

# Challenges & Innovations

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## Scientists uncover "missing link" to sustainable agriculture



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The breakthrough centers on the discovery of brachialactone, a hitherto unknown chemical compound released from the roots of the tropical pasture grass *Brachiaria*. The compound has been

shown to reduce nitrification, a soil microbial process that leads to nitrogen leakage into the environment, which is largely responsible for nitrogen pollution. Nitrification and denitrification processes in agricultural systems release nitrous oxide, a powerful greenhouse gas 300 times more potent than carbon dioxide. The finding could be particularly important for improving the nitrogen efficiency of cereal crops, which "waste" nearly 60% of the nitrogen applied in fertilizer—losses amounting to around US\$17 billion per year.

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## Scientists uncover "missing link" to sustainable agriculture



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The discovery comes from long-term collaboration between CIAT, the Japan International Research Center for Agricultural Sciences (JIRCAS), and the National Food Research Institute (NFRI) in Japan, and it marks the end of a 3 decade-long riddle. In the 1980s, CIAT researchers observed reduced soil nitrification in fields planted with *Brachiaria* grasses and recent work demonstrates that these grasses also release less nitrous oxide. The research article published in PNAS clarifies the underlying mechanism for the first time, and characterizes this unique plant function, known as biological nitrification inhibition (BNI).

"This is the first step in locating the gene responsible for nitrification inhibition and could very well be a critical step towards finding a genetic solution to improving nitrogen use efficiency in major staple food crops and pastures," said CIAT Director General Ruben Echeverría. "The discovery could be a major advance in improving the eco-efficiency of agriculture by reducing the amount of nitrogen fertilizers applied to crops and could help reduce the impact of nitrogen fertilizers on the environment, which is clearly a win-win position."

"These findings also show that research takes time to produce results," he continued. "There could be several other great opportunities out there to improve productivity and the management of natural resources, one of the challenges is identifying long-term sources of funding for agricultural research."

The research was partly funded by the [Ministry of Foreign Affairs of Japan](#).

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## CIAT's new structure will maximize impact



CIAT is pleased to announce an update of its organizational structure, which places its Latin American roots at the heart of its research strategy.

CIAT's current 10 Research Programs are part of three Research Areas: Agrobiodiversity (focusing on plant genetics and biotechnology); Tropical Soils (focusing on fertility and land management), and a regional research area dedicated to Latin America and the Caribbean (LAC).

The LAC research area signifies CIAT's recommitment to eradicating hunger and malnutrition and promoting eco-efficient agriculture in the region, through targeted research and by rebuilding ties with local and national institutions. In addition to a specific research area devoted to LAC, the other two areas will continue to play an important role in the region. CIAT's work in LAC will build upon the ongoing successes of its regional offices in Africa and Asia in providing sustainable, scientific solutions to hunger.

CIAT Director General Ruben Echeverría said: "The new organizational structure embodies CIAT's vision for the future. It is essential that we develop a strong relationship with Latin America while ensuring our regional work in Africa and Asia continue to play a vital role in the success of the organization. This is a chance for CIAT to reengage in LAC and ensure that, working in partnership, its groundbreaking science has maximum impact."

The new structure also sees the creation of the Decision and Policy Analysis (DAPA) Program, which marks a new era of impact assessment for the organization. DAPA will ensure that CIAT's work across the tropics continues to improve the livelihoods of the poorest of the poor and will help to guide the organization's future research. Also, a dedicated Intellectual Property service, in collaboration with the [CGIAR](#), will provide programs, donors, and partners with expert legal advice for developing their research.

You can see the overall structure in more detail [here](#).

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## End of the road for "Enola" bean



It seems the decade-long legal wrangle over the controversial "Enola" bean patent has finally been put to rest. On 16 September US courts rejected the latest legal move by seed company POD-NERS, which has been seeking to overturn a 2008 ruling to revoke the patent.

The latest decision marks a major victory for CIAT, the [CGIAR](#), our partners, breeders, and small farmers everywhere. It should also be the end of the so-called "Enola" bean once-and-for-all.

For details of the latest decision, see [here](#).

For a detailed background to one of the longest-running cases of biopiracy, see [here](#).

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## Global Soil Map could transform agriculture



An ambitious new project to digitally map soils all over the world could transform agriculture. An article in the journal *Science* describes how the GlobalSoilMap.net ([GSM](#)) initiative could help tackle pressing problems such as food insecurity, climate change, and environmental degradation worldwide.

The initiative follows the launch of the African Soil Information Service ([AfSIS](#)) earlier this year, which will use the latest satellite technology to produce high-quality maps of Africa's soils in order

to fine-tune farming practices. GSM will use the AfSIS methodology to produce similar maps for the whole world.

