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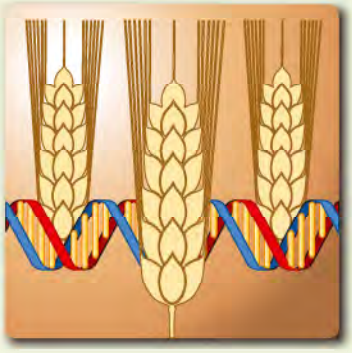
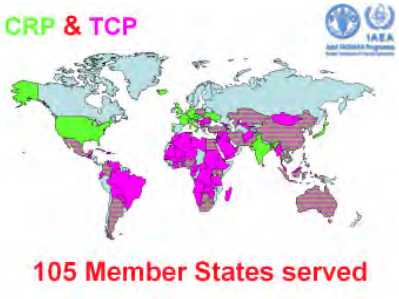


Contents

In September 2009 Dr. J. Neil Rutger was inducted into ARS Science Hall of Fame.
Left: *Dr. J. Neil Rutger compares golden-hulled low-phytate rice (left) with rice that lacks the color-coding gene.* ***Right:*** *In 1976, Dr. J. Neil Rutger released the first semidwarf rice cultivar in the United States, Calrose 76, which had a 15% yield advantage over tall cultivars. By some estimates, Calrose 76 and successors developed in California added an estimated $1 billion to California's economy.*

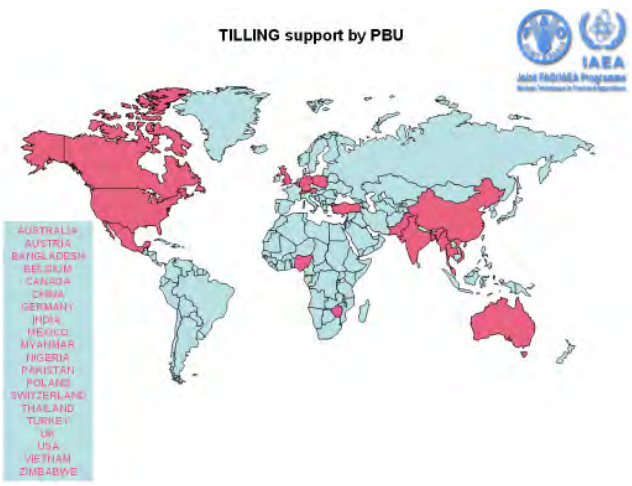
To Our Readers



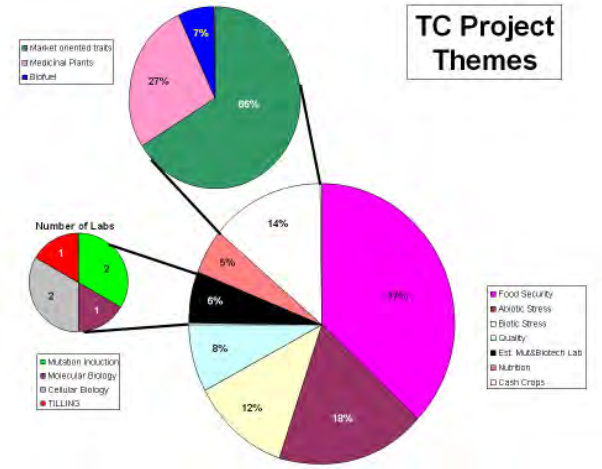
In the past biennium Plant Breeding and Genetics (PBG) subprogramme served 105 Member States through sixty-four national (30 Africa, 24 Asia and the Pacific, seven Latin America and the Caribbean, three Europe), seven regional (one Africa, four Asia and the Pacific, one Latin America and the Caribbean, one Europe) and one interregional Technical Cooperation Projects (TCPs), and six Coordinated Research Projects (CRPs). Chosen highlights of these activities, you will find inside this issue. The Plant Breeding Unit (PBU) in Seibersdorf supported capacity building in Member States for mutation induction in crop breeding through the provision of services at the request of 26 Member States: mutations were induced in 19 food crops, six ornamental plants, five oil crops and one industrial crop. Thirty scientists from developing countries, working on their own crops

IAEA
International Atomic Energy Agency

and production constraints, received individual training in induced crop mutations facilitated by biotechnologies for periods ranging from three to six months.



A control kit for proof of concept for TILLING (Targeting Induced Local Lesions In Genomes), a reverse genetics assay for the molecular detection of mutation events, was developed and on request, already distributed to five Member States – China, Poland, Myanmar, Germany and the United States of America (USA). Twenty Member States were supported through expert missions by PBU staff, including invited lectures on TILLING, protocol optimization and technical trouble shooting. Staff of the Unit published seven peer reviewed articles in scientific journals and as book chapters dealing with methodologies for enhancing efficiency in mutation induction for crop breeding and made presentations at three scientific meetings. The Mutant Variety and Genetic Stock database was updated and upgraded and is now more user-friendly. It currently contains 3088 officially released mutant varieties from 170 different crop species.



What will the future bring? The major concern is food insecurity, more than one billion people going hungry or suffering from malnutrition. The commodity chains are under duress by transboundary threats: climate variability and change as well as spreading diseases and pests such as wheat black stem rust, banana black Sigatoka, rice brown grasshopper, cause concern, superimposing on the competition for water, soil, human and financial resources. Small-scale farmer, particularly in developing countries, does not have the means to efficiently fight these threats with the resources available locally. There is a need, more urgent than ever to support his toils and to make his efforts more productive and rewarding. Thus, it comes as no surprise that the largest group of TC projects for the next biennium are focused on food security (37%) followed by stress (abiotic 18%, biotic 12%), cash crops (14%) and quality (8%). Biofuel is also a thematic area that is in rising (7% of cash crops). Cereals and pseudo-cereals (48%), beans/peas/lentils (14%), root and tuber crops (12%), banana and plantain (5%) and groundnuts (3%) are the major crops we will work on in the next biennium. The remaining groups comprise cash crops (including for biofuel), medicinal plants and orphan crops.

It is my great pleasure to spread the news that an outstanding mutation breeder, Dr. J. Neil Rutger, a US Agricultural Research Service (ARS) scientist, has been inducted into the US Department of Agriculture's Science Hall of Fame for research accomplishments. His outstanding career-long achievements in agricultural science and technology include improving rice varieties, increasing crop productivity in arid climates, and enhancing human health. Neil is also a friend and supporter of PBG and its subprogramme, and the benefits we are enjoying through his input is invaluable. In the *laudatio* to the induction of Dr. Rutger, ARS Administrator Edward B. Knipling states that Neil's "results have had long-term, lasting value to science and society, and contribute important national priorities of responding to climate change, food safety and health, and global food security". He serves "as exemplar of excellence in scientific research because of his creativity and dedication, the range of his scientific contributions and his service to both the agricultural community and the public". Neil was an ARS researcher for 18 years in California before he became director of the Dale Bumpers National Rice Research Center in Stuttgart, Arkansas, in 1993. Over the years, he developed semi-dwarf varieties of rice that increased crop yields by up to 20 percent. His first semi-dwarf rice cultivar, mutant Calrose 76, was integral to the development of dozens of dwarf varieties now used to breed rice around the world. By some estimates, Calrose 76 and successors developed in California added an estimated US$1 billion to California's economy. Neil also was instrumental in developing jasmine rice cultivars for United States growers, and his search for genes among rice's weedy relatives, that resist stem rot disease, was the first such attempt in the United States. Subsequent research has identified several genes among weedy relatives that resist other rice diseases.

PBG is blessed, indeed, to be supported by great men and women around the world. Without these resources in knowledge and knowhow, without their gracious as-

sistance and enlightening example, we could not succeed in our mandate.

Dr. Rownak Afza retired this year from her duties with the PBU. Rownak is a superb scientist and an empathic teacher, besides being a loving, dedicated and supportive wife, mother and grandmother. After joining the Plant Breeding Unit a quarter of a century ago, together with the late Unit Head Dr. František J. Novak, she established the tissue culture laboratory, which became renowned and recognized world wide for its work on *Musa* spp (banana). Her entire career has been dedicated to the development of superior crop varieties for food security, abiotic/biotic stress tolerance/resistance, through mutation induction and efficiency enhancing molecular and biotechnologies. Rownak established *in vitro* techniques (including shoot tip culture, somatic embryogenesis, and adventitious bud culture) in combination with mutation induction and mutant molecular fingerprinting characterization for improvement of *Musa* spp, rice, cassava, yam, sugarcane, ensete. Her latest achievement is the development of four salt resistant mutant rice lines. These mutants have been adopted by IRRI (Philippines) and used in at least nine breeding lines that are now spreading the beneficial alleles through West-Africa. Rownak developed assaying techniques for large-scale phenotypic screens for stress tolerance in mutants of rice. Her development of banana genetic transformation and regeneration protocols (using *Agrobacterium tumefaciens*) lead to patents in the USA. Finally, her work as a teacher, trainer and coach produced a multitude of superb scientists, from which an impressive number moved up to become directors or even ministers. Thus it comes as no surprise, that she received the Distinguished Service Award by the IAEA Director General, the Merit Award for Outstanding Performance by the IAEA Deputy Director General (Nuclear Science and Applications), and the IAEA Long Term Merit Award for 25 Years of Outstanding Service. Rownak was a Norwegian Nobel Committee Invited Attendee to the awarding ceremony of the Nobel Peace Prize for the 2005 to the IAEA and Dr. Mohamed El-Baradei, as a representative of the Department of Nuclear Sciences.

In some civilizations, a mother is valued ten times more than a father. In other cultures, a teacher is even valued ten times more than a mother. We, who had the privilege to work at her side, feel that Rownak is both to us. Rownak is the soul, the heart and the spirit of the Plant Breeding Unit, as well as its memory. So if you visit us, although she will not be in her office anymore, you will sense her presence. A sparkle in our eyes, an attitude, a way of doing bench work, will remind you of her imprint. And, if you are extremely lucky, she might just walk around the corner and smile at you, because we still need her advice, expertise and knowhow from time to time. Weaning is a long process, indeed…

But 2009 was also a sad year for plant science: two outstanding scientists, Prof. Mike Gale and Dr. Norman Borlaug, relocated to celestial fields, leaving us with their memories and life achievements as an example to formulate our own goals on these, our terrestrial grounds (see 'In Memoriam'). Thriving to match the service to Humanity both of these outstanding great men have accomplished, we stand in awe.

Pierre J.L. Lagoda
Head,
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Forthcoming Events

Regional Training Course on the Establishment of Standard Screening Protocols for *In Vitro* and *In Vivo* Selection of Crop Mutant Lines Tolerant to Drought, RLA/5/056, Cali, Colombia, 1–5 February 2010

Technical Officer: M. Spencer

The course is open to participants (breeders and crop scientists) of the regional technical cooperation (TC) projects, who are working on mutation breeding of some valuable crops in their countries. The programme will include establishment of proper parameters for identifying tolerance to drought, identification and characterization of mutants tolerant to drought and design of protocols for such screening for cereals and/or legumes included in the list of crops established during the first coordination meeting. There will be theoretical lectures but also hands-on experiments on the improvement of crop tolerance to drought. The training course will be supervised by well-known scientists of CIAT, Colombia, whose work on these topics is quite outstanding and is the most valuable source of information on tropical and sub-tropical crop improvement systems.

Regional Training Course on Wheat and Barley Plant Breeding - Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA), RAS/5/048, ACSAD, Damascus, Syrian Arab Republic, tentatively planned for April 2010

Technical Officer: P.J.L. Lagoda

This training course is open to junior scientists and technicians of the participating counterparts' project implementation teams. It will provide basic training in wheat and barley mutation breeding. Training material will become available publicly through our webpage at http://mvgs.iaea.org/MRPTableOfContents.aspx?ID=4

Regional (AFRA) Training Course on the Establishment of Guidelines on Socio-Economic Assessment Study on Newly Developed Mutant Lines Market Value and Impact in Populations' Livelihood, RAF/5/056, Pretoria, South Africa, tentatively planned for 3–7 May 2010

Technical Officer: M. Spencer

The purpose of the training course is to provide theoretical and practical skills to staff members working with the breeders and/or the scientists involved in the development of new and improved crop varieties using mutation induction to assess the commercial value and the impact of these lines in the socio-economic situation in the Member States based on valid national data. The course is meant for scientists and breeders, involved in the planning and evaluation of crop mutation induction programmes and is designed to establish standard methods for evaluating the distribution and the market value of these new lines. This course is open to participants with an academic background equivalent to a Bachelor's degree in plant science or related topics. Participants must be actively involved in crop breeding using mutation induction. Participating countries are encouraged to submit more than one application to provide wider scope for IAEA's final selection. The training course will be conducted in English; participants should be capable of freely expressing themselves and following lectures. The one-week training course consists of lectures in the form of technical presentations by the experts followed by discussion periods to allow an exchange of information. The establishment of a baseline of data, proper design of questionnaire for survey of the impact of new varieties, cost-benefit analysis, and specific extension promotion techniques for mutant derived lines will be presented among other topics.

Third Coordination Meeting on Responding to the Transboundary Threat to Wheat Black Stem Rust (Ug99), INT/5/150, St. Petersburg, Russian Federation, tentatively planned for 28–29 May 2010

Technical Officer: P.J.L. Lagoda

In conjunction with the BGRI Technical Workshop (30-31 May 2010) and the International Wheat Conference (1-4 June 2010), this meeting will be open to the designated counterparts of all IAEA Member States (where wheat is an important crop and which are facing the threat of the Wheat Black Stem Rust). In addition to the 25 INT/5/150 participants and partners (Algeria, China, Egypt, India, Islamic Republic of Iran, Iraq, Jordan, Kenya, Lebanon, Pakistan, South Africa, Sudan, Syrian Arab Republic, Tunisia, Turkey, Uganda, BARC, BGRI, CAAS, CIMMYT, DAFWA, FAO, ICARDA, IT-PGRFA, USDA-ARS), national specialists in plant breeding, genetics, phytopathology and/or biotechnology, working on wheat breeding and/or plant protection in their own countries, and stakeholders (public, private) with a vested interest on Ug99 are invited to contact the technical officer (TO) for further detailed information and declaration of interest to participate (mailto: p.lagoda@iaea.org).

Regional Workshop on Farmer Participation and Seed Multiplication - Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA), RAS/5/048, ICARDA, Aleppo, Syrian Arab Republic, tentatively planned for early May 2010

Technical Officer: P.J.L. Lagoda

This workshop is open to the counterparts, relevant farmers and decision makers of RAS/5/048. It will be held in Arabic and will serve as a regional platform to compare notes on on-going national farmer's participation paradigms. The expected outcome is a raise in awareness of the benefits of farmer's participation approaches in mutation breeding, and triggering of knowledge and knowhow exchange and transfer of mutant germplasm participatory breeding.

International Training Course on Producing Wheat and Barley Double Haploid Lines - Responding to the Transboundary Threat to Wheat Black Stem Rust (Ug99) & Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA), INT/5/150 & RAS/5/048, Seibersdorf, Austria/Katowice, Poland, tentatively planned for second quarter of 2010

Technical Officer: P.J.L. Lagoda

This training course is planned for the first half of 2010. It will be open to the participants of both regional and interregional TCPs. Training material will become available publicly through our webpage at http://mvgs.iaea.org/MRPTableOfContents.aspx?ID=4

Past Events

Second Coordination Meeting on Increasing Production of Nutritious Food through Mutation Breeding and Biotechnology, AFRA Project, RAF/5/056, Douala, Cameroon, 27–31 July 2009

Technical Officer: M. Spencer

The main objectives of this meeting were: 1) To review the activities and the national achievements under the project RAF/5/056 since 2007 and 2) To assess and readjust, where necessary, the regional project activities in the project document for 2007-2011.

