Nutrient and Water Management Practices Using Nuclear and Related Techniques to Enhance National Vegetable Production through Sustainable Agricultural Management	L. Heng
SUD5033	Enhancing Productivity of Major Food Crops (Sorghum, Wheat, Groundnut and Tomato) under Stress Environment Using Nuclear Techniques and Related Biotechnologies to Ensure Sustainable Food Security and Well-being of Farmers	J. Adu-Gyamfi in collaboration with Plant Breeding and Genetics Section
TAD5005	Developing Soil Conservation Strategies for Improved Soil Health	G. Dercon

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

Forthcoming Events

FAO/IAEA Events

First RCM of the CRP D1.20.12 on Optimizing Soil, Water and Nutrient Use Efficiency in Integrated Cropping Livestock Production Systems, 22–26 July 2013, Vienna, Austria

Technical Officers: Karuppan Sakadevan and Minh-Long Nguyen

The purpose of the first research coordination meeting (RCM) is to review the objectives and experimental plans of the research contracts in line with the objectives and work plan of the CRP and to provide common guidelines for the next 18 months. Eight research contract holders from Argentina, Brazil, China, India, Indonesia, Kenya, Uganda and Uruguay and three agreement holders from France, Nigeria and the United States of America are expected to participate in the meeting. The overall objective of the CRP is to enhance food security and rural livelihoods by improving resource use efficiency and sustainability of integrated crop-livestock systems under a changing climate.

Fourth and final RCM of the CRP D1.20.10. on Strategic Placement and Area Wide Evaluation of Water Conservation Zones in Agricultural Catchments for Biomass Production, Water Quality and Food Security, 26–30 August 2013, Vienna, Austria

Technical Officers: Karuppan Sakadevan and Lee Heng

The CRP is in the final year and the final RCM will be held from 26–30 August 2013 and all participants are expected to attend the meeting. The results obtained for the period from December 2008 to July 2013 will be discussed. The participants will also discuss their contribution to a TECDOC.

First RCM of the CRP D1.20.13 on Landscape Salinity and Water Management for Improving Agricultural Productivity, 15–19 July 2013, Vienna, Austria

Technical Officers: Lee Heng and Karuppan Sakadevan

The purpose of the meeting is to review the objectives and experimental plans of the research contracts in line with the work plan and objectives of the CRP and to provide common guidelines for the next 18 months. The CRP aims to address salinization problems in agricultural landscapes and to optimize the use of salt affected soils and saline water through improved soil, water and crop management practices, and to understand how salinity responds to land and water management at the field and landscape scale. The potential impact of on-farm practices on regional crop productivity, water and salt stores and fluxes under current and future climate will be studied through hydrological modelling.

The CRP consists of eleven participants including seven research contract holders from Bangladesh, China, India, Islamic Republic of Iran, Pakistan and Vietnam (two candidates) and four Agreement holders from Australia, Germany, Spain and USA. The CRP is expected to go on for five years (2013–2018). It was formulated on the basis of the recommendations of a consultants meeting held at IAEA headquarters in Vienna from 1–4 October 2012.

Nuclear and isotopic techniques will be used to unravel the relative importance of processes involving soil-plant-water interaction to maximize the benefits of salt affected soils through improved soil water and crop management practices.

- Soil moisture neutron probe (SMNP) to measure plot scale changes in soil water in combination with cosmic ray probes to measure larger scale changes in the soil water in the upper soil layer;
- The use of $\delta^{18}O$ and $\delta^{2}H$ to quantify the proportion of soil evaporation at field scale, as part of the field and regional water balances;
- The use of ^{13}C in plant tissues as indicator of drought and salinity tolerance.

Second RCM of the CRP D1.50.12 on Soil Quality and Nutrient Management for Sustainable Food Production in Mulch-based Cropping Systems in Sub-Saharan Africa (D1.50.12), 14–18 October 2013, Antananarivo, Madagascar

Technical Officers: Gerd Dercon and Minh-Long Nguyen

The CRP is in the second year and the second RCM will be held from 14–18 October 2013 and all participants are expected to attend the meeting. The results obtained from January 2012 will be discussed.

Fourth and final RCM 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, 4–8 November 2013, Vienna, Austria

Technical Officers: Gerd Dercon and Minh-Long Nguyen

The CRP is in the final year and the final RCM will be held from 4–8 November 2013 and all participants are expected to attend the meeting. The results obtained for the last five years will be discussed. The participants will also discuss their contribution to a TECDOC.

Training course on Agricultural Water Management: The Use of Innovative Isotopic and Conventional Techniques, 24 June–2 August 2013, Seibersdorf, Austria

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

About 25 fellows from Africa and Asia will be participated in this training course, which will be held at the Soil

and Water Management & Crop Nutrition Laboratory of the Joint FAO/IAEA Division for Nuclear Techniques in Food and Agriculture. The purpose of the training course is to provide basic knowledge and expertise on the use of isotopic and conventional techniques for managing agricultural water for food security. The training course will cover the following topics:

- Principles of water management in rainfed and irrigated agriculture at plot and landscape level;
- Monitoring techniques for estimating soil moisture at plot level;
- The use of isotopic, nuclear and conventional techniques for assessing soil water balance and crop water relations;
- Modelling crop water use and irrigation scheduling using AquaCrop and related software;
- Write-up of reports and assessment.

The course will be organized by the Soil and Water Management & Crop Nutrition Section and Laboratory, in collaboration with the University of Natural Resources and Life Sciences, Vienna (BOKU).

