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Nuclear Techniques in Food and Agriculture

# Soils Newsletter

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## Contents



*Water use efficiency is a major issue for sustainable agricultural production, since approximately 80% of freshwater use is related to agriculture as shown here, with traditional flooding rice cultivation in Bangladesh*

# To Our Readers

It is over a year since I took up the post as Head of the Soil and Water Management & Crop Nutrition Section (SWMCN). The end of 2005 is fast approaching and 2006 is just around the corner! This end-of-year newsletter provides me with an opportunity to thank you all for your valuable feedback on the newsletter's format and our research coordinated projects coordinated research projects (CRPs), technical cooperation (TCPs) projects and other activities outlined in our newsletters. I also would like to take this opportunity to share with you some of the initiatives that the SWMCN Section undertook in 2005 and to highlight activities for 2006.

In 2005, a major focus in the Section has been to address key concerns in our Member States on (i) minimizing crop nutritional stress by enhancing the recovery of soil major nutrients and (ii) optimizing water use and conservation in agriculture. A consultants meeting (CM) on crop nutritional stress was held in Vienna from 25-27 July and a new CRP resulting from this CM will be initiated in 2006 entitled "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". A call for research contracts and agreements will soon be posted on the SWMCN webpage (http://www-naweb.iaea.org/nafa/swmn/index.html).

IAEA International Atomic Energy Agency

In the meantime, please have a look on p. 18 for information on this new approved CRP. I hope this information will be sufficient for you to formulate your research contract proposals in readiness for submission once a formal call is made. A Regional Asia-Pacific workshop in collaboration with the Chinese Academy of Sciences on "The use of isotopes and nuclear techniques to improve water management for sustainable agriculture" was successfully organized on 21-23 November in Nanjing, with participants from Australia, China, Germany, India, Nepal, New Zealand, the Philippines, Thailand and Vietnam.

The workshop identified key issues in water management in agriculture and the research/technical activities required to address these issues (see p. 14).

Besides the increasing number of TCPs covering a range of activities (such as soil fertility, biological nitrogen fixation, desertification, water management in agriculture, irrigation technologies, soil erosion and integrated land management) in our Member States (p. 7), three research coordinated meetings (RCMs) will be held in 2006. These meetings will cover "Integrated soil-water and nutrient management for sustainable rice-wheat cropping systems in Asia" (D1.50.07), "Assessing the effectiveness of soil conservation measures for sustainable watershed management using fallout radionuclides" (D1.50.08) and "Integrated soil, water and nutrient management for conservation agriculture" (D1.50.09). A CM in Vienna is also scheduled in the first quarter of 2006 to develop a new CRP on "water management in agriculture."

Another highlight in 2006 will be the workshop to be held at the 18th World Congress of Soil Science (WCSS) on 9 July in Philadelphia, USA. There were over 64 applicants for the limited funding allocated for this workshop. At the time this newsletter goes to print, the final list of selected participants will be announced and I look forward to being involved in this exciting workshop, with participants drawn from many Member States.

Significant staff movement has occurred in 2005. Ms. Ruth Rossi retired in August, after 29 years of dedicated service to the IAEA. Her position was filled on 28th November with the arrival of Ms. Eveline Kopejtka (see p. 4) and we are pleased to welcome Eveline to our team. The Section also bade farewell to two professional staff members (Mr. Rachid Serraj and Ms. Lee Heng) on 2 December. Their departure represents a big loss for the Soils sub-programme. Rachid is leaving to take up a research post in the Irrigation Rice Research Center (IRRI), while Lee will take up a 6-month contract with FAO in Rome, Italy after 7 and a half years of sterling service with the IAEA. Further details of their contribution to the Soils sub-programme can be viewed in the Staff Section of this newsletter. In order to provide some assistance for our activities, Pierre Moutonnet, a previous staff member, has been back working as a consultant since 3 October. He is expected to complete his contract by the end of December.

With the departure of key staff members and the forthcoming activities, I remain optimistic that the Soils sub-programme will strive forward with the support and active participation of all team members from the Headquarters and the Soil Science Unit in Seibersdorf. Continuing support from you, our valued readers, in providing suggestions and critical evaluation of our research and technical cooperation programmes is also crucial to our success. I look forward to receiving your ongoing contributions.

I wish you and your families a Happy New Year, good health and every success in 2006.

*Long Nguyen*

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**Ms Eveline Kopejtka** joined the Soil and Water Management & Crop Nutrition Section (SWMCN) on 28 November to fill the vacant secretarial position following Ruth Rossi's retirement. Eveline is a native Austrian and has been working as a secretary for the Comprehensive Test Ban Treaty Organisation (CTBTO), a UN organization in Vienna for more than seven years. She loves outdoor sports such as rollerblading, hiking and biking, going to exhibitions and reading good books.

**Ms. Ruth Rossi** began her duties with the IAEA on 28 August 1976.
As of 1 March 1984, Ms. Rossi was employed as a Secretary with the SWMCN Section. She provided excellent secretarial, administrative and clerical support and was instrumental in the successful implementation of many newsletters, IAEA-TECDOCs, and RCMs for the Soils subprogramme. We thank Ruth for her inputs and wish her well in her retirement (30 August). She is looking forward to spending more time with her family and friends, gardening, choral singing and occasional overseas travel.

**Mr Rachid Serraj**, after 18 months of active service with the SWMCN Section, has left the Joint FAO/IAEA Division for a new position with the International Rice Research Institute (IRRI). Rachid acted as a project officer for two Coordinated Research Projects (CRPs) on the "Selection for greater agronomic water use efficiency in wheat and rice using carbon isotope discrimination" and the "Use of Nuclear Techniques for Developing Integrated Nutrient and Water Management Practices for Agroforestry Systems". He also involved as technical officer for many TCs. Starting from January 2006, Rachid will be posted at IRRI Headquarters in Los Banos (Philippines) and will be coordinating IRRI's Crop Physiology team on Drought Tolerance in rice. We thank Rachid for his excellent work for the FAO/IAEA and wish him all the best for the future. Rachid e-mail address at IRRI is: R.Serraj@cgiar.org

**Ms Lee Heng** has left the IAEA for FAO, in Rome, after more than 7 years with the Soil Science Unit. Lee joined the FAO/IAEA programme in May 1998. She brought with her an excellent background in soil physics and experience in irrigation, water management and modeling. Her work for the IAEA was in particular to perform research on the use of nuclear techniques in irrigation and water management and she coordinated several IAEA publications including the following: Water Balance and Fertigation for Crop Improvement in West Asia. IAEA-TECDOC-1266; Deficit Irrigation Practices, Water Reports 22; Comparison of Soil Water Measurement Using the Neutron Scattering, Time Domain Reflectometry and Capacitance Methods, IAEA-TECDOC-1137; Nutrient and Water Management Practices for Increasing Crop Production in Rainfed Arid/Semi-Arid Areas IAEA-TECDOC-1468. Lee trained 17 fellows at the Seibersdorf Laboratory and organised an inter-regional training course as technical officer for 18 participants on water management at the Laboratory in 2003 and training workshops in several Member States. Lee also coordinated national (Libyan Arab Jamahiriya, Sierra Leone, Yemen, Uzbekistan) and regional (West-Asia and Europe) TCs on water management. Some excellent results have been reported from these projects both in previous newsletters and in external publications. Lee will be working for the FAO for the next 6 months on water productivity, crop-water relations and modeling. We thank Lee for her excellent work for the FAO/IAEA and wish her all the best for the future.

**Ms Christine Ficker** retired after more than 30 years as a laboratory attendant for the Soil Science Unit (SSU). Christine performed excellent work in the maintenance of greenhouse and field experiments and sample preparation and assisted professional staff at the SSU with laboratory services for the training of IAEA fellows. We thank Christine for her contribution to FAO/IAEA projects and wish her all the best for the future.

**Mr Pierre Moutonnet**, a former staff member is currently on an a 3-month assignment to assist the Soils subprogramme with TC projects, the water management component of the November-December training course for Iraqi fellows (p.22) and the forthcoming CM in 2006 on water management in agriculture. Pierre will conclude his assignment on 30 Dec. and we thank Pierre for his dedication and excellent input.

# FORTHCOMING EVENTS

## Research Coordination Meetings (RCMs) of FAO/IAEA Coordinated Research Projects (CRPs)

**Third RCM of CRP on "Assess the Effectiveness of Soil Conservation Measures for Sustainable Watershed Management Using Fallout Radionuclides" 8–12 May 2006, Rabat, Morocco (D1.50.08)**

Technical Officer: Claude Bernard

The nineteen contract and agreement holders participating to this CRP are expected to attend the third RCM, which will take place in Morocco, on 8–12 May 2006. Dr Moncef Benmansour, of the Centre National de l'Énergie, des Sciences et des Techniques Nucléaires will act as the local organizer of the meeting. The results obtained since the 2nd RCM will be presented and evaluated, according to the objectives of the CRP. Discussions will also take place on the models that are used to convert fallout radionuclide inventories into erosion/deposition rates. Publication of the results of the CRP will also be discussed. The meeting will therefore play an important role in formulating work plans for the 2006–2007 cycle to ensure successful accomplishment of all the objectives and outcomes planned in this CRP.