The meeting was organized by Mr. Xavier Ndzana, Project Coordinator of RAF/5/056 in Cameroon. The countries represented at the meeting were: Algeria, Cameroon (Host Country), Central African Republic, Democratic Republic of the Congo, Egypt, Ghana, Kenya, Madagascar, Mauritius, Senegal, South Africa, United Republic of Tanzania, Zambia and Zimbabwe.

The country presentations, performed by the participating Project Coordinators (PCs), described the progress and results obtained since the last coordination meeting held in Mauritius in 2007. The presentations included: 1) Country work plans and arrangements for the future project activities 2) Strength, Weakness, Opportunity, and Threat (SWOT) analysis, and 3) Finalisation on future work plans and prioritization of the regional needs for 2009-2011 regional programmes.

The presentations, made by participants, were very positive, indicated progress achieved and described ongoing activities under the regional TC project RAF/5/056 since 2007. New crops and new methodologies were reported. Discussions made after each presentation were very useful and areas for improvement were suggested to enhance and speed up the acquisition and results in mutation induction. The meeting endorsed the possibility of sending new concept notes by the end of 2010 on regional breeding concerns in crops such as cassava for ACMV and drought tolerance, pearl millet for yield increase, rice for drought and disease and Striga resistance using mutation induction. Concern was expressed about the low rate of mutant varieties released in Africa and participants were urged to improve it. Since 2007 more progress was recorded on plant tissue culture infrastructures, however, some efforts on the molecular biology aspects are still needed. Participants were of the opinion that they should improve the sharing of protocols and other mutation related information through networking. Participants from the following countries were absent from this meeting: Benin, Burkina Faso, Ethiopia, Sudan and Tunisia. It was decided that the report of the meeting should be sent to those participants and also that they should be invited to present their progress reports and work plans for 2009-2011 in the same format as suggested in the meeting for inclusion and dissemination to all participants.

Borlaug Global Rust Initiative (BGRI) Coordination Meeting, INT/5/150, Aleppo, Syrian Arab Republic, 1–4 September 2009

Technical Officer: P.J.L. Lagoda

Meeting participants

The Borlaug Global Rust Initiative (BGRI) is warning that rapidly-moving, wind-borne transboundary diseases continue to threaten food security and wheat genetic diversity worldwide and has vowed new action to isolate and interrupt the steady march of wheat rust diseases. Each of the three rusts - black (stem), yellow (stripe), and brown (leaf) - can cause significant losses in production, but Wheat Black Stem Rust (race Ug99) is of global dimensions. Thus, the BGRI has taken a leading role in alerting the world to the dangers of stem rust Ug99, and in mobilizing the research community to take preventative measures. Thus, 104 Wheat experts from 30 countries and international organizations met in ICARDA, Aleppo, Syrian Arab Republic on 1–4 September 2009 for a BGRI Coordination and Wheat Rust Network Meeting.

The objective of the meetings was to coordinate activities aimed at reducing the world's vulnerability to stem, yellow and leaf rusts. Specifically, national activities and projects were reviewed by specific themes. Under each thematic heading, - (i) Pathogen tracking, (ii) Surveillance and Epidemiology, (iii) Pre-breeding and Use of Novel Genetic Resources, (iv) Breeding, (v) Seed Systems, (vi) Socio-economics and Advocacy, (vi) Capacity Building - short contributions had been invited. The aim was to inform the group on activities and collaborations under BGRI, without being too technical. Further, following the review of project and national activities, in order to perform gap analyses, the meeting split into four working groups for Pathology and Surveillance, Breeding, Seed Systems and Socio-economics, Advocacy and Capacity Building. Complementarities were assessed, gaps in research and capacity development identified and a tentative coordinated work plan for mobilization of resources developed.

The TO reported on the IAEA's TC project INT/5/150 at the session on Pre-breeding and Use of Novel Genetic Resources through a presentation entitled 'INT/5/150: Responding to the transboundary threat of wheat stem rust (race Ug99)'. Further, the TO participated in the Breeding Gap Analysis Session.

The mutants produced by INT/5/150 are interesting resources for the community of scientists: the TO was approached by interested meeting participants who want to screen the INT/5/150 mutant collection for minor resistance genes, yellow rust resistance and resistance to septoriosis.

Discussions at the conference identified key gaps in capacity building, the current knowledge of rust diseases, and opportunities to use biotechnology, including mutation induction, and modern communications capabilities to track and combat rust diseases faster and more efficiently.

A global rust reference laboratory was proposed, which would house a unique collection of all the world's known races of stem (black) rust, yellow (stripe) rust, and brown (leaf) rust in a secure containment facility.

A declaration, the Aleppo Declaration, issued at the end of the Aleppo meeting referred to the increasing danger of stem rust to wheat production and diversity, especially as the mapped trajectory of the destructive and virulent strain of black stem rust Ug99 shows it moving into the highly productive wheat belt that stretches from the Middle East to India. Wheat strike (yellow) rust epidemics have gained new momentum in the same areas, including the land where wheat first emerged as a domesticated crop. "The Middle East is the cradle of agriculture – where wheat cultivation began," the Declaration states. "This area is a great reservoir of breeding material and wild relatives of wheat that are vital for developing wheat varieties to combat many threats including drought (and) climate change…". The Declaration also cites the need to "develop early warning, seed production and delivery systems, and collaboration to allow us to anticipate wheat rust threats in the future as well as manage existing threats such as Ug99."

Dr. Amor Yahyaoui (Coordinator, ICARDA-CIMMYT Wheat Improvement Program, ICARDA) stated that "[…] based on the outcome of the meeting, I believe IAEA will have a great role to play […]". In this context, the Agency was encouraged to add a new tool to the toolbox of the wheat breeders: mutation induction and the additional resources of mutant genetic stock, human capacity and wheat mutation assisted breeding programmes.

Group Fellowship and Training Course on Inducción de Mutaciones en Cultivos de Importancia Económica, RLA/5/056, Lima, Peru, 23 September–6 November 2009

Technical Officer: M. Spencer

The training course was attended by 20 participants from Argentina, Bolivia, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Mexico, Paraguay and Peru. The lecturers were from Cuba, Brazil and Peru. The aim of the course was to enhance the scientific knowledge and practical skills of the RLA/5/056 participants in the field of crop breeding with specific emphasis on mutation induction for crop improvement. The participants were given lectures and practical exercises in the green house as well as in the fields on genetic variability, sources of variability including mutation induction, application of modern biotechnologies to crop improvement, and establishment of screening protocols adapted to the traits to be selected for. The practical examples were based on the crops for which the University of La Molina has already released the most prominent mutant varieties: barley, amaranthus, wheat and some other minor crops.

The feedback from the training course upon completion of a five-week group fellowship on mutation induction, establishment of the proper screening protocols, and handling of subsequent mutated populations, was extremely positive. All participants reported on the valuable and precious information gathered during these two events and praised the perfect organization including the quality of the lectures, the adequacy of the practical exercises, and even the living conditions in the vicinity of the location, where the course, offered by CIP, Peru, was conducted.

IAEA/RCA Regional Training Course on Mutation Breeding for Crop Disease Resistance, RAS/5/045, Mumbai, India, 5–9 October 2009

Technical Officer: Q.Y. Shu

The training course was organized by the International Atomic Energy Agency (IAEA) in cooperation with the Government of India through the Bhabha Atomic Research Centre, Mumbai, India. Fourteen participants from nine countries (Bangladesh, India, Indonesia, Republic of Korea, Malaysia, Myanmar, the Philippines, Thailand and Vietnam) participated in the training course. Lectures, case discussions and interactive activities were organized during the course, covering the following topics:

- Molecular basis of disease resistance;
- Genetic approaches to disease resistance improvement, particularly using mutation techniques; and
- Practical protocols and methods for screening disease resistant mutant.

The diseases addressed include bacterial leaf blight, blast and grassy stunt virus in rice; rust disease in wheat, rust and mildew in sorghum, and rust and yellow mosaic virus disease in legumes.

Third International Conference on Integrated Approaches to Improve Crop Production Under Drought Prone Environments (INTERDROUGHT-III), Shanghai, China, 11–16 October 2009

Technical Officer: M. Spencer

Ms. Victoria Sekitoleko, FAO Representative to China, Democratic People's Republic of Korea and Mongolia delivering her speech at the world food day in the Shanghai Ocean University, Shanghai, China, 16 October 2009

This conference was an excellent opportunity to assess the current status of ongoing research in the breeding field, namely agronomy and agricultural practices, as well as the fundamental aspects of plant responses to drought. Several well-known scientists and breeders from all over the world (≈369 attendees) were present. The

presentations were very informative and were followed by in depth discussions on the future of drought tolerance studies in agriculture on the wake of the tremendous climate changes predicted and which have already resulted in a serious increase of identified drought-prone areas in the world.

Several high ranking officials from the Ministry of Agriculture of China and the Shanghai Municipal Government welcomed the participants and expressed their wishes for a successful meeting at the opening ceremony of the conference. The messages from these opening remarks were mostly focused on the fact that drought is and will increasingly be the most challenging question to humankind in the near future. They also insisted on the outmost importance of such meeting of informed and knowledgeable scientists in assisting Governments, mainly those in the developing world in monitoring, preventing and fighting the decline of crop production in the wake of the climate changes.

The Chairperson of the first session Mr. Abraham Blum, Chair of Interdrought-III, opened the meeting and highlighted the positive feed-back from the last INTERDROUGHT conference. He also emphasized the need for more inputs from the scientific community to understanding and managing problems associated with drought occurrence in agriculture. The introductory speech focused on climate change and its likely effect on food production. It is, in fact, important to realize that today's research on drought problems is vital for establishing preventive measures against the future climate change.

The presentations were grouped around two crucial aspects of drought tolerance: breeding crops more tolerant to drought and developing sustainable agricultural practices to better manage drought occurrence in crop production.

The representative of the FAO proposed a comprehensive figure of the actual situation of water availability in the world, which may serve a basis for an integrated approach for water management in the world. After providing some precise definitions of terms like: water supply, water quality, water use efficiency and productivity, the presenter shared with the audience several arguments on the need to revise and better manage the water demand for human, animal, crops and industries. An additional meeting of the INTERDROUGHT group with the FAO representative was held one evening to discuss the possible involvement of INTERDROUGHT scientists or any other international organization to work on an ongoing programme called: the FAO model AquaCrop, which simulates attainable yields of the major herbaceous crops in response to water and may serve as an alert system aimed at applications at the level of extensions services, consulting firms, governmental agencies, NGOs, farmers associations, and farmers (see:www.fao.org/nr/water).

Among the presentations on the improvement of crop productivity in water-limiting environments, the representative from MONSANTO shared some results using transgenic approaches to identify genes that confer drought tolerance in both model plants and crops such as corn and also demonstrated the opportunity that exists for application of genomics to product development.

One may point out that in the light of the debates held during the conference, the approach developed in the Joint FAO/IAEA Division, and more specifically in its Plant Breeding and Genetics Section, which focuses on assisting Member States establish sustainable breeding programmes including mutation induction for traits related to drought tolerance as a whole, might in the near future provide strong outputs in ensuring food security even in harsh environments.

The FAO 'World Food Day' celebration was held on 16 October 2009 in the Shanghai Ocean University and presided by several members of Chinese government, the President of the university together with Ms. Victoria Sekitoleko, FAO Representative to China, Democratic People's Republic of Korea (DPRK) and Mongolia. Even though the celebration was festive for the invited students and pupils, the messages were very powerful in that while recognizing the tremendous results observed in several countries in increasing access to food for a greater number of people around the world, there are still challenging demands, which may even be increasing if the effects of climate change are not addressed timely and properly.

First Research Coordination Meeting on Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants, D2.40.13, St. Louis, USA, 26–31 October 2009

Technical Officer: P.J.L. Lagoda

Eight research contract holders (Argentina, Bulgaria, China, India, Republic of Korea and Poland) and five agreement holders and consultants (Germany, Switzer-

land and USA), participating in this CRP, met for the first RCM in St. Louis, in conjunction with the ninth International Plant Molecular Biology Congress (IPMB). The IPMB (more than 1200 registered participants, over 550 poster presentations) was the ideal platform to showcase the IAEA's work in general and specifically raise interest for this CRP. In addition to the RCM, an IPMB Workshop on Plant Mutagenesis 'From DNA Damage and Repair to Applications in Plant Breeding and Functional Genomics' was organized by the RCM participants, open to all IPMB attendees. Further the technical officer had been invited by the IPMB organizers as a speaker at the IPMB Panel Discussion 'Food for the Future' and delivered a talk on 'Feeding the Planet in the 21st Century under Climate Variability and Change: Commodity Chains, Biodiversity, Sustainability'.

The CRP participants charted the way ahead in the following years for the isolation and characterization of genes involved in the mutagenesis of crop plants. Plant mutagenesis can be artificially induced using nuclear techniques, such as gamma or ion beam irradiations, as well as using chemical mutagens. Understanding the genetic control of plant mutagenesis is vital for the proper application and manipulation for enhancing genetic variation and plant mutation breeding. Thus, this CRP aims to identify and characterize genes involved in mutagenesis in crop plants using recently emerging molecular and genomics tools, to determine their function in mutagenesis caused by different mutagens using genetic variants deficient of these gene, and to find out the spectrum of mutations induced by various mutagens particularly of mutagenic irradiations.

Although mutation induction has been widely used in crop breeding and basic research, the fundamental processes that lead to mutations and the molecular nature of mutations induced by physical mutagens remain largely unknown in plants. The rapid progress in functional genomics has provided unprecedented opportunities to study the mechanisms underpinning the response of plant genomes to physical and chemical mutagens. Recent advances in genomics have created an opportunity to apply our current knowledge of DNA repair and mutagenesis in model systems to crop plants. Furthermore, emerging reverse genetics tools enable direct analysis of consequences of various mutagenic treatments at molecular genetic levels.

Mutations can be obtained using different approaches. The classical approach consists in treating plant tissues with mutagenic agents (chemical or physical). Transposons or T-DNAs have also been widely used to produce mutants. Recently it has been demonstrated that plants defective in genes that control genome integrity display high rates of spontaneous mutation and can be used as mutation sources. Heritable changes can also be caused by altering epigenetic imprints, using chemi-cals or mutants defective in epigenetic maintenance. Therefore, mutants defective in genes involved in plant mutagenesis, induced by physical or chemical mutagens, could be an excellent producer of mutations. While gamma rays are commonly used for mutation induction, new physical mutagens, such as ion beams, are emerging as powerful and unique mutagens for mutation induction.

Significant progress has recently been made in studies on the mechanisms underpinning the response of plant genomes to physical and chemical mutagens in the model plant *Arabidopsis*. Various genes have been identified to be involved in the biological process of response to external and internal DNA damages, although studies on genes responsive to physical mutagens are generally limited. Understanding the biological control of the process of DNA damage, repair, and mutagenesis, is not only scientifically important, but also vital for manipulation of mutation induction using recently emerging molecular tools, and knowledge of molecular genetic features of induced mutation is necessary for the selection of proper mutagens suitable for specific purposes in mutation induction.