Regional Training Course on the Use of Nuclear and Isotopic Techniques in Assessment of Fertilizer and Water Use Efficiency, 23–27 September 2013, Manila, Philippines

Technical Officer: Karuppan Sakadevan

The objective of the regional training course on the "Use of Nuclear and Isotopic Techniques in the Assessment of Fertilizer and Water Use Efficiency" is to improve skills, knowledge and technical competency of scientific and technical personnel on the application of isotopic and nuclear techniques to study soil-water-nutrient-crop interactions and nutrient and water use by various crop under different agro-eco systems.

The training course will involve: (i) a general introduction to soil, water, crop and nutrient management, (ii) factors affecting nutrient and water use efficiencies in agriculture, (iii) soil and plant testing to determine nutrient requirement by crops, (iv) farming practices that improve soil fertility and reduce nutrient losses, (v) laboratory and field practical related to nutrient and water management, (vi) water quality, managing salt affected soils and saline waters for crop production, and (vii) isotopic techniques for quantifying water and nutrient use efficiency and evaluating crops tolerant to drought and salinity.

Participants from Bangladesh, China, India, Indonesia, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Sri Lanka, Thailand and Vietnam are expected to attend the training. The training will be hosted by the Philippines Nuclear Research Institute in Manila.

Regional Training Course for TC project RAF5063 on Supporting Innovative Conservation Agriculture Practices to Combat Land Degradation and Enhance Soil Productivity for Improved Food Security, 18–29 November 2013, Antananarivo, Madagascar

Technical Officer: Gerd Dercon

The purpose of the training course is to provide basic knowledge and skills on the use of fallout radionuclide (FRN) techniques for estimating soil erosion and assessing the effectiveness of soil conservation measures. The course will focus on the use of conversion models in estimating soil erosion and deposition rates, introduction of geo-statistics and visualization tools (Surfer), Geographic Information Systems (GIS), data interpolation and map editing. Approximately 20 participants from across Africa (Algeria, Benin, Côte d'Ivoire, Mali, Madagascar, Morocco, Senegal, Tunisia, Uganda and Zimbabwe) will attend this training course. The local organizer is the Institut National des Sciences et Techniques Nucléaires (INSTN), Antananarivo, Madagascar.

Non-FAO/IAEA Events

68th Annual International Conference of the Soil and Water Conservation Society (SWCS)
21–24 July 2013, Reno, NV. www.swcs.org/13AC

Utilization and Protection of Halophytes and Salt Affected Landscapes
4–6 September 2013, Kecskemét, Hungary.
http://members.iif.hu/tot3700/salinityconferencehungary2013.html

7th Int. Conference on Urban Soils, SUITMA7
16–20 September 2013, Torun, Poland.
www.suitma7.umk.pl

Sustainable Intensification: Pathway to Low Carbon Farming
25–27 September 2013, Edinburgh University, Edinburg, United Kingdom.
http://www.sruc.ac.uk/homepage/403/carbon_management_centre_international_conference

First International Conference on Global Food Security
29 September–2 October 2013, Noordwijkerhout, The Netherlands.
http://www.globalfoodsecurityconference.com/

First World Irrigation Forum
29 September–5 October 2013, Mardin, Turkey.
http://www.icid.org/wif_icid.html

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

9th International Soil Science Congress on "The Soul of Soil and Civilization"
14–16 October 2014, Side, Antalya, Turkey.
http://www.soil2014.com/invitation.aspx

11th International Conference of the East and Southeast Asia Federation of Soil Science Societies
21–24 October 2013, Bogor, Indonesia.
http://www.esafs11ina.org/index.php

6th International Nitrogen Conference
18–22 November 2013, Kampala, Uganda.
www.N2013.org

EGU General Assembly
27 April–02 May 2014, Vienna, Austria.

20th World Congress of Soil Science
8–13 June 2014, Seoul, Republic of Korea.
http://www.20wcss.org/

Past Events

Duty Travel

Argentina: To organize the final regional coordination meeting of the regional Technical Cooperation project RLA5052 on Improving Soil Fertility and Crop Management for Sustainable Food Security and Enhanced Income of Resource Poor Farmers, 4–9 February 2013, Buenos Aires, Argentina

Technical Officer: Karuppan Sakadevan

The Technical Officer organized this meeting with Rick Kastens, Programme Management Officer. Representatives from ten countries from Latin America (Argentina, Bolivia, Brazil, Chile, Cuba, Dominican Republic, Haiti, Mexico, Paraguay and Venezuela) attended the meeting. The project started in January 2010 and aims to improve fertility and quality of agricultural soils through improved soil, fertilizer and crop management, and to enhance the regional capacity to assess and manage soil fertility, quality and crop productivity through the use of isotopic and nuclear techniques.

The focus of the final coordination meeting was to: (i) discuss and analyse information collected from field studies, (ii) document regional success stories on soil fertility management and food security, (iii) lessons learned, and (iv) identify strategies for disseminating project outputs to farmers. These include presentations by counterparts on field studies carried out in each country from January 2010 to December 2012 and their outputs.

As part of the meeting, all participants visited two small farms which were mainly used for cash crop production that supply green produce to Buenos Aires. During the field visit participants received useful information on managing soil, crop, water and nutrients in small farms. The importance of soil, water and crop management to improve soil fertility and quality was reiterated in a farmer field experimental site. This field trip provided a useful learning experience for other counterparts for managing soil, water, nutrients and crops in intensive high input agriculture.

