Costa Rica paves the way for climate-smart agriculture

By Laura Gil

"In our transformation towards a knowledge-based economy, we're making efforts to develop sustainable agriculture and industry, applying science and technology."

— Carolina Vásquez Soto, Minister for Science, Technology and Telecommunications, Costa Rica

Costa Rica's Government is using nuclear techniques to reconcile two objectives: to become carbon neutral, while also remaining the world's number one producer of pineapples, which require a significant amount of fertilizer. With the help of the IAEA and the Food and Agriculture Organization of the United Nations (FAO), Costa Rican experts are exploring the use of nuclear technology to help producers grow fruit and other crops more efficiently and ecologically. They are testing how a new type of soil additive could help cut down the use of pesticides and fertilizers, as well as reduce greenhouse gas (GHG) emissions.

"Most producers apply more fertilizers and pesticides than the pineapples need, and a large part of these are lost to the atmosphere as greenhouse gases or pollute rivers and groundwater," said Cristina Chinchilla, agronomy scientist at the University of Costa Rica's Environmental Pollution Research Center (CICA).

CICA experts are working with the IAEA and the FAO to use biochar, a carbon-rich material produced from natural residues. In other parts of the world, biochar has been shown to improve soil fertility while helping to reduce the negative impact of chemicals on the environment.

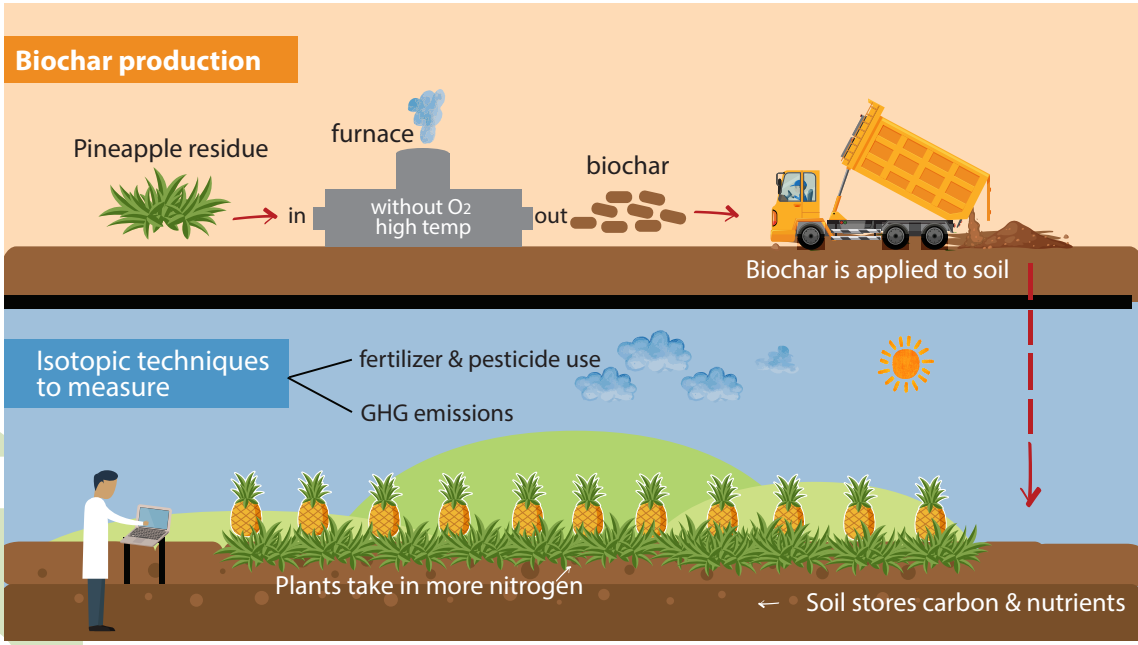
Pineapples and biochar

As Costa Rica generates more than 10 million tonnes of pineapple residues as a by-product per harvest every 18 months, the CICA team decided to use these residues to produce biochar.

Through an IAEA technical cooperation project, CICA experts are using nuclear-derived techniques to test the benefits of biochar. They crush the pineapple plant residue to produce biochar for farmers to use on their soil. They then apply pesticides labelled with a radioactive isotope — carbon-14 (^{14}C) — to plots of soil, which allows them to follow the behaviour of the pesticide molecules. With this technique they can also find out if biochar helps the soil store more carbon, reducing carbon dioxide (CO_2) emissions.

CICA experts also use fertilizer labelled with a stable isotope — nitrogen-15 (^{15}N) — to trace its pathway. Using this technique, they plan to see if pineapple plants can take up fertilizer in a more efficient way when planted into soil rich in biochar.

Reducing fertilizer and pesticides makes business sense. "Fertilizer and pesticides are expensive," said Donald González, a pineapple producer in Pital, northern Costa



Rica. “Sometimes we have to choose: either the plants eat or the family eats.”

Driven by growing environmental concerns, and stricter import regulations, the Costa Rican Government has established strong regulations for pineapple producers, banning certain chemicals and promoting sustainable practices.

The possibility of reducing fertilizer and pesticide use, while allowing farmers to continue earning a living and growing the crops the world demands, is the balance that all sides are looking for.

Reducing greenhouse gas emissions

In its plan to become a carbon-neutral country, Costa Rica is looking for ways to reduce its GHG emissions. Through the support of the IAEA and the FAO, experts are using nuclear techniques to measure the amount of GHG emitted from soil, including soil mixed with biochar, and to track where exactly these emissions come from.

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According to the Intergovernmental Panel on Climate Change (IPCC), agriculture and changes in land-use practices contribute to over 24% of the global release of GHG, and this continues to increase.

Donald González, pineapple producer in his field in Pital, northern Costa Rica, where scientists will test biochar.
(Photo: L. Gil/IAEA)

“Reducing greenhouse gas emissions related to agriculture is key to combating climate change,” said Ana Gabriela Pérez, coordinator of the University of Costa Rica’s National Reference Laboratory for Greenhouse Gases and Carbon Sequestration, which the IAEA equipped in 2014.

Isotopic techniques can provide essential information on the sources and amount of agriculturally derived greenhouse gases, said Mohammad Zaman, a soil scientist at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. “This information provides policy makers with sufficient knowledge to make informed decisions on carbon policies.”

THE SCIENCE

Carbon sequestration in soil

Soil is a mixture of minerals, organic matter, gases and water. Carbon is a key ingredient of soil and its health, but in a gaseous form as CO_2 it is a GHG. Plants capture carbon in the form of CO_2 from the air, transforming it into organic matter, which boosts soil productivity and resilience to harsh climate conditions.

The idea of soil capturing and storing atmospheric carbon dioxide, also known as carbon sequestration, can counterbalance the increase of GHG. Analysing the carbon-14 isotopes allows researchers to evaluate soil quality and sources of carbon sequestered in the soil. By measuring carbon sequestration, they can identify whether biochar is enhancing soil fertility and helping reduce CO_2 emissions.

Similarly, by using fertilizers in defined plots labelled with the nitrogen-15 stable isotope (^{15}N), scientists can track the amount of nitrogen taken up by plants or lost to the atmosphere as GHG or to surface and groundwater, and can determine how effectively the crops are taking up the fertilizer. This helps them optimize fertilizer use on farms.