The focus of this CRP is on both the enhancement of our understanding of mutagenesis and mutation technologies in plants and on the establishment of a database that will facilitate the transfer of this knowledge from model systems to crop plants. In addition, tools and resources will also be generated for more efficient use of mutant germplasm in breeding programmes.

This kind of research is right in the scope of the IAEA's subprogramme on Sustainable Intensification of Crop Production Systems, since its aim is to sustain and intensify crop production by using genetic variability generated through mutation induction. Obviously, the knowledge gained and tools generated through this CRP will improve the efficiency of mutation induction and selection, and hence improve and enhance the use of nuclear techniques for breeding new varieties that produce more and better foods, which is the main objective of the IAEA's engagement in Food and Agriculture. The IAEA is the main specialized international institution dedicated to foster the research and application of nuclear techniques in plant breeding. The knowledge and findings made available will be published in international journals and through IAEA publications, as well as presented in international conferences; therefore, they will be readily transferred to all Member States of the IAEA.

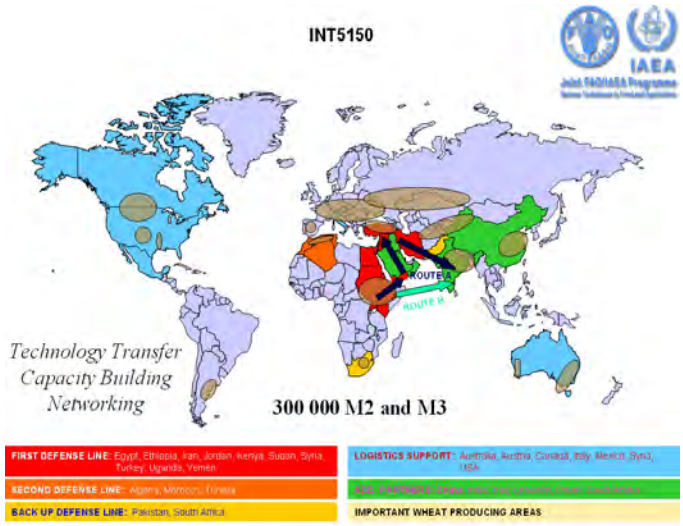
As there are still a couple of contracts open for application, interested researchers should contact the technical officer.

Second Coordination Meeting - Responding to the Transboundary Threat to Wheat Black Stem Rust (Ug99), INT/5/150, Nairobi, Kenya, 2–4 November 2009

Technical Officer: P.J.L. Lagoda

The meeting was open to the designated counterparts of all IAEA Member States, where wheat is an important crop and which are facing the threat of the Wheat Black Stem Rust who participated at the Vienna First Coordination Meeting, and those Member States who showed interest but could not be present at that time. The 25 attendees were national (Algeria, China, Egypt, India, Islamic Republic of Iran, Iraq, Jordan, Kenya, Lebanon, Pakistan, South Africa, Sudan, Syrian Arab Republic, Tunisia, Turkey and Uganda) specialists in plant breeding, genetics, phytopathology and/or biotechnology, working on wheat breeding and/or plant protection in their own countries, and stakeholders with a vested interest on Ug99: FAO, International Center for Agricultural Research in the Dry Areas (ICARDA), the International Maize and Wheat Improvement Center (CIMMYT), the United States Department of Agriculture – Agricultural Research Service (USDA-ARS), BGRI (USA), Chinese Academy of Agricultural Sciences (CAAS), Bhabha Atomic Research Centre (BARC, India) and Western Australian Department of Agriculture and Food of the Government of Western Australia (DAFWA). The private sector was represented by an observer from Kenya.

The pandemic of wheat stem rust spread by Ug99 is considered the most serious threat to wheat and barley in 50 years. The threat has already caused an increase in wheat prices, as all commercial varieties are sensitive to the disease - but it also threatens barley.



The Food and Agricultural Organization's (FAO) is monitoring and charting the spread of the disease in the framework of the Borlaug Global Rust Initiative (BGRI). IAEA

Interregional Project INT/5/150 is designed to complement the ongoing international activities and provide a platform for the coordination of a network of laboratories (based on the previously established laboratory infrastructure through the IAEA's technical cooperation projects) as a defense line against the Wheat Black Stem Rust (race Ug99) disease.

Implementing is being conducted in three phases: (i) Adoption and training in the use of uniform protocols, in order to assure homogeneity of handling (capacity building); (ii) Yearly coordination and steering meetings and workshops; (iii) Multilocation trials of mutant germplasm in endemic hot spots/screen houses. These phases are not necessarily consecutive, but overlapping.

The objectives of the meeting were to critically appraise the test run initiated in the first Coordination Meeting through reviewing the mutants in the field, identify gaps and bottlenecks in the mutant germplasm exchange pipeline and infer communication and feed-back optimizations. This progress evaluation let to chart the way for ward to 2010 activities by adjusting the national yearly work plans accordingly, where appropriate. Regular yearly meetings are essential for harmonizing cooperation between participating Member States, the IAEA, FAO and its partners, CYMMYT (Kenya), ARS, BGRI, CAAS, BARC, ICARDA, DAFWA and the Secretariat of International Treaty on Plant Genetic Resources for Food and Agriculture (FAO, Italy).

Field visit at Moi University, Egerton, Kenya

Unexpectedly, the test run mutant germplasm from three participating Member States already showed promising increased resistance, but these very preliminary observations need to be consolidated.

Scoring the mutant germplasm at the Kenya Agricultural Research Institute (KARI), Njoro. Participants from wheat growing countries protect their clothes by disposable coveralls, because Ug99 spores can be spread airborne, including Jumbo 747…

IAEA/RER Regional Training Course on Cytogenetics and *In Vitro* Techniques in Mutagenesis and Radiation-induced Gene Transfer, RER/5/013, Sofia, Bulgaria, 2–13 November 2009

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

Within the framework of the IAEA European Regional Cooperation Project RER/5/013 'Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques', the International Atomic Energy Agency in cooperation with the Government of Bulgaria through the Bulgarian Academy of Sciences' Institute of Genetics Akad. 'Doncho Kostoff', organized the training course which was facilitated by staff of the Institute Prof. K. Gecheff (course director), Dr. L. Stoilov, Dr. M. Vlahova and Dr. A. Iantcheva as well as by external lecturers Prof. J.S. (Pat) Heslop-Harrison (United Kingdom) and Dr. M. Molnar-Lang (Hungary). The course was attended by 13 participants from Albania, Bulgaria (2) Georgia, the Former Yugoslav Republic of Macedonia (2), Moldova, Poland, Serbia, Turkey, Ukraine and Uzbekistan (2).

The objective of the course was to provide participants with advanced theoretical knowledge and practical skills of various cytogenetic and biotechnological techniques and their application to genetics and breeding of cereals. The welcome address was delivered by the Scientific Secretary of the Bulgarian Academy of Sciences Prof. L. Kazakov. The course covered three major topics:

1) Effects of mutagenic agents on the chromosome structure and genome integrity. It included lectures on: Chromosomal effects of mutagenic agents – general mechanisms, aberration types, methods of scoring; Chromosomal reconstruction – application in cytogenetics and crop improvement; Effects of mutagenic agents on plant chromosome and genome integrity; and Practical exercises on: Cytologic techniques for scoring chromosomal rearrangements: metaphase and anaphase analyses; Cytologic identification of cereal chromosomes: Giemsa-banding techniques; Detection of DNA double-strand breaks in barley genome by the comet assay

2) Molecular cytogenetic approaches in analyses of genome constitution, including lectures on: Plant genome evolution and diversity with emphasis on crop plants; Identification of alien chromosomes in wheat background using fluorescent in situ hybridization; and practical exercises on: Initial steps of the cytomolecular genome analyses of crop plants, and

3) Biotechnologies in mutation breeding, including lectures on: Plant biotechnological approaches in mutation breeding, Retrotransposons as a tool for building insertional mutant collections in model species, and Practical exercises on: *In vitro* selection of plant cells for desirable characteristics and; Transposon display in Medicago truncatula by inverse PCR technique.

In addition to practical exercises on the main topics, participants delivered short presentations on the status of the national activities under the project RER/5/013 and how the knowledge and practical skills obtained during the

course might be utilized in their future work. As it was summarized by the course director Prof. K. Gecheff, the course was directed towards obtaining of advanced skills in the area of cereal molecular cytogenetics and breeding and extended knowledge on the experimental design and utilization of modern biotechnological approaches in genetic improvement of cereals.

Fourth Regional Coordination Meeting on Supporting Strategic Planning to Meet Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA), RAS/5/048, Vienna, Austria, 9–13 November 2009

Technical Officer: P.J.L. Lagoda

The Fourth Coordinators Meeting under RAS/5/048 was held at the IAEA headquarters in Vienna. The meeting was attended by participants from Jordan, Lebanon, Saudi Arabia, Syrian Arab Republic and Yemen. The main purpose of the Fourth Coordination Meeting was to evaluate and steer the participating ARASIA countries' on-going national efforts in this field and to facilitate and promote joint work to the mutual advantage of the collaboration during the period of 2008-2011. Consequently, the national project coordinators were asked to present an updated quantitative report on the activities carried out during the year 2009 and present a national work plan for the year 2010 containing quantifiable milestones. The national project coordinators discussed and formulated, with IAEA staff, a detailed project work plan for 2010 and beyond.

Wheat and barley are the most important food crops contributing to food security and sufficiency in ARASIA States Parties participating in this project. However, despite the advances in increasing their yields, several biotic (disease and pest) and abiotic factors, mainly drought and salinity, continue to limit their productivity. It is now a matter of urgency that new varieties should be bred with higher and more stable yield potentials, better quality, and multiple resistances to disease and insects. The use of mutation induction for creating useful new germplasm and developing new cultivars is a profitable approach to crop improvement. If desired traits are to be enhanced and mutant varieties with high yield, short duration, shatter-resistance, and stress tolerance are to be developed, it is important that various valuable mutant germplasm should be generated, identified, and made best use of. ARASIA State Parties have recognized the prime importance of developing improved varieties of food crops through the application of mutation techniques.

All participated countries have now signed the memorandum of understanding (MoU) on germplasm and phytosanitary measures. Iraq may wish to utilize the existing bilateral agreement between Iraq and ICARDA. Thus, under the umbrella of the multilateral system, it becomes possible to distribute the genetic resources relevant to RAS/5/048 to all participating countries utilizing the Standard Material Transfer Agreement (SMTA), warranting access and benefit sharing.

The national coordinators gave their country presentations regarding the implementation of the SMTA. Due to the previously identified difficulties, problems and bottlenecks, a workshop on the implementation of SMTA had been held previously in Vienna in April 2009 in order to assist the national programmes to make use of the SMTA for germplasm exchanges. It was evident that knowledge gained during this workshop was reflected during the national presentations. All participating countries in this meeting reported that germplasm had been obtained from various sources with no difficulties.

The participants revised the general project work plan. No major changes were needed to be implemented. The major activities are: survey, collection, storage, multiplication, distribution using the SMTA, mutation induction, trials and characterization of the target crops. The actual national work plans for 2010 have been discussed and agreed upon.

The National Coordinators agreed on implementing a regional trial to be executed in the growing season 2010-2011. The participating countries will provide some of the selected material to be tested after multiplication (in Lebanon) in all countries for their performance under dry conditions.

The meeting participants agreed, that given the results achieved and further positive developments foreseen, to have a regional report as one of the outputs of this project. It will include detailed technical information about the activities carried out and results achieved at the national level during the life time of the project. The first draft should be discussed at the next coordination meeting.

Plant breeding is a marathon and needs sustained support as well on the logistics as on the operational level. The process pipeline built by RAS/5/048 demands, in order to progress further towards releasing mutant varieties, sup-

port and dedication. It is good to remind here that from breeding start to release of varieties, eight to 10 years, as an optimistic view, must be considered. Mutation induction and efficiency enhancing molecular and biotechnologies have proven to cut up to two years from these incompressible cross breeding parameters.

In conclusion, the project is on track and progressing as planned. Although the reports are very satisfactory, there is no room for complacency. The successful progress of the project depends on the continuous activities of the national coordinators and other committed and supportive stakeholders, involved parties in the participating countries and the cooperation between the ARASIA State Parties and with the IAEA

Conference on Biotechnologies Applications for the Improving Neglected or Orphans Germplasm Patrimony in the Sahelian and Sudano-Sahelian Regions in Africa, Dakar, Senegal, 10–13 November 2009

Technical Officer: M. Spencer

This conference took place in Dakar, Senegal, and was co-organized by the University CAD, Dakar, Senegal and the Agency for the French speaking Universities (AUF).

Participants from Algeria, Belgium, Benin, Burkina Faso, Cameroon, Canada, Cote d'Ivoire, France, Morocco, Niger, Togo and Senegal (the host country) attended this conference. The presentations were of excellent quality and showed that scientists in Africa are putting much effort in addressing food security in the continent using local resources, i.e. human resources, plant germplasm and live stock together with modern biotechnologies. The presentations were followed by extensive debates resulting in valuable conclusions to be published and used by scientists interested in providing sustainable solutions for agriculture development and food security in Africa.

The reporting officer was most impressed by a presentation on neglected fruits in the targeted regions. This presentation by Dr. Mathieu Guèye from the University CAD, Institute of Fundamental Studies in Africa (IFAN) was thorough and quite out-standing. These fruits currently appreciated, used, and sold in 'pocket' regions are not cultivated and the continuous uncontrolled picking of these fruits is seriously depleting the genetic resources. Some have actually already disappeared and are unknown to the younger generations. Some partial studies on fruit quality (nutrients contents, vitamins and micro-nutrients content) have already been conducted and the results are very promising making the fight against vitamin A, iron and zinc deficiencies achievable through their development as fruit crops. Therefore, there is an urgent need for a more pro-active research on those fruits, on their commercial potential. Some are in fact already being exported including *Balanites aegyptiaca*, *Adansonia digitata*, *Tamarindus indica*, *Cola cordifolia,* in order to bring them to the proper status of fruit crops contributing to food security. They also act as an income generating activity for famers mostly at the end of the dry season as the trees, usually in more humid environments; retain their capacity to produce for a longer time than the usual cultivated cereals and legumes. The discussion introduced by the reporting officer on the need for domestication and the possible benefits of mutation induction were extremely well received and might trigger some new research avenues for junior scientists and breeders.

Neglected fruits in the Sudano-sahelian region in Africa. Photos courtesy of Dr. Mathieu Guèye, Department of Botany (IFAN-UCAD)

Fourth and Final Research Coordination Meeting on Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality, D2.30.25, Plovdiv, Bulgaria, 16–20 November 2009

Technical Officer: Q.Y. Shu

Fourteen scientists from 13 Member States (Australia, Bulgaria, China, France, India, Republic of Korea, the Former Yugoslav Republic of Macedonia, Pakistan, Sierra Leone, Thailand and Vietnam) as well as the technical officer participated in the meeting. Dr. Dimitar Grekov, Rector, Agricultural University Plovdiv, Bulgaria, opened the meeting and delivered welcome remarks as did Dr. Rumyana Georgieva, representative of the Nuclear Regulatory Agency of Bulgaria. The participants presented their research activities and achievements under this CRP. They also visited cotton ginning factory, the laboratory and field experimental facilities of the Agricultural University in Plovdiv.

The participants commended the excellent organization of this RCM and expressed their gratitude to Dr. Bojin Bojinov, Dean, Department of Genetics and Plant Breeding, Agricultural University Plovdiv and his university for their great support towards the organization of this meeting.

