



Using water and nutrient management to increase rice yields in Panama

The challenge

The average rice consumption per person in Panama is around 80kg per year. During the 1970s, local rice production could satisfy national needs, and enough rice was also produced for export.

Optimum rice crop yields depend heavily on a good pattern of water supply from rainfall. In recent years, however, climate change has affected both the frequency and amount of rainfall in Panama. Rice crops are under continuous conditions of water stress, which has a negative effect on nutrient availability, especially nitrogen, and on its absorption by the plant. This has resulted in decreasing yields and economic losses for farmers, many of whom have eventually abandoned this crop.

In 2014, rice yields were approximately 4.3 tons per hectare and around 6000 tons of rice had to be imported to meet Panama's needs every year.

The project

Rice sowing takes place at the beginning of Panama's rainy season. Nitrogen is applied via a

single dose of nitrogen, phosphorus and potassium (NPK) fertilizer. Panama sought the IAEA's support to determine the efficiency of the use of nitrogen and potassium fertilizers.

With the support of an IAEA technical cooperation project, more than 100 staff from the Ministry of Agriculture, as well as rice farmers, were trained in the management of fertilization and soil water. The Agricultural Research Institute of Panama aimed to determine the best dose of nitrogen for the rice crop with the support of the Food and Agriculture Organization of the United Nations, through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Soil samples were sent for analysis in the isotope laboratory at the University of Florida. The information generated from the analysis demonstrated that a single application of very high dose nitrogen fertilizer did not contribute to increasing crop yield. Instead, the nitrogen was lost to the atmosphere by volatilization due to the climatic conditions of the country. The nitrogen use efficiency was around 35%. Potassium, however,



Plots to test the efficiency of nitrogen and potassium fertilizers. (Photo: José Ezequiel Villarreal N/IDIAP-CIAC)

was generally used well with an efficiency of 60%. Furthermore, research showed that nitrogen application should be split, applying it at 25, 40 and 55 days after germination of the crop. Potassium, on the other hand, was best applied at the planting stage, because of its immobility and slow dissolution.

The findings also demonstrated that maintaining soil moisture without allowing it to dip below 35% did not affect crop yield. Soil moisture sensors were installed to a depth of 90 cm to monitor water content to ensure soil water was maintained above 35% so that crop performance during critical stages was not affected.

Professors and students from the Agricultural and Cattle Research Institute of Panama were trained during field experiments. Extension technicians of the Ministry of Agriculture and associates of the cooperatives of rice farmers visited the plots and the results of the project were presented in a final dissemination event.

The impact

As a result of the project, changes were made to fertilizer and water management, and crop yields increased by 50%, from 4.3 to 6.5 tons per hectare. This increased farmer income by more than \$40 000 per hectare (\$20 per bag of 45kg of rice) and is an important step towards rice production self-sufficiency in Panama.

The project also benefited the environment, as the findings of the study clearly showed that high doses of nitrogen were not needed to ensure increased performance. Nitrogen losses due to volatilization and leaching could be reduced by the targeted application of fertilizers, eventually protecting the environment and groundwater reservoirs, and reducing farmers' expenses.

The science

In the nitrogen study, urea, labelled with isotope N15, was used as nitrogen fertilizer. It was applied to a small plot of the rice field to track and measure how much the labelled fertilizer was absorbed by the crop, to determine the efficiency of fertilization and the best dose that should be recommended to farmers. In this case, 120 kg/ha was observed to be sufficient to obtain excellent yields of over 6 t/ha.

In the case of potassium chloride fertilizer, insoluble potassium (0-0-60) was used and mixed with potassium chloride rubidium enriched isotope 85. As this isotope is also absorbed by the plant, it is possible to measure how much of the absorbed potassium came directly from the fertilizer applied to the soil. In this case, 80 kg/ha is sufficient and an efficiency of 60% was achieved.

Soil water monitoring was carried out up to 90 cm depth using a soil moisture sensor. This information can be viewed online or on a cellphone, allowing real-time monitoring of changes in the moisture content of the soil. In the experiment it was found that maintaining a soil moisture of 35 % was sufficient to not affect the yield of the crop, especially in the critical stages of the crop (tilling, flowering and grain filling).

PROJECT INFORMATION

Project No: PAN5023

Project title: Enhancing Rice Crop Yields by Improving Water and Nutrient Management Using Nuclear and Isotopic Techniques

Duration: 2016-2017 (2 years)

Budget: €86 700

Contributing to:



Partnerships and counterparts

- Agricultural Research Institute of Panama;
- Ministry of Agriculture;
- International Centre for Tropical Agriculture Research (CIAT);
- Centre for Nuclear Energy in Agriculture (CENA);
- University of Ecuador;
- University of Panama;
- Veraguas Rice Farmers Association;
- Tonosi Rice Farmers Association;
- Technological University of Panama.

Facts and figures

- The average yield of rice in the test plots increased from 4.3 ton/ha to 6.5 ton/ha;
- Nitrogen fertilizer efficiency increased by 10% to 35% by the end of the project;
- Potassium fertilizer efficiency also increased by 10% to 60% by the end of the project;
- Soil moisture of 35% was discovered to be optimal after monitoring.