## Consultants' Meeting

**Consultants Meetings on Water Use Efficiency and Conservation of Water and Nutrients within the Plant Rooting Zone, First and second quarters of 2006, Vienna International Centre, Vienna, Austria**

Scientific Secretary: Long Nguyen

A consultants meeting (CM) is being planned for the first/second quarter of 2006 to address the two following issues which are of particular concern to Member States:

(i) Improving irrigation technologies and practices for efficient use and conservation of water and nutrients at farm scale through the use of isotopic and nuclear techniques.
(ii) Improving food security and agricultural sustainability by the tracking and quantification of water and agricultural nutrients through and beyond the rooting zones using isotopic techniques.

This meeting will be held in Vienna, Austria, and will be valuable for developing CRPs which are relevant to the outputs of Project E.1.08 (Technologies and practices for efficient agricultural water use and conservation) such as developing guidelines on crop water productivity and methodologies to measure various sources, flow paths and losses of water through crops and soils; data on crop water use and water balance for small scale irrigation systems and water saving technologies; and data on crop water transpiration.

If you have relevant research expertise and skills in the above areas and wish to participate in this CM, please contact the scientific secretary at M.Nguyen@iaea.org. Generally, 5 external experts will participate in each CM in addition to the staff of the SWMCN Section and the SSU.

## FAO/IAEA International Workshop on "The use Nuclear Techniques in Addressing Soil-Water-Nutrient Issues for Sustainable Agricultural Production", 9th July 2006, Philadelphia, Pennsylvania, USA

Scientific Secretary: Long Nguyen

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture will host a workshop on "the Use of Nuclear Techniques in Addressing Soil-Water-Nutrient Issues for Sustainable Agricultural Production" at the 18th World Congress of Soil Science to be held in Philadelphia, Pennsylvania, USA. This workshop, which will be held on the 9th July 2006, will provide an excellent opportunity for participants to exchange information on nuclear techniques in agriculture and to attend the 18th World Congress of Soil Science, which covers a range of research and technical issues highly relevant to the participants.

The Secretariat of the International Atomic Energy Agency has limited funds at its disposal and these funds will be used to help meet the costs of attendance at the workshop by selected specialists mainly from developing countries with low economic resources.

Attention is specifically drawn to the fact that the applicants need to independently contact the Organizing Committee of the 18th World Congress of Soil Science if they wish to register to attend the entire Conference (9–15 July 2006) and book hotel accommodation for the 18th World Congress of Soil Science at the following websites:
http://iuss.colostate.edu/18wcss/organizingcomm.html

http://www.18wcss.org

The following themes will be covered at the FAO/IAEAworkshop on 9 July:

(i) The use of isotopic tracers and soil moisture neutron probes to quantify stocks and flows of carbon, nutrients, water and soil in cropping systems.

(ii) The use of isotopic markers or tracers in germplasm selection or breeding programmes for enhanced tolerance to abiotic stresses.
(iii) Soil carbon sequestration and conservation agriculture in mitigating soil erosion, fertility degradation and desertification.
(iv) Agricultural water management and productivity (crop water productivity and agricultural water resource assessment/measurement).
(v) Integrated soil-nutrient management in agro-ecosystems (e.g., use of crop residues and fertilizer utilization efficiency and losses to environment).

## Non-FAO/IAEA Meetings

### 2006

- April 4–8, 2006. International Symposium on Water and Land Management for Sustainable Irrigated Agriculture, Cukurova University, Adana, Turkey. For further information, please contact Symposium Secretariat, Dr. Attila Yazar at: yazarat@cu.edu.tr or symp2006@cu.edu.tr.
- May 14–19, 2006. The 14th conference of the International Soil Conservation Organization (ISCO), Marrakesh, Morocco. The Soil and Water Management and Crop Nutrition Section is actively involved in this meeting, by organizing a session on "The Use of Fallout Radio-nuclides for Erosion/Sedimentation Studies". Some twenty (20) abstracts have been received for this session. For information on the ISCO meeting; Email: isco2006@wanadoo.net.ma; Web site: www.maneskovtravel.com/isco2006
- July 9–15, 2006. 18th World Congress of Soil Science. Frontiers of Soil Science: Technology and the Information Age, Philadelphia, Pennsylvania, USA. Contact: the Organizing Executive Committee at: http://iuss.colostate.edu/18wcss/organizingcomm.html and www.18wcss.org).
  See First Announcement at http://www7.nationalacademies.org/usncss/WCSS_First_Announcement.html

# TECHNICAL COOPERATION PROJECTS

## Operational Projects and Technical Officers responsible for implementation

| Project Number | Title | Technical Officer |
|---|---|---|
| ALG/5/020 | Combating Desertification | R. Serraj |
| ALG/5/021 | Optimising Irrigation Systems and Surface Water Management | L. Nguyen |
| BGD/5/023 | Development of Agroforestry-Based Livestock Production Systems | R. Serraj |
| CHI/5/048 | Integrated Watershed Management for the Sustainability of Agri-cultural Lands | C. Bernard |
| CMR/5/013 | Use of Nuclear Techniques in Soil Nutrient and Water Studies | R. Serraj |
| CPR/5/014 | Increasing the Productivity of Crop/Livestock Production System | G. Hardarson |
| CPR/5/015 | Assessment of Soil Erosion and Effectiveness of Soil Conservation Measures | C. Bernard |
| ECU/5/022 | Efficient Use of Nitrogen Fertilizers I Flower Production | R. Serraj |
| GHA/5/032 | Enhancing Production and Use of Cassava | R. Serraj |
| HAI/5/003 | Enhancing Crop Productivity through the Application of Isotope Nuclear Techniques | R. Serraj |
| IVC/5/029 | Improvement in Yield of Plantain and Cassava through the Use of Legume Cover Crops | R. Serraj |
| JAM/5/009 | Developing Soil Fertility Management | R. Serraj |
| KEN/5/023 | Combating Desertification Using Nuclear Technology | R. Serraj |
| KEN/5/026 | Isotope Techniques for Assessment of Water and Nitrogen Use Ef-ficiency in Cowpea and Maize Intercropping Systems | L. Heng |
| LIB/5/010 | Establishing a Drip Irrigation-fertigation System Using Nuclear Techniques | L. Heng |
| MAR/5/014 | Management Practices for Increased Efficiency of Fertilizers and Improved Productivity of Saline Soils | R. Serraj |
| MON/5/014 | Application of Isotopes in Soil and Plant Studies | G. Hardarson |
| NAM/5/008 | Increasing Crop Productivity and Resource Use Efficiency in the Northern Communal Areas | R. Serraj |
| PHI/5/031 | Assessment of Erosion and Sedimentation Processes for Effective Formulation of Soil Conservation and Water Quality Production Measures | C. Bernard |
| RAF/5/048 | Combating Desertification in the Sahel | C. Bernard |
| RAS/5/043 | Sustainable Land Use and Management Strategies for Controlling Soil Erosion and Improving Soil and Water Quality (RCA) | C. Bernard |
| SEN/5/028 | Enhancement of Biological Nitrogen Fixation and Phosphorus Use Efficiency in Cowpea under Drought Conditions | G. Hardarson |
| SIL/5/008 | Contribution of Nitrogen Fixing Legumes to Soil Fertility in Rice-based Cropping Systems | G. Hardarson |
| SIL/8/002 | Improved Water Management Technologies in the Inland Valley Agro-Ecology | L. Heng |
| SLO/5/002 | Protecting Groundwater and Soil against Pollutants Using Nuclear Techniques | L. Heng |
| SRL/5/038 | Application of Isotope Techniques for Soil Erosion Studies | C. Bernard |

| Project Number | Title | Technical Officer |
|---|---|---|
| TAD/5/002 | Assessment of Soil Erosion and Sedimentation for land Use | C. Bernard |
| TUR/5/024 | Improving Crop Productivity through Nuclear and Related Techniques | L. Nguyen |
| UGA/5/025 | Integrated Nutrient Management for Increased and Sustainable Crop Production on Smallholder Farms | L. Nguyen |
| URU/5/024 | Improving Carbon Sequestration in Agricultural Systems | L. Nguyen |
| YEM/5/002 | Drip Irrigation and Fertigation for Improved Agricultural Productivity | L. Heng |
| ZIM/5/011 | Combating Desertification in Agricultural Drylands | R. Serraj |

# PAST EVENTS

## Third RCM of CRP on "Integrated Soil-Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia" 11–15 July 2005, Dhaka, Bangladesh (D1.50.07)

Technical Officer: Long Nguyen

The 3rd RCM was successfully held at Bangladesh Rice Research Institute (BRRI), Gazipur, approximately 40 km from Dhaka, the capital of Bangladesh with the support of the Government of Bangladesh and the Director General of the BRRI. Both Drs. Akhter Hossain Khan and Murshedul Alam of the same institution provided excellent assistance with local organization and logistics. The meeting comprised 12 participants including 6 research contractors (two from China and one from each of the four countries, Bangladesh, India, Nepal and Pakistan), 2 technical contractors from Australia and the Philippines, 2 agreement holders from Australia (CSIRO) and India (CIMMYT), and 2 observers from Bangladesh and Germany. The six research contractors came from five countries (China, Bangladesh, India, Nepal and Pakistan) where rice-wheat (RW) cropping systems play an important role in rice and wheat production. The RCM was officially opened by Dr. Mahiul Haque, the Director General of BRRI, Gazipur. In his welcoming-opening address, Dr. Haque highlighted the importance of this CRP in providing essential information on integrated soil, water and nutrient management for rice-wheat (RW) systems, which are the two most important cereal crops in the world. These crops, grown in sequence on the same land in the same year over 28 million hectares (Mha) of South and East Asia, play an important role in food security in this Region, which represents 43% of the world's population on 20% of the world's arable land. The areas with RW systems in Pakistan, Bangladesh and Nepal (2.2, 0.8 and 0.5 Mha, respectively) are relatively minor, compared to India and China (growing area of around 12.3 and 13Mha, respectively).