For detailed information on the project achievements, see 'Status of Coordinated Research Projects'.

IAEA/RER Regional Training Workshop on Standardizing Methods for Antioxidants Analysis in Solanceous Food Crops, RER/5/013, Budapest, Hungary, 16–27 November 2009

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

Under the IAEA European Regional Cooperation Project RER/5/013 'Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques', the International Atomic Energy Agency in cooperation with the Government of Hungary through the Central Food Research Institute organized the training course which was facilitated by staff of the Institute with Dr. H. Daood as the course director. Fourteen participants from Albania, Bulgaria (2), Croatia, Georgia, Hungary (4), the Former Yugoslav Republic of Macedonia (2), Serbia and Turkey (2) attended the course.

The objective of the course was to provide participants with standard protocols in extraction and analysis of carotenoids, tocopherols and flavinoids, screening of carotenoids, tocopherols and flavinoids, to facilitate screening of mutant populations with improved levels of these antioxidants.

In addition to practical exercises on the main topics, participants delivered short presentations on the status of the national activities under the project RER/5/013, on the solanaceous food crops, and how the knowledge and practical skills obtained during the course might be utilized in their future work.

Status of Coordinated Research Projects

Enhancing the Efficiency of Induced Mutagenesis through an Integrated Biotechnology Pipeline, D2.40.12

Technical Officers: C. Mba and B. Till

This CRP was initiated in 2008. The first RCM was held in Vienna, Austria, 25–29 May 2009. The second RCM is planned to be held in the fourth quarter of 2010.

Improving Nutritional Quality by Altering Concentrations of Enhancing Factors Using Induced Mutation and Biotechnology in Crops, D2.30.28

Technical Officer: Y. Lokko

This CRP was initiated in 2008. The first RCM was held in Vienna, Austria, 29 June–3 July 2009. The second RCM is planned to be held in 2011.

Isolation and Characterization of Genes Involved in Mutagenesis of Crop Plants, D2.40.13

Technical Officer: P.J.L. Lagoda

This new CRP started in May 2009 and the first RCM was held in St. Louis, Missouri, USA, 26–31 October 2009. The second RCM is planned to be held in the first half of 2011 in conjunction with a relevant international meeting on DNA repair and plant breeding (yet to be determined).

For detailed information, see 'Past Events'.

Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality, D2.30.25

Technical Officer: Q.Y. Shu

This CRP was initiated in 2004 and will be completed by the end of 2009. The fourth and final RCM was held in Plovdiv, Bulgaria in November 2009.

The CRP worked on several crop plant species, including major staple food crops such as rice, wheat, and potato, and cash crops such as cotton, barley, okra and groundnut. The targeted traits represent a wide range of characters related to yield and quality, including tolerance to biotic/abiotic stresses. Mutants are induced by using chemical and physical mutagenesis, and different types of molecular marker and technological platform have been developed or adopted for tagging various traits, for mapping and cloning mutated genes, and for pyramiding them into breeding lines.

The CRP has generated a number of tangible results:

- Mutant germplasm: More than 30 novel mutant lines with desirable quality traits or enhanced stress tolerance have been developed and characterized; they are valuable germplasm for crop improvement. A similar amount of lines with unique mutant traits have also been generated and would be useful for basic research.
- Advanced breeding lines: More than 100 advanced breeding lines with better quality or enhanced tolerance to biotic/abiotic stress, selected by using molecular markers in some instances, have been developed and tested for yield and stability, a number of which showed the great potential to become new varieties for commercial production.
- New varieties released: Nine new varieties including rice (4), groundnut (3) and cotton (2) have been released for large scale production.
- Molecular markers: New molecular markers have been developed for basic and applied research, e.g. ~4,000 EST/SSR markers in cotton.
- Tagged quality and stress tolerance traits: Important quality and stress tolerance traits have been tagged by molecular markers in rice (e.g. for starch quality), barley (e.g. for high lysine content), okra (e.g. for resistance to yellow mosaic virus disease), groundnut (e.g. for leaf curling resistance), wheat (e.g. baking quality traits), cotton (e.g. for fibre quality traits), potato (e.g. for bacterial disease resistance).
- Methods and techniques developed/adopted: methods for large scale screening for salinity tolerance in groundnut; techniques for screening tolerance to acidic soil in rice are developed.
- Education: About 40 under- and post-graduate students have been involved in this CRP and get trained for various techniques; among them, 5 received their PhD and 14 a MSc.
- Publications: 20 peer reviewed papers have been published in international journals, 11 in national journals, and 26 abstracts/papers have been presented in national and international conferences/symposia.

The CRP has already brought the following impacts:

- Enriched knowledge of molecular genetics of quality and stress tolerance traits;
- Enriched germplasm for quality and stress tolerance improvement and research;
- Increased the production of quality foods and farmers' food supply and income (e.g. Vietnam);
- Enhanced bilateral and multi-lateral collaboration among the participating institutes (e.g. China –Japan; China-Australia; etc) and access to international expertise and facilities;

- Enhanced research and educational capacity on molecular marker technologies in the participating institutes (e.g. Thailand, India);
- Enhanced public awareness about the importance and potential of plant mutagenesis for meeting the challenges of climate change and global warming (e.g. Australia).

Identification and Pyramiding of Mutated Genes: Novel Approaches for Improving Crop Tolerance to Salinity and Drought, D2.30.26

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 and final RCM took place in Vienna, Austria, 11–16 August 2008 in conjunction with the International Symposium on Induced Mutations in Plants (ISIMP). This project is being completed and final progress reports are showing valuable results. These reports will be published as a Technical Document (IAEA-TECDOC) in the near future, and further details will be reported in our next Newsletter.

Molecular Tools for Quality Improvement in Vegetatively Propagated Crops Including Banana and Cassava, D2.30.27

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 took place in Vienna, Austria, 11–16 August 2008 in conjunction with the International Symposium on Induced Mutations in Plants (ISIMP). The fourth and final RCM is planned to be held in Brazil in the fourth quarter of 2010.

IAEA Coordinated Research Activities Web Site:

http://www-crp.iaea.org/html/forms.html

Technical Cooperation Field Projects

The Plant Breeding and Genetics subprogramme currently has technical responsibilities for the following technical cooperation projects that are managed by the IAEA's Department of Technical Cooperation.

Continuing Projects

Project Number	Country	Title and Objective(s)	Technical Officer
AFG/5/003	Afghanistan	Sustainable Increase in Crop Production in Afghanistan ***Objectives:*** 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.	Y. Lokko in collaboration with Soil and Water Management Section
ALG/5/023	Algeria	Protection of Date Palm Trees Against Bayoud Disease ***Objectives:*** Rehabilitation and development of date palm oasis using mutation induction in Algeria.	M. Spencer
ALG/5/024	Algeria	Improvement of Cereals for Tolerance to Drought and Resistance to Disease ***Objectives:*** 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.	M. Spencer
ANG/5/006	Angola	Improvement of Food Crops Through Mutation Breeding and Biotechnology ***Objectives:*** To establish a national capacity to develop crop varieties with increased vitamin and mineral content and improved yield, quality, disease resistance and stress tolerance.	M. Spencer
BGD/5/026	Bangladesh	Increasing Agricultural Production in the Coastal Area through Improved Crop, Water and Soil Management ***Objectives:*** To increase agricultural production in coastal areas through integrated and efficient management of crop, water, soil and land resources.	Q.Y. Shu
BOT/5/003	Botswana	Mutational Improvement of Groundnut Varieties ***Objectives:*** Development of high yielding groundnut mutant varieties with high tolerance to abiotic stress.	Q.Y. Shu
CAF/5/003	Central African Republic	Development of New Varieties of Cassava Through Mutation Breeding and Biotechnology Techniques ***Objectives:*** To develop manioc varieties with resistance to the African Cassava Mosaic Virus (ACMV) through mutation breeding and biotechnology techniques.	M. Spencer

Project Number	Country	Title and Objective(s)	Technical Officer
COS/5/027	Costa Rica	Generation of Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness ***Objectives:*** To contribute to an increase in the competitiveness and productivity of beans by strengthening the National Programmes for Bean Improvement.	M. Spencer
CPR/5/017	China	Construction of Radiation-Induced Mutant Libraries and Function Analysis of Mutated Genes in Crop Plants ***Objectives:*** 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.	M. Spencer/Y. Lokko
ECU/5/023	Ecuador	Inducing Mutations in Agriculture with the Aid of Radiation ***Objectives:*** To improve varieties of maize, potato and barley using mutagenic techniques leading to an increase in the productivity of these subsistence crops.	M. Spencer
ERI/5/004	Eritrea	Improving Crop Productivity and Combating Desertification ***Objectives:*** 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.	Y. Lokko in collaboration with Soil and Water Management Section
INS/5/035	Indonesia	Application of Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands ***Objectives:*** To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.	Q.Y. Shu
INS/5/036	Indonesia	Genetic Improvement of Artemisia Cina Using Irradiation Technique ***Objectives:*** To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.	M. Spencer/Q.Y. Shu
IRQ/5/017	Iraq	Optimization of Land Productivity Through the Application of Nuclear Techniques and Combined Technologies ***Objectives:*** 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.	Q.Y. Shu
JAM/5/010	Jamaica	Plant Breeding and Diagnostics Technologies ***Objectives:*** To enhance capacities in crop improvement in Jamaica so as to increase food production using induced mutations and related biotechnologies.	Y. Lokko

Project Number	Country	Title and Objective(s)	Technical Officer
MAR/5/018	Mauritius	Improvement of Banana and Tomato Varieties Through the Use of Nuclear Techniques for Mutation Induction and Biotechnology ***Objectives:*** Enhanced national capacity to develop varieties of bananas and tomatoes through mutation induction and biotechnology.	M. Spencer
MYA/0/007	Myanmar	Nuclear Science and Technology Training Centre (Currently a Human Development Project) ***Objectives:*** 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.	Q.Y. Shu
MYA/5/016	Myanmar	Development of Rice Varieties with Improved Iron Content/Bioavailability Through Nuclear Techniques ***Objectives:*** To combat iron deficiency through food based strategies.	Q.Y. Shu/Y. Lokko
NIR/5/035	Nigeria	Adding Value to Root and Tuber Crops Through the Use of Mutation Induction and Biotechnologies ***Objectives:*** To improve crop productivity for sustainable agricultural development in coastal areas through crop genetic improvement and development of soil, water and nutrient management practices.	Y. Lokko/Q.Y. Shu
PAK/5/044	Pakistan	Improvement of Drought Tolerance in Chickpea Through Induced Mutations ***Objectives:*** To develop drought-tolerant and high-yielding desi chickpea mutants for the low-moisture chickpea growing areas in Pakistan through induced mutation.	M. Spencer
PER/5/030	Peru	Genetic Improvement of Quinoa and Kiwicha Using Mutation Induction and Biotechnology ***Objectives:*** To improve the national capacity to increase the yields and market competitiveness of quinoa and kiwicha.	Y. Lokko
QAT/5/002	Qatar	Developing Biosaline Agriculture in Salt-Affected Areas in Qatar ***Objectives:*** 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.	Q.Y. Shu in collaboration with Soil and Water Management Section
RAF/5/056	Regional Africa	Field Evaluation and Dissemination of Improved Crop Varieties Using Mutation Breeding and Biotechnology Techniques ***Objectives:*** To assist AFRA Member States in the development and dissemination of improved mutation induced staple and market oriented crops.	M. Spencer

Project Number	Country	Title and Objective(s)	Technical Officer
RAS/5/045	Regional Asia	Improvement of Crop Quality and Stress Tolerance for Sustainable Crop Production Using Mutation Techniques and Biotechnology (RCA) ***Objectives:*** 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.	Q.Y. Shu
RAS/5/048	Regional Asia	Mutation Induction and Supportive Breeding and Biotechnologies for Improving Crop Productivity (ARASIA) ***Objectives:*** An improved regional partnership in the field of mutation induction to enhance breeding for food security and socioeconomic development.	P.J.L. Lagoda
RER/5/013	Regional Europe	Evaluation of Natural and Mutant Genetic Diversity in Cereals Using Nuclear and Molecular Techniques ***Objectives:*** 1) Genetic improvement of barley (*Hordeum vulgare*), pea (*Pisum sativum*), beans (*Phaseolus vulgaris* L.) and cotton through induced-mutations. 2) Animal nutrition and reproduction. 3) Vegetal physiology, soils and fertilizers applied to potatoes, barley and other crops.	Y. Lokko/Q.Y. Shu
SAF/5/008	South Africa	Mutant Amaranth, Bambara Groundnut and Cowpea with Enhanced Abiotic Stress Tolerance ***Objectives:*** To screen, evaluate, and identify mutant amaranth, bambara groundnut and cowpea with enhanced abiotic stress tolerance, in collaboration with resource poor farmers.	Y. Lokko
SAF/5/010	South Africa	Development of New Maize and Sorghum Germplasm with Enhanced Nutritional Content ***Objectives:*** 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.	Y. Lokko
SAU/5/003	Saudi Arabia	Improving Fertilization under Saline Conditions for Sustainable Crop Production ***Objectives:*** To improve use efficiency of water and fertilizer applied through fertigation and to establish criteria for optimum doses of fertilizer and water salinity for sustainable crop production.	Q.Y. Shu in collaboration with Soil and Water Management and Crop Nutrition Section
SEN/5/030	Senegal	Integrated Approach to Develop Sustainable Agriculture in Senegal ***Objectives:*** 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.	M. Spencer in collaboration with Soil and Water Management and Crop Nutrition Section
SIL/5/009	Sierra Leone	Improving Sorghum Productivity Through Nuclear and Biotechnology ***Objectives:*** To assist in the development of new mutant lines of sorghum with increased yield and disease resistance.	Q.Y. Shu

Project Number	Country	Title and Objective(s)	Technical Officer
SUD/5/030	Sudan	Increasing productivity of Selected Crops Using Nuclear Related Techniques ***Objectives:*** 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).	Q.Y. Shu
TUN/5/023	Tunisia	Radiation-Induced Mutations for Improvement of Cactus ***Objectives:*** To develop improved varieties of cactus by induced mutations, which are relatively high in nitrogen for use as feed for sheep and goats.	Y. Lokko
TUN/5/024	Tunisia	Development of Improved Strains of Olive Tree Through Mutation Breeding and Biotechnology ***Objectives:*** To develop a routine protocol for mass micropropagation of high yielding olive varieties.	Y. Lokko
UZB/5/004	Uzbekistan	Development of Mutant Cotton Breeding Lines Tolerant to Diseases, Drought and Salinity ***Objectives:*** 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
YEM/5/008	Yemen	Introduction of Gamma Ray Irradiation Techniques for Agriculture Purposes ***Objectives:*** To support the use of gamma ray irradiation techniques, such as mutation induction enhanced breeding, for service and applied research purposes.	Y. Lokko
ZAI/5/016	Democratic Republic of the Congo	Mutation Techniques for Improving Nutritional and Medicinal Plants with a Curative Effect on Human Diseases and Alimentary Plants ***Objectives:*** To build the basis for a long-term national strategy to fight malaria and improve food security.	M. Spencer
ZIM/5/013	Zimbabwe	Development of Drought Tolerant and Disease Resistant Grain Legumes, Phase I ***Objectives:*** To develop drought and/or disease tolerant mutant grain legume varieties suitable for resource poor smallholder farmers in Zimbabwe.	Y. Lokko

