Benin farmers triple yields and improve livelihoods thanks to isotopic technique

Félix Kouelo Alladassi, Assistant Professor in Soil and Water Conservation at the University of Abomey-Calavi, preparing soybean plants for an experiment using isotopic techniques.

(Photo: M. Gaspar/IAEA)

Soybean farmer Leonard Djegui never had the chance to go to school, but he has learned two facts about nuclear science in recent years: atoms make up the soil and they have helped triple his income, allowing him to build a new house and send his children to university.

Djegui is not alone: around 14 000 farmers in central and northern Benin have achieved significant yield increases for both maize and legume crops such as soybean — providing more food for their families and much higher incomes than they could even dream of a few years ago.

“I did not go to school, but I do understand that science is important,” Djegui said, proudly showing his new house, made of bricks, replacing his previous mud hut. “It allows my maize and soya to grow taller and provides for a much richer harvest.”

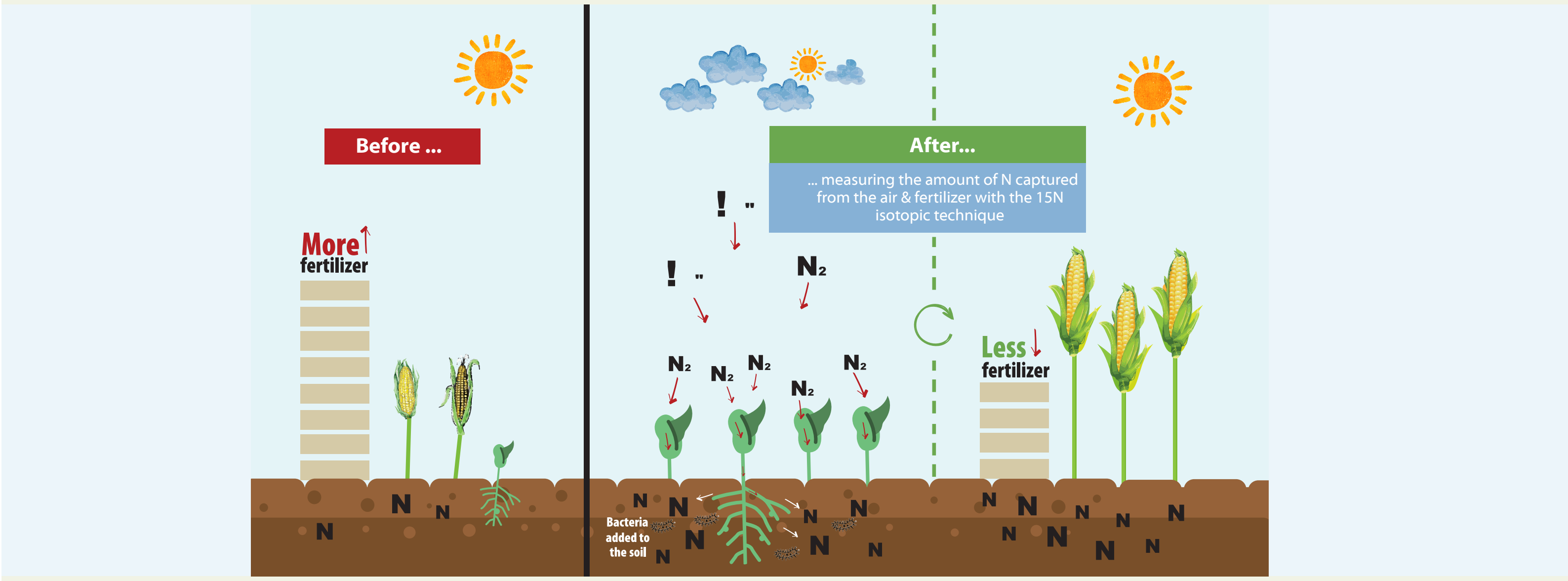
The secret: the use of isotopic and nuclear-derived techniques to measure and properly increase the amount of nitrogen — necessary for plant growth — the crops take up (see The Science box). Legumes such as soybean and peanuts are able to take up nitrogen from the air, which they then deposit in the soil, making it more fertile for the maize crop that farmers plant the following season, explained Pascal Houngnandan, Vice President of the National University of Agriculture and Director of Soil Microbiology at the University of Abomey-Calavi, the country’s main research institution, just outside the capital Cotonou. This intercropping of maize and legumes results in increased yields of both crops. Depending on the soil type, it also means little or no commercial fertilizer is required, saving farmers that additional expense.