The dominant characteristics of the rice-wheat (RW) system is the annual cycle, consisting of flooded anaerobic conditions for rice and then followed by the aerobic conditions, necessary for wheat. Under this anaerobic-aerobic system, soil is compacted (puddle) to reduce the seepage of standing water and to ensure flooded conditions for rice growing. The impaired soil structure of the puddle layer and subsequent drying effects after rice harvesting and prior to the sowing of the wheat crop may affect the germination and establishment of the wheat crop and the transformation of soil organic matter and soil nutrients. To mitigate any negative impact of soil puddling on the efficient use of soil-water-nutrient resources and to address water scarcity in agriculture, various technologies (e.g., rice on non-puddled soils or on raised beds, direct seeding, and zero tillage for wheat after rice) have been introduced. The main objective of this CRP was to investigate the effects of these alternative technologies on rice-wheat production and water-nutrient use efficiency.

Results presented at the third RCM indicate that there were variable grain and straw yields for rice and wheat crops when comparing traditional flooding rice cultivation with alternative aerobic rice growing technologies. Similarly, variable results for both N use efficiency by crops and the extent of N remaining in the soil after a growing season were reported, indicating that further studies are required to investigate nitrogen recovery for a range of rice-wheat growing technologies under different soil moisture and climatic conditions. Not only nitrogen but also phosphorus transformations in soils under wetting-drying and aerobic-anaerobic soil conditions can influence the plant-available soil phosphorus pool. Further research is therefore required to investigate the impact of soil-water interactions on soil P dynamics under a range of RW cropping soil systems (e.g., rice on flat land or on raised beds; mulching or no-mulching). Besides presenting the results obtained, the meeting played an important role in formulating contract renewals and project implementation in the 2005-2006 cycle to ensure successful accomplishment of all the objectives and outcomes set out in this CRP. It was decided at the meeting that the 4th and final RCM will be held in Vienna, Austria. The original dates were 23-27 October 2006 but were rescheduled to 6-10 November 2006 because of the official IAEA holidays on 24 and 26th October. 2006. The report of the meeting will soon be available at http://www.iaea.org/programmes/nafa/d1/crp/d1-crp.html.

*Long Nguyen with some participants at the third RCM (D1.50.07), Dhaka, Bangladesh, on 11-15 July 2005*

*Participants at at the third RCM (D1.50.07), Dhaka, Bangladesh, on 11-15 July 2005*

## Second RCM of CRP on "Selection for Greater Agronomic Water-Use Efficiency in Wheat and Rice Using Carbon Isotope Discrimination", 21–25 November 2005, Meknes, Morocco (D1.20.08)

Technical Officer: Rachid Serraj

The Second Research Coordination Meeting of the CRP on C-13 and agronomic water use efficiency was hosted and organized by Mr M. Jlibene, the contract holder from Morocco, at Hotel IBIS, Meknes, Morocco from 21-25 November 2005.

The overall objective of this project is to use the carbon isotope discrimination technique to contribute to increasing the agronomic water-use efficiency of wheat and rice production, where agronomic water-use efficiency is defined as grain yield/total water use including both transpiration and evaporation.

Nine contract holders from Algeria, Bangladesh, China (2), India, Morocco, Pakistan, the Syrian Arab Republic and Yemen, three technical contract holders from Australia (CSIRO), IRRI-Philippines and CIMMYT-Mexico, and one agreement holder from the USA attended this RCM, in addition to three observers from other Moroccan institutions. The Project Officer, Mr. R. Serraj served as the Scientific Secretary for the RCM.

During the opening session of the RCM, Mr R. Lemrabet, Regional Director of INRA Regional Centre in Meknes welcomed the participants and presented an overview of INRA's research mandate and current activities. The scientific secretary presented the objectives and the programme of the RCM. All participants presented reports on the achievements and conclusions of their research covering the second year of the project (2004-2005). The presentations of the participants were followed by extensive discussions.

On Wednesday 23 November, a field visit was organized to the INRA Regional centre in Kenitra and to CNESTEN in Rabat, where participants were introduced to the activities carried out at CNESTEN in the field nuclear techniques applications.

Two working group sessions were organized to review the progress of the CRP and to discuss the future activities. Detailed work plans were established for future research activities in each participating country and in line with the project objectives. A final plenary session was dedicated to general discussion, and to report the main conclusions and recommendations of the RCM. A detailed report of the second RCM will be shortly available at: www-naweb.iaea.org/nafa/swmn/crp/d1_2008.htm.

*Participants at the RCM in Meknes, Morocco, on 21-25 November 2005*

## FAO/IAEA Technical Meeting on "Combating soil degradation to enhance food security in Africa: the role of nuclear techniques in developing improved soil, water and nutrient management practices", 10–12 October 2005, Nairobi, Kenya

Scientific Secretary: Claude Bernard

Rotational agriculture in Africa is gradually disappearing as increasing population density and pressures for land use leads to intensive, sedentary agriculture on small-scale land holdings and expansion of agriculture into marginal areas. This has resulted in widespread soil degradation through several processes. This technical meeting was thus organized with the objectives of (1) reviewing recent advances in the use of nuclear and related techniques for the development of integrated soil, water and nutrient management practices, (2) enhancing the knowledge and awareness of the potential of these techniques to generate such information and (3) providing a forum for participants to exchange ideas and experiences and establish linkages for future collaboration.

Twenty-one (21) participants from Burkina Faso, Egypt, Ghana, Kenya, Madagascar, Morocco, Mozambique, Senegal and Zimbabwe attended the meeting, which addressed the following land degradation issues: (1) nutrient management, (2) carbon management, (3) soil acidity,

(4) soil salinization, (5) water management and (6) soil erosion and sedimentation.

After the welcome addresses by representatives from the National Council for Science and Technology of Kenya and from the Tropical Soil Biology and Fertility Institute of CIAT, in Nairobi, fourteen (14) technical papers were presented in the first two days of the meeting. Each had been selected to present an example of how nuclear techniques can help investigate soil degradation problems. There were six papers related to nutrient management, three on carbon management and two on water management. Salinity, acidity and erosion problems were covered by one paper each.

Future perspectives and research needs in relation to combating soil degradation in Africa were identified and discussed on the third day of the Meeting.

*Participants at the Technical Meeting in Nairobi, Kenya, on 10-12 October 2005*

The papers presented at the meeting indicate that significant progress has been made in the understanding of processes leading to land degradation and in the development of improved soil, water and nutrient management. However, further research is still required to achieve better integrated soil-water-nutrient management leading to increased and sustainable food production.

## Consultants' Meeting on "Crop Nutritional Stresses", 25-27 July 2005, Vienna International Centre, Vienna, Austria

Scientific Secretary: Rachid Serraj

In order to address the issue of crop nutrient-use efficiency and tolerance to soil nutrients stresses, the main objectives of the CM were to (i) review the state of the art in the physiology and breeding of crop nutritional stress, (ii) identify key research areas related to the use of isotope and nuclear techniques, and (iii) to develop the proposal of a coordinated research project (CRP) on the selection and development of germplasm tolerant to nutritional stress in tropical crops.

Five external experts, Mr J. Adu-Gyamfi (Ghana), Mr. Broadley (UK), Mr. J Lynch (USA), Mr. I.M. Rao (Colombia), and Mr. T.R. Sinclair (USA) participated in the meeting in addition to the staff of SWMCN section and SSU Laboratory Unit. The consultants concluded that:

- Low soil nutrient availability, particularly N and P, are widespread limitations of crop production and food security in many developing countries, particularly in Sub-Saharan Africa,
- Use of superior crop genetic lines that better utilize N and P (internal and external) resources will contribute to the mitigation of the cycle of unsustainable agriculture and soil fertility degradation in these areas,
- The CRP should focus on major elements (N and P) and regions with inherent low soil fertility and where water deficit is not the main environmental constraint, to avoid the complexity of water-nutrient interactions.
- The CRP will develop technologies including the use of isotopes, for identifying superior lines for key plant characteristics leading to enhanced accumulation of N and P by major cereal and grain legume crops.
- The CRP should foster the exploitation of the identified crop lines in breeding efforts and improved management schemes, including cereal-legume rotations and intercropping
- The outputs of this CRP will provide improved knowledge, approaches, and cereal and grain legume genotypes to enhance crop performance in regions of low soil fertility.

The consultants formulated the following recommendations:

- The IAEA should support national / regional / international efforts to improve major food (cereal and grain legume) crop genotypes tolerant to nutritional stress factors, mainly N and P deficiency
- Research should be supported through a CRP according to the project document (attached)
- The CRP should focus on major elements (N and P) and regions with inherent low soil fertility and where water deficit is not the main environmental constraint, to avoid the complexity of water-nutrient interactions. It is recommended to not solely focus on tropical areas but on all zones with low soil nutrient availability.
- Specifically, there is a need to develop methodologies and experimental approaches for: a) screening grain legume and cereal genotypes for plant traits associated with N and P acquisition under low soil fertility conditions, b) develop integrated plant genetic and natural resource management strategies.
- Research Contract Holders should be multidisciplinary teams of scientists already conducting research on cereal and legume crop improvement, and soil and

crop management. Experience in the use of nuclear techniques will be required.