Projects Started in 2009

Project Number	Country	Title and Objective(s)	Technical Officer
AFG/5/004	Afghanistan	Enhancing Crop Productivity through Mutation Breeding and Pest Control ***Objectives:*** To build a thorough knowledge base in the use of nuclear technology to enhance crop productivity through mutation breeding and pest control.	Y. Lokko in collaboration with Insect Pest Control Section
BKF/5/007	Burkina Faso	Improving Voandzou and Sesame Based Cropping Systems through the Use of Integrated Isotopic and Nuclear Techniques	M. Spencer

Project Number	Country	Title and Objective(s)	Technical Officer
		Objectives: To improve crop production in the interest of food security and to combat poverty through induced mutagenesis and modern biotechnology to improve the agricultural productivity of voandzou and sesame and to improve soil fertility management in voandzou sesame based cropping systems.	
BOL/5/018	Bolivia	Enhancing Food Security Using Conventional and Nuclear Techniques for the Acquisition of Climate-Change Tolerant Commercial Potato Seed ***Objectives:*** To generate sustainable induced mutation-related technologies to obtain seeds of economic importance to Bolivia in order to maintain the country's food sovereignty.	M. Spencer/Q.Y. Shu
COL/5/023	Colombia	Enhancing Mutagenesis and Biotechnology Used in the Improvement of Rice ***Objectives:*** To increase the genetic variability of rice in Colombia through radiation induced mutagenesis for use in the National Programme for the Genetic Improvement of Rice.	Y. Lokko/Q.Y. Shu
COS/5/028	Costa Rica	Generating Promising Strains of Beans through Induced Mutations in Calluses and Seeds to Increase Competitiveness (Phase II) ***Objectives:*** To increase competitiveness and productivity of beans by strengthening the National Bean Programme.	M. Spencer
ECU/5/025	Ecuador	Inducing Genetic Variability in Soya, Banana and Rice ***Objectives:*** To induce genetic variability using physical or chemical mutations in soya, banana and rice in order to obtain cultivars that meet the requirements of food and environmental security protection.	M. Spencer
INS/5/037	Indonesia	Applying Nuclear Techniques for Screening and Improving Cash Crop Plants in Coastal Saline Lands ***Objectives:*** To improve crop productivity for sustainable agricultural development in coastal areas.	Q.Y. Shu
INS/5/038	Indonesia	Using Induced Mutations to Improve Rice Productivity through a Hybrid Rice Breeding Programme ***Objectives:*** To breed high yielding hybrid rice varieties with good grain quality and resistance to main pests and diseases.	Q.Y. Shu
INT/5/150	Interregional	Responding to the Transboundary Threat of Wheat Black Stem Rust (Ug99) ***Objectives:*** To facilitate and coordinate a network of laboratories as a defense line against the Wheat Black Stem Rust (Ug99) disease in high risk countries.	P.J.L. Lagoda/Q.Y. Shu
IVC/5/031	Cote d'Ivoire	Improving Plantain and Cassava Yields thought the Use of Legume Cover Crops ***Objectives:*** To increase the yield of plantain and cassava in smallholder farming systems by improving fertility of degraded soils in coastal areas through the use of leguminous cover crops.	M. Spencer

Project Number	Country	Title and Objective(s)	Technical Officer
KAZ/5/002	Kazakhastan	Improving Wheat and Maize Using Nuclear and Molecular Techniques ***Objectives:*** To increase availability of genetic resources and techniques for the improvement of quality characteristics of wheat and maize and their tolerance to abiotic stresses such as drought and salinity.	Q.Y. Shu/Y. Lokko
KEN/5/029	Kenya	Developing Appropriate Artemisia Varieties for Management of Malaria ***Objectives:*** To develop high artemisinin producing varieties of *Artemisia annua*, adapted to different agro-ecological zones in Kenya, through induced mutation breeding and biotechnologies.	Y. Lokko/M. Spencer
MAG/5/018	Madagascar	Improving Cereal Production (Rice and Maize) through Mutation Breeding for Tolerance/Resistance to Striga (*Striga asiatica*) ***Objectives:*** To increase cereal productivity by developing mutant rainfed upland rice and maize varieties tolerant or resistant to the parasite plant *Striga asiatica*.	M. Spencer
MAK/5/006	Macedonia, the Former Yugoslav Republic of	Improving Wheat, Barley and Triticale for Food and Feed in Drought-Prone Areas, Using Nuclear Techniques ***Objectives:*** To improve wheat, barley and triticale for food and feed in drought-prone areas via nuclear techniques.	Y. Lokko
MAL/5/028	Malaysia	Enhancing the Production of Bioactive Compounds in a Local Herbal Plant by a Soilless Planting System and *In Vitro* Mutagenesis ***Objectives:*** To enhance the productivity of bioactive compounds extracted from local herbal plants using soilless planting systems, radiation induced mutagenesis technology and supportive biotechnologies.	Y. Lokko/M. Spencer
MYA/5/017	Myanmar	Studying Yield Improvement of Local Rice Varieties though Induced Mutation ***Objectives:*** To strengthen food security through increased yield in rice by induced mutation.	Q.Y. Shu/Y. Lokko
MYA/5/019	Myanmar	Developing Thermo-Insensitive (Cold-Tolerant) Green Gram Genotypes, Using Mutation Techniques ***Objectives:*** To create genetic viability and to develop thermo-insensitive (cold-tolerant) black gram varieties.	Q.Y. Shu/Y. Lokko
NAM/5/009	Namibia	Using Mutation Breeding and Integrated Soil Plant Management Techniques to Develop Sustainable, High Yielding and Drought Resistant Crops ***Objectives:*** To improve germplasm of pearl millet and cowpea and to evaluate the nitrogen economy of intercropped pearl millet and water uptake ability of drought stressed pearl millet.	Y. Lokko in collaboration with Soil and Water Management Section

Project Number	Country	Title and Objective(s)	Technical Officer
NER/5/014	Niger	Improving the Productivity of Cowpea/Finger Millet Based Cropping Systems ***Objectives:*** To develop improved drought resistant lines and soil fertility management practices using nuclear, isotopic and mutation breeding techniques for cowpea-finger millet based cropping systems.	M. Spencer in collaboration with Soil and Water Management Section
RLA/5/056	Regional Latin America	Improving Food Crops in Latin America though Induced Mutation (ARCAL CV) ***Objectives:*** To increase food production in drought affected areas through the development and dissemination of drought tolerant advanced mutant lines of different food crops (legumes, cereals, pseudocereals, fruit trees etc.) traditionally cultivated in marginal and semi-arid areas in Latin America.	M. Spencer/Y. Lokko
ROK/5/035	Republic of Korea	Using a Gamma Phytotron for Mutant Induction to Improve Food and Ornamental Crops ***Objectives:*** To improve the production of food and ornamental crops through the use of a gamma phytotron for mutant induction; to determine low-energy and chronic effects of a gamma ray on crop mutagenesis; to provide diverse mutants for plant improvement and genomics study.	Q.Y. Shu
SEN/5/032	Senegal	Improving the Productivity of Jatropha Curcas Plantations in Semi-Arid Areas ***Objectives:*** To develop new varieties of *Jatropha curcas*.	M. Spencer
THA/5/049	Thailand	Increasing Productivity of Selected Crops Using Nuclear Related Techniques ***Objectives:*** To set up an ion beam biotechnology centre for mutation induction of agricultural and horticultural crops for quality and quantity improvements and pest resistance.	Q.Y. Shu
TUR/5/025	Turkey	Using Molecular Techniques for Enhancing the Efficiency of Mutation Induction and Utilization of Mutants in Agriculture ***Objectives:*** To upgrade the laboratory for using molecular techniques for enhancing the efficiency of mutation induction and utilization, developing new techniques for mutant screening and characterization as well as new mutant varieties of important plant species.	Q.Y. Shu
URT/5/026	United Republic of Tanzania	Improving Rice Varieties through Mutation Breeding and Biotechnology in Zanzibar ***Objectives:*** To improve the capacity of Zanzibar rice researchers in the field of radiation technology.	Q.Y. Shu
YEM/5/010	Yemen	Using Induced Mutations and Efficiency Enhancing Biomolecular Techniques for Sustainable Crop Production ***Objectives:*** To select wheat, barley, lentil, sesame and cotton mutants with drought and salt tolerance, disease resistance, early maturity and good yield.	Y. Lokko

Project Number	Country	Title and Objective(s)	Technical Officer
ZAM/5/026	Zambia	Improving Crop Varieties through Use of Nuclear Techniques ***Objectives:*** To develop crop (beans and cassava) varieties with high yields that are resistant to multiple pests and diseases together with the establishment of a sustainable crop and land management system.	Y. Lokko in collaboration with Soil and Water Management Section

TC Projects Closed in 2009

Project Number	Country	Title and Objective(s)	Technical Officer
GHA/5/032	Ghana	Enhancing Production and Use of Cassava ***Objectives:*** 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.	M. Spencer/Y. Lokko
IRQ/5/015	Iraq	Induction of Mutations in Crops through *In Vitro* Culture ***Objectives:*** To develop mutants of crops with high yield and tolerance to salinity, drought and heat, using *in vitro* techniques.	Q.Y. Shu
NER/5/012	Niger	Improvement of the Productivity and Sustainability of Cowpea with Finger Millet ***Objectives:*** To develop improved drought-resistant lines and amelioration of soil and water management practices using nuclear, isotopic and mutation breeding techniques for cowpea.	M. Spencer in collaboration with Soil and Water Management Section
PHI/5/029	Philippines	Enhancing Agricultural Productivity through Radiation Technology in Mindana ***Objectives:*** To develop new mutant varieties of fruit crops such as mangosteen 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.	M. Spencer/Y. Lokko
RAS/7/014	Regional Asia	Monitoring of Food Fortification Programmes Using Nuclear Techniques ***Objectives:*** 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.J.L. Lagoda
SIL/5/007	Sierra Leone	Development of High-Yielding Rice Varieties for Low-Input Agriculture Systems Using Mutation Techniques ***Objectives:*** 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.	Q.Y. Shu

Project Number	Country	Title and Objective(s)	Technical Officer
TUR/5/023	Turkey	Application of Nuclear and Gene-Based Biotechnology in Agriculture ***Objectives:*** 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	United Republic of Tanzania	Enhancing Crop Productivity through Radiation Technology ***Objectives:*** 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
VIE/5/015	Vietnam	Enhancement of Quality and Yield of Rice Mutants Using Nuclear and Related Techniques ***Objectives:*** 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	Yemen	Use of Induced Mutations and *In Vitro* Culture for Improving Crops ***Objectives:*** 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.	Y. Lokko

For details, see the IAEA Technical Cooperation Programme's Web Site at:

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

TC Project Highlights

High Yielding, Early Maturing Rice Mutant Variety is Transferring Crop Production Landscape in Bangladesh (RAS/5/037)

Background: The IAEA/RCA TC project RAS/5/037 was implemented from 1997 to 2002 with the participation of 10 Asian countries. In this project, a regional rice mutant variety trial was organized in the participating countries. One of the mutant lines, TNDB100, developed by the Cuu Long Rice Research Institute of Vietnam, showed promising results in Bangladesh. However, it was still under segregation. The counterpart in Bangladesh, Dr. A. Azam, continued to select best performing plants from this variety and in 2007 a stable line was released as a new rice variety with the name '**BINA Dhan-7'**.

This new variety has been tested and grown by farmers in rural areas of northern Bangladesh, where two crops of rice are grown during the year (rain fed production in raining season - July to November/December and irrigated production in dry season - January to May). The season from October to early November is called 'Monga', where rice is still maturing in the fields. During this season farmers are not able to work and thus at times do not have sufficient food to eat.

Performance and advantage of BINA Dhan-7. In the tested area, BINA Dhan-7 can be harvested approximately one month earlier than other rice varieties and has almost similar yield as late maturing varieties. Therefore, it provides an important means for combating the Monga. There are other early maturing rice varieties; however most of them are not high yield. Cultivation of BINA Dhan-7 showed the following advantages: 1) combating the seasonal food shortage 2) creation of job opportunities for farm workers 3) farmers can produce another crop of potato 4) the rice straw can be sold at a good price as feed (feed is also in shortage in October) 5) rice can be sold at a higher price since BINA Dhan-7 is a high quality variety and at that moment in time, rice is less available at the market place, and 6) there is a great potential to avoid drought stress, which happens from time to time in November.

Rapid expansion and potential. Due to the above merits and potential impact, BINA Dhan-7 is being accepted

very quickly by farmers. Several non-governmental organizations (NGOs) and government agricultural extension workers have set up hundreds of demonstration sites and organized demonstration and dissemination activities such as field days. For example, one NGO - Rangpur-Dinaspur Rural Agriculture Service - disseminated seeds of BINA Dhan-7 to about 2 300 farmers in 2008, and plans to increase to 10 000 in 2010. It is expected that about 80% of rice areas might be cultivated by this variety in the coming two to three years. Therefore, the socio-economic impact will be huge.

Qingayo Shu
Technical Officer

Field Day - BINA Dhan-7

'The Daily Star' (Second Edition) newspaper

Dhaka, Bangladesh, Tuesday, 20 October 2009

Scientists see bright prospect for high-yielding BINA Dhan-7

CORRESPONDENT, *Rangpur*

BINA Dhan-7 bears bright prospect for a massive change in the socio-economic condition and food security status in the monga-hit northern region as opportunity to cultivate a third crop (an additional crop) in a year will benefit both the farmers and farm labourers.

Scientists of Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh and Agriculture Extension Department (AED) and farmers expressed the hope as they met on a 'Field Day' on the prospect of the high-yielding variety of aman rice at Joyrampur Anwar village in Mithapukur upazilla yesterday.

BINA and Rangpur AED with the assistance of a few NGOs cultivated the early variety rice on 7000 hectares of land in greater Rangpur region this season.

Ideal for the soil and climate of the region, BINA Dhan-7 is least affected by natural calamities like flood, drought and pest attack, said Dr Lokman Hakim, chief scientific officer (Plant Biotechnology and Genetic Engineering Division) of BINA.

Farmers can get about 4.7 to 5 tonnes of rice per hectare by cultivating BINA Dhan-7 and the fine quality rice will be more profitable than usual varieties, said Dr M Raisul Haider, principal scientific officer (Training Communication and Publication Division) of BINA.

BINA Dhan-7 can be harvested in mid-October and it will create job opportunity for the farm labourers during October and November when monga prevails in the northern region, speakers said at the function.

International Atomic Energy Agency developed the variety in Vietnam in 1999. BINA brought the variety and conducted experiment and research on it for long. In 2007, National Seed Board of Bangladesh approved it as BINA Dhan-7.

Plant Breeder of International Atomic Energy Agency Qingyao Shu also spoke on the occasion.

Developments at the Plant Breeding Unit, Seibersdorf

Introduction

The Plant Breeding Unit (PBU), by maintaining its ongoing activities in technology development and adaptation, the provision of technical and analytical services, and by providing training and human capacity building, plays implemental roles in enhancing the capacity of Member States of both FAO and the IAEA in the use of induced crop mutations to provide superior crop varieties. The activities, mostly laboratory-based, complement other project management-based interventions implemented largely out of the Plant Breeding and Genetics Section to meet the overall goal of enhancing the efficiency of induced crop mutagenesis. Laboratory activities focus on three crops that provide the opportunity for work on different biological systems and production constraints: banana, cassava and rice. Examples of work on each crop are provided under the Technology Development and Adaptation sub-heading below. Additionally, highlights of the Unit's support to activities in Member States through training and the provision of services are also presented.