Participants of final regional coordination meeting project RLA5052.

Norway: International Conference on the Humanitarian Impact of Nuclear Weapons, 4–5 March 2013, Oslo, Norway

Technical Officer: Gerd Dercon

Gerd Dercon attended the International Conference on the Humanitarian Impact of Nuclear Weapons, Oslo, from 4–5 March 2013.

The aim of the conference was to provide an arena for the international community to have a fact based discussion of humanitarian and developmental consequences that would result from a nuclear weapon detonation.

The conference programme included presentations by experts and discussions around the following three key aspects: (i) the immediate humanitarian impact of a nuclear detonation, (ii) the possible wider developmental, economic and environmental consequences, and (iii) preparedness, including plans and existing capacity to response to this type of disaster.

Official delegates from 127 countries as well as several United Nations (UN) organizations, the International Red Cross Movement, representatives of civil society and other relevant stakeholders participated in the conference.

The UN was represented at the conference by personnel from field oriented agencies including the United Nations High Commissioner for Refugees (UNHCR), Antonio Guterres, the UN Office for Coordination of Humanitarian Affairs (OCHA) and the United Nations Development Programme (UNDP). These agencies actually delivered key lectures at the conference. UNDP supported the organization of the conference by sponsoring the participation of requesting States. Other UN agencies including the United Nations Emvironment Programme (UNEP), The United Nations Children's Fund (UNICEF), the World Health Organization (WHO), the World Fund Programme (WFP), the IAEA and the FAO were observers at the conference.

The detailed programme, expert presentations, statements from the floor, the chair summary and pictures are available on-line:

http://www.regjeringen.no/en/dep/ud/selected-topics/humanitarianefforts/humimpact_2013.html?id =708603

Niger: To review project results and outputs for the Technical Cooperation (TC) project NER5015 on Improving Productivity of the Millet-Cowpea Cropping System through Development and Dissemination of Improved Varieties and New Water and Fertilizer Management Techniques, 25–29 March 2013, Niamey, Niger

Technical Officer: Karuppan Sakadevan

Karuppan Sakadevan travelled to Niamey, Niger, and met with counterparts from: (1) Institut des Radio-isotopes (IRI), Université Abdou Moumouni de Niamey, and (2) Département de Gestion des Ressources Naturelles (DGRN); Institut National de la Recherche Agronomique du Niger (INRAN), who are the main counterparts in the TC project. The objective of the project was to increase cowpea and millet food production through the development and dissemination of new improved varieties along with new integrated techniques for the management of water and mineral elements for resource poor farmers. This project was a continuation of TC project NER5014 on Improving the Productivity of Cowpea/Finger Millet Based Cropping Systems which started in 2009 and took three years. In this context, the technical officer visited Niamey, Niger, to discuss project results and outputs for the period from January 2009 to December 2012.

The focus of the meeting was to discuss and analyse information collected from field studies in relation to: (i) evaluating a number of cowpea varieties to water management, (ii) micro fertilization and placement under millet production, and (iii) further evaluation of cowpea production in farmers' field. During the visit, the technical officer also met the Director General of INRAN and a number of soil and water scientists who are working in the area of cowpea and millet production. The Director General was committed to full INRAN support (staff and resources) for implementing best practice soil, water and crop management practice for improving cowpea and millet production in different agro-eco systems in Niger. The duty travel also provided an opportunity to travel to INRAN's field experimental site where improved varieties of cowpea, millet, maize and vegetable are tested for water and nutrient use.

Kenya: To reassess priorities and strategies of TC project RAF5058 on Enhancing the Productivity of High Value Crops and Income Generation with Small Scale Irrigation Technologies, and to finalize discussions with Kenyan mobile phone providers on the use of communication technology for improving irrigation scheduling, Nairobi, 14–18 April 2013

Technical Officer: Lee Heng

The travel was accompanied by the RAF5058 project management officer (PMO), Abdou Ndiath.

Both, I and the PMO held discussions with Kenyan mobile phones service providers to assess the suitability to be contracted for providing services on the use of communication technology for improving soil, water and nutrient management. The criteria for selection includes past experience in developing mobile phone short-message service (SMS) on water management; knowledge on soil, water and nutrient management; and the availability of real-time weather information. The selected candidate was a soil scientist and has experience in developing SMS that provides advice on crop management, fertilizer recommendations and crop varieties to farmers in Nairobi. In addition, discussionss were held between the Kenyan and Algerian project counterparts and the IAEA team on the way forward to target the different levels of achievement in nineteen countries of the RAF5058 project. A field excursion was made to visit a Maasai community in the Kajiado County, approximately 100 km east of Nairobi. The trip was to determine the status of implementation of work supported by IAEA through KARI to assist the Maasai community in the adoption of drip irrigation technology to improve their livelihood. As climate change and the lack of water became more frequent, the Maasai men have to travel further and for longer period to look for pasture for their livestock.

A meeting was held with the national team of KEN5031 on Improving Agricultural Productivity in Mixed Cropping Systems through Application of Knowledge Based of Technologies Generated with the Aid of Nuclear Techniques where progress of the project was discussed. Anthony Esilaba, the counterpart gave an overview of the work of the team and the challenges the team faced which are insufficient field equipment and the lack of local operating fund, as well as low soil fertility and high fertilizer prices.