- Technical contracts should be awarded (2 per year) to accomplish the following critical tasks: a) Screening of germplasm, b) Systems analysis-modeling, c) Standardization of experimental protocols and use of P-32 for root traits related to P acquisition, d) characterization and quantification of changes in soil N and P pools resulting from changes in crop genotypes with superior resource use recovery.
- Wherever possible, the CRP should operate within existing crop and soil research networks (e.g. Root consortium, PABRA, PRM, PROFRIJOL, MIS, AfNet, SWIM, etc.), to optimize resources and obtain maximum synergy.

Based on these conclusions and recommendations, a CRP proposal entitled "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 been submitted to the IAEA within the Programme and Budget for 2006-2007 (E1.05).

## National Training Course on "The use of isotopic and nuclear-related techniques for integrated soil fertility management" as part of the TCP on "Efficient Use of Nitrogen Fertilizers in Flower Production" ECU/5/022, 15-20 August 2005, Quito, Ecuador

Technical Officer: Rachid Serraj

The course was held at the campus of IASA-ESPE in Quito and involved 23 participants, including scientists and staff from IASA, CEEA and personnel from private floriculture companies.

Two regional experts, Mr Segundo Urquiaga (Embrapa, Brazil) and Mr Carlos Cervantes (Univ. Costa Rica) served as resource persons for the NTC in addition to the project Technical Officer. The programme of the course combined a series of 10 lectures and 3 practical sessions, in addition to general discussions and consultations.

The lectures covered several aspects of the application of isotopic techniques in soil fertility management, including the following topics: technical characteristics of rose production systems in the tropical and subtropical regions, fertigation and soil nutrient management in floriculture, use of isotopes (particularly 15N) and nuclear techniques in soil-plant studies, nitrogen balance, fertiliser application and efficiencies, nitrogen losses and leaching under high fertilizer input supply systems, design and management of field micro plots and pot experiments, principles of field experimental design, data analysis and interpretation.

The practical sessions included simulation exercises on the techniques of 15N application in field and pot experiments and guidelines for plant sampling, sample preparation and analysis. A series of exercises related to project activities were also carried out in working group sessions for the calculation of total biomass and flower production, nitrogen balances, and estimation of 15N excess needed for typical experimental trials.

A field visit was organized with all the course participants to the San Andrés farm, dedicated to the commercial production of roses. During this visit, it was possible to observe the systems of rose production and management of fertilization (soil beds and hydroponics). It was also the occasion to discuss with the technical manager of the farm the various aspects of nitrogen fertilization in the commercial farms, and the future needs of technical investigation to optimize these production systems. On the last day of the course, a general discussion was organized to answer specific technical questions from the participants, and to prospect new ideas and concepts about the general use of isotopic and nuclear-related techniques in soil and water management and crop nutrition, and future potential applications in Ecuador.

# Non-FAO/IAEA Meetings

## Second International Conference on "Integrated Approaches to Sustain and Improve Plant Production under Drought Stress", 24-28 September 2005, Rome, Italy

Technical Officer: Rachid Serraj

The second InterDrought conference is a major scientific event for the R&D community working on dryland agriculture. It was organized 10 years after the first conference (1995 at Montpellier, France). There were 534 registered participants from 59 countries and a total of 450 posters were presented. Oral presentations were delivered during 8 sessions by 28 invited speakers and 44 selected speakers. The full programme of the conference is available at www.plantstress.com/id2/Programme.htm.

R. Serraj presented a scientific paper in Session 7, entitled 'Crop Improvement of Salinity and Drought Tolerance Using Nuclear and Related Techniques' co-authored with P.J. Lagoda (Plant Breeding & Genetic section) and also contributed as panellist in the final discussion of the plenary sessions. The following conclusions and recommendations were endorsed by the International Steering Committee of InterDrought-II:

- As water available for irrigation is becoming scarce, the cropping pattern is shifting to reserve irrigation water for high value crops while the commodities and grain crops are shifted to dryland and rainfed conditions. Cropping with insufficient moisture supply is expected to become more widely adopted. Deficit irrigation will become the major system for

field irrigation. Water scarcity will cause greater use of recycled and brackish water which can lead to soil salinization.

- Significant progress has been made during the past decade in crop management under water limited conditions, such as conservation and minimum tillage methods. Other avenues of progress were achieved by novel approaches such as cropping system simulations with farmers' participation. A new idea towards crop management systems to cope with drought conditions is the hypothesis that cropping systems in the arid-zone must be flexible. This is in contrast to the basic ideas of the contemporary precision agriculture.

Conventional plant breeding has made well-recorded achievements in releasing varieties that perform well under water-limited conditions. Transgenic technology has also helped to identify certain genes conferring drought resistance in model organisms, which are now being tested in the field in transgenic crop plants, with encouraging results. On the other hand, the contribution of marker-assisted selection (MAS) towards improved crop production under water-limited conditions did not meet expectations, although substantial progress has been achieved during the past decade in our capacity to identify and clone genes and **Q**uantitative **T**rait **L**ocus *(*QTLs).

## WUEMED Workshop, 29-30 September 2005, Rome, Italy

Technical Officer: Rachid Serraj

The WUEMED workshop was organized under the theme of "Improving water use efficiency in Mediterranean agriculture: what limits the adoption of new technologies?", as a satellite event to InterDrought-II. The participants from various developed and developing countries met with the objective to assess and discuss how the knowledge and technology generated through the past and ongoing EU INCOMED projects, together with the scientific evidence presented in InterDrought-II, may be transferred to technical improvements in the field of agriculture under drought and impact the end users in Mediterranean agriculture.

The programme of the workshop (www.distagenomics.unibo.it/wuemed) included a panel discussion on the impact of EU projects and activities on dryland agriculture in the Mediterranean basin, followed by a presentation of summary of InterDrought-II conclusions, subsequently by three sessions:

- Session 1. Strategies and policies for a more sustainable use of water resources. This session focused on issues related to socio/economic and political aspects of sustaining the use of the available water resources in the Mediterranean region.
- Session 2. Water management and breeding for improved drought tolerance. This session was mainly dealing with the optimization of the management of water resources and with the application of modern breeding (e.g. marker-assisted selection) and other advanced approaches (e.g. remote sensing, modeling, etc.) to mitigate the effects of drought on the agricultural systems of Mediterranean countries.
- Session 3. Producing more food with less water: the challenge of the 21st century: This session was devoted to present projects/issues related to the improvement and sustainability of crop production in Mediterranean countries vulnerable to drought, and to discuss the feasibility of establishing a network of excellence for drought-related issues in the Mediterranean basin.

## FAO Regional workshop presenting Priority Actions Programme (PAP)/Regional Activity Centre (RAC) and FAO experiences in combating land degradation in Mediterranean coastal areas, 10-12 October 2005, Rome, Italy,

Technical Officers: Long Nguyen and Lionel Mabit

The FAO Regional workshop presenting PAP/RAC and FAO experiences in combating land degradation in Mediterranean coastal areas was held in Rome, Italy, 10-12 October 2005. The workshop focused on soil degradation and especially on soil erosion. The workshop objectives were to (i) harmonise land degradation assessment methodologies (ii) disseminate experience gained by PAP/RAC and FAO during 15 years of cooperation and (iii) identify proposals for evaluating the harmonized PAP/RAC methodologies in Mediterranean countries Approximately 40 participants from Mediterranean countries (Algeria, Cyprus, Italy Lebanon, Malta, Morocco, Spain, the Syrian Arab Republic, Tunisia, Turkey) and organisations (FAO, PAP/RAC, WOCAT (World Overview of Conservation Approaches and Technologies), CIHEAM (International Centre For Advanced Mediterranean Agronomic Studies), European Commission and IAEA) were present at this workshop. Mr. Lionel Mabit of the SSU made an oral presentation on "The use of fallout radio-nuclides to investigate soil erosion at different scales and complement conventional approaches" and Mr. Long Nguyen of the SWMCN Section presented a paper on "The use of isotopic and associated techniques to investigate land degradation and integrated soil-plant-nutrient water management issues".

Discussions at the workshop sessions indicate that some improvements can be made in the following areas within the PAP/RAC's erosion and degradation guidelines:

- Introducing further socio-economic components to the guidelines

- Quantitative assessment of the extent of land degradation and soil erosion under a range of scales and management conditions.
- Test the guidelines at a national level.
- Soil erosion/land degradation needs to be considered in the broad context of integrated soil-water-nutrient-plant management.
- Improve the dissemination to end users (farming and rural communities).

## FAO/IAEA Regional Asia-Pacific Workshop on Water in Agriculture, "The use of isotopes and nuclear techniques to improve water management for sustainable agriculture", 21-23 November 2005, Nanjing, China

Scientific Secretary: Long Nguyen

The Regional Asia-Pacific workshop on water in agriculture: "The use of isotopes and nuclear techniques to improve water management for sustainable agriculture" was organized by the Institute of Soil Science, Chinese Academy of Sciences in cooperation with the Joint FAO/IAEA Division on Nuclear Techniques in Food and Agriculture and held in Nanjing, China from 21 to 23 November 2005. Twenty-eight papers were presented at the workshop by invited scientists (18) from China and (10) from Asia and the Pacific region. The invited 'overseas' scientists came from Australia, New Zealand, Japan, the Philippines, Vietnam, Germany, India, Nepal and Thailand. The invited Chinese scientists came from several universities, the Chinese Academy of Sciences (CAS), the Chinese Academy of Agricultural Sciences (CAAS) and other research agencies. In addition, there were more than 30 local scientists and students from the Institute of Soil Science, CAS and Nanjing Agricultural University attending the workshop. The meeting was formally opened by the Scientific Secretary. This was followed by the welcoming address from Prof. Dr. Jianmin Zhou, the Director General of the Institute of Soil Science, CAS.