Technology development and adaptation

Reverse genetics for high throughput mutation discovery

Heritable mutations in DNA sequence have had profound impacts on agrobiodiversity. DNA variation is a driver of evolution and provided the means for crop domestication. Early in the 20th century, scientists demonstrated that the capacity for using heritable mutations for plant breeding and for understanding basic biological mechanisms could be significantly increased by inducing mutations with ionizing radiation (and later by chemical mutagens). The success of this approach is readily appreciated by the over 3200 registered plant varieties being cultivated all over the world that were created using induced mutations in the last 80 years. While incredibly powerful, induced crop mutations could be made a lot more efficient (and hence, appealing) by improvements in the scale and speed for the induction, detection and deployment of desirable mutation events in the generation of superior crop varieties. PBU is actively engaged in the development, adaptation and evaluation of technologies that hold promise to improve efficiencies in both seed and vegetatively propagated plants.

Discovery of induced mutations: Targeting Induced Local Lesions IN Genomes (TILLING)

One major bottleneck for using induced mutagenesis in the genetic improvement of vegetatively propagated crops is the need to generate thousands of plants that are genotypically homogenous for the induced mutation events. This is because after mutation by exposing a multi-cellular tissue to a mutagen, each cell of the mutated tissue accumulates different mutations and thus the plant is chimeric. One strategy to dissolve chimeras is to sub-culture plantlets of the putative mutants under aseptic conditions in tissue culture. This is achieved by cutting up the plantlets into nodal segments that each in turn regenerate individual plantlets in the subsequent generation. After a certain threshold in number of sub-cultures, the cells playing roles in the ontogeny of plantlets become uniform for the mutation events they harbour. This is known as the dissociation of chimeras.

We are using the high-throughput mutation discovery methods developed for Targeting Induced Local Lesions IN Genomes (TILLING) to evaluate when in the process of cyclical mitotic cell divisions chimeras are dissolved. Our work focuses on banana and cassava. Establishing, via empirical studies, the number of sub-cultures or generations it takes for chimeras to be dissolved in vegetatively propagated plants will allow the streamlining of what is traditionally a labour and time intensive task. Preliminary data we have obtained for banana suggest that it possible to estimate precisely how many cycles of vegetative propagation are required for dissolving chimeras. This work also allows an estimation of the rate of accumulation of small nucleotide polymorphisms due to the tissue culture environment, i.e. somaclonal variations, another important factor in the estimation of frequency of induced mutations in vegetatively propagated species maintained in *in vitro* cultures.

Another avenue for enhancing the efficiency of induced mutations is to through the understanding of the type, density, and effect of mutation events on the plant genome. With this knowledge, the currently perceived 'black box' of induced mutations can be turned into a statistically predictive algorithm that can be used to establish the relationships between mutagen, dose and size of population required to provide a high probability of acquisition of the desired crop traits. This information is an expected output from our reverse-genetic activities using TILLING. With TILLING, mutations in specific genes can be isolated. Reverse genetic methods utilize knowledge of gene function and the ready availability of genome sequences to target specific genes for alterations without the *a priori* need of phenotypic characterization. Large mutant populations are studied in an early generation and only desired mutants, chosen on the basis of the presence of the target mutations, are further subjected to phenotypic characterization and genetic analysis. Indi-

viduals that do not harbour mutations hypothesised to cause phenotypic changes are eliminated from further analysis. This can provide enhancements in significant orders of magnitude in the efficiency of phenotypic characterization. Additionally, reverse genetic strategies allow the identification of alleles that have no phenotypic consequences on their own, but do when combined with other alleles. This provides a mechanism for the development of traits that are either unlikely or impossible with traditional induced mutation methods.

Our TILLING work with EMS mutagenized triploid banana continues and we have now confirmed a high density of induced transition mutations in the population. The type and density of mutations meet expectations for a triploid species mutagenized with EMS. We also continue our beta-test screening of this population with counterparts at the Katholieke Universiteit (KU), Leuven, Belgium. Also, efforts in TILLING in cassava have increased significantly in the past six months with genomic DNA from over 3000 gamma and EMS mutagenized individuals now extracted, pooled and arrayed for mutation screening.

Discovery of spontaneous mutations: Ecotilling

Work also continues in the development and adaptation of methods for the discovery and characterization of natural nucleotide polymorphisms. Here, we are using a modification of the TILLING method known as Ecotilling. In collaboration with counterparts at the KU Leuven, we have characterized 80 diploid and polyploid banana accessions and discovered over 6000 polymorphic bands and over 300 novel alleles. Analysis of this large data set is currently in progress and will yield critical information to be used in developing tools for the characterization of the complex *Musa* genome.

Comparative phenotypic screening for salinity tolerance

Reliable and repeatable screening techniques are the mainstay of any successful breeding programme for abiotic stress in rice. Though screening techniques vary with growth stages, type and time of stress imposed, ideally the technique should be rapid, reproducible, easy, accessible and affordable for the researcher. The screening techniques become more crucial and challenging when mutation techniques are used to obtain a salt tolerant mutant as large mutated populations must be screened. PBU has been working on different screening techniques for salinity with the goal of the establishment of an integrated efficient screening protocol. The hydroponics screening techniques for salt tolerance, currently used at the PBU screen houses, are based on growing the seedlings in water containing varying concentrations of salt. This (hydroponics culture) was compared another technique involving the growing of the plants in soil in which predetermined concentrations of salt had been similarly introduced. The comparisons were based on morphological data collected at the different stages of growth and development of the seedlings (and subsequently, plants). The responses to salinity by the diverse rice genotypes (of varying levels of salinity tolerance) were unaffected by the culture method. It is therefore probable that screening for salt tolerance in rice using soil (rather than hydroponics) might provide a reliable predictive estimation of field response to this stress condition. Soil-based assays are also more practical as the availability of inputs for the more technically challenging hydroponics assays might be limiting factors. In collaboration with the Soil Science Unit of ABL, the carbon isotope discrimination (CID) method was also evaluated for its efficacy in the identification of stress tolerant rice genotypes. The CID method had proved to be an effective tool to select hardy crops in water logging conditions. The roots and leaves harvested from rice plants used in the study are being analyzed for CID and some mineral contents in order to gain a better understanding of the mechanisms of salt tolerance of different rice varieties.

Mutagenicity studies

Induced mutations, by permitting the uncovering of inherent allelic variations, are highly effective in enhancing the utility of a crop's genetic resources and have therefore been used in developing improved crop varieties. Gamma irradiation has been one of the most popular methods for inducing mutations of all the different mutagens (physical and chemical) used in breeding programmes. During the last few decades, of the over 3200 crop varieties that have been released officially all over the world, a great majority of them have been developed by the use of gamma irradiation[1]. In recent years, due to the increasingly limiting security restrictions imposed on shipping materials with high radioactivity, the production of new Gamma sources for mutation induction has been severely curtailed. PBU has initiated a study which is focused on the comparison of the efficacy of different mutagens (X-ray, EMS and gamma irradiation) for inducing mutations in crops. As part of the efforts aimed at calibrating a newly acquired X-ray irradiator, different rice varieties are being used for this study. The aim is to ultimately develop routine protocols for using X-rays to induce mutations in crop breeding programmes. The experiments are being carried out with different rice genotypes from both the *indica* and *japonica* groups. The sensitivities of the different rice genotypes to different mutagenic treatments (physical and chemical) are being ascertained from measurements of different phenotypic parameters as well as genotypic characterizations using the molecular marker system, Amplified Fragment Length Polymorphisms (AFLP). The AFLP markers will provide estimates of damage at the DNA sequence level in M_1 generation. The expected outputs include baseline

[1] Mutant Varieties and Genetic Stock Database (http://mvgs.iaea.org/default.aspx)

data that will form the basis for the gradual replacement of gamma sources with X-ray irradiators in induced crop mutagenesis. It is unlikely the current trend of phasing out the production and marketing of previously common gamma sources will be reversed in the near future.

Doubled haploidy in induced crop mutations

It is already well established that in plant breeding the production of di-haploid plants speeds up the breeding cycle by fixing homozygousity in one generation. It allows an increase in selection efficiency on account of the savings in time ordinarily required for several generations of selfing to attain homozygousity in the mutated alleles. Doubled haploidy has the potentials for becoming a powerful complementary tool to mutation induction as both dominant and recessive alleles will be phenotypically expressed very early. This would therefore allow for easier isolation of mutants harbouring desirable recessive mutation events. During the last few years, a considerable development has been reported in the anther culture of different crops and it has been found that the response of anthers in *in vitro* culture conditions has significant genotypic components. For rice, especially the *indica* genotypes, the production of green plants from androgenic calli has remained a major constraint to the development of genotype-independent protocols for doubled haploidy in rice. The common problems encountered in the anther culture of *indica* rice include low frequency of callus induction and high frequencies of the regeneration of albino plantlets, and of haploid plantlets. Improvement of anther-derived di-haploid plant regeneration frequency, especially that of the recalcitrant *indica* varieties of rice, is an imperative before the integration of doubled haploidy in mutation induction in rice, a crop for which induced mutagenesis has had the greatest success (in terms of number of officially released mutant varieties). Thus keeping in view the importance of anther culture in rice especially for the recalcitrant *indica* genotype, experiments were carried out to improve the frequency of green plantlet regeneration. One area of intervention has been the stimulation of callus induction; rice panicles were treated with low dose of irradiation to achieve this end. Overall, the results obtained from studies on a wide range of genotypes were encouraging and highlight areas requiring fine-tuning.

Training-the-trainer activities

The PBU remained active in the area of individual and group training in the last six months. The highlights include the following:

Individual trainees

A total of nine individual trainees, made up of three Fellows and six Interns, joined the Unit between June and December 2009 and worked on specific research projects under the tutelage of Unit staff members.

Fellowships

Three Fellows from two countries were supported by the IAEA Technical Cooperation (TC) Programme to enhance capacities in areas where skills critical for the implementation of TC projects were lacking in their home institutes. Details of the Fellows are provided in the following table:

Name	Country	Areas of training	Period
Ms. Linshu ZHAO	China	• induced mutagenesis facilitated by *in vitro* techniques, • molecular biology techniques for the genotyping of plant germplasm, and • *In vivo* and *in vitro* techniques for screening plants for salt tolerance.	October 2009 – March 2010
Ms. Lydia Ndinelao HORN	Namibia	• Induced mutations for improvement of pearl millet, legumes and sorghum, • Genetic diversity study of different accessions of cowpea varieties from Namibian and IITA.	July–November 2009
Mr. Hairui CUI	China	• Induced mutations for improvement of rice, • TILLING and Ecotilling for characterization of herbicide resistance, salinity/drought tolerance, high iron content, • Alternative readout platforms for enzymatic mismatch cleavage.	June–November 2009

Interns

Six Interns from four countries, at varying stages of educational formation, worked on specific aspects of induced crop mutagenesis facilitated by biotechnologies.

Name	Country	Areas of training	Period
Mr. Federico FROESTL	Argentina	Screening cassava mutagenic population developed for TILLING technology adaptation for starch quality.	August 2009 – January 2010
Mr. Joseph Okechukwu NWOZOR	Nigeria	Induced mutations in rice using physical and chemical mutagens.	March–December 2009
Mr. Ralf RAPPEL	Austria	Screening banana ITC collection for biotic stress tolerance using the fungus *Mycrosphaerella fijiensis*.	August–October 2009
Mr. Stefan LAUBER	Austria	Screening cassava mutagenic population developed for TILLING technology adaptation for starch quality.	July–October 2009
Ms. Weronika BARCIK	Poland	Screening cassava mutagenic population developed for TILLING technology adaptation for starch quality.	January–August 2009
Ms. Marta BROZYNSKA	Poland	Screening banana ITC collection and banana putative mutants for abiotic stress tolerance, drought profiling.	July–September 2009

Plant Breeding Unit's Staff Travel to the Member States

Mr. B. Till

- Served as representative of the Vienna cluster of plant sciences at the 10th EPSO (European Plant Science Organisation) general meeting in Prague, Czech Republic, 4-5 June 2009.
- Visited the Max Planck Institute for Plant Breeding Research, to present a lecture on the induction, discovery and maintenance of mutations in vegetatively propagated crops in Cologne, Germany 27 and 28 October 2009.

Ms. J. Jankowicz-Cieslak

- Attended the Plant Genomics and Beyond Conference in Every, France, 6-9 July 2009.

Training Courses and Workshops

Joint FAO/IAEA International Training Course on Novel Biotechnologies and Molecular Technologies for Enhancing Mutation Induction Efficiency, Seibersdorf, Austria, 2 November – 4 December 2009

Course Director: C. Mba

This training course was a hybrid of the usual training programmes organised by the Joint FAO/IAEA programme and a group fellowship in that it was sponsored jointly with the TC Programme. This was reflected in about 50% of the participants being drawn from institutes participating in the IAEA Regional Technical Cooperation Project under the auspices of the Cooperative Agreement for Arab States in Asia for Research, Development and Training Related to Nuclear Science and Technology (ARASIA). This cooperative agreement is aimed at pooling resources in the use of induced crop mutations to address common themes in the region. In addition to 22 participants from 19 developing countries, half of which were selected on the basis of participation in ARASIA and the other half on a competitive basis, two Fellows and two Interns from four countries (see list of participant) took part in the course.

The aim of this course was to train the participants in induced crop mutations and novel biotechnologies and molecular tools for enhancing the efficiency of mutation induction. The five-week training course comprising theoretical lectures, demonstrations, seminars, practical exer-

cises and computer laboratory demonstrations was structured around the following modules:

- Mutation induction in crop improvement;
- Molecular genetic and cytogenetic marker techniques for the enhancement of crop improvement and germplasm management (including marker-aided selection);
- Cell and tissue biology techniques for crop improvement and germplasm management;
- High throughput molecular identification of mutation events with emphasis on Targeting Induced Local Lesions in Genomes (TILLING);
- Computer-based molecular genetic and cytogenetic data analyses for bioinformatics, genetic mapping, and population genetics.

In addition to staff members of the Joint FAO/IAEA Programme, the following external lecturers provided instructions during the course:

Ms. Margit Laimer and Mr. Johann Vollmann both of the University of Natural Resources and Applied Life Sciences (BOKU, its German acronym), Vienna, Austria; Mr. Juan Fernando Fernandez of the University of Paris XI, Paris, France, and Mr. John S. Heslop-Harrison of the University of Leicester, Leicester, United Kingdom.

Each participant received CD-ROM copies of all the instructional materials.

List of participants[2]

Country	Participant
Cote D'Ivoire	Mr. Desire N'daN'Guessan POKOU
Dominican Republic	Mr. Genaro Antonio REYNOSO CASTILLO
El Salvador	Ms. Karla Maria QUINTANILLA MORENO
India	Mr. Suvendu MONDAL
Indonesia	Ms. Aryanti AMSAL
Islamic Republic of Iran	Ms. Leila BAGHERI
Iraq	Ms. Ekhlas AL-KAABI
Jordan	Ms. Nawal ABU Q. ALHAJAJ
Jordan	Mr. Faddel Mohammad M. ISMAIL
Kazakhstan	Ms. Asrandina Saltanat SHINTAEVNA
Lebanon	Mr. Ahmad EL BITAR
Malaysia	Mr. Azhar Bin MOHAMAD
Mauritius	Ms. Hiranee GOWREESUNKUR
Nigeria	Mr. Damian Ndubuisi NJOKU
Peru	Ms. Carmen Estrellita PONCE TERASHIMA
Saudi Arabia	Mr. Abdullah ALSALMAN
Saudi Arabia	Mr. Saad ALZAHRANI
Syrian Arab Republic	Mr. Basel SALEH
Thailand	Ms. Montira PUTIVORANAT
Yemen	Mr. Ali Mahmoud SALEM
Yemen	Mr. Abdulwahab Othman ALSALEHI
Zimbabwe	Mr. Nyarai Savemore NGIRAZI

Also four Fellows and Interns, Mr. J.O. Nwozor (Nigeria), Ms. L.S. Zhao (China), Mr. F.J. Froestle (Argentina) and Ms. L.N. Horn (Namibia) were given the opportunity to participate in the training course.

