



**Joint FAO/IAEA Programme**  
Nuclear Techniques in Food and Agriculture

# Plant Breeding & Genetics Newsletter

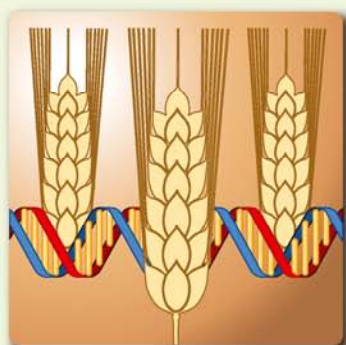
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*Mutant canna varieties and their parents (control). Photo courtesy of Dr. P. Jompuk*

## To Our Readers

As the year 2007 closes and the biennium 2006-2007 has to be reported on, this is a time for reflection, introspection and to look towards the future. Much we did well, some activities might have been implemented better, but we take some pride in having assisted 141 Member States (both from IAEA and FAO) through our activities in Technical Cooperation Projects (TCPs), Coordinated Research Projects (CRPs), our yearly Interregional Training Course and as consultants and experts. We did our best and hope we served you efficiently.

One important event I want to point out was the Second Coordinators Meeting under RAS/5/048 (ARASIA): 'Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity', on 11-15 November 2007, in Damascus, Syrian Arab Republic. A major achievement of this regional project was the adoption of the Standard Material Transfer Agreement (SMTA) for germplasm exchanges. It puts the ARASIA States Parties participating in this project into a leadership position for the regional application of the SMTA under the Multilateral System on Access and Benefit Sharing in the framework of the International Treaty on Plant Genetic Resources for Food and Agriculture.



**IAEA**  
International Atomic Energy Agency

Thank you all for your invaluable input to our activities. As always, we learned a lot from you and tried to pass on your invaluable experience onto colleagues worldwide. Our collaborations and interactions made us feel richer not only on the scientific and technical, but also on the human level.

But this time of the year is also the time to look forward, the time for pledges. As 2007 is slowly fading out, the sun of 2008 is rising. The biennium 2006-2007 will soon be history and the biennium 2008-2009 is full of challenges and promises. The Plant Breeding and Genetics (PBG) Section of the Joint FAO/IAEA Programme (NAFA/AGE) currently implements six coordinated research projects (CRPs), ranging from fundamental aspects of the effects of mutagens on the DNA sequence to the assessment of nutrient uptake from biofortified crops. Recently we held three consultants meetings on which I wish to focus your attention:

- ‘Enhancing Nutritional, Nutraceutical and Pharmaceutical Value of Crops Using Mutation Induction Techniques’;
- ‘Development of Integrated Technology Packages for Enhancing the Efficiency of Induced Mutagenesis in Crop Plants’;
- ‘Straw Digestibility’.

These consultants meetings prepare CRPs bound to become of critical importance in 2008 and 2009. These CRPs touch subjects as diverse and new as climate change, biofuels and bioreactors. They address future activities and concerns which we pledge to tackle with enhanced efficiency in the service of the Member States. Agriculture remains central in addressing the world’s problems of hunger, poverty and economic and social development. It is crucial in addressing the challenges of climate change and the sustainable management of natural resources.

In the changing world ahead, mutation induction is bound to strengthen its role in:

- overcoming hunger and malnutrition;
- consolidating agriculture’s contribution to sustainable economic and social development;

- conserving and exploiting the natural resource base in a sustainable way.

In the medium to long term (next biennium and beyond), a combination of mixed technology packages will be developed and optimized, based for example on the most advanced molecular high throughput genomics screening techniques at the DNA level. Combining mutation induction with modern biotechnology fosters powerful new tools profiting genomics and reverse genetics (gene discovery and gene function identification) as well as breeding.

One concern for crop improvement through mutation induction will be the effective adaptation to climate change, such as high temperature resistance or drought tolerance. Technology packages for mutation breeding will be developed to broaden the adaptability of crops and to reclaim soil (marginal land, drought and salinity, phyto-remediation) for crop production.

Effective management of biomass for biofuel and other industrial uses will be achieved through the use of mutation induction to improve quantity and quality of by-products from food and feed crops for biofuel production, e.g. increasing the digestibility of by-products for ethanol production.

Among all these endeavors, the greatest challenge will be to balance food, feed, fiber and pharmacy, and prevent competition for soil and water.

The year 2008 will be a particularly demanding and difficult year for the Joint FAO/IAEA Programme (NAFA/AGE) on the institutional level as FAO moves toward reform. More than ever we need your support as this year progresses, and we are grateful to know that you offer it willingly.

In closing, I would like to wish all of you a peaceful new year and the very best in your future endeavors.

*Pierre J.L. Lagoda  
Head,  
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## Forthcoming Events

### **IAEA/RER Regional Training course (RTC) on Methodology in Drought Tolerance Research, RER/5/013, Aleppo, Syrian Arab Republic, tentatively planned for March 2008**

Technical Officers: Y. Lokko and Q.Y. Shu

Cereals are the most important grain crops in South-Eastern Europe; but their production is greatly affected by various biotic and abiotic stresses, particularly drought. Therefore new varieties with enhanced tolerance to drought stress are in high demand to improve cereal production in the affected areas. However, due to the complex nature of drought stress and its effect on various physiological activities of plants, development of drought tolerance has been hampered by the lack of necessary knowledge of its biological control as well as of methods and techniques that can be efficiently used in breeding programmes in developing countries. Under the regional TC project RER/5/013 'Evaluation of natural and mutant genetic diversity in cereals using nuclear and molecular techniques', a training course on methods in drought tolerance research will be organized by the International Atomic Energy Agency (IAEA) in cooperation with the International Center for Agricultural Research in Dry Areas (ICARDA). The objective of the course is to provide participants from participating Member States with: the up-to-date knowledge of genetics and physiology of plant drought tolerance; methods, techniques and skills to assess agronomic and physiological traits related to drought tolerance and their use in breeding for drought tolerance; and expertise and know-how of design and management of breeding programmes for drought tolerance in cereals.

### **National Training Course on Tissue Culture Techniques including Rice Anther Culture, SIL/5/007, Freetown, Sierra Leone, tentatively planned for April 2008**

Technical Officer: Q.Y. Shu

This training course will be organized by the counterparts of the IAEA technical cooperation project SIL/5/007 in Rokupr, Sierra Leone. The training course will cover tissue culture techniques, rice anther and their use in rice breeding, and micro-propagation of tropic fruit plants, especially banana. Both lectures and practical exercises will be provided by international experts and local professionals. It will be open to Sierra Leone scientists working on plant genetics and breeding in universities and research stations.

**Local organizer:** Dr. Sydney Johnson, Rice Research Station, Freetown, Sierra Leone

### **IAEA-AFRA Regional Training Course on TC on Basic Molecular Markers and Data Analysis, RAF/5/056, Thiès, Senegal, 7–18 April 2008**

Technical Officer: M. Spencer

The training course will include lectures and hands-on experiments on:

- i) DNA as the source of genetic information;
- ii) Introduction to molecular marker systems;
- iii) Principle of polymerase chain reaction (PCR);
- vi) Principles of mapping [recombination, linkage data and segregation analysis, quantitative trait loci (QTL) analysis]; and
- v) Other molecular biology techniques used in crop improvement.

The lectures will also include demonstrations and practical calculations including:

- i) Analysis of molecular marker data;
- ii) Estimating genetic diversity in-breeding;
- iii) Genetic diversity analysis by using molecular markers (DNA Fingerprinting);
- iv) Estimation of genetic structure;
- v) Introduction to computer programmes; and
- vi) Web search for molecular data.

**Course Director:** Dr. Khadidiatou Ndir, Centre d'Etude Régional pour l'Amélioration, de l'Adaptation à la Sécheresse (CERAAS), Thiès Escale, Senegal

### **National Training Course on Molecular Marker Techniques for Mutant Characterization, VIE/5/015, Ho Chi Minh City, Viet Nam, tentatively planned for May 2008**

Technical Officer: Q.Y. Shu

This training course will be organized by the counterparts of the IAEA technical cooperation project VIE/5/015 in Ho Chi Minh City, Viet Nam. The training course will cover molecular marker and related biotechnologies for mutation induction, and characterization and their use in rice breeding. It will be open to Vietnamese scientists working on plant genetics and breeding, particularly those applying mutation techniques in breeding programmes. Both international experts and local professionals will give lectures.

**Local organizer:** Dr. Xuan Tham Le, Centre for Nuclear Techniques, Ho Chi Minh City, Viet Nam

## Past Events

### **Third Research Coordination Meeting on Effects of Mutagenic Agents on the DNA Sequence in Plants, Stellenbosch, South Africa, 24–28 September 2007**

Technical Officer: P.J.L. Lagoda

Twelve contract and agreement holders from 10 different countries (Bulgaria, Colombia, China, India, the Philippines, Poland, the Republic of Korea, South Africa, the United Kingdom, the United States of America), in addition to local support staff and post-graduate students, took part in this Research Coordination Meeting. Ten research contracts had been awarded at the beginning of the CRP and nine were extended. Research agreements were reached with three advanced laboratories and all were extended.

Physical, chemical and biological mutagenic agents cause genes to mutate at rates above the spontaneous baseline, thus producing a range of novel traits and broadening the genetic diversity of plants. The use of induced mutants in breeding has had a profound impact on world agriculture and more than 2,700 new crop varieties, all carrying novel induced variation, have now been officially registered (IAEA Mutant Variety Database, <http://www-mvd.iaea.org/MVD/default.htm>). This has been achieved largely without knowledge of the precise changes induced at the DNA level. Indeed there is still very little understanding of the nature of the mutations induced by different mutagens. With the advent of molecular genetics and genomics, induced mutations are finding new applications in modern plant breeding. Reverse genetics and deletion library methodologies capable of discovering new genes and their modes of action are often underpinned by variations induced by both physical and chemical mutagens. However, the efficiency of these new methods will be enhanced only when the type, frequency and distribution of mutations in a range of crop species can be predicted, and ideally directed.

Knowledge of types, frequencies and distribution of mutations has important implications for biology and biotechnology. It impacts our understanding of evolutionary processes at the most fundamental molecular level and sheds light on mechanisms bridging genotype to phenotype, and phenotype to organismal fitness. This opens up an entire new field of research that focuses on early processes perhaps linked to mutation repair mechanisms and the role of nucleic acid structure in the mutation process. These investigations will chart the limits of the evolutionary potential of genomes for the sustainable exploitation of natural resources using integrated technology packages that would include mutation induction and efficiency-enhancing biotechnologies. Ultimately, this would lead to a better understanding of genome-environment and genome interactions adapted to develop strategies in the context of impending global change and the needs to satisfy increasing demands in renewable energy sources.

Today, with the range of technologies available to the scientific community to assay variation in DNA sequence

and the availability of a vast amount of crop plant DNA sequence (including the complete sequences of Arabidopsis, rice and poplar), these questions can now be dealt with. Thus, this Coordinated Research Project sets out to define the type, frequency and patterns of molecular changes induced by the range of physical and chemical mutagens in a range of crop species.