According to GSM, the project should produce "fine-resolution, three-dimensional grid of the functional properties of soils." It aims to provide highly accurate soil information in real-time, as well as state-of-the-art analysis of soil properties. This can include factors such as soil water storage and carbon density, which can be crucial for farmers, scientists, and policy-makers taking decisions about land use. The project also calls for the information to be made available free, online.

"Improved soil management for better crop productivity is crucial for providing food security—an intensifying challenge in the context of population growth, increasing numbers of hungry people, and the impacts of climate change on agriculture," said Pedro Sanchez, director of AfSIS and the Tropical Agriculture Program of [The Earth Institute at Columbia University](#). Sanchez is one of team of authors writing in *Science* (7 August 2009), outlining their vision of a global soil map.

The article explains how the map-making technology will be deployed, as well as some of the problems with existing soil maps, which are often paper-based, compiled using outdated or imprecise methodologies, and of visual quality too poor to be of practical use in land management. Finally, the article explains that scientists will be able to use the new information to develop evidence-based soil management recommendations to help agricultural extension workers, farmers, land-use planners, wildlife managers and more.

"A few years ago the very idea of a global digital soil map was little more than a dream—now it's fast becoming a reality," said Dr Nteranya Sanginga, of the Tropical Soil Biology and Fertility ([TSBF](#)) Institute of CIAT, the main implementer of AfSIS. "The Digital Soil Map for Africa will transform agriculture in Africa; a global map could transform agriculture globally."

Work is already underway in sub-Saharan Africa, following an US\$18 million grant awarded to CIAT from the [Bill & Melinda Gates Foundation](#) and the Alliance for a Green Revolution in Africa ([AGRA](#)), which established AfSIS. The initiative will produce the first-ever detailed digital soil map of 42 countries in the region.

CIAT's TSBF Institute, based in Nairobi, Kenya, is leading the effort, with the support of The Earth Institute at Columbia University in New York, the World Soil Information ([ISRIC](#)), and the

World Agroforestry Centre ([ICRAF](#)), also based in Nairobi. The project has been widely endorsed by national governments and the training of national research scientists to work with the new tools is underway.

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## Cassava "accident" brings tolerance hope



When a consignment of carotene-rich cassava roots was packaged and sent for bioavailability tests, there was the usual hopeful wait for results. Ten months later and those results, soon to be officially announced, suggest that the carotene contained in yellow-flesh of the so-called "egg yolk" cassava has good bioavailability, meaning it can be easily absorbed by humans, and converted into the essential micronutrient vitamin A. This in itself is great news for CIAT and researchers working as part of the [CGIAR-wide HarvestPlus](#) program. But the story doesn't end there.

In an interesting twist, a handful of surplus roots that were omitted from the consignment and left in a store room were discovered by a researcher 2 months later—in pristine condition. Cassava roots normally degrade naturally within just 2-3 days, due to post-harvest physiological deterioration (PPD), which leaves them unusable either as food or by industry. Realizing the potential importance of the discovery, the researcher quickly raised the alarm.

"The roots should have been totally spoiled and rotten," explained Hernán Ceballos, coordinator of CIAT's Cassava Program, "but when they were cut open they were completely PPD-free. What was interesting was that the yellow color of the root had faded away. A biochemical hypothesis can explain this finding: the antioxidant activity of carotenoids gives the root some kind of PPD tolerance."

The potential impact of the discovery is far-reaching, as PPD is a major constraint on cassava production, transport, and processing. "PPD imposes a pressure on the whole cassava production system," continued Ceballos. "The root has to be taken from the ground and be processed or consumed within 3 days. Imagine the advantages if farmers could harvest their cassava all at once, store it safely, and plant a new crop straight away. For industry, PPD tolerance means that if a truck breaks down or there is a power cut in a processing plant and it takes a couple of days for things to return to normal, the crop could still be usable.

"This could be an important discovery in solving the major problem of cassava root storage."

Despite the excitement, Ceballos and his team are proceeding with caution, and have set up a series of experiments to assess the deterioration of carotenoid-rich roots over periods of up to 40 days. They are also keen to establish whether the supposedly PPD-tolerant roots were affected in some way by a growing season that saw unusual levels of rainfall, and the possible influence of the roots' lower-than-usual dry matter content, which can reduce the



rate of PPD. But the team is hopeful that the discovery backs a previous study from 2004 that found a weak, but positive link between carotenoid content and PPD tolerance.

"Serendipity is a part of the life of a scientist, like Fleming's discovery of Penicillin," said Ceballos. "We don't expect that in 20 years cassava will be stored like potato or sweet potato, but it is possible that roots will be able to be left for 2-3 weeks from harvest to processing without spoiling. That will be a major contribution.