Enzyme Purification Training Workshop, Seibersdorf, Austria, 14–16 October 2009

Course Director: B. Till

The workshop was organized primarily at the request of the University of Silesia, Katowice, Poland, a counterpart institute in various IAEA activities including the hosting of trainees. The aim was to train the participants in the extraction and purification crude celery juice extract (CJE) which contains an enzyme that cleaves single nucleotide mismatches. Internal own laboratory capacity for the production of crude CJE contributes significantly to a lab's ability to carry out TILLING assays. There were two participants from the Polish University while a Fellow from China took the opportunity of his presence in the Unit to participate in the workshop as well.

[2] Mr. Desalegn GETINET, from Ethiopia who is studying at the Agricultural University of BOKU, Vienna, Austria audited some aspects of the course.

The three-day training workshop comprising theoretical lectures, practical exercises and computer laboratory analyses was structured around the following activities:

- Celery juice extraction
- Enzyme activity tests
- TILLING gel analyses

List of participants

Country	Participant
China	Mr. Hairui CUI
Poland	Ms. Miriam SZURMAN
Poland	Mr. Damian GRUSZKA

Services in support of activities in Member States

Eighteen Member States requested support with irradiating the propagules of 22 different plant species. Out of these, 17 were food crops; three were ornamental plants while there was one request apiece for an industrial crop and a model plant for functional genomics studies. The following irradiation service requests from Members States were handled from June to November 2009:

Member State	Crop species
Italy	Wheat
Burkina Faso	• Sesame • Cassava (plantlets)
Poland	Barley
South Africa	• Sorghum • Maize
Sierra Leone	Rice
Denmark	• Spinach • *Brachypoduim*
Kenya	Wheat
Central African Republic	Cassava (1514 plantlets)
Ireland	Shrub Hebe
The Former Yugoslav Republic of Macedonia	• *Lycopersicon lycopersicum* L. • *Capsicum annuum* L.
Jamaica	Yam
Tunisia	Wheat
Namibia	• Pearl millet • Cowpea • Sorghum Cotton
Germany	• Petunia terracotta • Petunia scarlet
Zimbabwe	• Soybean • Cowpea • Bambara groundnut
Romania	*Brassica napus*
Madagascar	• Rice • Maize
Jordan	Durum wheat

TILLING and Ecotilling positive control kit

The Plant Breeding Unit in Seibersdorf has developed a positive control kit for TILLING and Ecotilling that it is now available for researchers in Member States upon request. The kit contains genomic DNA with known nucleotide polymorphisms, gene-specific oligonucleotide primers, buffers and enzymes for mutation and polymorphism discovery. Along with the protocols, examples of high quality data produced with these materials are provided to serve as a reference point for assay optimizations.

Announcements

Conference on Green Plant Breeding Technologies, Vienna, Austria, 2–5 February 2010

This conference will cover the following topics:

- Doubled Haploids in Plant Breeding
- Molecular Markers in Plant Breeding
- Gene Mapping in Plant Breeding
- Quantitative Genetics and Plant Breeding
- Marker Assisted Selection
- Crossing Barriers: Male Sterility
- Crossing Barriers: Self Incompatibility
- Plant Genetic Resources, Natural Variability
- Genotype x Environment Interactions, Heterosis
- Alternative Breeding Technologies (but non-GMO)
- Breeding for Physiological and Morphological Traits
- Breeding for Resistance to Diseases
- Asexual Reproduction in Plant Breeding

Amongst the invited speakers are internationally known names such as H. Geiger, J.B. Nasrallah, G. Pelletier, M. Koorneef, D.J. Mackill, P. Ozias-Akins, R.J. Nelson, R. Dirks, C.D. Chase, B. Stich, A.R. Fernie, P.C. Struik, R.A. van der Hoorn, J. Snape and others. The program combines plenary lectures, poster sessions, and sightseeing tours of the beautiful city of Vienna.

For more details, visit: www.vipca.at/greenbreeding

Conference on Molecular Aspects of Plant Development, Vienna, Austria, 23–26 February 2010

- Seed development, dormancy and germination
- Plant organ development (shoot, root, leaf, etc)
- Flower development
- Plant male gametophyte development
- Plant female gametophyte development
- Plant zygotic embryogenesis
- Plant somatic embryogenesis and regeneration
- Hormones and Plant development
- Signaling in Plant Development
- Plant cell fate, totipotency, lineage and polarity
- Epigenetics and Plant development
- Modeling and Systems Biology of Plant development

Amongst the invited speakers are internationally known names such as P.N. Benfey, U. Grossniklaus, M. Tsiantis, D.C. Bergmann, V. Sundaresan, L. Ostergaard, C.S. Gasser, T. Berleth, V. Walbot, K. Palme, S. De Vries, H. Ma, M.J. Holdsworth, A.J. Fleming, F. Hochholdinger and others. The programme combines plenary lectures, poster sessions, and sightseeing tours of the beautiful city of Vienna.

For further details, visit: mapd2010@mondial-congress.com or mapd.plantmolbio@univie.ac.at

FAO International Technical Conference on Agricultural Biotechnologies in Developing Countries: Options and Opportunities in Crops, Forestry, Livestock, Fisheries and Agro-industry to Face the Challenges of Food Insecurity and Climate Change (ABDC-10), Guadalajara, Mexico, 1-4 March 2010

This conference is co-organized by FAO and the Government of Mexico, and co-sponsored by the International Fund for Agricultural Development (IFAD). The Consultative Group on International Agricultural Research (CGIAR), the World Bank and the International Centre for Genetic Engineering and Biotechnology (ICGEB) are major partners in this initiative. Participation at the conference is by invitation only.

Impetus for the conference comes from the need for concrete steps to be taken to move beyond the 'business-as-usual' approach and to respond to the growing food insecurity in developing countries, particularly in light of climate change that will worsen the living conditions of farmers, fishers and forest-dependent people who are already vulnerable and food insecure. The conference encompasses the crop, forestry, livestock, fishery and agro-industry sectors, as well as the entire range of agricultural biotechnologies currently available.

For more details, visit:

http://www.fao.org/biotech/abdc/conference-home/en/

EUCARPIA Cereal Section Meeting, Cambridge, United Kingdom, 6–8 April 2010

The conference is being hosted in Cambridge by the National Institute of Agricultural Botany.

The main topic of the conference is 'Molecular and Functional Diversity of Diploid and Polyploid Cereal Genomes: 'How can we effectively detect and exploit this variation in breeding programmes?'

A special session on 'Improvement of Bioactive Compounds in Grain and Biotechnology Toolkit for Plant Breeders' will be organized by the HEALTHGRAIN FP6 project, Module 2 leader Prof. Peter Shewry.

For further details, visit: www.niab.com and EUCARPIA homepage http://www.eucarpia.org/

The 28th International Horticultural Congress – IHC, Lisbon, Portugal, 22–27 August 2010

The world conference on horticultural sciences is under the patronage of the International Society for Horticultural Science (ISHS). The theme of the Congress, Science and Horticulture for People, emphasizes horticulture's scientific components and interactions with scientists, producers, consumers and society-at-large. People are also the target of horticulture for development. Lisbon is a magical city on the Atlantic coast of Portugal, with a delightfully cool-summer Mediterranean climate. The city, home of fado, fine dining and monuments, is close to major growing regions of horticultural crops in the Iberian Peninsula.

For further details, visit:

http://www.ihc2010.org/content.asp?page=welcome

News

Rice Mutation Breeding in China

Recent studies on Asian wild rice and land races of cultivars indicate that South Asia is most likely the main centre of origin of cultivated rice. Differentiation of the indica (hsien) rice would have occurred in South Asia, and that of the japonica (keng) rice in South-eastern and Eastern Asia. In the Chinese common wild rice, well isolated populations appeared more primitive than others, as the enzymatic variations they carried were limited. In tracing the domestication and differentiation of cultivated rice, they may be taken as prototypes. The central and lower Yangtze basin seems to be the cradle of Chinese rice cultivation as evidenced by recent archaeological excavations. In fact, during the reporting officer's duty travel to China, a visit was organized to Humudu Rice Museum of the Zhejiang Province. This museum offers a display of fossil rice discovered in the 1970s and dated back -7000 to -5000 years BP. Such a great discovery has helped, together with the identification of a few other sites, establishing China as one of the centres of origins of cultivated Asian rice.

The extraordinary wealth of mutant lines displayed by Prof. Dianxing Wu from the Zhajiang University in the Humudu Experimental Station is certainly in the direct heritage of this ancient rice cultivation tradition. Prof. Wu and his team have produced a large population of M_2 putative rice mutant lines of over one million individuals. Batches of these lines conserved in various germplasm banks in private as well as public sites are being characterised phenotypically every year under field conditions. Several high value added mutants have already been released and adopted by farmers; moreover, their products have been promoted for commercialisation, for example the new variety 'Zhefu Liangyou12' in 2009. Several other advanced mutant lines are under multi-locations trials prior to release; the mutant rice RS111 providing source for improved starch content rice for diabetes & obesity-affected people, the high zinc rice (with more than 30mg/Kg of Zinc in the polished rice), additionally a secondary mutant derived from this rice and presenting small round grains is being promoted as baby food.

The rice layer in the excavation from the Humudu site

The closed relationship between the breeders, the farmers and the agro-food industry is quite outstanding and may inspire more than one breeder as the best way for promoting their work on mutation induction and also getting the much needed additional funding.

Proud and happy farmer in front of his high zinc mutant lines under seed increase trial

Various rice mutant lines under release process from this programme (photos A, B, C and D)

A. *High zinc rice*

B. *Rice high in flavonaid healthy for coronary vessels*

C. *Rice high in lutein benefits for: eye health (reducing the risk of macular degeneration) skin health and cardiovascular health*

D. *Rice starch specific for gelatine like properties allowing the production of medicinal adjutants*

(Photos courtesy of Prof. Dianxing Wu, IAEA Collaborating Centre, Institute of Nuclear Agricultural Sciences, Zhejiang University, China).

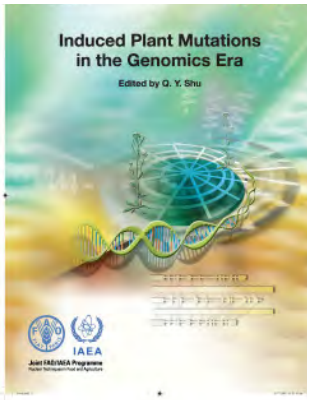
Madeleine Spencer
Technical Officer

Publications

Staff Publication in the Field of Plant Breeding and Genetics

Induced Plant Mutations in the Genomics Era (2009)

Edited by Q.Y. Shu



Abstract

Induced mutations have been widely used in plant genetic researches and breeding programmes during the past half century. This book contains 121 peer-reviewed papers contributed to the International Symposium on Induced Mutations in Plants, which was organized by the FAO and IAEA in 2008. The papers reported the progress made in the last decade in fields from breeding of new varieties to discovery and characterization of genes and clearly demonstrated the usefulness of induced mutations in numerous plant research fields in the genomics era. The topics cover plant mutagenesis, genetic diversity, biofortification, abiotic stress tolerance and adaptation to climate changes, crop quality and nutrition, breeding of seed and vegetatively propagated plants, gene discovery and functional genomics. Therefore, this publication should be an excellent reference book for researchers, students and policy makers for understanding the development and future prospect of the use of induced mutations in crop improvement and biological research. Individual papers in PDF are freely available on the Agency's website:
http://mvgs.iaea.org/MRPTableOfContents.aspx?ID=2

Recent Staff Articles Published in Scientific Journals

Mutations of the multi-drug resistance-associated protein ABC transporter gene 5 result in reduction of phytic acid in rice seeds

Xu, X.H., Zhao, H.J., Liu, Q.L., Frank, T., Engel, K.H., An, G.H. and Shu, Q.Y.

Theoretical and Applied Genetics, 2009, 119(1):75-83

Abstract

Phytic acid (PA, myo-inositol 1,2,3,4,5,6-hexakisphosphate) is important to the nutritional quality of cereal and legume seeds. PA and its salts with micronutrient cations, such as iron and zinc, cannot be digested by humans and non-ruminant animals, and hence may affect food/feed nutritional value and cause P pollution of groundwater from animal waste. We previously developed a set of low phytic acid (LPA) rice mutant lines with the aim of increasing the nutritional quality of rice. Two of these lines, Os-lpa-XS110-2 (homozygous non-lethal) Os-lpa-XS110-3 (homozygous lethal), contain two mutant alleles of a LPA gene (hereafter XS-lpa2-1 and XS-lpa2-2, respectively). In this study, we mapped the XS-lpa2-1 gene to a region on chromosome 3 between microsatellite markers RM14360 and RM1332, where the rice orthologue (OsMRP5) of the maize lpa1 gene is located. Sequence analysis of the OsMRP5 gene revealed a single base pair change (C/G-T/A transition) in the sixth exon of XS-lpa2-1 and a 5-bp deletion in the first exon of XS-lpa2-2. OsMRP5 is expressed in both vegetative tissues and developing seeds, and the two mutations do not change the level of RNA transcription. A T-DNA insertion line, 4A-02500, in which OsMRP5 was disrupted, also showed the same high inorganic phosphorus phenotype as Os-lpa-XS110-3 and appeared to be homozygous lethal. PA is significantly reduced in Os-lpa-XS110-2 (similar to 20%) and in 4A-02500 (similar to 90%) seeds compared with their wild type lines, and no PA was detected in Os-lpa-XS110-3 using HPLC analysis. This evidence indicates that the OsMRP5 gene plays an important role in PA metabolism in rice seeds.

Publications within Coordinated Research Projects (CRPs) 2009

Effects of Mutagenic Agents on the DNA Sequence in Plants (D2.40.11)

Contreras Rojas M., Pérez J.C., Ceballos H., Baena D., Morante N. and Calle F. (2009) Introduction of inbreeding and analysis of inbreeding depression in eight S_1 cassava families. Crop Sci. 49:543-548.

Rice Starch Quality Research and Utilization. Edited by Wu D.X. and Shu X.L. China Agriculture Publishing House. May 2009.

Sánchez T., Salcedo E., Ceballos H., Dufour D., Mafla G.T., Morante N., Calle F., Pérez J.C., Debouck D., Jaramillo G. and Moreno I.X. (2009) Screening of starch quality traits in cassava (*Manihot esculenta* Crantz).Starch/Stärke 61:12-19.

van der Vyver C. (2009) Submited paper: "RDA, RAPD and SSR analysis of radiation-induced genome alterations in *Vigna unguiculata",* Annals of Botany.

Wang M., Caetano-Anollés G. (2009) The evolutionary mechanics of domain organization in proteomes and the rise of moduarity in the protein world. *Structure* 17:66-78.