It became obvious at the RCM that this CRP, through its output, will stimulate work on functional genomics using radiation and other mutagenic agents and will provide data on the action of particular mutagenic agents on DNA structure. This will enhance the discriminate use of mutation induction for research and development in agriculture. Modern science and technology advancements prompt the IAEA to take operational and normative action in research on behalf of its Member States to ensure excellence in advising and controlling the safe and informed use of nuclear techniques in biotechnologies applied to crop improvement. Analyzing acute DNA damage is a prerequisite for understanding how mutation induction affects spontaneous mutation rates and contributes to genetic diversity. This is necessary to understand the effects of chronic DNA damage through mutagenic agents in crops, e.g. to define thresholds for environmental protection policies. Moreover, this CRP will certainly develop a knowledge base and foster collaboration with advanced research institutions that will encourage distribution and dissemination of basic information and genetic resources, and transfer knowledge and technologies between participating research groups, particularly from developing countries. Finally, the CRP will produce guidelines and publish methods on the effect of mutagenic agents on plant DNA sequence.

### **Third Research Coordination Meeting on Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality, South Perth, Australia, 15–19 October 2007**

Technical Officer: Q.Y. Shu

Fifteen scientists from 12 member states, CIAT, and the FAO/IAEA Programme participated in the meeting. Dr. Rob Delane, Deputy Director General, Department of Agriculture and Food, Western Australia (DAFWA), opened the meeting and highlighted the overall research activities of DAFWA. Participants reported their research activities and achievements since last meeting in Nanjing and presented their work plan for 2007–2009. During the meeting, which included a keynote speech and lectures, participants met scientists based in Western Australia, and took part in a technical field visit and social events. Participants praised the excellent organization of this RCM and expressed their gratitude to Dr. Chengdao Li and his team, and the Department of Agriculture and

Food, and acknowledged the great support of Agriculture Research Western Australia for this meeting.

**Research progress and workplan** The group is working on several crop plant species, including some of the major staples such as rice, barley, wheat, cotton, potato, and other 'orphan' crops (okra and groundnut) whose study is not as extensive. The targeted traits represent a wide range of yield and quality characters, as well as biotic and abiotic stresses, which have an impact on crop quality. Good progress has been achieved in all target crops. Mutants and advanced breeding lines derived from mutants have been produced for most species under study. In some cases where mutants are not available (e.g. potato), the natural diversity of the crop is being used to exploit naturally occurring variability. Mapping populations have been established for the genetic analysis of mutant phenotypes, and significant progress has been made in accurate localization of genes and QTLs for target traits. Moreover, there is substantial development of other germplasm for breeding and further genetic analysis (e.g. NILs, RILs, advanced backcross lines, introgression lines). A wide range of marker technologies (RAPD, AFLP, ISSR, SSR, SNP, MFLP, isozyme) are being used by the participants to tag and pyramid mutant genes. Encouragingly, there has been progress in the use of multiplex marker technologies (e.g. multiplex SSR), especially in wheat and barley. There are plans to move towards more advanced methodologies (e.g. eQTL, cDNA-AFLP, microarrays, and high-throughput SNP-based markers) in the near future. Some groups (e.g. rice) are making good use of the available genome sequence data, and such resources should prove useful for targeted marker development. Other groups are employing candidate gene approaches in attempts to isolate genes corresponding to target traits. Numerous publications have been generated by the CRP's participants. Several new varieties derived from mutant lines will be available by the end of the project. Moreover, the project should produce many molecular and biochemical markers for use in plant breeding programmes. The project has made significant progress in pyramiding multiple genes (including mutated genes) and QTLs using molecular marker technologies.

**Group activities** Following the presentation of the group's activities, their achievements and workplan for 2007-2009, specific points were made regarding:

- specific recent technological developments in the field of mutation breeding and mutagenesis, their application to a broader range of commodities, and technology transfer through possible organization of training sessions: directed mutagenesis, TILLING, 'space mutation induction', 'ion beam technology', doubled haploid technique, SSR-multiplexing, new high through-put marker technologies (DaRT, SNP, Illumina technology);

- new areas for future research and future projects in the context of climate change (impact of drought, salinity) - need for screening of existing germplasm and for generating genetic variability;
- databases and bioinformatics tools for data management (IMS);
- improving interactions and exchanges of expertise and results among the CRPs of the IAEA;
- organizing the next meeting (Sept-Oct 2009). Proposals from the group were: Thailand (Bangkok), Scotland (Dundee/Edinburgh) or Vienna. A decision will be taken by the end of September 2008;
- the possibility for new applicants to replace the 2 terminated contracts.



### IAEA/AFRA Regional Training Course on Advanced Plant Tissue Culture and Doubled Haploid Techniques, RAF/5/056, Accra, Ghana, 15–19 November 2007

Technical Officer: M. Spencer

This training course was organised under regional TC project RAF/5/056 together with the Government of Ghana and Ghana Atomic Energy Commission (GAEC). Overseas participants travelled from Cameroon, Libyan Arab Jamahiriya, Algeria, Sudan, Mauritius, Madagascar, Niger, Kenya, Uganda, United Republic of Tanzania, Zambia and Senegal and six participants came from Ghana. The lecturers were Dr. Chikelu Mba from the IAEA, Vienna and Prof. Ludmila Ohnoutkova from the Czech Republic. The local lecturers were Dr Richard Akromah, from Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, and Dr. Harry Amoatey and Dr. Kenneth E. Danso, both research scientists at the Biotechnology and Nuclear Agriculture Research Institute (BNARI) of the Ghana Atomic Energy Commission.

The first week was devoted to lectures and practical exercises on the use of induced mutations in crop improvement; demonstrations of methodologies for inducing mu-

tations; technical basis for phenotyping and genotyping mutants; and an introduction to molecular marker data analysis for mutant characterisation. The second week included lectures, demonstrations, and practical exercises in the principles, development and applications of various plant tissue culture techniques - with specific emphasis on embryogenesis, embryo rescue and doubled haploids, post-flask growth of plantlets, and demonstrations and practical exercises using major crops included in the various research programmes developed within this project. The participants are expected to have taken home new skills in various advanced plant tissue culture techniques and increased knowledge of techniques for handling the molecular characterization aspect of such projects.

According to the feedback received, the course developed in a very positive way, with lectures and practical exercises conducted in a professional and efficient manner.



*Trainees in the field discussing the appropriate morphological tips for collecting anthers at the adequate stage for haploid production.*

### **Consultants Meeting on Straw Digestibility through Mutation Breeding, Vienna, Austria, 19–22 November 2007**

Technical Officers: A. Schlink and M. Spencer



This was an unusual consultants meeting organized jointly by two NAFA sections: Plant Breeding and Genetics and Animal Production and Health. The debate was launched with the following question: “What innova-

tive aspect does the technology package of induced mutation and related biotechnologies bring in improving crop residues digestibility for livestock feed?”

Five consultants (Dr. Jinsong Bao, China; Prof. Peter Neumann, Israel; Dr. Karen Beauchemin, Canada; Dr. Hans-Joachim Jung, USA; and Dr. Michael Blummel, India), with expertise in plant breeding, plant physiology and ruminant nutrition from National Agricultural Research Organizations and Universities, attended the meeting together with staff members of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Dr. Gerrit Viljoen formally opened the meeting and gave an overview of the Animal Production and Health Section. Dr. Pierre Lagoda gave an overview of the Plant Breeding and Genetics Section, and later formally closed the meeting expressing his support for the ideas put forward. Dr. Paul Boettcher outlined the various IAEA support mechanisms to the Member States and Drs. Spencer and Schlink presented the background and objectives of the meeting.

The consultants presented state-of-the-art reviews in their areas of expertise. The debate was challenging yet very fruitful. The most important output of the meeting is that the answer to the above-mentioned question is in the affirmative. Induced mutation can be a powerful tool for improving crop residues digestibility. This answer, however, needs a comprehensive review of the plant parameters as well as those of animal aspects, with several pilot projects prior to any generalization of the concept. Therefore the meeting participants decided to implement a Coordinated Research Programme (CRP) on ‘Strategies to develop a ‘Proof of concept’ whereby food-feed crops can be selected for improved productivity and nutritive value for livestock using mutation breeding and complementary biotechnologies’. A number of options were proposed to advance the preliminary screening of individual plants from breeding programmes to have the capacity to screen large number of plants for ruminant nutritive value within the constraints of a plant breeding programme. The consultants identified a well focused area for the CRP which will have significant impact on livestock production where crop by-products are an important component in livestock feeding. Moreover, they identified other areas for future research in plant-animal interface.

### **IAEA/RER Regional Training Course (RTC) on Induced Mutations and Related Biotechnologies in Cereal Breeding, RER/5/013, Ankara, Turkey, 26 November – 1 December 2007**

Technical Officers: Y. Lokko and Q.Y. Shu

Under the regional TC project REP5/013 ‘Evaluation of natural and mutant genetic diversity in cereals using nuclear and molecular techniques’ a regional training course

(RTC) on mutation breeding in cereals was organized by the International Atomic Energy Agency (IAEA), in cooperation with the Sarayköy Nuclear Research and Training Center - Turkish Atomic Energy (TAEA) Authority, Ankara, Turkey. The objective was to provide hands-on experience in using mutation techniques and biotechnologies to expand the genetic breeding diversity of cereals. Twelve researchers from nine participating countries (Albania, Bulgaria, Kazakhstan, Moldova, Poland, Romania, Ukraine, Uzbekistan and Turkey) participated in the six-day RTC. The course included lectures, practical demonstrations and exercises on mutation breeding; use and effect of physical and chemical mutagenic treatment; handling of mutant generations; bio assays in plant cells for radiation detection; and doubled haploid techniques in seed propagated crops. Participants made presentations on their research activities in their home institutions and had the opportunity to hold discussions with experts on specific aspects of their work, and suggestions and advice were given for future research.



### **Consultants Meeting on Enhancing Nutritional, Nutraceutical and Pharmaceutical Value of Crops Using Mutation Induction Techniques, Vienna, Austria, 3–7 December 2007**

Technical Officer: Y. Lokko

Adequate intake of vitamins and minerals is essential to prevent common micronutrient disorders. Agricultural products are the primary source of calories and nutrients for people, with crop plants providing the largest proportion of the total weight of dietary requirements. Plants are also the main source of health beneficial agents such as sterols - known to lower cholesterol levels - and polyphenols (e.g. epigallocatechin gallate) - known to prevent cancer - , and are used in nutraceutical and pharmaceutical preparation. Many food crops, however, do not provide the essential phytonutrients in adequate quantities and quality. For instance, inadequate levels of the essential amino acids (lysine and tryptophan) and micronutrients (iron, zinc and vitamin A) in some staple crops and

excessive amounts of anti-nutrients (e.g. cyanogenic compounds, calcium oxalate crystals) may lead to health risks due to the consumption of oils rich in the heat-unstable polyunsaturated fatty acids, or with high levels of saturated fatty acids. These food quality concerns require efficient and sustainable interventions such as plant breeding to provide new varieties with the desired nutritional content in the crops.

A Consultants Meeting was held with staff of the Joint FAO/IAEA subprogram on Plant Breeding and four experts to formulate a proposal for a new Coordinated Research Project (CRP) on 'Enhancing nutritional, nutraceutical and pharmaceutical value of crops using mutation induction techniques.' The experts consulted were Dr. Søren K. Rasmussen (Denmark) and Dr. Dianxing Wu (China), plant breeders with expertise in breeding for improved micronutrient content; Prof. Philip White (UK), a Plant Nutritionist with expertise on plant nutritional genomics (including biofortification); and Dr. Nasia Tomlekova (Bulgaria), a geneticist with expertise in improving beta carotene content in vegetables. The CRP proposal is due for approval by the IAEA in 2008.