The IAEA, in cooperation with the Food and Agriculture Organization of the United Nations (FAO), has supported the project by providing expert advice and helping Houngnandan and his team interpret the data. The IAEA, through its technical cooperation programme, has also provided much needed equipment and training that allow the researchers not only to conduct the experiments, but also to produce the bacteria required for the legumes to take up even more nitrogen from the air.

Scientists in 70 countries benefit from such assistance, including support to customize the method to their particular crops and soil types, said Joseph Adu-Gyamfi, soil fertility management specialist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

Mixing seeds and bacteria

In June, at the beginning of the planting season, Djegui and his neighbours were busy mixing the bacteria received from the lab with the soybean seeds that were to be planted in the following weeks. Meanwhile, other workers from this village of 1000 were clearing weeds from surrounding land that used to lay bare, so that more soybean can be grown.



The nitorgen-15 isotopic techique enables scientists to measure the amount of nitrogen legumes conver from the air and deposit in the soil, thereby improving soil fertility for other crops - in this case maize. Using bacteria, they can also enhance the legumes' ability to fix more nitrogen. (Infographic: F. Nassif/IAEA)

Albert Ahotondji, one of Djegui's neighbours, is now growing soybean on six hectares of his land, up from two hectares two years ago. Previously he did not have the cash to buy seeds and fertilizer for all of his land, and was forced to leave some of it unused. He now has enough cash to till his entire land and can also put money aside for when his children go to university. "I will be able to afford to rent a room for them in the city," he said proudly.

It is the fourth consecutive season that the smallholder farmers of this village have been making use of the bacteria they buy from the university through the extension workers, who also showed them how to improve their farming practices.

There are 100 000 soy farmers around Benin, and the use of the new technique is spreading fast, said Fortuné Amonsou Biaou, Executive Director of the National Union of Soybean Producers of Benin. Seeing yields triple or even quadruple is very common, he said. Depending on the region, farmers used to harvest between 500 and 800 kilograms of soybean per hectare. This has now increased to between 1.2 and 2 tons. This is particularly important in this primarily agricultural country, where over half of the population is engaged in farming, which makes up 40% of the economy.

Soybean is used to make vegetable oil and animal fodder, and is also a major export crop on regional markets. "By also increasing maize yields, we increase food security for the rural population, while the higher soybean production increases their disposable income," Amonsou Biaou said.

Houngnandan founded the laboratory in 2002 to research the impact of intercropping on yields. Experiments with the use of isotopic techniques and the inoculants began a few years later, and field experiments followed in 2008. A few farmers started to use the technique as part of a pilot project in 2011, with large-scale use beginning in 2013, when the growers' association and local agricultural authorities joined in to promote it. During the 2016-2017 growing season, the laboratory produced 16 000 bags of the inoculant bacteria in the form of biofertilizers.

"It has taken us a while to scale up, but the results are very clear now," said Houngnandan while demonstrating the use of the equipment he has received from the IAEA. "I hope that in a few years every single farmer will be using it."

The Science: nitrogen uptake from the air

Scientists have known for decades that legumes can convert nitrogen from the air and deposit it in the plant and in the soil, thereby improving soil fertility. What they did not know until recently was how to measure accurately the amount of nitrogen that can be taken up by each type of crop and how to enhance legumes' ability to fix more.

When legumes are inoculated with a dose of bacteria, their ability to fix nitrogen from the air increases dramatically, as the bacteria facilitates the development of the nodules on legume roots that fix nitrogen. Researchers at the Joint FAO/IAEA Division have promoted the nitrogen-15 isotopic technique to measure how much nitrogen the legume absorbs from the air. It is based on the use of a labelled isotope of nitrogen, which has the same chemical properties as ordinary nitrogen, but contains an extra neutron, which allows it to be tracked. This nitrogen-15 methodology can also be used to estimate how efficiently cereal crops such as maize, rice and wheat absorb nitrogen fertilizer applied to maximize crop yields.

— By Miklos Gaspar