Vienna: International Experts' Meeting on Decommissioning and Remediation after a Nuclear Accident, 28 January–1 February 2013

Technical Officer: Gerd Dercon

Gerd Dercon attended the International Experts' Meeting (IEM) on Decommissioning and Remediation after a nuclear accident, convened by the IAEA from 28 January to 1 February 2013.

Vowing to improve plans to protect the public and the environment from radiation following potential nuclear incidents in the future, more than 200 international experts concluded a week long forum to share their experience and views. The Vienna meeting was part of the implementation of the IAEA Action Plan on Nuclear Safety, endorsed by the IAEA General Conference in September 2011 and was organized by the IAEA Department of Nuclear Safety and Security and the Department of Nuclear Energy.

The discussion of the meeting revolved several themes, including:

- The need for detailed frameworks to provide clear direction where national organizations are responsible for aspects of recovery from such a nuclear accident;
- The importance of thorough and sustainable stakeholder interaction to help develop clear lines of responsibility and constructive relationships among the institutions addressing a post-accident situation;
- The value in formulating appropriate targets for remediation, keeping in mind the public perception of radiation risk;

- The need to develop methods and technologies for decommissioning and remediation, and to improve ways of making those tools widely available;
- The challenge of managing damaged fuel and radioactive waste following an accident.

Vienna: 60th Session of the United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR)", 27–31 May 2013

Technical Officer: Gerd Dercon

The mandate of the United Nations Scientific Committee on the effects of Atomic Radiation (UNSCEAR), established in 1955, is to undertake broad reviews of the sources of ionizing radiation and the effects on human health and the environment. Its assessments provide a scientific foundation for United Nations agencies and governments to formulate standards and programmes for protection against ionizing radiation. UNSCEAR has conducted a scientific evaluation of the levels and effects due to radiation exposure resulting from the Fukushima accident. It does not deal with or assesses nuclear safety or emergency planning issues.

On behalf of the FAO, Gerd Dercon attended the 60th Session of the Vienna based UNSCEAR.

The effect of radiation exposure on humans and the environment following the accident at the Fukushima-Daiichi Nuclear Power Plant in March 2011 was one of the major issues discussed at the Committee's annual session. The second important issue was related to the short and long term effects of exposure to radiation on children.

The report adopted by the Committee will be presented to the United Nations General Assembly later in 2013, and the scientific data and evaluation underpinning that report will be published separately.

More than 80 leading international scientists have worked on analysing the information available on the levels and effects of exposure following the events of 11 March 2011 in Japan. Material prepared was scrutinized by the 27 countries on the Scientific Committee at their annual session. When the Committee's report is published, it will be the most comprehensive international scientific analysis of information available to date.

Contribution of the FAO to UNSCEAR assessment

The Joint FAO/IAEA Division for Nuclear Techniques in Food and Agriculture through its Subprogrammes including Soil and Water Management & Crop Nutrition, Food and Environmental Protection, Animal Production and Health and Plant Breeding and Genetics, played a significant role in the UNSCEAR assessment.

An interactive, referential integrity database, used to monitor the radiological contamination of foodstuffs aimed for human consumption after the Fukushima Nuclear accident was developed by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Since March 2011, data were provided by the Ministry of Health, Labour and Welfare (MHLW) Government of Japan through the FAO/WHO International Food Safety Authorities Network (INFOSAN) in a Microsoft Excel datasheet format. In order to enable standardized data entry and facilitate the UNSCEAR assessment of exposure and dose assessment for the public and environment, the Joint FAO/IAEA division developed a referential integrity database, comprising of six external nomenclature tables, linked with the main, source table via unique identifiers.

The process of data normalization was considerably supported by appropriate UNSCEAR Work Groups and the authorities in Japan, especially by the Ministry of Agriculture, Forestry and Fisheries (MAFF). The result of these efforts was the establishment of a compact data collection and data reporting system which enables scientifically to define datasets (reports) for further analysis by UNSCEAR. Approximately 126 000 records on radionuclide concentrations in over 500 types of foodstuffs, collected from 1 076 locations in all 47 prefectures of Japan have been compiled in the database. The database was made available to the respective expert groups for the UNSCEAR Fukushima assessment as a "final product" during September 2012, and has been used for the assessment of radiation doses for the public and the environment.

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 overall objective of this CRP is to develop integrated isotopic approaches to identify hot spots or critical areas of land degradation in agricultural catchments so that effective soil conservation measures (precision conservation) can be implemented. Specific objectives are to: (i) develop the combined use of fallout radionuclide (FRN) and conventional techniques with spatial analysis to establish soil redistribution patterns and rates over several temporal scales on an area-wide (catchment) basis, (ii) develop and validate protocols for the application of compound specific stable isotope (CSSI) techniques to identify and apportion the amount of source soils (land degraded areas) from main land uses or land management (cropland, grassland and forestland) in the catchment, (iii) integrate nuclear based approaches with other non-nuclear techniques through modelling and other tools to establish comprehensive soil redistribution studies on an area-wide basis, and (iv) create a basis for developing decision support tools to implement precision conservation and contribute to sustainable land management.