### **Consultants Meeting on Development of Integrated Technology Packages for Enhancing the Efficiency of Induced Mutagenesis in Crop Plants, Vienna, Austria, 3–7 December 2007**

Technical Officer: C. Mba

The meeting provided a framework for the development of a proposal to unleash the full potential of relevant biotechnologies in a concerted modular manner to mitigate the common bottlenecks to the widespread application of induced crop mutagenesis for crop improvement and genomics. These bottlenecks include the prerequisite for the generation of large putative mutant populations, cost and repetition of phenotyping strategies and the adaptation of marker-aided selection in the integration of the mutants into crop breeding schemes; or their maintenance and exploitation as mutant stocks.

The use of breeding objectives and targets for genomics studies that address topical interregional issues - such as added value for enhanced income generation and nutrition and global climate change to validate the several steps of the pipelines being proposed for addressing traits in crops of differing biological systems - are amongst the innovations foreseen for this CRP. It is hoped that calls for participants in this CRP will be released soon on our websites and other media.

For additional information on this proposed CRP, please contact the Scientific Secretary, Mr. Chikelu Mba ([c.mba@iaea.org](mailto:c.mba@iaea.org)).



## Expert Consultation on Micronutrient Deficiencies: Can Agriculture meet the challenge? Cairo, Egypt, 11–13 December 2007

Technical Officer: M. Spencer



The meeting was attended by 22 participants from the Near-East Region (Egypt, Lebanon, Jordan, Islamic Republic of Iran, Syrian Arab Republic (ICARDA)), scientists from the UK, Canada, Spain and Uganda, and representatives of other UN agencies (IAEA, FAO, WHO, and WFP). The representatives from the FAO Nutrition and Consumer Protection Division and from the WHO/EMRO formally opened the meeting emphasizing the urgency of addressing micronutrient deficiencies in the world, and particularly in the Near-East Region. It was acknowledged that throughout most of the world, including in the region targeted by this meeting, nutrition programmes may be considered successful because populations are receiving the required DES (Dietary Energy Supply) regularly. Such results are very encouraging for the FAO and all other UN agencies working for food security in the world, but the focus should be maintained and even strengthened by also considering the quality of the food provided to vulnerable populations: children under five and mothers. In fact for several, if not all, developing countries, including countries in the Near East, ‘pockets’ of malnutrition and even famine are recorded in some remote and marginal areas. Nutritionists reported that low weight, mental disabilities and stunted growth owing to micronutrient deficiencies are on the rise together with an increasing incidence of obesity and related

diseases such as diabetes. In most cases, mothers are obese owing to a diet based solely on high calory/low energy food (starch, sugar, oil), while children present stunting syndrome owing to micronutrient deficiencies (mainly Fe, Zn, Vitamin A) and disturbed metabolism. The Food and Nutrition Officer of the FAO/Regional Office for the Near East (scientific secretary of the meeting) stressed that the FAO takes these observations into consideration, and emphasized the need to associate the ‘quality’ aspect to all studies related to food security and to provide the right ‘quantity’ for long term interventions as well as during disaster operations.

All participants agreed that biofortification of food products *can* be a cost-effective way to control micronutrient deficiencies. Strong support was therefore expressed for research for additional long term solutions such as adding micronutrients to fertilizers and/or breeding for more nutrient balanced crops, including through induced mutagenesis. Examples of improved micronutrient contents of maize, rice and other crops used as staple foods in different IAEA Member States through TCPs and CRPs encourage the use of such technology as well as *in vitro* and molecular marker technologies in crop improvement for better food quality. Providing adequate micronutrients through agriculture could also be achieved by promoting and developing indigenous (‘orphan’) crops which are rich in micronutrients and/or antioxidants but also benefit from local traditional know-how and acceptability, as is now widely implemented e.g. in Latin America with quinoa and amaranthus

The meeting also identified some limits for biofortification food programmes. In fact, relying solely on biofortified food products usually derived from major cereals and/or oil crops may contribute to the simplification of diets, undermine biodiversity conservation, and is most unlikely to benefit local small-scale farmers.

The meeting was very informative if at times challenging; it was an excellent opportunity for scientists from different fields to exchange their findings and views: medical doctors, nutrition and food scientists, plant breeders, and soil scientists were all working towards improving the livelihood of populations in their respective Member States.

# Status of Coordinated Research Projects

## Physical Mapping Technologies for the Identification and Characterization of Mutated Genes Contributing to Crop Quality

Technical Officer: Y. Lokko

This CRP was initiated in 2002. The second RCM was held in Reykjavik, Iceland, 22–26 August 2005. The third RCM took place in Cordoba, Argentina, 19–23 March 2007. The fourth and final RCM is tentatively planned in conjunction with the International Symposium on Induced Mutations in Plants in August 2008

The fourth and last RCM is tentatively planned for the second half of 2008 in conjunction with the International Symposium on Induced Mutations in Plants, in Vienna, Austria, August 2008.

## Effects of Mutagenic Agents on the DNA Sequence in Plants

Technical Officer: P.J.L. Lagoda

This CRP was initiated in 2003. The first RCM was held in Vienna, Austria, 1–5 March 2004. The second RCM was held in Seoul, Republic of Korea, 14–18 November 2005. The third RCM took place in Stellenbosch, South Africa, 24–28 September 2007.

This CRP has now entered its last phase, in which the participants will consolidate their results. New developments in DNA analysis and genomics to define types, frequencies, rates and patterns of mutation induced by different mutagens have been exploited. This will generate a knowledge base that will guide and assist future users of induced mutation technologies for crop improvement and genomics. Furthermore, it will focus on physical mutagens, such as gamma and fast neutron or X-ray radiation. The relative efficiency of these physical and selected chemical mutagens was compared. The effects of these mutagens were evaluated on genetically homogeneous seed and vegetatively propagated plant material. Specific major objectives included:

1. Determining mechanisms and total levels of DNA damage at the M1 generation, e.g. directly in treated seed in pre- and post-germination assays;
2. Determining types, frequencies, rates and patterns of mutations in M2 generations, over (a) whole genomes and (b) in targeted DNA sequences within genomes;
3. Determining the type and rate of spontaneous mutation over generations in key crop plant groups (e.g., a select plant system, to determine the spontaneous rate as a baseline and as an inherent indicator of genotype mutagenicity);

4. Preparing protocols and guidelines for the use of particular mutagens for a range of specific applications in crop improvement and genomics.

Subsidiary objectives included:

5. Determining the chemical and molecular basis for differential radiation-sensitivity in different varieties of the same crop species;
6. Quantifying the type and rate of baseline spontaneous mutation, using multi-generation mutation accumulation experiments.

## Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality

Technical Officer: Q.Y. Shu

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 13–17 September 2004. The second RCM was held in Nanjing, China, 10–14 April 2006. The third RCM took place in South Perth, Australia, 15–19 October 2007.

For more information, see ‘Past Events’

## Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought

Technical Officer: M. Spencer

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 14–18 March 2005. The second RCM was held in Accra, Ghana, 6–10 November 2006.

The third RCM is planned to take place in conjunction with the International Symposium on Induced Mutations in Plants, in Vienna, Austria, August 2008.

## Molecular Tools for Quality Improvement in Vegetatively Propagated Crops Including Banana and Cassava

Technical Officer: C. Mba

This CRP was initiated in 2004. The first RCM was held in Vienna, Austria, 18–22 July 2005. The second RCM took place in Thiruvananthapuram, Kerala, India, 5–9 February 2007.

The third RCM is planned to take place in conjunction with the International Symposium on Induced Mutations in Plants, in Vienna, Austria, August 2008.

## Assessment of Nutrient Uptake from Bio-fortified Crops in Populations from Developing Countries

Technical Officers: T.P. Trinidad and P.J.L. Lagoda

This CRP was initiated in 2005. The first RCM was held in Vienna, Austria, 17–19 May 2006.

The second and last RCM is tentatively planned for the second half of 2008 in conjunction with the International Symposium on Induced Mutations in Plants, August 2008, Vienna, Austria.

Biofortification is the process of breeding staple food crops that are rich in micronutrients. The ultimate goal of the biofortification strategy is to reduce mortality and morbidity rates related to micronutrient malnutrition and to increase food security, productivity, and quality of life for poor populations of developing countries by breeding staple crops that provide, at low cost, improved levels of bioavailable micronutrients in a sustainable manner. Indeed, the effective supply of micronutrients in the human body not only depends on micronutrient concentrations in the ingested food, but also on the amount of food consumed and many factors that influence bioavailability and bioefficacy. Quantitative estimates of bioavailability of iron and zinc and bioefficacy of provitamin A carotenoids are lacking for many crops. Thus, a crucial step in the development of improved crop varieties is to conduct studies to determine bioavailability and bioefficacy. This should also guide plant breeders on target concentrations of micronutrients to be achieved in edible parts of the crops, so consumption of nominal amounts of these foods provide a substantial amount of the daily recommended intake.

This CRP proposal was developed together with the Human Nutrition Section (at NAHU) and HarvestPlus, a global alliance of research institutions and implementing agencies that have come together to breed and disseminate

crops for better nutrition. HarvestPlus is coordinated by the International Center for Tropical Agriculture (CIAT) and the International Food Policy Research Institute (IFPRI). The main objective of this project is to determine the bioavailability and bioefficacy of micronutrients in humans from nutritionally improved crop varieties or biofortified crops provided by HarvestPlus and the CRP counterparts using stable isotope techniques. Bioavailability has been defined as the amount of ingested nutrient that is absorbed and available for physiological processes in the human body. Iron and zinc, once absorbed in the human body, are bound in blood to proteins for transport to sites where they can directly fulfill their functions. However, provitamin A carotenoids must be converted in the intestine, or other sites in the body, to retinol to exert vitamin A activity. Bioefficacy refers to the proportion of the ingested nutrient that is absorbed and converted to its active form.

So far this CRP has developed and optimized efficient methodologies and techniques to assay and quantify bioavailability and bioefficacy of micronutrients. One fact worth mentioning is the development of a ferritin assay for cereals. Using this preliminary method, we could begin to characterize various cereals and legumes for ferritin content as well as the distribution of ferritin between outer layers and endosperm.