"Beyond anything else, this shows that there is great value in cassava, and that there are hidden treasures in its germplasm that are just waiting patiently for us to discover them."

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## The power of cassava fuel



The first vehicle completely powered by a biofuel made from cassava roots is on the move in the department of Valle del Cauca, Colombia. The test run is being carried out using a CIAT pick-up truck and fuel produced in conjunction with [Clayuca](#) (Latin American and Caribbean Consortium to Support Cassava Research and Development).

The fuel was produced using ethanol prepared by Clayuca's pilot plant at CIAT's headquarters in Cali, which has the capacity to produce an average of 300 liters of hydrated ethanol (containing 4%-5% water) per day.

The processing plant is part of a major project to develop rural social bio-refineries—low-cost fuel production plants that use cassava, sugar sorghum, or sweet potato as feedstock. As well as powering vehicles, cassava biofuel can also be used to generate electricity—a lifeline for rural communities in developing countries lacking access to the national grid. Waste products from fuel production can be used to make fertilizers and nutritional blocks for livestock.

"The potential impact is enormous if we consider that, according to the United Nations, nearly 2 billion people worldwide still do not have access to electric power. Any rural community that is not yet connected to electricity power can set aside 3-5 hectares to grow cassava as an energy crop and what they would produce would be sufficient to provide electric power for 6 hours a day, all year round."

The biofuel requires the use of inedible high-starch cassava varieties, developed by CIAT researchers for industrial use, meaning there is no direct trade-off between fuel and food. The stems of sugar sorghum and sweet potato can also be used.

You can see the full story [here](#).

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## Bucking the trend: cassava enters the climate spotlight



Cassava could be about to experience something of a heyday. With climate change expected to take its toll on staples like rice, wheat, and maize, the potential of cassava—notoriously hardy when the going gets tough—is growing by the day.

CIAT climate change models show that by 2050 almost one-fifth of cassava-growing land is expected to benefit from rising temperatures and changes in rainfall. While this is good news for one of the world's most important sources of carbohydrate, improving cassava varieties to

become even more resilient could result in an additional 60 million hectares of new land becoming suitable for cassava production.

Grown across the tropics for its energy-packed tuberous roots, cassava is of particular value to smallholders due to its remarkable ability to tolerate drought-like conditions and thrive in poor soils. While it is predominantly grown as a food crop in Africa and Latin America, cassava starch processing is a major employer, and Asia is a world leader in the industrial production of the crop.

In order to protect both food and livelihoods, improved cassava varieties that capitalize on the crop's inherent resilience could become the cornerstone of climate change adaptation. This is particularly true of Latin America—the ancestral home of cassava—that has much to gain from improved varieties. While some parts of the region are likely to see increases in cassava suitability, the models show large areas where suitability falls. It is in these frontiers where improved cassava could have the greatest impact.

According to climate change expert Andy Jarvis of CIAT's Decision and Policy Analysis Program, developing cassava lines with improved tolerance to both heat and cold, and greater resistance to drought and flooding is essential.

"The message coming out of the modeling is that there is no single trait that provides global gains for cassava. Instead, breeding must tackle multiple constraints," said Jarvis. If this happens, then by 2050 these new technologies could benefit one-third of current cassava fields in Latin America, and nearly triple the area suitable for cassava production. But there is one catch: there is no time to lose.

"The scientific community makes these decisions now," urged Jarvis. "It takes a minimum of a decade from beginning work on crop improvement to getting the new variety in farmers' fields, so we need to be looking closely at what the models are telling us about the future challenges, and tailoring our research to match. With the right science and the right priorities, cassava could become a super-crop, but we have to move now."

Jarvis also stressed the importance of research-and-development networks, such as [Clayuca](#) (Latin American and Caribbean Consortium to Support Cassava Research and Development) for ensuring new technologies reach farmers quickly. The CIAT-coordinated network, which recently celebrated its 10th anniversary, has members from the public and private sectors in 16 countries, all working to improve the generation, and exchange of new cassava-related technologies. The initiative has been responsible for the development, adaptation, and transfer of several "technological platforms" for cassava production, processing, and utilization that are helping farmers increase yields and improve livelihoods.

"Collaboration and dissemination are essential for climate change adaptation," continued Jarvis. "Networks like Clayuca are vastly improving the impact of cassava research; they enable high-speed links between the laboratories and farmers' fields."

Uncertainties remain about the impact of climate change on cassava's susceptibility to pests and diseases, and therefore the extent to which increases in land planted to the crop will correspond to increases in yields. While Jarvis recognizes the limitations of the climate models, he is also assured of the need for action.

"There's simply no time to wait-and-see," he continued. "By combining the right research now, with the right partnerships and the right methods for dissemination, cassava can fulfill its potential as a crop capable of thriving in the face of climate change."

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