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Rice is from China, Findings say

Research now points to China as the origin of domesticated rice. These new findings have caused a rethink of past research suggesting that rice was domesticated in India as well as China *and* at different times.

A team of US-based genome researchers traced back thousands of years of evolutionary history through large-scale gene re-sequencing, they found that about 9,000 years ago farmers in the Yangtze Valley of China grew the world's first domesticated rice.

The team led by, Barbara Schaal of the Washington University in St Louis and Michael Purugganan of New York University, published the study titled "Molecular evidence for a single evolutionary origin of domesticated rice", in May Proceedings of the National Academy of Sciences (PNAS).

Asian rice, *Oryza sativa*, is one of world's oldest crop species. It is a very diverse crop, with tens of thousands of varieties known throughout the world. Two major subspecies of rice *japonica* and *indica* represent most of the world's varieties. Sushi rice, for example, is a type of *japonica*, while most of the long-grain rice in risottos are *indica*.

Due to its diversity the origin of rice has been the subject of scientific debate. One theory suggests that *indica* and *japonica* were domesticated once from wild rice. Another, a multiple-origin model, proposes that these two major rice types were domesticated separately and in different parts of Asia. The latter has been more popular in recent years as biologists have observed significant genetic differences between *indica* and *japonica*.

In this latest study, the researchers re-assessed the evolutionary history of domesticated rice using previously published datasets, some of which have been used to argue that *indica* and *japonica* rice have separate origins. Using more modern computer algorithms, however, the researchers concluded these two species have the same origin because they have a closer genetic relationship to each other than to any wild rice species found in either India or China.

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Slow But Steady Growth for Africa

In 2010 Africa attained a biotech first, South Africa, Africa's first and biggest adopter of biotech crops, was ranked amongst the world's top ten in terms of biotech crop acreage. It stood at number 7 with about 2.2 million hectares under soybean, maize and cotton. The figures are based on ISAAA's (International Service for the Acquisition of Agri-biotech Applications) annual report on the global status of biotechnology for 2010.

Last year, Africa's other significant mention, Burkina Faso, grew biotech cotton for its third year running. About 80,000 farmers - most of whom were smallholders - cultivated 260,000 hectares of insect-resistant cotton, otherwise known as Bt cotton. The land under Bt cotton increased 126 percent from the 2009 figure of 115,000 hectares. Biotech cotton now makes up 65 percent of all cotton grown in Burkina Faso and is yielding positive results. Burkinabè farmers are reporting benefits of growing biotech over conventional cotton; there's an average yield increase of about 20 percent, plus a savings on labour and insecticide spraying costs - farmers are now spraying twice rather than six times.

> "the second decade of commercialization is likely to feature significantly more growth in Asia and Africa..."

For Egypt, which strides Africa and the Arab world 2010 was also a growth year. The country grew 2000 hectares of 'Ajeeb YG' insect-resistant maize up from 1000 in the previous year, this amid hitches in importing….Egypt was the first in the Arab world and the second African nation to commercialise biotech crops. The country planted its first commercial acres of biotech crops in 2008. While growth in the biotech acreage has been slow, this country probably has one of the most active biotechnology research institutes on the continent.

As yet, there isn't any GE crop growing commercially in East Africa, but the region holds a great deal of promise for future forays into biotechology. Kenya and neighbouring Uganda already have several seasons of trials for Bt cotton under their belt; both nations

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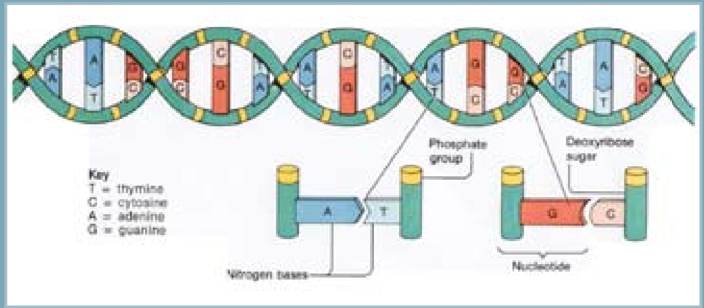
inside

Advanced DNA Technology Thousand Times more Sensitive

An international team of researchers has developed new DNA technology which makes it possible to perform reliable analyses on DNA quantities that are a thousand times smaller than was previously the case.

