IAEA Technical Cooperation Programme

Increasing the genetic variability of rice in Colombia to secure food supply

The challenge

Rice is one of the most important staples in the Colombian food basket, and is of considerable economic and social value in the country. Although traditional crop improvement programmes have developed improved crop varieties with better yield and quality, rice is still highly sensitive to diseases such as blast. Climate change is also of great concern for the rice sector, as it has increased the incidence of abiotic stress by acid soils, and crops show poor absorption of nutrients, and are not well adapted to drought conditions. These factors contribute to an annual loss for farmers of up to 60% of their harvest.

Colombian farmers have also had to face another challenge: the increase of production costs for the use of chemicals, which has affected international competitiveness.

The project

An IAEA technical cooperation project supported by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture was established in 2014 with the goal of characterizing the genetic variability of advanced lines of rice obtained by radiation-induced mutations. The project built on an earlier TC project, COL5023, and sought to increase the genetic variability of rice, and to develop rice cultivars in Colombia that would show resistance and tolerance to various biotic and abiotic stress conditions. Biotic stress conditions that could harm rice plants are caused by diseases and insects, while abiotic factors describe external factors that include drought, heat, cold and salinity.

The project team meeting at an experimental station of FEDEARROZ, Colombia. (Photo: S.Nielen/IAEA)

A long term goal of the project was to develop elite rice varieties that would combine multiple desired characteristics, such as resistance to diseases and insect pests, and high efficiency in nutrient and water use. Breeding such varieties requires the use of modern biotechnology tools for identifying the genes conferring the desirable traits. If such traits have been achieved by induced mutations, these mutations need to be discovered by molecular tools. Once molecular markers have been developed for the traits, the related genes are progressively integrated into the genetic pool of elite varieties by molecular marker-assisted selection.

Colombia's District University Francisco José de Caldas, in collaboration with the National Federation of Rice (FEDEARROZ), have developed new rice mutant lines with favourable characteristics such as short cycle (earliness), high temperature tolerance, and improved amylose content. The project provided the University with support to establish the technology needed to identify the mutations responsible for the new traits. The results will help to speed up the process of gene pyramiding in Colombia's rice breeding programme.

The impact

As a result of the project, advanced mutant lines of rice were developed, and molecular markers for genes associated with resistance to rice blast were designed and tested in mutant plants. Moreover, certain molecules (peptides) were identified and

17-39171

characterized, which will be synthesized and used in the development of diagnostic enzyme-linked immunosorbent assay (ELISA) kits, an affordable diagnostic laboratory technology that will aid significantly in screening for disease resistance.

Knowledge transfer was also at the heart of the project: essential training was provided through fellowships and expert visits.

Essential genome sequencing equipment was purchased and set up, and the national team was thoroughly trained in operating it and in the analysis of data collected. This has strengthened the country's capacity in modern molecular technologies, and will ultimately strengthen farmers' abilities to harvest resilient crops.

Rice Field with Mutant Lines at FEDEARROZ, Colombia (Photo: S.Nielen/IAEA)

PROJECT INFORMATION

Project No: COL5024

Project title: Supporting Mutagenesis and Functional Genomics Applied to the Improvement of Rice

Duration: 2014–2016 (3 years)

Budget: €252 280

Contributing to:

Partnerships and counterparts

The main partner involved in this project was the Colombian National Federation of Rice (FEDEARROZ), a national association of rice producers with trade union status, and the counterpart is the District University Francisco José de Caldas, Colombia.

Facts and figures

- 19 advanced mutant lines of rice varieties LV 8323-287 (5) and LV823-306 (14) were developed for short cycle duration (earliness) and improved amylose content.
- Mutant line LV 1143 was under national trials for official registration. Due to the appearance of grain spotting during tests the line could not be registered but will be used for breeding purposes.
- 42 advanced mutant lines were developed with desirable characteristics, such as tolerance to drought and high temperatures. With this material, genetic resources for pre-breeding and for the development of new varieties have been established.
- FEDEARROZ breeders have started the evaluation of 170 mutant lines, specifically looking for male sterility, which is desirable for the production of hybrid rice.

The science

Mutation breeding is based on the induction of heritable genetic changes (mutations) in plant material, using gamma- or X-rays or other mutagens. The mutations are expressed in the mutant plants, which are selected for new and useful traits, such as disease resistance, or tolerance to abiotic stresses. Mutation breeding uses the plant's own genetic make-up and enhances the natural process of spontaneous mutation. Apart from further advancing and testing the selected mutant rice lines, the project has introduced new state-of-the-art technologies to discover the mutations either in the genes or in the gene products. High-throughput DNA- and RNA sequencing in combination with powerful bioinformatics tools allow the identification of the mutations. Molecular markers can be developed that will aid the introduction of beneficial mutated gene(s) into other varieties.