Papers were presented by all invited participants during the first two days and the final day involved discussion sessions on current issues in water in agriculture in the Asia-Pacific region and future activities to address these issues.

The presentation sessions covered the following main themes: (i) Crop Water Productivity: Enhancing livelihoods in Asia-Pacific farming systems through the improvement of farm-scale water and nutrient use efficiency; (ii) Sustainable water use for agriculture: irrigation technologies and their effects on water productivity and farmers' livelihoods; (iii) Impacts of agricultural productivity on water quantity and quality; and (iv) The application of isotopes and nuclear techniques in research areas covered in (i), (ii) and (iii).

*Participants at the FAO/IAEA Regional Asia-Pacific Workshop on Water in Agriculture, Nanjing, China, 21-23 November 2005*

During the discussions at the workshop, both Chinese and Regional Asia/Pacific scientists emphasized that (i) more precise knowledge-based management of agro-ecosystems is needed to tackle soil degradation and environmental problems and (ii) integrative research in soil-plant-nutrient-water interactions is needed to address water management in agriculture. Without understanding these interactions, water management issues for sustainable agriculture are not adequately addressed. The participants identified the following issues which should form the focus for future CRPs:

(i) Nutrient and water mass balance under an alternative rice-based cropping system for improving water use efficiency (rice-wheat in China and India, Rice-Corn in Vietnam, rice-legumes in the Philippines and Thailand).
(ii) Use of isotopic techniques for improving irrigation and fertigation technology to increase water use efficiency (cotton in China, coffee and vegetables in Vietnam, and rice-wheat and corn in India and China).
(iii) Potential impacts of agriculture practices on the environment: tracking and quantification of agriculture pollutants through and beyond the rooting zone

Outcomes of the workshop included not only the valuable exchange of knowledge during the paper presentations and issues identified during discussion, but also the networking of groups involved in a wide range of scientific subjects.

The Secretary of the workshop is extremely grateful for the support and efficient organizational skills of the local organizers (Prof. Dr. Bin Zhang, Institute of Soil Science, CAS, Nanjing; Prof. Dr. Qirong Shen, Nanjing Agricultural University and Prof. Dr. Zhonghe Pang, Institute of Geology & Geophysics, CAS, Beijing).

## Joint FAO/IAEA Division of Nuclear Techiques in Food and Agriculture in the Second International Conference on 'Water Resources in Mediterranean Basin' (WATMED-II, 14-17 November 2005, Marrakech, Morocco

Scientific Secretary: Rachid Serraj

The Second WATMED conference is a major scientific event for the R & D community working on water resources management in the Mediterranean basin. There were more than 200 registered participants from various Mediterranean countries. The main objectives of the WATMED-II conference were: i) to review and compare the state of water resources in the Mediterranean basin, ii) to reconcile between scarcity, quality, durability of resources, iii) to analyse the interrelationships between global change, drought and desertification, iv) to review the methods for assessment and monitoring of aquatic ecosystems health, v) to formulate strategies and identify eco-technological approaches for the restoration and management of aquatic ecosystems, and vi) to identify areas of cooperation in aquatic sciences between Mediterranean countries.

In addition to poster sessions, oral presentations were delivered during 7 concurrent sessions by invited speakers, addressing the following topics: 1- Integrated water resources management, 2- Global change: effects on water resources, 3- Optimisation of water use in terrestrial ecosystems, 4- Mediterranean aquatic systems functioning, 5- Domestic and industrial waste waters: treatment and reuse, 6- Water quality, pollution and health, 7- Hydrology–Hydrogeology. The full programme of the conference is available at www.ucam.ac.ma/fssm/watmed2/ang/programme.htm.

Overall, the WATMED-II conference was very successful in bringing together scientific partners from both European and southern Mediterranean countries involved in various disciplines related to water resources management. In addition to strengthening the integrated approaches in research and development for water management, this initiative also contributed in fostering the international cooperation among the Mediterranean partners in water resource management.


*Opening Session at II Watmed Conference 2005*

# Status of Coordinated Research Projects (CRPs)

## Use of Nuclear Techniques for Developing Integrated Nutrient and Water Management Practices for Agroforestry Systems (D1.20.07)

Technical Officer: Rachid Serraj

The final RCM of this CRP was held from 18-22 April 2005, at the Vienna Internatioanl Centre, Vienna, Austria (see past events). All participants presented their final reports summarizing the major achievements of the project. Four working sessions were organized to present and discuss all the results obtained by the contact holders. This was followed by two working group sessions, which focused on project evaluation, discussion of the major achievements and outputs of the CRP and formulation of final project reports.
The final report of the RCM and CRP was prepared by the Scientific Secretary Mr. Rachid Serraj. The report is available at:
www-naweb.iaea.org/nafa/swmn/crp/d1_2007.html. In addition the publication of an IAEA-TECDOC is in progress, with contributions from reporting all contract holders the major project results and achievements.

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

Technical Officer: Rachid Serraj

The overall objective of this project is to contribute to increasing the agronomic water-use efficiency of wheat and rice production, where agronomic water-use efficiency is defined as grain yield/total water use including both transpiration and evaporation. The CRP is also aimed at increasing wheat productivity under drought and rice yield in salt-affected areas.
Significant progress has already been achieved during the first phase of this CRP. All research and technical contracts were renewed for the second year. The first RCM was held from 12-16 November 2001, at the Vienna International Centre, Vienna, Austria. The second RCM took place from 21-25 November 2005, in Meknes, Morocco. The reports of the first two RCMs are available at:
www-naweb.iaea.org/nafa/swmn/crp/d1_2008.html.

## Development of Management Practices for Sustainable Crop Production Systems on Tropical Acid Soils through the Use of Nuclear and Related Techniques (D1.50.06)

Technical Officer: Long Nguyen

This CRP has been completed in 2005 after the successful completion of its final RCM (15-19 November 2004, Vienna). The final report of this CRP is available at www-naweb.iaea.org/nafa/swmn/crp/d1_5006.html.
Eighteen papers have been submitted by 6 research contract holders, 3 technical contractors and 2 research agreement holders for publication as an IAEA TECDOC. The compilation and editing of this IAEA-TECDOC were completed in August 2005. However, final formatting is still required.

## Integrated Soil, Water and Nutrient Management for Sustainable Rice-Wheat Cropping Systems in Asia (D1.50.07)

Technical Officer: Long Nguyen

The technical officer for this CRP at the time of its implementation on 1 October 2001, was Phil Chalk. After over four years of operation and three two RCMs, the first in Vienna (4-8 March 2002), and the second in Nanjing, China (8-12 December 2003), and the third in Bangladesh (11-15 July 2005), significant data accumulation and project progress has been made, with some changes in the number of research contracts and participants: Manbir Sachdev from India was unable to be involved in this CRP because of other commitments, while both Md Akter Khan from Bangladesh and Fayyaz Hussain from Pakistan received additional support from Murshedul Alam and Abdul Rashid, respectively.

As the technical officer for this CRP since late October 2004 with some new implementations proposed at the 3rd RCM, I look forward to receiving a successful implementation of this CRP and good outcomes at the fourth RCM in Vienna, Austria on 6-10 November 2006. This meeting is important for each participant to present the major project results and achievements, to formulate final project reports and to plan a publication of results in an IAEA-TECDOC and/or international journals.

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

Technical Officer: Claude Bernard

This CRP was initiated in 2003. The overall objective is to develop diagnostic tools for assessing soil erosion and sedimentation processes and effective soil conservation measures for sustainable watershed management. More specific research objectives are related to: i) further develop fallout radionuclide (FRN) methodologies, with particular emphasis on the combined use of $^{137}Cs$, $^{210}Pbex$ and $^{7}Be$ for measuring soil erosion over several spatial and time scales, ii) establish standardized protocols for the combined application of the above techniques, and iii) utilize these techniques to assess the impact of short-term changes in land use practices and the effectiveness of specific soil conservation measures. A total of nineteen researchers form Argentina, Australia, Austria, Brazil, Canada, Chile, China, Japan, Morocco, Pakistan, Poland, Romania, the Russian Federation, Switzerland, Turkey, UK, USA, and Vietnam are currently participating in the project. The individual studies cover a wide range of conditions (land use, environment, and spatial scales) that should allow a robust testing of the potential of the FRNs to assess the efficiency of soil conservation practices. The first RCM was held in Vienna and Seibersdorf, Austria, 18-22 May 2003. The second RCM was in Istanbul, Turkey, from 4-8 October 2004. The third one will be held in Morocco, from 8-12 May 2006. Reports from the RCMs are available at: http://www-naweb.iaea.org/nafa/swmn/crp/d1_5001.html

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

Technical Officer: Claude Bernard

The overall objective of this new CRP, planned to be implemented from 2005 to 2010, is to enhance the productivity and sustainability of farming systems through a better understanding of the principles and practice of conservation agriculture. More specifically, the individual and interactive effects of conservation tillage practices, residue management, crop rotations, nutrient and water inputs on soil organic matter stocks, resource use efficiency, agricultural productivity and environmental quality will be investigated.