**IAEA Coordinated Research Activities Web Site:**

**<http://www-crp.iaea.org/html/forms.html>**

# Technical Cooperation Projects

## Currently Active Projects

Project Number	Title and Objective(s)	Technical Officer
AFG/5/003	<p>Sustainable Increase in Crop Production in Afghanistan</p> <p><b>Objectives:</b> To increase the productivity and production of crops through the development of improved nitrogen fertilizer and water management practices using nuclear and supportive biotechnologies. Phase I (2007-2008) will aim at refurbishing the national soil fertility laboratory and developing national capacities to provide fertilizer recommendations. In phase II (2009-2010), the laboratory will be upgraded and staff will be trained to conduct experimental work using nuclear techniques for improving water and nitrogen fertilizer management for wheat in target areas; recommendations on these will be formulated and disseminated to the farmers. In phase III (2011-2012), plant breeding programmes initiated in phases I-II will be developed on the basis of integrated soil-water-plant approaches using nuclear and supportive biotechnologies.</p>	P.J.L. Lagoda in collaboration with Soil and Water Management Section
ALG/5/023	<p>Protection of Date Palm Trees Against Bayoud Disease</p> <p><b>Objectives:</b> Rehabilitation and development of date palm oasis using mutation induction in Algeria.</p>	P.J.L. Lagoda
ALG/5/024	<p>Improvement of Cereals for Tolerance to Drought and Resistance to Disease</p> <p><b>Objectives:</b> To increase the cereal production (wheat and barley) by introducing at the farmer's level new high yield varieties tolerant to biotic and abiotic stresses.</p>	P.J.L. Lagoda
ANG/5/006	<p>Improvement of Food Crops Through Mutation Breeding and Biotechnology</p> <p><b>Objectives:</b> To establish a national capacity to develop crop varieties with increased vitamin and mineral content and improved yield, quality, disease resistance and stress tolerance.</p>	M. Spencer
BGD/5/026	<p>Increasing Agricultural Production in the Coastal Area through Improved Crop, Water and Soil Management</p> <p><b>Objectives:</b> To increase agricultural production in coastal areas through integrated and efficient management of crop, water, soil and land resources.</p>	Q.Y. Shu
BOT/5/003	<p>Mutational Improvement of Groundnut Varieties</p> <p><b>Objectives:</b> Development of high yielding groundnut mutant varieties with high tolerance to abiotic stress.</p>	Q.Y. Shu
CAF/5/003	<p>Development of New Varieties of Cassava Through Mutation Breeding and Biotechnology Techniques</p> <p><b>Objectives:</b> To develop manioc varieties with resistance to the African Cassava Mosaic Virus (ACMV) through mutation breeding and biotechnology techniques.</p>	M. Spencer

Project Number	Title and Objective(s)	Technical Officer
CPR/5/017	<p>Construction of Radiation-Induced Mutant Libraries and Function Analysis of Mutated Genes in Crop Plants</p> <p><b>Objectives:</b> To establish large-scale screening of induced mutations using molecular high-throughput techniques for mutant germplasm characterization and construct-induced mutant libraries for new variety development, genomics, proteomics and mutational analysis of gene networks in order to increase the efficiency of nuclear irradiation-induced mutation breeding of major crops (especially rice and wheat) in China.</p>	P.J.L. Lagoda
COS/5/025	<p>Development of Induced Mutations and Biotechnology for Improved Productivity and Competitiveness</p> <p><b>Objectives:</b> To contribute to improved quality of life of the small-scale bean farmers and strengthening of the food security in Costa Rica through increased productivity and competitiveness of the national bean production system by means of the control of the bean web blight disease (<i>Mustia hilachosa</i>).</p>	M. Spencer
COS/5/027	<p>Generation of Promising Strains of Beans Through Induced Mutations in Calluses and Seeds to Increase Competitiveness</p> <p><b>Objectives:</b> To contribute to an increase in the competitiveness and productivity of beans by strengthening the National Programmes for Bean Improvement.</p>	M. Spencer
ECU/5/023	<p>Inducing Mutations in Agriculture with the Aid of Radiation</p> <p><b>Objectives:</b> To improve varieties of maize, potato and barley using mutagenic techniques leading to an increase in the productivity of these subsistence crops.</p>	M. Spencer/P.J.L. Lagoda
ERI/5/004	<p>Improving Crop Productivity and Combating Desertification</p> <p><b>Objectives:</b> To improve and sustain crop productivity through the development of efficient breeding, water and fertilizer management practices in arid and semi- arid areas in the eastern and western lowlands of the country.</p>	P.J.L. Lagoda in collaboration with Soil and Water Management Section
GHA/5/032	<p>Enhancing Production and Use of Cassava</p> <p><b>Objectives:</b> To develop cassava varieties with high-quality starch, tolerance to African Cassava Mosaic Virus (ACMV), and excellent cooking quality; and to develop soil and nutrient management strategies in the sustainable production of cassava.</p>	M. Spencer/Y. Lokko
INS/5/030	<p>Sustainable Agriculture Development in Yogyakarta</p> <p><b>Objectives:</b> To increase overall crop production by integrating newly developed drought-tolerant crops into existing cropping systems; to identify drought- and salt-tolerant crop varieties by radiation-induced mutation techniques; to identify promising fertilizer management practices for improved crop rotations by using nuclear techniques such as nitrogen-15 labeled fertilizers; and to develop sustainable agricultural practices for increased crop production in Gunung Kidul area in Yogyakarta.</p>	M. Spencer
INS/5/031	<p>Mutation Breeding of Horticultural Crops</p> <p><b>Objectives:</b> To develop commercially viable induced mutant varieties of horticultural crops such as cut flowers, garlic, and citrus by gamma irradiation; to increase farmers' income by growing better quality mutant varieties; and to create more employment opportunities.</p>	M. Spencer

Project Number	Title and Objective(s)	Technical Officer
INS/5/035	<p>Application of Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands</p> <p><b>Objectives:</b> To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.</p>	Q.Y. Shu
IRQ/5/015	<p>Induction of Mutations in Crops Through <i>In Vitro</i> Culture</p> <p><b>Objectives:</b> To develop mutants of crops with high yield and tolerance to salinity, drought and heat, using in-vitro techniques.</p>	P.J.L. Lagoda
IRQ/5/017	<p>Optimization of Land Productivity Through the Application of Nuclear Techniques and Combined Technologies</p> <p><b>Objectives:</b> To improve use and efficiency of water and fertilizer and to establish criteria for optimum fertilizer dose and water salinity for sustainable crop production followed by an effective plant breeding programme for new cultivars and improved plant resistance techniques.</p>	P.J.L. Lagoda
JAM/5/010	<p>Plant Breeding and Diagnostics Technologies</p> <p><b>Objectives:</b> To enhance capacities in crop improvement in Jamaica so as to increase food production using induced mutations and related biotechnologies.</p>	Y. Lokko
MAR/5/018	<p>Improvement of Banana and Tomato Varieties Through the Use of Nuclear Techniques for Mutation Induction and Biotechnology</p> <p><b>Objectives:</b> Enhanced national capacity to develop varieties of bananas and tomatoes through mutation induction and biotechnology.</p>	M. Spencer
MYA/0/007	<p>Nuclear Science and Technology Training Centre (Currently a Human Development Project)</p> <p><b>Objectives:</b> To establish a nuclear science and technology training centre for scientists, engineers, technicians, and graduate students in the field of nuclear science and technology; and to develop local human resources for application of nuclear techniques in various fields.</p>	P.J.L. Lagoda
MYA/5/016	<p>Development of Rice Varieties with Improved Iron Content/Bioavailability Through Nuclear Techniques</p> <p><b>Objectives:</b> To combat iron deficiency through food based strategies.</p>	P.J.L. Lagoda
NER/5/012	<p>Improvement of the Productivity and Sustainability of Cowpea with Finger Millet</p> <p><b>Objectives:</b> To develop improved drought-resistant lines and amelioration of soil and water management practices using nuclear, isotopic and mutation breeding techniques for cowpea.</p>	M. Spencer
NIR/5/031	<p>Radiation-Induced Mutations for the Development of Cowpea Varieties</p> <p><b>Objectives:</b> To develop pest tolerant/resistant cowpea varieties using radiation-induced mutation and advanced screening techniques for insect pests to improve the cowpea yield, quality, and diversity.</p>	P.J.L. Lagoda
NIR/5/035	<p>Adding Value to Root and Tuber Crops Through the Use of Mutation Induction and Biotechnologies</p> <p><b>Objectives:</b> To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.</p>	Y. Lokko

Project Number	Title and Objective(s)	Technical Officer
PAK/5/044	<p>Improvement of Drought Tolerance in Chickpea Through Induced Mutations</p> <p><b>Objectives:</b> To develop drought-tolerant and high-yielding desi chickpea mutants for the low-moisture chickpea growing areas in Pakistan through induced mutation.</p>	M. Spencer
PER/5/028	<p>Use of Nuclear Techniques to Improve Cotton Production</p> <p><b>Objectives:</b> To improve cotton production, particularly that of short vegetative period, using nuclear and related techniques.</p>	Y. Lokko
PER/5/030	<p>Genetic Improvement of Quinoa and Kiwicha Using Mutation Induction and Biotechnology</p> <p><b>Objectives:</b> To improve the national capacity to increase the yields and market competitiveness of quinoa and kiwicha.</p>	Y. Lokko
PHI/5/029	<p>Enhancing Agricultural Productivity Through Radiation Technology in Mindana</p> <p><b>Objectives:</b> To develop new mutant varieties of fruit crops such as mango and cashew with high yield, improved quality, short stature, early maturing, and non-seasonal; and to develop new rice mutant varieties with resistance to pests and tolerance to abiotic and biotic stresses through radiation-induced mutations and molecular techniques.</p>	M. Spencer/Y. Lokko
QAT/5/002	<p>Developing Biosaline Agriculture in Salt-Affected Areas in Qatar</p> <p><b>Objectives:</b> To develop biosaline agriculture in salt-affected areas in Qatar through: 1) sustainable utilization of saline groundwater and land resources, 2) introduction of salt-tolerant plant species, selected for their comparative advantages over others (as to water-using efficiency, greening of desert, forage and fodder use, etc.), 3) creating national capacities to utilize isotopic, nuclear and other modern techniques, and 4) transfer of the technologies to beneficiaries and end users.</p>	P.J.L. Lagoda in collaboration with Soil and Water Management Section
RAF/5/049	<p>Field Evaluation of Bayoud-Resistant Date Palm Mutants</p> <p><b>Objectives:</b> To assist Algeria, Morocco, and Tunisia in producing date palm trees with improved fruit yield, short height, and resistance to Bayoud disease.</p>	M. Spencer
RAF/5/056	<p>Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques</p> <p><b>Objectives:</b> To assist AFRA member states in the development and dissemination of improved mutation induced staple and market oriented crops.</p>	M. Spencer
RAS/5/045	<p>Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA)</p> <p><b>Objectives:</b> The objectives of this project are to develop and transfer methodologies and technologies for the induction and identification of mutated genes contributing to important crop quality characters and stress tolerance to RCA Member States, and to develop improved breeding material using molecular marker-assisted selection, through: 1) Development and establishment of efficient methodologies for the induction of mutants and the screening of crop germplasm with various and desirable quality characters, including nutrition and process characters, and tolerance to stress; 2) Development of molecular markers for tagging genes for quality characters and enhanced tolerance to stress in induced mutants; 3) Use of molecular markers with the aim of developing improved crop varieties; and 4) Development of improved germplasm with enhanced quality traits and improved resistance to stress.</p>	Q.Y. Shu