This CRP, which was formulated on the basis of a recommendation from a consultants meeting held at the IAEA, Vienna, 5–7 November 2007, is in its third year. The first RCM was held at the IAEA in Vienna from 8–12 June 2009. The second RCM was held at the National Centre for Atomic Energy, Nuclear Sciences and Applications (Centre National de l'Energie, des Sciences et des Techniques Nucléaires (CNESTEN)) in Rabat, Morocco, from 27 September–1 October 2010. A mid-term review of the CRP was successfully carried out in November 2011. The third RCM was held in Vienna from 23–27 July 2012 at the same time as the FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation. Seven research contract holders from Chile, China, Morocco, Poland, the Russian Federation and the Syrian Arab Republic, four technical contract holders from Belgium (University of Ghent), China (Chinese Academy of Agricultural Sciences) and Germany (University of Hohenheim) and five agreement holders from Australia (CSIRO), Canada (University of Manitoba), New Zealand (National Institute of Water & Atmospheric Research) and the United Kingdom (University of Exeter and University of Plymouth) attended the third RCM. By linking this RCM to the symposium, the results of this successful CRP were effectively disseminated to a much wider scientific audience.

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

A staff member from the Soil and Water Management & Crop Nutrition Laboratory (Christian Resch) was trained in the use of the CSSI technique at the University of Hohenheim, Stuttgart (3–14 December 2012). This training will support the project through facilitating the rapid identification of increased land degradation in Member States, particularly in tropical and subtropical regions, and will also enable Resch C., to “train the trainers”, so that he can provide expertise and training in this technology to other SWMCNL staff, allowing them to start the next step of disseminating this novel analytical technique to Member States through group or individual fellowship trainings to be conducted at the Seibersdorf laboratories.

The final research coordination meeting will be held from 4–8 November 2013, in Vienna.

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

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

This CRP is now in its fifth and final year, and the final RCM will be held from 26–30 August 2013 in Vienna, Austria. During this meeting the final reports from all participants will be presented and discussed. Eight research contract holders from China, Estonia, Islamic Republic of Iran, Lesotho, Nigeria, Romania, Tunisia and Uganda, and four agreement holders from United States of America (University of Florida and University of Rhode Island) and France (University of Renne and Institut de Recherche pour le Développment (IRD) are participating in this project.

All research contract holders have collected field data on ^{15}N, $\delta^{18}O$ and $\delta^{2}H$ for water and vegetation from water conservation zones and catchments to identify sources and sinks of water and nutrient in water conservation zones.

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

Technical Officers: Gerd Dercon and Minh-Long Nguyen

The objective of this CRP is to improve the livelihoods of low socio-economic farmers and rural communities in a region that is dominated by a savannah ecosystem in its natural state. The CRP seeks to address four key issues relating to soil quality and nutrient management for sustainable food production in mulch based cropping systems in sub-Saharan Africa in order to:

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

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

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

This CRP was formulated on the basis of the recommendations of a consultants meeting held at IAEA, Vienna, 5–8 July 2010. The first research coordination meeting was held in Vienna, 30 January to 3 February 2012. Fifteen participants, with seven research contract holders from Benin, Kenya, Madagascar, Mauritius, Mozambique, Pakistan and Zimbabwe, three technical contract holders from China, the Czech Republic and the United Kingdom and five Agreement holders from Austria, Belgium, Kenya, New Zealand and United States of America attended the first RCM.

The SWMCN Laboratory team has also started a series of research activities to support this CRP. Currently a long term field experiment of over 15 years in Gross Enzersdorf (BOKU Research Station, 8 km east of Vienna) is being used to adapt stable isotope techniques (^{13}C and ^{15}N) for the assessment of soil organic carbon sequestration and stability. Two additional experiments were initiated to validate these techniques: (i) a long term field experiment in Grabenegg, at the experimental research station of the Austrian Agency for Health and Food Safety (AGES), west of Vienna; and (ii) a greenhouse column experiment in the SWMCN Laboratory. Guidelines for using these stable isotopic techniques are currently being tested.

A video has been made on the CRP activities at the Grabenegg site. This video was published on the IAEA website during the IAEA Scientific Forum on “Food for the Future: Meeting the Challenges with Nuclear Applications”, held during the IAEA General Conference in September 2012:

http://www.iaea.org/newscenter/multimedia/videos/gc56/180912/bettersoil/index.html.

The second research coordination meeting will be held in Antananarivo, Madagascar, from 14 to 18 October 2013.

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

Technical Officers: Karuppan Sakadevan and Pierre Lagoda

This CRP is in its second year. All research contract holders have submitted the project progress report for the first year and the contracts have been renewed. The CRP aims to increase crop productivity and water and nutrient use efficiencies in agro ecological zones affected by abiotic stresses such as drought, salinity and high temperatures by using best fit soil and water management practices and improved crop varieties through demonstrations in small farmers’ fields. A total of 12 research contract holders from Bangladesh, China, Indonesia, Kenya, Malaysia (two contracts), Mexico, Pakistan, Peru (two contracts), Uganda and Vietnam, and one Agreement holder from South Africa are participating in this project. The overall objective of this CRP is to increase crop productivity and food security by developing and extending to farmers, technology packages which include information about improved crop varieties and best-fit soil, water, nutrient and crop management practices that

make cropping systems resilient to environmental stresses. The specific objectives are: (i) to increase the productivity of improved mutant varieties of crops tolerant to environmental stresses under existing soil and climatic conditions, and (ii) to enhance nitrogen and water use efficiencies of crops tolerant to environmental stresses through best practice involving soil, water, crop and fertilizer management.

Field studies implemented in all countries for evaluating improved varieties of rice (aerobic, ratooning and saline tolerant varieties), sorghum (tolerant to acidity and drought), soybean (tolerant to extreme temperatures and water stress), banana and potato (disease resistance), amaranthus (high yielding), wheat (disease, water and nutrient use efficiencies), barley (early maturity) and quinoa (adapted highlands) for yield, water and nutrient use efficiencies.