Eleven researchers from Argentina, Australia, Brazil, Chile, India, Kenya, Morocco, Pakistan, Turkey, Uganda and Uzbekistan are participating in the CRP.

The first RCM was held in Vienna, Austria, from 13 to 17 June 2005. The report of the meeting will soon be available at http://www.iaea.org/programmes/nafa/d1/crp/d1-crp.html

# NEW COORDINATED RESEARCH PROJECTS

## General information applicable to all Coordinated Research Projects

**Submission of proposals**
Research Contract proposal forms can be obtained from IAEA, National Atomic Energy Commissions, UNDP offices or by contacting the Technical Officer. The form can also be downloaded from the URL http://www-crp.iaea.org/html/forms.html

Such proposals need to be countersigned by the Head of the Institution and submitted directly to the Head, Research Contracts Administration Section, IAEA, P.O. Box 100, A-1400, Vienna, Austria, or by email (Official.Mail@)iaea.org). They do not need to be routed through other official channels unless local regulations require otherwise.

### 1. TITLE 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 (E1.05)

### 2. DURATION: 5 years (2006-2010)

### 3. JUSTIFICATION

Meeting the increasing demands for food, forage, fibre and fuel will be a pressing challenge for the world community during the years ahead. This will require a longer production of biomass over a shrinking cultivated land area. One of the major constraints facing agricultural production in most developing countries in tropical and subtropical regions is the widespread utilization of marginal lands with fragile soils having adverse soil characteristics, and vulnerable to soil erosion and other degradation problems. Low inherent soil nutrient status, in particular severe nitrogen (N) and phosphorus (P) deficiencies are the most common nutritional stresses in many regions of the developing world. The adverse effects of these inherent constraints are exacerbated by land mismanagement and subsistence farming by resource-poor farmers. A recent assessment of on-farm nutrient balances (FAO, 2003) showed that nutrient mining (limited or no replenishment of these nutrients) was occurring in many parts of Sub-Saharan Africa, with negative nutrient balances for N and P. Although considerable efforts have been devoted to the improvement of soil conditions for plant growth through the development and use of best soil-nutrient management practices, their adoption has been low because of several socio-economic constraints and the interactions between soil stresses and other environmental factors that influence the plant's response to that stress.

A complementary approach that has received much less attention is improving the adaptation of crops to these unfavourable soil conditions by selecting, improving and developing crop genotypes with enhanced nutrient use efficiency (NUE) in soils with low nutrient status, and/or plants that require moderately low external inputs to express their genetic potential for adequate production. This strategy is now considered as a more promising, energy-efficient, ecological-friendly and socio-economic feasible approach than major reclamation processes and related soil management practices. Substantial information on the genetic variation for response to low soil nutrient availability has been reported in major staple crops such as maize, rice, wheat and common bean by the work conducted by the research centres belonging to the Consultative Group on International Agricultural Research (CGIAR). As example, two CIMMYT-released maize varieties (Grace and Zm521) were reported to yield 30-50% higher than traditional varieties grown by smallholder African farmers in nutrient-depleted soils. Researchers have also identified a number of root traits that could potentially enhance nutrient acquisition from soil through increased bioavailability of nutrients. However, extremely few plant breeding programmes have yet exploited these traits because of lack of reliable screening techniques for accurate phenotype characterization, poor understanding of the potential of genetic sources of these traits in crop germplasm, their overall performance in cropping systems and the uncertainty of the long-term effects of improved plant traits on soil fertility and productivity.

The cycle of soil fertility degradation and unsustainable agricultural production in the marginal areas can only be mitigated by using a holistic approach of appropriate strategies for integrated soil nutrient management and improved crop varieties. Screening of crop germplasm for higher nutrient use efficiency, and harnessing crop genetic diversity for root physical traits, and improved rhizosphere such as root exudates, and interaction with soil micro-organisms offer a wide variety of mechanisms and approaches for crop improvement under nutritional stress. Inter- and intra-specific variation for plant growth and mineral nutrition use efficiency are known to be under genetic and physiological control and are modified by environmental variables of the ecosystem. Developing

and selecting crop genotypes with high nutrient recovery thus requires an integrated approach to plant and soil interactions under a range of agroecological (climatic and soil) conditions. Without an adequate understanding of the interaction between changes in soil fertility status with time and the introduction of plant genotype with superior resource recovery, extrapolation of findings and application of introduced genotypes to different soil fertility environment may be extremely limited.

This CRP will build upon the current knowledge and research achievements in national and international crop improvement programmes of nutritional stress tolerance, and will complement activities of several past coordinated research projects on isotope-aided soil fertility and plant nutrition studies (Rock Phosphate CRP, Acid Soils CRP, CRP on Mutational analysis of root characters in annual food plants, etc.). The project will address the various facets of nutritional stress by adapting, testing and applying existing nuclear-based techniques and related methodological options for improved nutritional stress tolerance. It will develop technologies to identify superior genotypes for plant traits such as key root characteristics and nutrient uptake, transport, utilization and mobilization within the plant leading to enhanced accumulation and use efficiencies of N and P by major cereal and grain legume crops. The specific processes involved in nutrient uptake efficiency indicate that a basic understanding of plant-soil interactions in the rhizosphere will also be necessary to develop meaningful screening techniques for the identification of crop genotypes adapted to low input conditions. Isotopes will be critical tools in the identification and exploitation of superior crop genotypes. The use of local landraces, elite lines and mutant varieties with improved nutrient uptake will also be explored to complement the main thrust of this CRP and to broaden the genetic diversity of the (pre-) breeding germplasm. In doing so, this CRP will improve our understanding of the interactions between plants, soil nutrients, and micro-organisms, to elaborate crop improvement strategies for combating soil fertility decline in developing countries. The identification of crop genotypes with superior NUE coupled with appropriate soil-nutrient management practices will contribute to sustainable agricultural production in such agro-ecological zones where there are soil nutritional problems with low input conditions, thus ensuring food security and protecting soil and water quality.

The approved CRP will be implemented through the creation and coordination of a network of National Agricultural Research Systems (NARS) from developing countries, International Agricultural Research Centres (IARCs) and Advanced Research Institutes (ARIs) with expertise in crop improvement tolerance to nutritional stress. The technologies developed under this project should be properly disseminated and ultimately transferred to the farmers, who are the end-users and main beneficiaries of the project. Whenever possible, participatory field trials should be carried out in farmers' fields and close links should be established with extension services.

The involvement of the IAEA in the CRP is justified since:

- The objectives of the approved project are in line with project E1.05 (IAEA PWB 2005-2006), and with the overall strategy of programme E set in the medium term plan and also with the strategic objectives of the FAO's Department of Agriculture.
- The use of isotopes (stable N-15 and radioactive P-32 and P-33), use of mutant lines and other nuclear-related techniques will be essential to characterize the plant nutrition-related traits of the superior genotypes and elucidate soil-plant-nutrient interactions, and to develop proper screening protocols and methodologies for improved nutrient (N and P) use efficiencies.
- The research objectives and expected project outputs are highly relevant to a number of developing Member States with extensive tracts of marginal lands with soil nutritional (N and P) problems. Identified superior genotypes can be easily adopted by resource-poor farmers for such environments and further utilized by genetic improvements programmes.
- Characterisation and quantification of soil N and P pools that can be mobilised by crop genotypes with superior nutrient resource recovery are important consideration in introducing these genotypes to a range of soils with different soil N and P status and fractions. The expertise and experience of the SWMCN Sub-programme in the use of isotopic dilution techniques to investigate soil N and P dynamics and soil-plant interactions will be highly relevant to this CRP.
- The IAEA's Seibersdorf Laboratory has strong in-house capacity to support the CRP through training, quality assurance, analytical services and strategic research capacity.

## 4. OBJECTIVES

### 4.1. Overall Objective

To develop integrated crop, soil and nutrient management practices to increase crop production in marginal lands by identifying and promoting the development of food (cereal and legume) crop genotypes with enhanced nutrient (N and P) use efficiency and greater productivity in low fertility soils.

### 4.2. Specific Research Objectives

4.2.1. Develop and validate screening protocols for plant traits that a) enhance N and P acquisition and nutrient use efficiencies of major cereal crops (maize, upland rice, and wheat), and b) enhance P acquisition of nitrogen-fixing grain legume crops (common bean, soybean, and cowpea), from low fertility soils where water deficit is not the primary constraint to crop production.

4.2.2. Employ validated screening protocols, including the use of isotopic tracer techniques and induced mutations, to identify genotypes with superior N and P acquisition and nutrient use efficiencies.

4.2.3. Determine effects of genotypes with enhanced nutrient acquisition and nutrient use efficiencies on cropping systems performance, including yield and productivity of intercrops and rotations, and long-term sustainability of soil fertility at levels that do not compromise crop productivity.

## 5. EXPECTED RESEARCH OUTPUTS

5.1.1.

- Field-validated screening protocols for plant traits associated with enhanced N and/or P acquisition of major cereal crops from low fertility soils.
- Field-validated screening protocols for root traits associated with enhanced P acquisition of grain legume crops from low fertility soils.

5.1.2.

- Sources of plant traits for enhanced N and/or P acquisition in cereal crops identified.
- Sources of plant traits for enhanced P acquisition in grain legume crops identified.
- Exchange of germplasm amongst project partners and member states promoted.

5.1.3. Effects of genotypes with enhanced nutrient acquisition on cropping systems performance, including yield and productivity of intercrops and rotations, and long-term effects will be determined.