Project Number	Title and Objective(s)	Technical Officer
RAS/5/048	<p>Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA)</p> <p><b>Objectives:</b> An improved regional partnership in the field of mutation induction to enhance breeding for food security and socioeconomic development.</p>	P.J.L. Lagoda
RAS/7/014	<p>Monitoring of Food Fortification Programmes Using Nuclear Techniques</p> <p><b>Objectives:</b> The objectives of the project are twofold: 1) to evaluate and monitor the food fortification intervention programmes in five participating Member States, and 2) to develop rice mutants with low phytic acid from the country's high-yield rice varieties.</p>	P.J.L. Lagoda
RER/5/013	<p>Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques</p> <p><b>Objectives:</b> 1) Genetic improvement of barley (<i>Hordeum vulgare</i>), pea (<i>Pisum sativum</i>), beans (<i>Phaseolus vulgaris</i> L.) and cotton through induced-mutations. 2) Animal nutrition and reproduction. 3) Vegetal physiology, soils and fertilizers applied to potatoes, barley and other crops.</p>	Y. Lokko/Q.Y. Shu
SAF/5/008	<p>Mutant Amaranth, Bambara Groundnut and Cowpea with Enhanced Abiotic Stress Tolerance</p> <p><b>Objectives:</b> To screen, evaluate, and identify mutant amaranth, bambara groundnut and cowpea with enhanced abiotic stress tolerance, in collaboration with resource poor farmers.</p>	Y. Lokko
SAF/5/010	<p>Development of New Maize and Sorghum Germplasm with Enhanced Nutritional Content</p> <p><b>Objectives:</b> To develop and characterize new maize and sorghum germplasm with enhanced nutritional value that are suitable for subsistence farming systems. To develop human capacity in the region to use mutation breeding to improve the nutrition of cereals.</p>	Y. Lokko
SEN/5/030	<p>Integrated Approach to Develop Sustainable Agriculture in Senegal</p> <p><b>Objectives:</b> To screen, select and develop improved cowpea and sesame cultivars for nitrogen fixation and natural phosphorus uptake under drought conditions using mutation induction and biotechnologies.</p>	M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
SIL/5/007	<p>Development of High-Yielding Rice Varieties for Low-Input Agriculture Systems Using Mutation Techniques</p> <p><b>Objectives:</b> To develop high-yielding rice varieties adapted to low-input agriculture systems using mutation techniques in order to enhance the capacity for crop improvement, rice in particular, and increase food (rice) self-sufficiency in Sierra Leone.</p>	Q.Y. Shu
SIL/5/009	<p>Improving Sorghum Productivity Through Nuclear and Biotechnology</p> <p><b>Objectives:</b> To assist in the development of new mutant lines of sorghum with increased yield and disease resistance.</p>	Q.Y. Shu
SUD/5/030	<p>Increasing productivity of Selected Crops Using Nuclear Related Techniques</p> <p><b>Objectives:</b> To use nuclear techniques to expand production of established varieties in banana and wheat lines and to increase the productivity of new varieties in sugarcane and tomatoes in Sudan through introduction of new production packages (new variety, new cultivation technology and crop management system).</p>	Q.Y. Shu



Project Number	Title and Objective(s)	Technical Officer
TUN/5/023	Radiation-Induced Mutations for Improvement of Cactus <b>Objectives:</b> To develop improved varieties of cactus by induced mutations, which are relatively high in nitrogen for use as feed for sheep and goats.	P.J.L. Lagoda
TUN/5/024	Development of Improved Strains of Olive Tree Through Mutation Breeding and Biotechnology <b>Objectives:</b> To develop a routine protocol for mass micropropagation of high yielding olive varieties.	P.J.L. Lagoda
TUR/5/023	Application of Nuclear and Gene-Based Biotechnology in Agriculture <b>Objectives:</b> To establish a biotechnology laboratory for molecular characterization of induced mutants and thus enhance the efficiency and widen the application of induced mutations in crop improvement, i.e. quality, yield, biotic stress and disease tolerance in Turkey.	Q.Y. Shu
URT/5/023	Enhancing Crop Productivity Through Radiation Technology <b>Objectives:</b> To develop improved varieties of basic crops such as rice, banana and barley through tissue culture, radiation-induced mutations and molecular techniques, and enhance the crop breeding capacity in United Republic of Tanzania.	Q.Y. Shu
UZB/5/004	Development of Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity <b>Objectives:</b> To develop new mutant prebreeding cotton lines and enhance breeding capacities for resistance to the major fungal diseases, drought and salinity in Uzbekistan.	Y. Lokko/P.J.L. Lagoda
VIE/5/015	Enhancement of Quality and Yield of Rice Mutants Using Nuclear and Related Techniques <b>Objectives:</b> To further develop and extend improved mutant varieties and advanced mutant lines of rice for export and high-grade domestic consumption.	Q.Y. Shu
YEM/5/007	Use of Induced Mutations and <i>In Vitro</i> Culture for Improving Crops <b>Objectives:</b> To use radiation-induced mutation technology, in combination with modern biotechnology, to produce improved mutants of major crops that have higher yields and that can adapt to the changing climate and water resources.	P.J.L. Lagoda
YEM/5/008	Introduction of Gamma Ray Irradiation Techniques for Agriculture Purposes <b>Objectives:</b> To support the use of gamma ray irradiation techniques, such as mutation induction enhanced breeding, for service and applied research purposes.	P.J.L. Lagoda
ZAI/5/016	Mutation Techniques for Improving Nutritional and Medicinal Plants with a Curative Effect on Human Diseases and Alimentary Plants <b>Objectives:</b> To build the basis for a long-term national strategy to fight malaria and improve food security.	M. Spencer
ZIM/5/013	Development of Drought Tolerant and Disease Resistant Grain Legumes, Phase I <b>Objectives:</b> To develop drought and/or disease tolerant mutant grain legume varieties suitable for resource poor smallholder farmers in Zimbabwe.	Y. Lokko

## Recently Closed Projects

Project Number	Title and Objective(s)	Technical Officer
INT/5/147	<p>Developing Salt-Tolerant Crops for Sustainable Food and Feed Production in Saline Lands</p> <p><i>Objectives:</i> To assist IAEA Member States in the improvement and sustainability of food and forage crop production in salt-affected environments through the development of salt-tolerant crops using nuclear and related biotechnological techniques.</p>	M. Spencer
KEN/5/024	<p>Crop Improvement and Management Through Application of Nuclear and Biotechnology Techniques</p> <p><i>Objectives:</i> To use radiation-induced mutation technology in combination with modern biotechnology to increase yield potential and adaptability of major and under-exploited crops to drought, soil acidity, pests, and diseases for smallholder farmers.</p>	Y. Lokko/Q.Y. Shu
MYA/5/010	<p>Development of Improved Rice with Tolerance to Drought</p> <p><i>Objectives:</i> To develop drought-tolerant rice mutants for rain-fed uplands and hilly areas, and to develop salt-tolerant rice mutants for coastal areas.</p>	Q.Y. Shu
PAK/5/040	<p>Improvement of Heat-Tolerant Semi-Dwarf Bread Wheat Through Radiation Induced Mutations</p> <p><i>Objectives:</i> To develop heat-tolerant semi-dwarf genotypes of bread wheat with high yield and better quality characteristics through radiation-induced mutation techniques.</p>	P.J.L. Lagoda
PAK/5/042	<p>Induced Mutation to Improve Salt-Tolerance in Non-Aromatic Rice Varieties</p> <p><i>Objectives:</i> To induce mutations in existing semi-dwarf non-aromatic rice varieties in order to achieve salt tolerance, high grain yield, good grain quality, early maturity, and resistance to insect pests and diseases.</p>	Q.Y. Shu
RAF/5/050	<p>Increasing Production of Nutritious Food Through Mutation Breeding and Biotechnology</p> <p><i>Objectives:</i> To assist AFRA Member States in the development and field evaluation of improved crops for higher agricultural productivity, better nutrition, and greater tolerance to stress.</p>	Q.Y. Shu/M. Spencer

**IAEA Technical Cooperation Programme's Web Site:**

<http://www-tc.iaea.org/tcweb/default.asp>

## TC Project Highlights

**Second Coordinators Meeting on Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity, RAS/5/048 (ARASIA), Damascus, Syrian Arab Republic, 11–15 November 2007**

Wheat, barley, lentils and potato are among the most important food crops contributing to food security and sufficiency in ARASIA States Parties participating in this project (Iraq, Jordan, Lebanon, Saudi Arabia, Syrian Arab Republic and Yemen). However, despite increased

yields, several factors, both biotic (disease and pest) and abiotic (drought and salinity), continue to limit their productivity. It is now a matter of urgency that new varieties be bred with higher and more stable yield potentials, superior quality, and multiple resistances to disease and insects. The use of induced mutation to create useful new germplasm and to develop new cultivars is a profitable approach to improvement. If desired traits are to be enhanced and mutant varieties are to be developed with high yield, short duration, shatter-resistance, and stress

tolerance, it is important that various valuable mutant germplasm be generated, identified, and exploited. ARASIA States Parties have recognized the prime importance of developing improved varieties of food crops through the application of mutation techniques.

The main purpose of the Second Coordinators Meeting was to evaluate and steer ARASIA participating countries' on-going national efforts in this field and to facilitate and promote collaboration during the period 2008-2011. Consequently, national project coordinators were asked to prepare and present country reports on national legislations regarding germplasm, dissemination, phytosanitary measures, and a national project. The national project coordinators discussed and formulated a detailed project work plan for 2008 and beyond with IAEA staff and the expert from the Secretariat of the International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA), FAO,.

Mr. Selim Louafi, Senior Treaty Officer of the International Treaty on Plant Genetic Resources for Food and Agriculture, FAO, gave two presentations: one on the International Treaty and its main provisions; and one on the Multilateral System on Access and Benefit Sharing and the use of Standard Material Transfer Agreement (SMTA) for germplasm exchanges. Each national coordinator gave a presentation on national legislation relating to germplasm dissemination and phytosanitary measures. These presentations consolidated the draft presentations on the above item in the first coordinators meeting. Lengthy discussions on a draft MoU on germplasm and phytosanitary measures, based on the adoption of the SMTA, finally led to agreement and signature.

This is a major achievement of this regional project and puts the ARASIA States Parties participating in this project into a leadership position for the regional application of the SMTA under the Multilateral System.

*Pierre J.L. Lagoda  
Technical Officer*

### **Rewarding Rice Mutant Varieties in Viet Nam, VIE/5/015**

A dozen mutant varieties have been developed by the counterparts of the IAEA's TCP VIE/5/015 working on rice improvement for better quality and tolerance to bio/abiotic stresses using mutation techniques and biotechnologies in Viet Nam.

In Southern Viet Nam, the mutant rice variety VND95-20, among others, has been widely grown in the past 5 years. In addition to its high yield potential (10-17% increase in controlled yield trial), it has premium grain quality and is one of the key rice varieties produced for export. It has very good tolerance to salinity, hence it adapts very well in the Mekong Delta. It also shows moderate resistance to brown plant hopper, a devastating insect pest recently affecting southern Viet Nam. There-

fore it emerged as the number one rice variety in terms of growing area in 2007, with an annual acreage of 300 k.ha. Other mutant varieties under large scale cultivation include: VND95-19, VND404, VND99-3. TNDB-100 and recently released varieties are: VN 121 and VN 24-4. Referring to the impact of mutant varieties developed in his institute, the Director General of the Institute of Agricultural Genetics, located in northern Viet Nam, noted that: "we talk a lot of biotechnology, but the outcome has been only from mutation techniques". A new mutant variety, DT38, was recently released as a national variety for ecosystems where farmers grow rice and farm shrimps.

Rice mutation breeding has never been so rewarding in Viet Nam. Farmers from the Mekong Delta to the highlands have been benefiting from higher yields and better price thanks to the high quality of the varieties. The VND serial varieties alone produced a net benefit for farmers amounting to **186.30 millions USD**. Scientists - like Dr. Do Khac Thinh, chief breeder of VND95-20 - , are also rewarded with national prizes recognizing their contributions. In highland areas, farmers began stopping deforestation since they can now produce enough food on their land. Besides, dozens of local officials who helped disseminate these varieties are also rewarded with promotions to higher positions. The plant breeding community is also foreseen to benefit from these achievements, as the Vietnamese government has recognized the usefulness of nuclear techniques and has approved a plan to launch a large-scale project on nuclear techniques in food and agriculture, under the 'Atoms for Peace' action.