The second RCM of the CRP will be held from 24–28 June 2013 in Kuala Lumpur, Malaysia, and all participants are expected to participate. During this meeting the project work plan for the third and subsequent years will be discussed, gaps identified and work plans will be fine-tuned.

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

Technical Officers: Lee Heng and Minh-Long Nguyen

This project was officially completed in September 2012. The last RCM of this CRP D1.20.09 was held in July 2012, coincided with the FAO/IAEA International Symposium on Managing Soils for Food Security and Climate Change Adaptation and Mitigation, held from 23–27 July 2012. Eleven papers from the CRP participants were submitted to the symposium proceedings which will be published later in 2013. A TECDOC is also currently being prepared and it is expected to be published in 2014.

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

Modernization of the Soil and Water Management & Crop Nutrition Laboratry

Gerd Dercon

Over the last decades, isotopic and nuclear techniques have been successfully used in the Soil and Water Management & Crop Nutrition Section (SWMCN) and Laboratory for: (i) identifying farm management factors affecting fertilizer and water use efficiency in rainfed and irrigated agriculture, (ii) quantifying the contribution of organic sources to crop nutrition, (iii) estimating biological nitrogen fixation, and (iv) assessing the effectiveness of soil and water conservation strategies for controlling soil erosion and improving water quantity and quality .

With an increasing focus on Member States to enhance the efficient use of soil and water resources and to make agriculture resilient to climate change and variability, the SWMCN Laboratory is going through significant shifts in the use of isotopic and nuclear techniques.

The SWMCN Laboratory is in the process of developing and adapting isotopic and nuclear techniques allowing scientists to move **from field to area wide scale**. An area wide scale approach will allow the designing of more effective soil and water management practices and conservation strategies for helping farming communities enhance agricultural resource use efficiency and protect soil and water resources.

To achieve this shift in the context of soil and water management and conservation, the SWMCN Laboratory invests in the **development and adaptation of new, robust and cost effective isotopic, nuclear and closely related techniques**. Cavity Ring-Down Spectroscopy (CRDS, Laser isotope analysers) and in-situ gamma spectroscopy in combination with isotope ratio mass spectroscopy and mid-infrared spectroscopy applications are important tools for this shift.

Training services in soil and water management are being updated to better serve the Member States and allow scientists and technical staff to assess soil and water quantity and quality at farm and landscape levels.

In addition to the use of isotopic and nuclear techniques in the field of soil and water management, emphasis is also being given to the **use and design of innovative on-line data management and geo-visualisation platforms to improve communication and data exchange between policy makers and end users.**

To help modernization, the following new equipment and infrastructure are currently being acquired by the SWMCN Laboratory:

- Existing greenhouses were partially modernized jointly with the Plant Breeding and Genetics Laboratory, to make them more suitable for carrying out experiments with temperate crops;
- Two walk-in growth chambers (12.5 m^3 each) for plant growth experiments under controlled CO_2 and temperature conditions were installed mid-June 2013;
- The Cosmic-ray Soil Moisture Observing System (COSMOS) was procured. With this tool to quantify soil water at area-wide scale, assessment of water dynamics at landscape level can be improved;
- Laser isotope analysers for the analysis of ^{15}N and ^{13}C in N_2O and CO_2 samples have been approved. These portable analysers do not require frequent calibration and can be deployed in the field. With such accuracy and robustness, these analysers provide more precise quantification of greenhouse gas emissions and soil carbon processes in agricultural landscapes across different spatial and temporal scales, and hence open up new frontiers in assessing greenhouse gas emissions and soil carbon sequestration;
- A motor operated rotary drum soil sieve machine has already been delivered to the lab. This machine will significantly increase the efficiency of plant experiments (Fig. 1).

Fig. 1. Motor operated rotary drum soil sieve machine increases the efficiency of preparing soils for pot and cosmos experiments.

Training Activities

One of the pillars of the Soil and Water Management & Crop Nutrition Laboratory (SWMCNL) is training activities to support technology transfer for different technical cooperation projects (TCPs).

FAO/IAEA Training Course on Soil Organic Carbon Dynamics and Management: The Use of Innovative Isotope and Conventional Techniques, 15 April–14 May 2013, Seibersdorf, Austria

Maria Heiling[1], Martina Aigner[1], Leo Mayr[1], Christian Resch[1], Arsenio Toloza[1], Norbert Jagoditsch[1], Franz Augustin[1], Ika Djukic[2], Gorana Rampazzo Todorovic[2], Egbert Schwartz[3], Gerd Dercon[1]

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[2]University of Natural Resources and Applied Life Sciences (BOKU), Austria

[3]Department of Biological Sciences, North Arizona University, USA

The FAO/IAEA Training Course on Soil Organic Carbon Dynamics and Management: The Use of Innovative Isotope and Conventional Techniques was held at the Soil and Water Management and Crop Nutrition Laboratory from 15 April to 14 May 2013. Eighteen fellows from ten countries (Algeria, Benin, Côte d'Ivoire, Iraq, Madagascar, Mozambique, Oman, Palestine, Senegal and Zimbabwe) participated in the training. The main focus of the training was to: (i) understand the importance of soil organic carbon for soil quality and climate change, (ii) soil sampling and sample processing techniques for estimating soil organic carbon, (iii) the use of isotopic and conventional techniques for assessing soil organic carbon dynamics, and (iv) modelling soil organic carbon dynamics.