## 6. ACTION Plan (Activities)

6.1. Tasks:

6.1.1. In relation to specific objective 4.2.1:

- Conduct site characterization (soil & climate, nutrient availability) of selected pilot sites for field and pot experiments
- Develop protocols including the use of isotopes and nuclear techniques, for screening plant traits which enhance N and P acquisition, e.g., root hair length and density, root growth and architecture, root exudates, nutrient uptake, transport, utilization and mobilization within the plant; tolerance to (sub)soil acidity, aluminium toxicity.
- Validate the association between phenotypic variation in plant traits and nutrient acquisition, including legume symbiotic nitrogen fixation, in low fertility soils under field conditions.

6.1.2. In relation to specific objective 4.2.2:

- Assemble and evaluate cereal and legume genotypes with known variation in plant traits and/or superior N and P acquisition including landraces, elite lines, and mutants developed in previous CRPs.
- Screen a wide range of genetically diverse cereal and legume germplasm (landraces, elite lines, and mutants) for variation in plant traits related to N and P acquisition.
- Develop a material transfer agreement (MTA) to exchange germplasm among project partners and member states.

6.1.3. In relation to specific objective 4.2.3:

- Assess effects of genotypes with enhanced nutrient acquisition on cropping systems performance, including yield and soil productivity of intercrops and rotations
- Analyse potential benefits and trade-offs of increased crop growth and nutrient uptake on long-term cropping systems productivity using empirical and/or modeling approaches.
- Develop integrated management strategies incorporating germplasm selected for conditions of low soil fertility.
- Investigate changes in soil N and P pools with time in response to the introduction of crop genotypes with superior N and P use efficiency.
- Establish the relationships between changes in different soil N and P pools and plant N and P uptake so as to identify the major soil N and P pools that are mobilised by crop genotypes with superior nutrient use efficiency.

6.2. Sites & Partners Selection

6.2.1. Contract holders:

- National research systems (NARS) from Africa, Asia and Latin America with active research programmes on the selection of major cereal or legume crops for improved nutrient use efficiency and on soil fertility and plant nutrition interactions.
- Preferably teams with experience in inter-disciplinary approaches (soils, plant physiology, plant genetic resources enhancement and germplasm improvement, etc.)
- Staffing with skills and experience and facilities for using isotopic techniques in soil-plant studies

6.2.2. Technical contracts:

- Access and screening of germplasm
- Systems analysis-modeling
- Development of experimental protocols for plant (root) traits
- Characterization and quantification of changes in soil N and P pools

6.2.3. Agreement holders:

- Advanced research institutions with expertise in the use of isotopic techniques in plant nutrition and soil fertility-plant nutrition interaction studies.

6.2.4. Locations:

For all crops, target environments would include:

- Agro-ecosystems in which the target crops are important for food security
- Agro-ecosystems in which low soil fertility status (N and P deficiencies) is a principal crop production constraint
- Agro-ecosystems in which drought is not the principal production constraint

Sites that are:

- Representative of the main soil nutritional problems in study with potential for intensification and operating with existing farmers practices (on station and on-farm studies)
- Well characterized in terms of soil type (World Reference Base for Soil Resources, FAO-AGL site, international classification), soil profile description and properties, water table, and available climatic data.
- Good record of field history (past crops and average yield data)

## 7. CALL FOR PROPOSALS

Proposal forms for research contracts and agreements can be obtained from the IAEA website (http://www-crp.iaea.org/html/forms.html). They must be countersigned by the Head of the Institution and submitted to the Head, Research Contracts Administration Section, IAEA, P.O. Box 100, A-1400, Vienna, Austria. Further information can be obtained from the Head of the SWMCN Section at M.Nguyen@iaea.org

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# Laboratory Activities

## Research

### Test of $^{134}$Cs as soil erosion tracer under rainfall simulation

*L. Mabit (SSU) and C. Bernard (SWMCN)*

Soil erosion can be estimated from $^{137}$Cs spatial redistribution data. Relationships between this radioisotope distribution and soil losses have been validated and used in many locations around the world. However, estimations of soil movement from residual $^{137}$Cs may overestimate net loss and underestimate net deposition if the selectivity of erosion is not taken into consideration. In order to investigate this aspect, experimental erosion tests were conducted under controlled conditions in a greenhouse with $^{134}$Cs-labelled soil and using rainfall simulator.

Twenty 0.35 m$^2$ boxes were filled with a loamy soil and placed on a 5% slope. The soil of the boxes was labelled with a surface application of $^{134}$Cs. This isotope was selected because it has the same physical and chemical behaviour in soils as $^{137}$Cs. Once applied, the radiocaesium was incorporated in the first 5 cm of soil. Ten boxes received 7100 Bq (20285 Bq m$^{-2}$) of $^{134}$Cs and the other ten, twice this amount. At the downslope end of each experimental plot, an S-shaped stainless steel ramp was placed in such a way to force deposition of some part of the suspended load leaving the plots. Eroded sediments leaving the plots, those deposited on the ramp and those leaving the ramp were sampled, analysed and compared to the source material they originated from. A GRS-II type rainfall simulator was used to generate runoff and erosion from the plots. Three successive 80 mm hr$^{-1}$ rains were applied, with a delay of 24 hours between each event. The first rain was 30 minutes long, the two other lasted 20 minutes. Radiocaesium measurements on soil and sediment samples were performed using a high purity coaxial germanium detector with a relative efficiency of 26% and resolution of FWHM of 1.8 keV at 1.3 MeV. Counting times ranged between 7 000 and 50 000 seconds, to produce an error smaller than 10% at the 0.05 significance level. All the values were adjusted to a common date. Some 200 samples were thus counted, 180 sediment samples and 20 soil samples.

For the twenty experimental plots, individual runoff coefficients ranged between 75 and 83% and soil losses varied from 0.94 to 1.24 Mg ha$^{-1}$. The $^{134}$Cs concentration of the plot soils, in the first 5 cm, varied from 90 to 345 Bq/kg$^{-1}$.

For each simulated rainfall, approximately 1% of the initial $^{134}$Cs input was exported with eroded soil. Moreover, for the same soil loss, the loss of $^{134}$Cs was directly proportional to the initial soil activity. Losses from plots having received 14200 Bq of radiocaesium produced sediments with a $^{134}$Cs concentration 2 to 2.8 times that of the plots receiving 7100 Bq.

On the sediments eroded from the plots, the concentration was between 590 and 7550 Bq/kg$^{-1}$. This translates into an average enrichment ratio (concentration on sediments divided by that on plot soils) of 16. The sediments that deposited on the flat section of the ramp showed a higher content in large particles, as compared to sediments eroded from the plots. This translated into lower radiocaesium concentrations and lower enrichment ratios. At the opposite, the sediments leaving the downslope portion of the ramp were strongly enriched in fine particles. This was reflected by $^{134}$Cs concentration that was, on the average, 23 times higher than on plot soils.

These results indicate that $^{134}$Cs can be used for erosion studies. They also show that enrichment ratios of eroded sediments can be high and that this enrichment effect must be considered when comparing eroded material to the soil it originates from.

## Supportive Services

## Training

Training is provided by the Soil Science Unit in the form of training courses, workshops, fellowships or scientific visits. The subject of training is predominantly the use of nuclear technology in soil science, soil and water management, crop nutrition and isotope analyses.

### Fellowships

The SSU trains approximately 10–15 fellows annually. The training periods vary from 1 to 6 months. There are two categories of fellows, i.e. analytical fellows, who are accepted for short periods of 2 to 3 month to learn isotope analytical techniques used in plant nutrition. This form of training includes technical tutoring and hands-on practical sessions. Particular emphasis is given to specific techniques relevant to research conducted under technical cooperation projects, i.e. total N and $^{15}$N isotope-ratio analyses by emission spectrometry or isotope analyses by mass spectrometry. Whenever possible, group training of three to five fellows is organized. Research fellows are accepted for periods between four and six months to work on problems or techniques related to the Unit's research programme. The fellows receive guidance on experimental strategies and the use of isotopes and related techniques relevant to a particular area of research, which the fellow will pursue upon return to his or her home country. The fellow is expected to complete and write up a report of the research conducted.

The Soil Science Unit has trained fifteen fellows during 2005:

**Mr. J. Louissaint** (HAI/05001) received one month of training on the use of nuclear techniques for quantification of fertilizer recovery and biological nitrogen fixation under supervision of Mr Gudni Hardarson.

**Mr. F. Al-Ain** (SYR/04055) was trained for one month in the use of crop simulation modeling (APSIM) with Ms Lee Heng for simulating wheat yield data from field experiments that were carried out in Syria to evaluate seed rates and N fertilizer effects on wheat yields. Good agreement between measured and predicted yields was obtained. These results have helped the identification of new research areas in Syria.

**Ms. M. Walker** (JAM/05001) and **Mr. D. Asare** (GHA/05003) were both trained in the use of $^{15}N$ methodology to quantify nitrogen fertilizer recover, crop nutrition and biological nitrogen fixation. They conducted two field experiments (1) to measure the effect of N fertilizer placement and time of application on fertilizer N recovery in sunflowers and (2) to evaluate the inoculation response on biological nitrogen fixation in common bean using $^{15}N$ isotope dilution methodology. Ms. M. Walker and Mr. D. Asare were supervised by Mr Gudni Hardarson with the assistance of Ms. Maria Heiling and Ms. Martina Aigner.