*Qingyao Shu  
Technical Officer*

### **Breeding High Yielding Rice Varieties for Low Input Agriculture System, SIL/5/007**

After years of civil strife, Sierra Leone is making a slow recovery. Rice produced in the country is far from enough to feed the population. The IAEA has been cooperating with the Rokupr Rice Research Station through a TCP to develop high yield rice varieties. During the past three years, eight scientists were trained in rice breeding and related techniques, and a rice breeding laboratory equipped with tissue culture facilities is being built. Most

importantly, the rice mutation breeding programme has been shaping up and some mutant lines showed very promising results in the uplands.



Rice mutation breeding in Sierra Leone

**Qingyao Shu**  
Technical Officer

### Flowers Blooming - A follow-up of a previous TCP in Thailand, THA/5/045

The IAEA had been working with Kasetsart University in Thailand on building capacities for plant mutation breeding through several TCPs. The most recent one, Radiation induced mutation for bean and chrysanthemum (THA/5/045), was completed in 2001. With the capacities built on these projects, the Gamma Irradiation Service and Nuclear Technology Research Center was established and is now providing services for scientists in Thailand. During the past few years, scientists in this center developed more than 50 new mutant varieties, including canna (37), chrysanthemum (6), portulaca (10) and adenium (2) which were released to farmers. Moreover, they also collaborated with floriculture farmers and helped them develop several registered varieties of adenium such as Super Red and Super White.

**Qingyao Shu**  
Technical Officer



a



b



c



d



e



f



g

Taihei and its registered mutant varieties (a) Taihei (b) Kasetsart 60-1 (c) Kasetsart 60-2 (d) Kasetsart 60-3 (e) Kasetsart 60-4 (f) Control and Kasetsart 60-5 (g) Kasetsart 60-6 (THA/5/045)

### Generation of Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness, COS/5/027

This TC project has the potential to have a great impact on Costa Rica's bean production and to ensure a better livelihood for the country's population. The visit and discussions with the national programme officer of the Bean and Maize programme in Costa Rica was very informative. The research and development institute is located in the south east of the country and has close links with universities, research institutes and local producers. In his extensive presentation on the components of the national

programme for beans, the national programme officer emphasized the great impact of bean production for the country: the areas devoted to it were evaluated in 2006 at 14,827 Ha and are still growing (Figs 1 and 2). This shows the importance of the crop as a staple food in Costa Rican cuisine in different forms for all meals: puree, flour, raw, and cooked. The other strong argument in favour of the breeding programme - which is of great importance to the IAEA - is the fact that this crop is the main if not the only activity of small farmers located in the impoverished regions of the country. Any success in this TC project will immediately be translated into a real

change in the nutrient intake of the Costa Rican population and will certainly improve the livelihood of the farmers.



*Fig. 1 - Mutation induction may assist in increasing the yield of red beans.*

The national programme officer is convinced that cooperation between his institute and the University of Costa Rica on this mutation breeding programme could have a great economic impact and would create new and specific areas of enhanced local productivity and/or would improve crop quality.

*Madeleine Spencer  
Technical Officer*



*Fig. 2 – Corn and beans grown alternatively on marginal areas.*

# Ongoing Activities at the Plant Breeding Unit, Seibersdorf

## Introduction

The Plant Breeding Unit's work continues to focus on the enhancement of efficiency in induced crop mutagenesis while concentrating on identified crop improvement objectives of interregional relevance. To achieve this, we devote significant resources to research and development (R&D) activities; train scientists from developing Member States; and provide services. Strategically, the modalities for addressing this mandate continue to rely heavily on building synergies with counterparts in both national and international organizations whose personnel, and indeed perspectives, enrich both the conceptualization and implementation of activities and who often collaborate in the actual implementation of activities.

## Research and development

The Plant Breeding Unit (PBU) is continuing its efforts to establish strong high-throughput TILLING and Eco-TILLING platforms for the discovery of induced and natural nucleotide variation. The majority of necessary bench protocols have now been prepared and validated. Natural populations (accessions) of rice and cassava have been prepared for screening and have passed the first set of quality control assays. A set of robust primers for genes involved in abiotic stress resistance has been developed in rice. Primers for starch biosynthesis in cassava are currently being tested for suitability in the high-throughput assays. When complete, the focus will move to developing banana populations and primers. Efforts will then shift from optimizations to production screening in all three organisms. Once in production mode, mutagenized populations being prepared by our collaborators can be integrated into the screening pipeline.

Some other R&D-related highlights include:

- In collaboration with our counterparts at the International Centre for Tropical Agriculture (CIAT), Cali, Colombia, the generation of cassava variants with significantly enhanced
  - shelf life on account of the delayed post-harvest physiological deterioration (10 days as against 1 day) opening up the possibility for transporting the crop from the hinterland to the processing factories with minimum of damage; and
  - content of amylose, hence greater fermentability, thereby making such variant candidates for use as biofuel sources.

These putative mutants, still undergoing field trialling, are the subjects of reverse genetics strategies for uncovering the mutation events leading to altered phenotypes.

- Significant progress made towards the adaptation and validation of protocols for high throughput querying of induced mutants for subtle changes at the gene level, thereby obviating the need for large-scale field trialling.
- Setting up a pipeline for the rapid use of live pathogens to identify disease resistant banana variants.
- Signing of a Memorandum of Agreement with the International Institute for Tropical Agriculture, an agreement that facilitates in-depth access to African partners, trial sites and genetic resources for target crops and most importantly the sharing of expertise in the generation and evaluation of induced mutants of this crop.

## Human Capacity Development

The Unit's training activities usually involve both group and individual programmes.

### Group Training Activity

The FAO/IAEA Interregional Training Course on Mutant Germplasm Characterisation Using Molecular Markers remains one of the foremost human capacity building mechanisms used by the Joint Programme. It trains a critical number of personnel to use induced crop mutagenesis to develop better crop varieties with the aim of achieving sustainable food security.

The seventh edition of this Training Course was held at the Plant Breeding Unit of the FAO/IAEA Agriculture and Biotechnology Laboratory from 21 May to 22 June 2007. This 5-week course was divided into six modules. Resource staff consisted of six external lecturers (consultants) and the Joint Programme's staff member. The Table below lists the external lecturers according to the different modules in which they participated.

The main components of the course were theoretical lectures, practical exercises in the laboratory, screen houses and computer-based analyses. There were also special seminars led by both the external lecturers and Joint Programme staff members. Participants also made presentations based on ongoing activities in their home institutes with projections on the integration of the newly acquired

skills. Moreover, participants had the opportunity to get an overview of the Secretariat's mechanisms when working with Member States through presentations on the

Technical Cooperation and Coordinated Research Projects.

### Breakdown of the Seventh Interregional Training Course by Modules and Resource Persons

Week	Module	Resource Person
1	Inducing and Detecting Mutants	<b>Mr. Brian Forster, PhD.</b> Genome Dynamics Department of Scottish Crop Research Institute, Dundee, Scotland, UK
	<i>In vitro</i> Techniques in Crop Improvement	<b>Mr. Mohan S. Jain, PhD.</b> Department of Plant Production, University of Helsinki, Helsinki, Finland
2	Molecular Genetic Markers	<b>Mr. Gustavo Caetano-Anolles, PhD.</b> Department of Crop Sciences, University of Illinois, Urbana, IL, USA.
3	Molecular Cytogenetics	<b>Mr. John Heslop-Harrison, PhD.</b> Department of Biology, University of Leicester, UK
4	Reverse Genetics for high throughput detection of mutation events	<b>Mr. Bradley Till, PhD.</b> The Seattle TILLING Project, Department of Biology, University of Washington, Seattle, WA, USA
5	Population Genetics and Data Management	<b>Mr. Juan Fernando Fernandez, PhD.</b> Laboratoire d'Ecologie, Systématique et Evolution, Université Paris 11 Sud, Orsay, France

The gender-balanced group included 20 participants from 20 developing Member States of both the IAEA and the Food and Agriculture Organization (Algeria, Bangladesh, Belarus, Democratic Republic of Congo, Egypt, Ghana, Guyana, Iraq, Jamaica, Kenya, Malaysia, Myanmar, Pakistan, Sri Lanka, St. Vincent and the Grenadines, Sudan, Thailand, Tunisia, Uganda, and Viet Nam) who had been selected from about 100 Member States nominees. Contact details for these participants, including their institutions of affiliation, are presented in the attached Training Course agenda.

### Individual Training Activities

Individual training programmes, funded by the IAEA's Technical Cooperation Programme, also constitute a major implementation mechanism for human capacity development. Young scientists and designated cost-free interns (usually students or those transitioning between one phase of study to another) also get the opportunity to work in the Unit and thereby gain invaluable hands-on experience in the applications of induced crop mutagenesis in crop improvement and genomics. The following fellows and interns worked in the Unit during the period under review.

### Fellows/Cost-Free Interns

Name	Country	Type of Training	Area of Training	Period
Mr. Danilo Gabriel Moreno Maldonado	Ecuador	Cost-free intern	<ul style="list-style-type: none"> <li>Induced mutagenesis</li> <li>Mutant germplasm characterization using molecular markers</li> <li>Flow cytometry for ploidy determination</li> </ul>	2007-06-18 – 2008-02-14
Ms. Nwaiwu Blessing Ifeyinwa	Nigeria	Cost-free intern	<ul style="list-style-type: none"> <li>Induced mutations in rice</li> <li>Molecular genetics and <i>in vitro</i> techniques</li> </ul>	2007-07-02 – 2007-12-31
Ms. My Linh	Viet Nam	Fellow	<ul style="list-style-type: none"> <li>Molecular characterization of rice mutant using different molecular systems</li> </ul>	2007-10-01 – 2007-12-31

## Services

The services provided by the Unit in support of activities in MSs for the period June to November 2007 are summarized below:

### Irradiation

A total of 70 irradiation treatments were carried out and are broken down thus:

Number of requests	9
Number of species	7
Number of varieties	33
Number of treatments	70
Number of requesting Member States	4

### Molecular genetic fingerprinting

Molecular genetic fingerprinting of eight mutant lines and their parents were requested by national programmes from Egypt and Viet Nam. AFLP markers (with different primer combinations) were used for the characterization of the mutants using the high throughput fingerprinting facilities at the Unit. The analyzed data were provided to the requesting Member States.

Number of requests	2
Number of species	1
Number of varieties	11
Number of primers combination used	20
Number of requesting Member States	2 (one each from Egypt and Viet Nam)

## Consultants

The following consultants provided expert advice to support ongoing activities during the period under review.