The training was funded by IAEA Technical Cooperation Department through national TC projects. Besides lectures and practical laboratory demonstrations, a technical visit to a long term field experiment run by the IAEA in collaboration with the Austrian Agency for Health and Food Safety (AGES) at Grabenegg (ca. 120 km from Vienna) was organized to give the possibility of hands-on training in soil sampling.

To validate the effectiveness of the training, a self-assessment was carried out at the end of the training.

Feedback from the participants showed that such intensive training, focussing on one topic from theory to application, will improve research capacity significantly (Husamuldeen A. Tawfeeq). In addition, it was stated that the course helped the participants to better understand soil sampling procedures and the use of modelling to assess soil carbon sequestration (Rakotovao, Madagascar). Knowledge gained during the training will also be used to change teaching practices and will help support research and development (Cambule). The training was participatory with a great deal of interaction between trainers and trainees. The free sharing of information provided an ideal environment for learning and exchange with colleagues from other countries (Gwandu, Zimbabwe).

Soil Organic Carbon Modelling

Gorana Rampazzo Todorovic and Ika Djukic, Institute of Soil Research, University of Natural Resources and Life Sciences (BOKU), Austria

Soil organic matter (SOM) is key to ecosystem functions and soil productivity. Improving the SOM pool is essential to restore degraded soils, advancing food security, enhancing environmental quality and agronomic productivity. Through the application of diverse models, predictions of changes of SOM due to climatic or management influences could be provided (Fig. 1). Models are generally used to provide information faster and are cost effective compared to traditional experimentation by its ability to interpolate and extrapolate with a limited set of data. However, they should be considered complementary to experimentation rather than replacing it, as models cannot be developed or verified without reliable datasets. Isotopic techniques (stable isotopes and radionuclides) have emerged as a very important tool for calibration and validation of models. A major advantage of isotopic techniques lies in their ability to track long term changes of SOM turnover and to separate organic C pools according to their origin. One such model is RothC-26.3-Model, a process oriented soil carbon model, developed on the data from long term experimental plots in Rothamsted, UK. This model takes into account the quantity and quality of the organic matter added, soil type, climate variables and plant cover (Fig. 1).

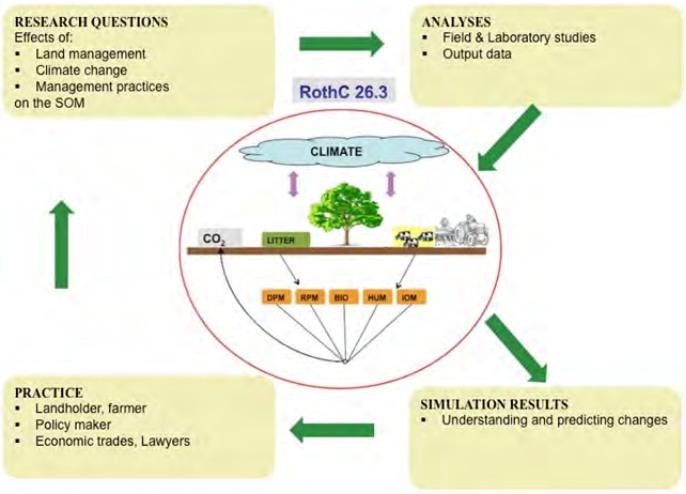

Fig. 1. Simplified scheme of RothC-26.3-Model and its application. Soil organic carbon is split into four active pools: decomposable plant material (DPM), resistant plant material (RPM), microbial biomass (BIO), humified plant material (HUM), inert organic material (IOM).

In the frame of the training course on Soil Organic Carbon Dynamics and Management: The Use of Innovative Isotope and Conventional Techniques at the Soil and Water Management & Crop Nutrition Laboratory, Seibersdorf, Austria, modelling of soil organic carbon with RothC-26.3-Model was introduced to the fellows. For easier use and better model calibration, the MS Excel version of RothC-26.3-Model was applied (Rampazzo Todorovic et al., 2010). The main objective of the course was to predict changes in SOM pool in relation to climatic change, land use, land management, and fertilization on the datasets from different world regions (e.g. Austria, Kenya) as well as to translate acquired knowledge into practical application.

The modelling of SOC under corn for a period of 50 years in central Kenya was discussed during the training. All input data required for the model calibration (e.g. climate, crop and soil) of the Kenya exercise were extracted from literature. For the validation of the model, the Root Mean Square Error (RMSE) was used as a measure of the difference between values predicted by a model and the values actually observed from the environment that is being modelled (Fig. 2). The smaller the RMSE value, the better the relationship between measured and simulated data.