In press:

Dimitrova A., Todorovska E., Christov N., Stoilov L., Atanassov A. and Gechef K.. Molecular characterization of ionizing radiation-induced mutational alterations in barley. Genetics and Breeding.

Gecheff K., Manova V., Bonchev G., Kitanova M., Vlahova M. and Stoilov L. Position-specific effects in the action of mutagenic agents on the chromosomes of barley (*Hordeum vulgare* L.) Genetics and Breeding.

Sanchez, T., A. Rosero, A.P. Tofiño, K. Denyer, A. Smith, H. Ceballlos, N. Morante, and J.C. Pérez. (2009). Induction and identification of useful mutations for root quality traits in cassava. FAO/IAEA International Symposium on Induced Mutations in Plants. 12-15 August, Vienna, Austria.

Pyramiding of Mutated Genes Contributing to Crop Quality and Resistance to Stress Affecting Quality (D2.30.25)

Chen H., Qian N., Guo W.Z., Song Q.P., Li B.C., Deng F.J., Dong C.G. and Zhang T.Z. (2009) Using three overlapped RILs to dissect genetically clustered QTL for fiber strength on chro.24 in Upland cotton. Theor Appl Genet. 119: 605-612.

Song X.L. and Zhang T.Z. (2009) Identification of Quantitative Trait Loci Controlling Plant Architectural Traits in Cotton. Plant Sci. 177: 317-323.

Wu C.T., Zhou B.L. and Zhang T.Z. (2009) Isolation and characterization of a sterile dwarf mutant in Asian cotton (*Gossypium arboretum* L.). J Genetics & Genomics 36: 343-353.

Ivanova B. and Bojinov B. (2009). Identification of QTLs for fiber quality in a Bulgarian cotton breeding collection. Genetics and Breeding (Blg.), accepted.

Mondal S. and Badigannavar A.M. (2009). Molecular diversity and association of SSR markers to rust and late leaf spot resistance in cultivated groundnut (*Arachis hypogaea* L.). Plant Breeding. DOI:10.1111/j.1439-0523.2009.01635.x.

Badigannavar A.M., Mondal S. and D'Souza S.F. (2009) Success story of radiation based induced mutagenesis in groundnut (*Arachis hypogaea* L.). International Conference on Peaceful Uses of Atomic Energy, Sept 29 – Oct 1, 2009, New Delhi. Vol .II Pp: 544-545.

Do Khac Thinh, Nguyen Thi Cuc, Hung Phi Oanh & Dao Minh So et al, (2009) Mutation Breeding and Socio-economic Effectiveness in Southeastern & Highlands 2009, Proceedings of National Conference of Vietnam on Application of Nuclear Techniques, organized, 20-22th August, 2009, Nha Trang, Vietnam.

Guzy-Wrobelska J., Nawrot M., Janiak A., Adamska K., Matyszczak I. and Szarejko I. (2009) Molecular mapping of genes responsible for root architecture in barley. The 4th Conference of Polish Society of Experimental Plant Biology. Experimental Plant Biology. Why not?! 21-25 September, 2009 Kraków.

Park H.H., et al., (2009). Analyzing seed protein in a high lysine barley mutant using proteomics approach. Spring Annual Meeting of The Korea Society of Crop Science, pp. 133.

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.
2008	Vol. 2, No. 1	• Induced genetic variability in kacholam • Mutagenesis of guar • Cocoyam radiation sensitivity • Virus resistant rice variety • Cold tolerant mutant rice • Proton radiation • Tomato adapted to low water supply • Increasing crossability of mungbean	ISSN 1011-260X
2007	Vol. 1, No. 3	• Mutation breeding and genetics in Korea • Genetic enhancement of groundnut • Virus resistant banana • Ion beams implantation on wheat • Trombay mutant groundnut varieties • Lodging tolerant rice variety	ISSN 1011-260X
2006	Vol. 1, No. 2	• 30 years rice mutation breeding and genetics • Mutant groundnut varieties in Bangladesh • Shortening durum wheat plants • Seedless mutant sweet orange • Colorful chrysanthemum mutations • Radiosensitivity of cassava *in vitro* culture	ISSN 1011-260X
2006	Vol. 1, No. 1	• Rice mutation breeding in China • Long grain aromatic rices and induced mutations • Significant contribution of mutation techniques to rice breeding in Indonesia • Use of induced mutants in rice breeding in Japan • Katy deletion mutant populations • Rice mutation breeding in Vietnam	ISSN 1011-260X

Mutation Breeding Newsletter and Reviews

Year	Edition	Contents (a sampling of the papers are listed below):	Reference No.
2005	No. 1	• High yielding mutants in cotton • Drought resistant tomato • Groundnut resistant to foliar diseases • Lodging resistant glutinous rice • First ever oilseed mustard mutant	ISSN 1011-260X

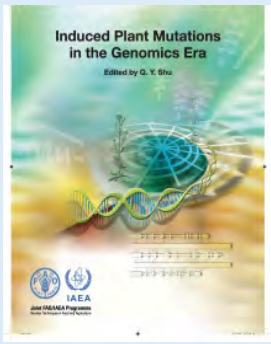
Mutation Breeding Review (published until 2004)

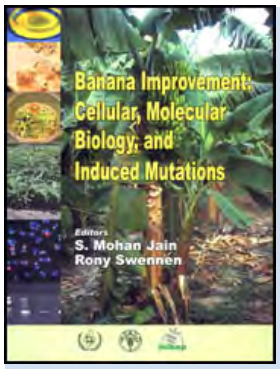
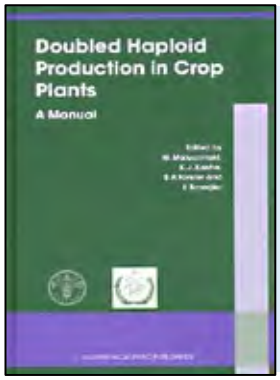
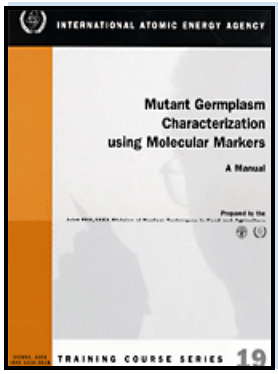
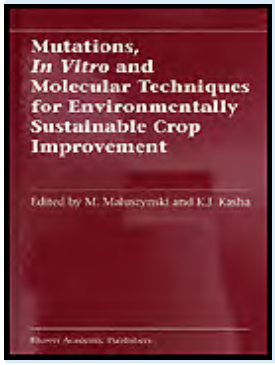
Year	Edition	Title	Reference No.
2004	No. 14	Officially released mutant varieties in China	ISSN 1011-2618
2001	No. 13	Grain legume cultivars derived from induced mutations, and mutations altering fatty acid composition	ISSN 1011-2618
2000	No. 12	Officially released mutant varieties – The FAO/IAEA database	ISSN 1011-2618
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.
2009		Induced Plant Mutations in the Genomics Era		ISBN-978-92-5-106324-9

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
2002		Mutations, *In Vitro* and Molecular Techniques for Environmentally Sustainable Crop Improvement		ISBN 1-4020-0602-0

Technical Documents

Year	Type of Publication	Title	Reference No.
2009	IAEA-TECDOC-1615	Induced mutation in tropical fruit trees	ISBN 978-92-0-1027-09-2
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	*In vitro* 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	*In vitro* 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
1994	IAEA-TECDOC-781	Mutation breeding of oil seed crops	ISSN 1011-4289

For details on IAEA Publications, visit: http://www-pub.iaea.org/MTCD/publications/publications.asp

New FAO/IAEA Database of Mutant Varieties and Genetic Stocks

Welcome to our new FAO/IAEA Database of Mutant Varieties and Genetic Stocks! At the moment, we just completed construction of the part for Mutant Variety Database, which is still in the process of information up-dating. We will add the other part for Mutant Genetic Stocks in due time. The new database has improved over the FAO/IAEA Mutant Variety Database in many ways. We are working to make the new database as the global information source of mutant varieties and mutant genetic stocks, as well as activities and events related to plant mutation breeding and research.

The key feature of the database is that you can register your mutant varieties from your desktop. For this purpose, you need first register an account; then you will be authorized to submit or edit a mutant variety.

We would greatly appreciate your support by registering your mutant variety in our database. Once the variety is registered, it will have its own 'homepage' (see below). Therefore, you can use it as an important platform to showcase your new varieties (The introduction of this variety may be shown in local language).

Please visit the website http://mvgs.iaea.org and send us your valuable suggestions and comments regarding the structure and content of this database. Please also send us other information, related to plant mutation breeding and mutant varieties, genetic stocks; we may post them on the website.

YOU MAY STILL SEND US INFORMATION ON YOUR MUTANT VARIETY AND WE WILL UPLOAD THEM INTO THE SYSTEM, IF IT IS DIFFICULT FOR YOU TO DO SO.

IMPORTANT!

AUTHOR'S GUIDELINES FOR MANUSCRIPT SUBMISSION TO PLANT MUTATION REPORTS

Articles will be indexed and abstracted in CABI!

Scope

Plant Mutation Reports (PMRs) publishes (mini) reviews, short communications and complete research papers in all areas of plant mutation research which focuses on mutagenesis, mutation induction, mutant characterization, and mutant applications. It also publishes description papers on mutant germplasm and mutant varieties. Papers on social-economic impact analysis of induced mutations and mutant varieties are also accepted.

Style

The manuscript should be concisely written with the following sections:

Title page

- Title: the title should be as short as possible, but should contain adequate information regarding the contents.
- Authors: Initials of given name followed by full family name.
- Affiliation(s)/Address(es):
- Email address: the corresponding author's email address should be given.

Abstract and keywords

A brief and informative summary of the paper not exceeding 150 words. Optional for short communications. Each paper should have 3-5 keywords.

Main text

- Review articles may be organized according to their specific requirements.
- Research articles should include: Introduction, Materials and Methods, Results (and) Discussion (this could be combined for Short communications).
- New mutant germplasm should include a short description of initial material used and the mutagen and doses applied; selection process; mutated characteristics and its genetic and agronomic analysis. Description of mutant variety should, in addition, include its performance in yield trials for varietal release and the releasing committee, when applicable.

Acknowledgements

- Acknowledgements of grants, support etc, should follow the text and precede the references.

References

The literature references should be cited either as John (1990) for single author paper, John and Johnson (2000) for papers with two authors, or John *et al.* (2000) for papers with more than two authors throughout the text, and alphabetically listed in the Reference following the style shown below:

- Periodicals: Shamsuzzaman K.M. and Shaikh M.A.Q. (1991) Early maturing and high seed yielding chickpea mutant. Mut Breed Newslett 37: 4-5.
- Books (edited by someone other than author of article): Maluszynski M. (1990) Gene manipulation in plant improvement. In: Gustafsson J.P. (ed), Induced Mutations in Plant Improvement. Plenum press, New York. Pp239-250.
- Books (identical author and editor) van Harten A.M. (1998) Mutation Breeding, Theory and Practice. Cambridge University Press, Cambridge, U.K. pp. 237-240.

Figures and Tables

- All tables and figures, e.g. photographs, graphs and diagrams should be referred to as either 'Table' or 'Fig.' and be numbered consecutively (1, 2, etc.) in the text.
- In tables, footnotes are preferred over long explanatory material in the heading or table body. Such explanatory footnotes, identified by superscript letters, should be placed immediately below the table.
- Do not use boxes; use horizontal lines only. Figures and tables should be placed on separate pages.

Units and symbols

The standard SI units and symbols should be used throughout (www.scenta.co.uk/tcaep/science/siunit/index.htm).

Publication

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Submission

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In Memoriam

Prof. Mike Gale FRS (1944 - 2009)

Prof. Mike Gale was a friend of the Plant Breeding and Genetic Section (PBG) and a knowledgeable supporter of the Sustainable Intensification of Crop Production Systems subprogram. He worked at the Plant Breeding Institute and then at the John Innes Centre (JIC), where he was an Associate Research Director and subsequently Director of the JIC until 1999. The JIC states that "He was a highly eminent scientist whose work provided many key insights into cereal genetics and breeding. […] His tireless dedication to institutions such as the CGIAR and the Rockefeller Foundation has been instrumental promoting international agricultural research."

In his obituary, Michael Pollitt confirms, that Prof. Mike Gale was "One of the country's (UK) top plant scientists, who played a leading role in helping to feed the world's rapidly-expanding population. His research into wheat genetics at the John Innes Centre was groundbreaking but he was also an inspirational promoter of international agricultural science policy. Prof. Gale, who was elected a Fellow of the Royal Society in March 1996, was also honoured by the world's scientists" through many organizations world-wide "for his outstanding contribution to cereal genetics and to crops such as wheat and millet." His many awards include the Rank Prize and "he was presented with the Royal Agricultural Society of England's research medal by the Duke of Gloucester in July 1994. Four years later, he was jointly awarded the Royal Society's Darwin Medal with colleague, Dr. Graham Moore. […] Prof. Gale's scientific achievements were legion as he also unravelled the genetics of the Green Revolution semi-dwarfing genes and of pre-harvest sprouting resistance in wheat. He mapped the molecular structure of bread wheat, which has enabled plant breeders to develop higher yielding varieties. But his impact on global science was probably as important. Since 2004, he was a member of the science council of the Consultative Group of International Agricultural Research, which represents about 2 000 scientists from 100 countries and helps to coordinate global research policies. He was passionate that better science could help to alleviate poverty in the developing world. He was a director of the Rockefeller Foundation's biotechnology program, which transformed rice research from a scientific 'orphan' into a world-beater. He encouraged the International Rice Research Institute in the Philippines to use modern molecular methods in plant breeding programmes. In 1999, he became a member of the Chinese Academy of Engineering.'

PBG is deeply indebted to Mike for his flawless and tireless support as a training lecturer, consultant and expert. His footprint can be seen in our operations, processes and program, without him we would not be as we are today.

Dr. Norman Borlaug (1914 - 2009)

Nobel Peace Prize Laureate 1970. "**The first essential component of social justice is adequate food for all mankind.**"

Dr. Borlaug's work provided the grain that allowed one billion people to live. In its tribute to late Dr. Borlaug (member of its Board of Directors for 10 years, 1994-2003), the International Center for Soil Fertility and Agricultural Development (IFDC) states: "The list of Dr. Borlaug's accomplishments and honours is long and storied. However, it is likely that he will be best remembered for being the "father" of the Green Revolution that redefined and revitalized agricultural production in Latin America and Asia. Dr. Borlaug's development of high yielding and disease-resistance cereal varieties, coupled with the correct mineral fertilizers, helped nations and even continents move from hunger and famine to food security."

In its article reporting his death, The Wall Street Journal wrote, "Dr. Borlaug upended conventional wisdom among scientists of his era both by the way he created super strains of wheat that have since spread across much of the developing world, and by proving that the world's harvests can grow faster than the human population".

PBG is gratefully acknowledging Dr. Borlaug's support of its activities and pledges to keep up his memory by avoiding complacency in its operations. His life accomplishments are an inspiration to all of us for achieving the UN Millennium Development Goals, in the spirit of Atoms for Peace, Health and Prosperity. In this issue, you will read more about the Interregional TC project INT/5/150, which was directly inspired by his work on wheat black stem rust resistance and is following his call to arms to fight an old foe that reappeared with new vigour: wheat black stem rust (race Ug99).

IAEA International Atomic Energy Agency

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