Name	Subject Area	Period
Bradley Till	<ul style="list-style-type: none"> <li>Establishing and optimizing TILLING and EcoTILLING protocol for rice, banana and cassava</li> </ul>	2007-07-16 – 2008-07-15
Juan F. Fernandez-Manjarres	<ul style="list-style-type: none"> <li>Bio-statistical guidelines for data analysis and research strategies for the handling of data from mutant germplasm accessions of rice, banana and cassava produced at PBU in Seibersdorf</li> </ul>	2007-11-15 – 2007-11-16
Harivelo V.S. Andrianaivo	<ul style="list-style-type: none"> <li>Assisting ploidy measurement by using FCM</li> </ul>	2007-11-13 – 2007-12-13

### Staff Travel

#### Fourth Tri-National Arabidopsis Meeting, BOKU, Vienna, Austria, 12-15 September 2007

This conference focused on the model plant *Arabidopsis thaliana*, and recent research by members of a European network of plant scientists, primarily from Germany, Switzerland and Austria. Many important breakthroughs in plant biology were first discovered or developed in Arabidopsis. Keeping up to date with the latest progress in basic plant research will allow a more rapid evaluation of how new methods and information can be utilized to improve crops for developing nations. Dr. Till presented a poster outlining the TILLING method and plans of the Plant Breeding Unit for integrating this method into their research activities. Conference attendees expressed interest in the work. Members of the local Vienna plant community were happy to see participation by the Joint Programme, and stressed their desire to maintain a strong network of local plant researchers.

#### Conference on New Approaches to Plant Breeding of Orphan Crops in Africa, Bern, Switzerland, 19-21 September 2007

This conference was focused on underutilized or 'orphan' crops. The goals included addressing major productivity problems, and to discuss the prospects of modern biotechnology for improving productivity. Attendees from a number of developed and developing countries gathered to present current progress on the study of orphan crops and to evaluate how new approaches and methods might be applied to their crop of interest. Dr. Till gave an oral presentation on his work on TILLING (Targeting Induced Local Lesions IN Genomes) and the work that the Plant Breeding Unit is doing to adapt this technology for crops important to developing nations. Conference attendees expressed interest in the work, and in the possibility of collaborative projects.



## Reports

### Duty Travel to Ecuador, ECU/5/023, Inducing Mutations in Agriculture with the Aid of Radiation 2007

Technical Officer: M. Spencer

In the South-eastern regions of Ecuador, we met with several potato farmers' associations during a field day and with the head of the growers association. This visit allowed a thorough assessment of the impact of INIAP (*Instituto Nacional Autonomo de Investigaciones Agropecuarias*) in the improvement of potato breeding, production and commercialization. The institute together with the associations have created so-called 'Farmers Schools' for different crops where committed young farmers are trained in the different aspects of breeding: seed production, crop protection, socio-economic development, etc. Interestingly the farmer-trainees collect, conserve and classify bugs as friendly, predators and neutral for use by other farmers for an environmentally balanced management of pests in potato production.

A visit to the FAO representation in Ecuador included discussions on the objectives of the current IAEA TC project as well as on the main activities planned for the next cycle with the FAO representative. We were very pleased with his commitment to assist the counterparts in this TC project in organising the national workshop planned for 2008. The different agricultural projects currently conducted by the FAO in Ecuador were presented and several may be connected to this TC project, and collaboration is foreseen. The FAO representative also noted that the FAO/IAEA Joint Division could provide information on animal and crops health issues which are on the rise - such as screw-worm development for cattle and fruit flies - and impeding exports. During the same meeting, we were introduced to the NRAs Coordination Analyst who presented the UNDAF approach in Ecuador and emphasized the need to establish contacts in an effort to coordinate UN interventions in Ecuador, especially for Agencies such as the IAEA which do not have representative offices in the country.



*Display of insects by the Potato Farmers' School in Ecuador*

# Announcements

## International Symposium on 'Induced Mutations in Plants (ISIM)' International Atomic Energy Agency, Vienna, Austria, 12-15 August 2008

### Announcement and Call for Papers

#### 1. Background

The year 2008 will mark the 80<sup>th</sup> anniversary of mutation induction in crop plants. The application of mutation techniques, i.e. gamma rays and other physical and chemical mutagens, has generated a vast amount of genetic variability and has played a significant role in plant breeding and genetic studies. The widespread use of induced mutants in plant breeding programmes throughout the world has led to the official release of more than 2600 mutant crop varieties. A large number of these varieties (including cereals, pulses, oil, root and tuber crops, and ornamentals) have been released in developing countries, resulting in enormous positive economic impacts.

The International Symposium on Induced Mutations in Plants (ISIM) will be the eighth in the Joint FAO/IAEA Programme's Symposium series dedicated exclusively to harnessing and disseminating information on current trends in induced mutagenesis in plants, the first of which was held in 1969 and the last in 1995. These previous symposia dealt with themes relating to the development of efficient protocols for induced mutagenesis and their role in the enhancement of quality traits, as well as resistance to biotic and abiotic stresses in crops and the integration of in vitro and molecular genetic techniques in mutation induction.

Since 1995, there has been an increased interest within the scientific community, not only in the use of induced mutations for developing improved crop varieties and for the discovery of genes controlling important traits and understanding their functions and mechanisms of actions, but also in deciphering the biological nature of DNA damage, repair and mutagenesis. A symposium that brings together the key players in basic research, as well as in the development and application of technologies relating to the efficient use of induced mutations for crop improvement and empirical genetic studies, is therefore justified and necessary.

#### 2. Main Topics

Topics to be addressed at the symposium:

- Molecular genetics and biology of physical, chemical and transposon-induced mutagenesis
- New mutation techniques, i.e. ion beam implantation, and their integration with other molecular and biotechnological techniques
- Induced mutations in crop breeding programmes
- Mutation induction for gene discovery and functional genomics, including targeting induced local lesions in genomes (TILLING) and other reverse genetic strategies
- Mutational analysis of important crop characters (tolerance to abiotic stresses, resistance to diseases and insects, quality and nutritional characters, etc.)
- Socio-economic impact of widespread mutant varieties.

#### 3. Target Audience

It is envisaged that this symposium will not only attract eminent basic research scientists but also active plant breeders from all over the world. Therefore, the symposium will at once provide the platform for the exposition and rigorous discourse on current research and technology development in this field and establish linkages among scientists in order to develop knowledge-based breeding strategies and mechanisms for sharing information and resources. It will also be a venue for project managers of international and national organizations, as well as multinational and private companies engaged in plant breeding activities, to gain insights into the applications of, and current trends in, mutation techniques.

#### 4. Exhibits

Limited space will be available for commercial vendors' displays/exhibits during the symposium. Interested parties should contact Mr. Qingyao Shu, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture IAEA, at e-mail: [q.shu@iaea.org](mailto:q.shu@iaea.org).

#### 5. Contributed Papers and Posters

Concise papers on issues falling within the topics outlined in Section 2 above may be submitted as contributions to the symposium.

##### (a) Submission of synopses

Persons who wish to present a paper or poster at the symposium must submit an extended synopsis (in English) of 800 words maximum (i.e. two A4 format pages of single spaced typing or the equivalent, including any tables or diagrams and a few pertinent references) on one of the topics listed under Section 2. The extended synopsis should be submitted together with the completed Form for Submission of a Paper/Poster (Form B), and the Participation Form (Form A) to the competent national authority for official transmission to the IAEA in time for them to be received by the IAEA by **17 December 2007**. In addition, the synopsis must be sent electronically to the IAEA scientific secretariat, e-mail: [plant.mutation@iaea.org](mailto:plant.mutation@iaea.org).

Authors are urged to make use of the Synopsis Template in Word on the symposium web page (see Section 15).

The specifications and instructions for preparing the synopsis and how to use the synopsis template are given in the attached instructions. Also attached is a sample extended synopsis.

The synopsis should give enough information on the contents of the proposed paper to enable the selection committee to evaluate it. Introductory and general matters should not be included. The synopsis - if accepted - will be reproduced in unedited form in the Book of Extended Synopses; the original must therefore be submitted as a camera-ready copy in a form in which the author will wish to have the work presented. The general style and presentation should be as in the attached sample.

#### ***(b) Acceptance of Papers for Oral Presentation and Poster Presentation***

Given the number of papers anticipated and the need to provide ample time for discussion, the number of papers that can be accepted for oral presentation is limited. Authors who would prefer to present their papers in a poster session are requested to indicate this preference on Form A with which they send the extended synopses.

Authors will be informed whether their papers/posters have been accepted for presentation on the basis of the extended synopsis. Guidelines for the preparation of the papers and the deadlines for their submission will be provided at that time.

The IAEA reserves the right to decline to present or publish any paper that does not meet expectations based on the information in the extended synopsis.

**Further details about the preparation of papers and oral presentation at the symposium will be sent to the authors of the papers accepted together with notification of acceptance.**

#### **6. Expenditures**

No registration fee is charged to participants.

As a general rule, the IAEA does not pay the cost of attendance, i.e. travel and living expenses, of participants. However, limited funds are available to help meet the cost of attendance of selected specialists mainly from **developing countries with low economic resources**. The grants awarded will be in the form of lump sums usually covering only part of the cost of attendance. Generally, not more than one grant will be awarded to any one country.

If governments wish to apply for a grant on behalf of one of their specialists, they should address specific requests to the IAEA to this effect. Governments should ensure that applications for grants are submitted by **17 December 2007** and are accompanied by a duly completed and signed Grant Application Form (as attached). Applications that do not comply with these conditions cannot be considered.

#### **7. Symposium Proceedings**

The proceedings of the meeting will be published by the IAEA as soon as possible after the symposium.

#### **8. Distribution of Documents**

A preliminary programme of the symposium will be sent to participants in advance. The final programme and the book of extended synopses will be distributed at registration.

#### **9. Working Language**

The working language of the symposium will be English.

#### **10. Participation**

All persons wishing to participate in the symposium are requested to **register in advance online**. In addition they must send a completed Participation Form (Form A) and if relevant, the Form for the Submission of a Paper (Form B) and the Grant Application Form (Form C) through the competent official authority (Ministry of Foreign Affairs, Ministry of Agriculture, national FAO committee, or national atomic energy authority) to the IAEA. A participant will be accepted only if the Participation Form is transmitted through the government of a Member State of the Sponsoring Organizations or by an organization invited to participate.

- Participants whose official submissions have been received by the IAEA will receive further information on the symposium approximately three months before the meeting. This information will also be posted on the symposium web page.

#### **11. Accommodation**

Detailed information on accommodation and other symposium related information will be sent to all designated participants well in advance of the symposium. This information will also be available on the symposium website.

#### **12. Visa**

Designated participants who require a visa to enter Austria (Schengen State) should submit the necessary applications to the nearest diplomatic or consular representative of Austria or any other consular authority of a Schengen partner State representing Austria as early as possible (please note that it could take up to three weeks to obtain a visa).

#### **13. Channels of Communication**

The Participation Form and as applicable, the Form for Submission of a Paper/Poster, and the Grant Application Form, should be sent to the competent national authority (Ministry of Foreign Affairs, Ministry of Agriculture, national FAO committee, or national atomic energy authority) for official transmission to the IAEA.

Subsequent correspondence on scientific matters should be sent to the Scientific Secretary and correspondence on administrative matters to the IAEA Conference Services Section.