Tables 1 and 2 show results of the Kenya exercise on development of 11 modelling scenarios with variable land management (three tillage systems e.g. minimal factor 1, reduced factor 1.4, conventional factor 1.8; farmyard amendment of 0.5 and 2 t ha^{-1} and lower plant input of root+chaff or higher of root+chaff+straw); and 4 climatic (mean air temperature and temperature uncertainty of + 3°C combined with minimal and conventional tillage) datasets. From the difference between the end and start values of SOC, the gain or loss of soil C for the whole period of 50 years and on the yearly step as well as storage or emission of CO_2 were calculated. The gains of SOC and CO_2 are shown by positive values and the losses

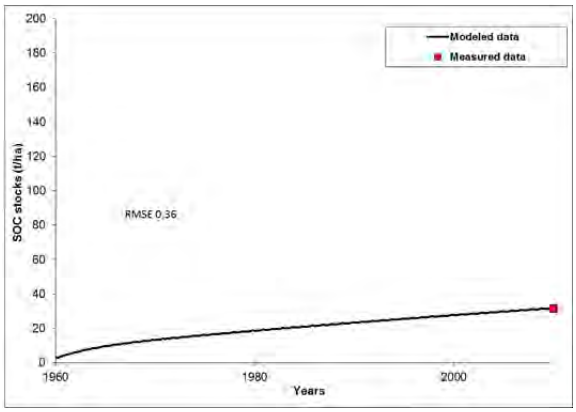

Fig. 2. Calibration for RothC-Excel-Model and *its RMSE.*

by negative values (see Table 1). Results of the modelling exercise have shown that at low soil tilling intensity (factor 1) and higher organic carbon (2 t/ha) input into the soil, the sink activity for C and greenhouse gas prevails as well as higher input of plant residues (roots + chaff + straw) after the yield. In the scenarios one to seven, the intensity of tilling has come out as the main driver of soil CO_2 emissions when all other conditions are the same (input of the organic amendment and plant residue input). The change of tillage management from conventional to minimal tillage adds about 3.3 t C ha^{-1} $year^{-1}$ without fertilizer addition. Application of 2 t ha^{-1} $year^{-1}$ of farmyard manure could result in the accumulation of 7.3 t C ha^{-1} $year^{-1}$ with minimal tillage (scenario 5). In the scenarios 8 to 11, the influence of higher plant input (root + chaff + straw) could be seen on C dynamics in soil when compared with the scenarios from 1–7 with lower plant input (roots + chaff). The decrease in C content was observed with decreased plant input. In the scenarios 3 and 9 with the conventional tillage and without organic amendment, the results of modelling show that higher residue input could bring 6.4 t ha^{-1} $year^{-1}$ to the soil.

Table 1. Modelled soil organic carbon (SOC) for 11 different land management scenarios (corn cultivation) in central Kenya

Modelling scenarios	Start SOC (t C/ha)	End SOC after 50 years (t C/ha)	Gain/loss of SOC after 50 years (t C/ha)	Gain/loss SOC (t C/ha/year)	Gain/loss of CO_2 (t CO_2/ha/year)	Tillage	Farmyard amendment (t/ha)	Plant residues input: roots+chaff	Plant residues input: roots+chaff+straw
1	31.5	19.2	-12.3	-0.25	-0.90	1	-	+	-
2	31.5	17.5	-14	-0.28	-1.03	1.4	-	+	-
3	31.5	15.9	-7.1	-0.14	-0.52	1.8	-	+	-
4	31.5	24.4	-7.1	-0.14	-0.52	1	0.5	+	-
5	31.5	39.8	+8.3	+0.17	+0.61	1	2	+	-
6	31.5	20.2	-11.3	-0.23	-0.83	1.8	0.5	+	-
7	31.5	33.1	+1.6	+0.03	+0.12	1.8	2	+	-
8	31.5	26.9	-4.6	-0.09	-0.34	1	-	-	+
9	31.5	22.3	-9.2	-0.18	-0.67	1.8	-	-	+
10	31.5	47.5	+16	+0.32	+1.17	1	2	-	+
11	31.5	39.45	+7.95	+0.16	+0.58	1.8	2	-	+

In our validation/calibration, an increase of the mean air temperature of 3°C resulted in a loss of C in soil for two tillage systems (conventional 1.8 and minimal 1) (Table 2). Moreover, the highest emission of CO2 was due to conventional tillage (factor 1.8) under the climatic conditions of increased mean air temperature.

The modelling exercise showed that for enhanced SOC sequestration, the minimal tillage is of high importance as well as the addition of higher plant input and organic amendments into the soil. Increased plant production with increasing fertilizer application rates may represent an opportunity to enhance C sequestration (Carlisle et al., 2006). The influence of climate warming process could be counteracted by an adjustment of green cover or intra-row mulching due to possible reduction of the evaporation. For better application of research, results on SOC modelling deserve special attention as a tool that provides information, which can be used for recommendation of suitable agricultural management practices.

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Table 2. Modelled soil organic carbon (SOC) for 4 different land management (corn cultivation) and climatic scenarios of central Kenya

Modelling scenarios	Start SOC (t C/ha)	End SOC for mean air temp. (t C/ha)	End SOC for mean air temp. + 3°C (t C/ha)	Gain/loss of SOC after 50 years (t C/ha)	Gain/loss of SOC (t C/ha/year)	Gain/loss of CO_2 (t CO_2/ha/year)	Tillage
1	31.5	19.2	-	-12.3	-0.25	-0.90	1
2	31.5	-	18.1	-13.4	-0.27	-0.98	1
3	31.5	15.9	-	-14	-0.28	-1.03	1.8
4	31.5	-	14.5	-17	-0.34	-1.25	1.8

Publications

List of Publications in 2013

Adu-Gyamfi, J., Dercon, G., Overview of FAO/IAEA Coordinated Research Project on Crop Genotypes Tolerant to Low N and P Soils, Proc. International Symposium on "Managing Soils for Food Security and Climate Change Adaptation and Mitigation", 23–27 July 2012, Vienna, Austria, 2013 (In press).

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Web Sites

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

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

- Food and Agriculture Organization of the United Nations (FAO) http://www.fao.org/about/en/

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

Impressum

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