**Ms. J. Altangerel** (MON/05008) received training on water management and **quantification** of fertilizer recovery and biological nitrogen fixation under the supervision of Ms Lee Heng and Mr. Gudni Hardarson. She performed several experiments using nuclear equipment (Soil Moisture Neutron Probe) for soil water study of crop water use and water use efficiency under rainfed conditions. Furthermore she participated in field experiments measuring biological nitrogen fixation using $^{15}N$ isotope dilution methodology.

*Field sampling in Mistelbach (Austria) (Photo Ms. Lu Li, 2005)*

**Ms. L. Li** (CPR/05017) and **Ms. L. Bai** (CPR/04002), from the Chinese Academy of Agricultural Science, were trained for three months on erosion assessment using nuclear techniques. The training was provided entirely by Mr. Lionel Mabit (SSU) for Ms Li and by both Mr. Mabit and Mr. Marek Makarewicz partly at the Chemistry Unit and the SSU for Ms Bai. The topics included were: introduction to erosion process, use of isotopes (e.g. $^{137}Cs$) to estimate erosion, sampling strategy at the field and watershed scale, sample preparation for gamma analysis, introduction to geostatistical analysis, mapping, analysis and interpretation of data and use of conversion models. This training included field sampling in the Mistelbach agricultural watershed located 50 km north of Vienna (Austria) to establish the spatial distribution and the initial $^{137}Cs$ fallout in a forest soil.

**Scientific Visits**

Several scientific visitors have also been at the Soil Science Unit for a one week visit: **Mr. J.S. ANTOINE** (HAI/05002)**, Mr. H.N. KHAN** (PAK/04040), **Mr. M.B. HALITLIGIL** (TUR/05018), **Mr. B. SONMEZ** (TUR/05011), **Mr. A.A. FAHAD** (IRQ/05022) and **Mr. Z. GNANKAMBARY** (BKF/05003).

**Training Course**

**FAO/IAEA Training Session on the Use of Nuclear and Related Techniques in Studies of Soil/Plant Relationships with Emphasis on Soil Water Management**

A training course was implemented by the Soil Science Unit from 7 November–9 December, 2005 with the following eight fellows from Iraq: **Mr. J. ABDUL-RIDHA** (IRQ/05027), **Ms. B.H.A. AL-AMERI**, (IRQ/05028), **Mr. K.H.S. AL-JUBOURI,** (IRQ/05031), **Mr. H. AL-SAADI**, (IRQ/05032), **Mr. A.S. FALIH** (IRQ/05025), **Mr. T. RASHEED** (IRQ/05030), **Mr. S. SALIM** (IRQ/05024) and **Mr. M.M. SHAKER**, (IRQ/05029). The course covered crop nutrition, water management and soil erosion and conservation. Lectures and practical demonstrations were given by staff members from both the SSU and SWMCN Section with two external lecturers assisting with the implementation. Dr Pierre Moutonnet (France), gave lectures and practical exercises on the use of nuclear techniques in irrigation and water management and Dr Nanthi Bolan (New Zealand) covered the field of fertilizer use efficiency and crop nutrition.

*Trainees from Iraq with Mr Mabit and Mr Bernard (Photo: L. Mabit, 2005)*

**Isotope analyses**

*L. Mayr*

In the first half of the year 2005 the Soil Science Unit received 2611 samples from CRPs, TCPs and training and research activities of the Seibersdorf laboratory. Together with blanks, calibration, test samples and the backlog of samples from 2004, a total of 17 000 measurements were performed.

**Samples received:**

| | | |
|---|---|---|
| CRP | 1977 | 75.7% |
| TC | 370 | 14.2% |
| Seibersdorf | 264 | 10.1% |
| Total | 2611 | 100.0% |

**Requested analysis:**

| | | |
|---|---|---|
| $^{15}$N enriched level | 1433 | 42.0% |
| $^{15}$N natural abundance | 180 | 5.3% |
| $^{13}$C natural abundance | 1083 | 31.7% |
| $^{18}$O natural abundance | 718 | 21.0% |
| Total | 3414 | 100.0% |

**Measurements carried out:**

| | | |
|---|---|---|
| $^{15}$N enriched level | 5030 | 36.1% |
| $^{15}$N natural abundance | 1077 | 7.7% |
| $^{13}$C natural abundance | 3954 | 28.4% |
| $^{18}$O natural abundance | 3881 | 27.8% |
| Total | 17040 | 100.0% |

From the middle of May to the end of July 2005 the mass spectrometer room was renovated, newly furnished and all electrical and gas installations were renewed. This was necessary because place for a new mass spectrometer and a preparation device, which was ordered last year, had to be made available and the mass spectrometer room with it's 20 year old installations and furniture was not suitable for that purpose. During that period of renovation, the analytical service was reduced to a minimum because only one of the four mass spectrometers of the Soil Science Unit was set-up at a different place and could be used to measure $^{15}$N/$^{14}$N ratios.

The new mass spectrometer is an Isoprime IRMS (GV Instruments, GB) with continuous-flow inlet. The preparation device is a high-temperature conversion unit with a glossy carbon tube from HEKAtech, Germany. With this setup $^{2}$H and 18O/$^{16}$O ratios of solids (plant material) and as little as 1 µL of water can be determined. The installation of the new instruments was carried out in October 2005. It is expected that at the beginning of 2006 this analytical service is in full operation.

*The new Isoprime mass-spectrometer at the Soil Science Unit, Seibersdorf*

The stable isotope laboratory of the Soil Science Unit is now equipped with 4 mass spectrometers and can perform the following analyses:

| Mass-spectrometer | Preparation device | Isotope analyses |
|---|---|---|
| Isoprime (GV-Instruments, GB), continuous flow interface | High-temperature conversion system (HEKAtech, Germany) | D/H and $^{18}O/^{16}O$ in plant material<br><br>D/H and $^{18}O/^{16}O$ in 1µl water |
| OPTIMA (Micromass, GB), continuous flow and dual inlet interface | NA1500 combustion unit (Carlo Erba, Italy) | $^{15}N/^{14}N$ in plant and soil at natural abundance and enriched levels<br><br>$^{13}C/^{12}C$ in plant and soil samples |
| 20-20 (Europe Scientific, GB), continuous flow interface | ANCA combustion unit (Europe Scientific, GB) | $^{15}N/^{14}N$ and $^{13}C/^{12}C$ in plant and soil samples |
| | Equilibration line (Europa Scientific, GB) | $^{18}O/^{16}O$ in water (sample size 0.5ml minimum) |
| Integra-N (Europe Scientific, GB), continuous flow interface | Combustion unit integrated into the mass-spectrometer | $^{15}N/^{14}N$ enriched level in plant and soil samples |

**Proficiency Test "EQA2005" on 15N and 13C analysis of plant materials`**

*M. Aigner*

A new round of the annual proficiency test (PT) has started in January 2005. The instruction and reporting forms were re-designed as a result of harmonizing related external quality assurance activities within the IAEA under the consideration of relevant international standards (ISO17025). Several questions on the implemented quality control system were included in the report forms. The purpose of these questions was to enable the Soil Science Unit to understand the Quality Control measures employed in determining the laboratories' results. The answers to these questions allow the PT-organizer to estimate the uncertainty of the measurements and to draw general conclusions about the exercise as a whole.
After completion of the evaluation of the PT, by end of 2005, a new and more detailed report was sent to the participants.
It is planned to publish the addresses of laboratories that agree and fulfil the quality requirements established by the Soil Science Unit in the next Soils Newsletter. This will provide an opportunity to our readers to get into direct contact with laboratories that provide high quality $^{15}N$ and $^{13}C$ analyses of plant materials.

# Publications

## Recent Publications of the Sub-programme

A list of articles from Soils Section and Unit staff published in scientific journals and Conference Proceedings are available on our SWMN Section website at the URL http://www.iaea.org/programmes/nafa/d1/public/d1_pbl_1.html

## Recent Titles

**Nutrient and Water Management Practices for Increasing Crop Production in Rainfed Arid/Semi-Arid Areas**


**IAEA-TECDOC Series No. 1468**

(2005) ISBN 92-0-109405-1

€ 15.00

The efficient use of scarce water resources is vital for ensuring adequate and stable agricultural production in many developing countries located in arid and semi-arid regions. The results from ten Member States have shown that crop yields can increase and yield variation be reduced in rainfed agriculture with proper management of cropping systems, stored rainfall water and judicious use of inputs such as supplemental water use, chemical fertilizers and organic residues. This publication shows how improved fertilizer management practices when suited to local conditions are carried out can reduce by up to 50% the current recommended fertilizer nitrogen rates without significant loss of crop yields. The amount and distribution of rainfall during the growing season had a strong impact on crop yields and the utilization of applied nitrogen, while the application of nitrogen fertilizer enhanced water use efficiency of crops through improved ground cover and reduced evapo-transpiration. The inclusion of grain legumes as intercrops or rotation crops in millet based cropping systems also helped to significantly increase the efficiency of nitrogen use by millet.
http://www-pub.iaea.org/MTCD/publications/PubDetails.asp?pubId=7270

## Award

**Messrs Lionel Mabit** and **Claude Bernard** received the 2005 "Arnold-Drapeau Award" for the best scientific paper published in the journal "Vecteur Environnement" edited by the Réseau Environnement (www.reseau-environnement.com), in Quebec. The awarded paper was entitled: "Quantifying Soil Erosion and Study of the Origin of Sediments Clogging the Spawning Ground of the Boyer River (Quebec)".

## 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
- FAO/AGL (Land and Water Development Division) http://www.fao.org/ag/agl/default.stm

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