#### **14. Symposium Secretariat**

##### **The Address of the Secretariat:**

International Atomic Energy Agency  
IAEA-CN-167  
Vienna International Centre  
P.O. Box 100  
Wagramer Strasse 5  
1400 Vienna, Austria  
Tel.No.: +43 1 2600 (0) plus extension  
Fax No.: +43 1 26007  
E-mail: [official.mail@iaea.org](mailto:official.mail@iaea.org)  
E-mail for paper submissions: [plant.mutation@iaea.org](mailto:plant.mutation@iaea.org)

##### **The Scientific Secretary of the Symposium:**

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##### **Symposium Organizer:**

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Tel.No.: +43-1-2600 ext. 21317  
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#### **15. Symposium Web Page**

Please visit the IAEA symposium web page regularly for new information regarding this symposium: <http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=167>

# Publications

## Recent Staff Articles Published in Scientific Journals

### Characterization on an 18,166 EST dataset for cassava (*Manihot esculenta* Crantz) enriched for drought-responsive genes

Lokko, Y., Anderson, J.V., Rudd, S., Raji, A., Horvath, D., Mikel, M.A., Kim, R., Liu, L., Hernandez, A., Dixon A.G.O. and Ingelbrecht, I.L.

Plant Cell Report 26:1605-1618 (online as of 31 May 2007, DOI 10.007/s00299-007-0378-8)

#### Abstract

Cassava (*Manihot esculenta* Crantz) is a staple food for over 600 million people in the tropics and subtropics and is increasingly used as an industrial crop for starch production. Cassava has a high growth rate under optimal conditions but also performs well in drought-prone areas and on marginal soils. To increase the tools for understanding and manipulating drought tolerance in cassava, we generated expressed sequence tags (ESTs) from normalized cDNA libraries prepared from dehydration-stressed and control well-watered tissues. Analysis of a total of 18,166 ESTs resulted in the identification of 8,577 unique gene clusters (5,383 singletons and 3,194 clusters). Functional categories could be assigned to 63% of the unigenes, while another ~11% was homologous to hypothetical genes with unclear functions. The remaining ~26% was not significantly homologous to sequences in public databases suggesting that some may be novel and putatively specific to cassava. The dehydration-stressed library uncovered numerous ESTs with recognized roles in drought-responses, including those that encode late-embryogenesis-abundant proteins thought to confer osmoprotective functions during water stress, transcription factors, heat-shock proteins as well as proteins involved in signal transduction and oxidative stress. The unigene clusters were screened for short tandem repeats for further development as microsatellite markers. A total of 592 clusters contained 646 repeats, representing 3.3% of the ESTs queried. The ESTs presented here are the first dehydration stress transcriptome of cassava and can be utilized for the development of microarrays and gene-derived molecular markers to further dissect the molecular basis of drought tolerance in cassava.

(2007)

## Recent Staff Articles Presented at a Meeting

### Nuclear Techniques in Breeding and Genetics of Root and Tuber Crops

Presented by Y. Lokko, at the 10<sup>th</sup> Triennial Symposium International Society for Tropical Root Crops – Africa Branch (8-12 October 2007), Maputo, Mozambique

#### Abstract

Many staple crops - including root and tubers - do not provide the adequate levels of essential amino acids and micronutrients. Undesirable levels of antinutrient secondary metabolites are also a concern as mitigation requires efficient and sustainable interventions such as plant breeding. Inherent problems hindering genetic improvement in most root and tuber crops through conventional breeding include erratic/shy flowering, tuber dormancy, long growing seasons and complex genetic structure. A highly efficient means to alter the genetic constitution of a crop, in order to generate desirable genetic variability, is to employ induced mutations. The technology also has the advantage of improving existing elite varieties and is not only economically viable but also environmentally and socially sustainable. Recently induced mutations are also playing a significant role in plant genomics research, with techniques such as radiation mapping, reverse genetic strategy and Targeting Induced Local Lesions IN Genomes (TILLING) contributing to gene discovery and the elucidation of functions. The Plant Breeding activities of the Sustainable Intensification of Crop Production Systems of Nuclear Techniques in Agriculture aim at assisting national plant breeding programmes in the use of mutation techniques, coupled with biotechnological tools, and in developing improved varieties of major and under-exploited food and industrial crops. This paper reviews the use of nuclear techniques - including induced mutations in root and tuber crop improvement - and highlights the interventions of the IAEA through its Joint Programme with the Food and Agriculture Organization of the United Nations in the use of induced mutagenesis to facilitate genetic improvement and gene discovery in root and tuber crops.

(2007)

# Publications within Coordinated Research Projects (CRPs) as of 2004

## Effects of Mutagenic Agents on the DNA Sequence in Plants

Martin N., Ruedi E.A., LeDuc R., Sun F.-J. and Caetano-Anollés G. (2007). Gene-interleaving patterns of synteny in the *Saccharomyces cerevisiae* genome: are they proof of an ancient genome duplication event? *Biology Direct* 2: 23.

Sun F.-J., Fleurdepine S., Bousquet-Antonelli C., Caetano-Anollés G. and Deragon J.-M. (2007). Common evolutionary trends for tRNA-derived SINE RNA structures. *Trends in Genetics* 23: 26-33.

Ceballos H., Sánchez T., Morante N., Fregene M., Dufour D., Smith A.M., Denyer K., Pérez J.C., Calle F. and Mestres C. (2007). Discovery of an Amylose-free Starch mutant in cassava (*Manihot esculenta* Crantz). *Journal of Agricultural and Food Chemistry* 55(18): 7469-7476.

Shu X.L., Jia L.M., Gao J.K., Zhao H.J., Wu D.X. (2007). Metabolite profiling of rice high in resistant starch. *Journal of Agricultural and Food Chemistry*, Accepted.

Shu X.L., Gao J.K., Jia L.M., Song Y.L., Wu D.X. (2007). The influence of chain length of amylopectin on resistant starch in rice (*Oryza sativa* L.). *Starch*, Accepted.

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### **Mutational analysis of root characters in annual food plants related to plant performance**

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# List of Plant Breeding and Genetics Section's Publications

## Plant Mutation Reports

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
2007	Vol. 1, No. 3	<ul style="list-style-type: none"> <li>• Mutation breeding and genetics in Korea</li> <li>• Genetic enhancement of groundnut</li> <li>• Virus resistant banana</li> <li>• Ion beams implantation on wheat</li> <li>• Trombay mutant groundnut varieties</li> <li>• Lodging tolerant rice variety</li> </ul>	ISSN 1011-260X
2006	Vol. 1, No. 2	<ul style="list-style-type: none"> <li>• 30 years rice mutation breeding and genetics</li> <li>• Mutant groundnut varieties in Bangladesh</li> <li>• Shortening durum wheat plants</li> <li>• Seedless mutant sweet orange</li> <li>• Colorful chrysanthemum mutations</li> <li>• Radiosensitivity of cassava <i>in vitro</i> culture</li> </ul>	ISSN 1011-4289
2006	Vol. 1, No. 1	<ul style="list-style-type: none"> <li>• Rice mutation breeding in China</li> <li>• Long grain aromatic rices and induced mutations</li> <li>• Significant contribution of mutation techniques to rice breeding in Indonesia</li> <li>• Use of induced mutants in rice breeding in Japan</li> <li>• Katy deletion mutant populations</li> <li>• Rice mutation breeding in Viet Nam</li> </ul>	ISSN 1011-260X

## Mutation Breeding Newsletter and Reviews

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
2005	No. 1	<ul style="list-style-type: none"> <li>• High yielding mutants in cotton</li> <li>• Drought resistant tomato</li> <li>• Groundnut resistant to foliar diseases</li> <li>• Lodging resistant glutinous rice</li> <li>• First ever oilseed mustard mutant</li> </ul>	ISSN 1011-260X

## Mutation Breeding Review (published until 2004)

Year	Edition	Title	Reference No.
2004	No. 14	Officially released mutant varieties in China	ISSN 1011-2618
2001	No. 13	Grain legume cultivars derived from induced mutations, and mutations altering fatty acid composition	ISSN 1011-2618
2000	No. 12	Officially released mutant varieties – The FAO/IAEA database	ISSN 1011-2618

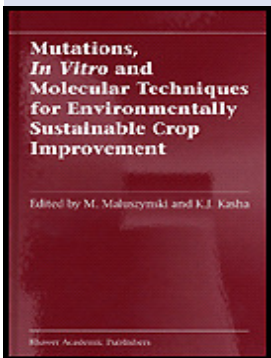
Year	Edition	Title	Reference No.
1999	No. 11	Oilseed cultivars developed from induced mutations and mutations altering fatty acid composition	ISSN 1011-2618

### Mutation Breeding Newsletter (published until 2003)

Year	Edition	Title	Reference No.
2003	No. 46	Index Issue No. 21-44	ISSN 1011-260X
2001	No. 45	Issue No. 45	ISSN 1011-260X
1999	No. 44	Issue No. 44	ISSN 1011-260X

### Books

Year	Edition	Title	Book Cover	Reference No.
2004		Banana Improvement: Cellular, Molecular Biology, and Induced Mutations		ISBN 1-57808-340-0
2003		Doubled Haploid Production in Crop Plants – A Manual		ISBN 1-4020-1544-5
2002	Training Course Series No. 19	Mutant Germplasm Characterization using Molecular Markers – A Manual		ISSN 1018-5518

Year	Edition	Title	Book Cover	Reference No.
2002		Mutations, <i>In Vitro</i> and Molecular Techniques for Environmentally Sustainable Crop Improvement		ISBN 1-4020-0602-0

## Technical Documents

Year	Type of Publication	Title	Reference No.
2006	IAEA-TECDOC-1493	Mutational analysis of root characters in food plants	ISBN 92-0-103106-8 ISSN 1011-4289
2004	IAEA-TECDOC-1384	Low cost options for tissue culture technology in developing countries	ISBN 92-0-115903-X ISSN 1011-4289
2004	IAEA-TECDOC-1426	Genetic improvement of under-utilized and neglected crops in low income food deficit countries through irradiation and related techniques	ISBN 92-0-113604-8 ISSN 1011-4289
2003	IAEA-TECDOC-1369	Improvement of new and traditional industrial crops by induced mutations and related biotechnology	ISBN 92-0-101603-4 ISSN 1011-4289
2001	IAEA-TECDOC-1195	Sesame improvement by induced mutations	ISSN 1011-4289
2001	IAEA-TECDOC-1216	Induced mutations in connection with biotechnology for crop improvement in Latin America	ISSN 1011-4289
2001	IAEA-TECDOC-1227	<i>In vitro</i> techniques for selection of radiation induced mutations adapted to adverse environmental conditions	ISSN 1011-4289
2001	IAEA-TECDOC-1253	Radioactively labeled DNA probes for crop improvement	ISSN 1011-4289
1998	IAEA-TECDOC-1010	Application of DNA based marker mutations for improvement of cereals and other sexually reproduced crop plants	ISSN 1011-4289
1998	IAEA-TECDOC-1047	Use of novel DNA fingerprinting techniques for the detection and characterization of genetic variation in vegetatively propagated crops	ISSN 1011-4289
1997	IAEA-TECDOC-951	Improvement of basic food crops in Africa through plant breeding, including the use of induced mutations	ISSN 1011-4289
1996	IAEA-TECDOC-859	Use of mutation techniques for improvement of cereals in Latin America	ISSN 1011-4289
1995	IAEA-TECDOC-800	<i>In vitro</i> mutation breeding of banana and plantains	ISSN 1011-4289
1995	IAEA-TECDOC-809	Improvement of root and tuber crops in tropical countries of Asia by induced mutations	ISSN 1011-4289
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**Acknowledgements**

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- Books (identical author and editor) van Harten A.M. (1998) *Mutation Breeding, Theory and Practice*. Cambridge University Press, Cambridge, U.K. pp. 237-240.

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