The method can be used, for example, to study small quantities of stem cells, starting tumor tissue, parts of plant and animal tissue, and archaeological samples. The team, is publishing the new method in Nature Methods under the name LinDA.

The main difference between LinDA and commonly used methods, is how DNA molecules are copied to make them identifiable in analysis equipment. With the current PCR-based DNA amplification methods only fragments between two primers can be amplified. Therefore regions with a higher GC content are more often amplified than regions with a higher AT content, as primers with high GC content bind to the DNA template at a higher temperature. With existing PCR based methods DNA fragments are amplified exponentially while LinDA, DNA is amplified linearly.



The latter is in particular attractive for the identification and quantification of low abundant DNA (or RNA) fragments.

In the new technology a specific DNA fragment is attached to the beginning and end of all DNA molecules in an analysis sample. This fragment is based on a specific piece of DNA that derives from a virus: the so-called T7 promoter. All DNA fragments containing this T7 promoter will be transcribed multiple times enabling DNA identification.

The new technology only copies original DNA molecules, while the commonly used techniques also copies copied molecules. The 'old' technologies are therefore often called 'exponential' because every copying attempt results in twice as many DNA molecules: 1, 2, 4, 8, 16, etcetera. As LinDA only copies the original DNA molecules, it creates a linear sequence: 1, 2, 3, 4, and so on.

> " new DNA technology ... makes it possible to perform reliable analyses on DNA quantities that are a thousand times smaller than was previously the case."

Because the LinDA technology copies all DNA fragments in an analysis sample and in a linear sequence as well, the DNA of a couple of thousand cells or a small archaeological find is sufficient. 'Old' technologies require approximately a thousand times more DNA. Moreover, the linear method is extra reliable as it has no bias toward GC reach regions, in contract to PCR based methods.

The LinDA technology can be used, for example, on a very small archaeological sample to determine what animal species it is from. It can also be used on starting tumours to study which genes are more or less active. In plants, the technology creates the opportunity to analyze the cells involved in a fungal infection in detail, thus building a better picture of a plant's defensive system. This knowledge can then be used to develop plants which can better protect themselves against the fungus, which can in turn results in more sustainable plant production.

(June 2011, Wageningen University - Plant Research International)

GM Banana Resistant to Fungus Shows Promise

A banana strain resistant to a common fungal disease could help smallholder farmers in East Africa better control the crippling disease, which has been spreading across the region over the last three decades.

The results of confined field trials of a genetically modified (GM) banana with improved resistance to a black sigatoga disease, the devastating leaf spot fungus, are promising, researchers have told SciDev.Net.

The disease is caused by the fungus *Mycosphaerella fijiensis* and it can halve fruit production in affected plantations. It is easily spread by airborne spores, rain, planting material, irrigation water and packing material used in transporting goods between banana-growing countries.

The dark leaf spots caused by the fungus eventually enlarge and merge together, causing much of the leaf area to dry.

The team led by Andrew Kiggundu - head of banana biotechnology research at the Uganda's National Agricultural Research Laboratories Institute (NARL) in Kawanda - analyzed 19 lines of GM bananas and found promising results in five of them. Andrews told SciDev.Net further research is needed to calculate the exact yield gains from using the resistant banana strain.

The researchers inserted genes for chitinase - an enzyme that breaks down chitin, the hard substance that makes up the cell walls of the invading fungi - preventing the fungus from invading the plant cells and causing the disease.

Kiggundu said laboratory tests using leaves from transgenic plants showed almost full immunity when cultured fungi were applied to the leaves.

Researchers collaborated closely with the Catholic University of Leuven in Belgium, where several banana lines were engineered to include the chitinase gene before being brought to NARL for testing.

However, Settumba Mukasa, resident banana expert in the department of crop science at Uganda's Makerere University, said the field trials had more significance for building research capacity in Uganda than the development of a new disease-resistant banana.

"[The project] is a stepping stone for subsequent breeding programs and genetic engineering programmes. As a consequence of this project we can now do transformations of other varieties of bananas and other crop species," said Mukasa.

While black sigatoka is among the top three diseases affecting bananas in Uganda it mainly affects Cavendish, which are not as widely cultivated as other types of bananas.

But for the few farmers in Uganda who do grow Cavendish bananas, the development may be useful since the disease is currently controlled by aerial pesticide spraying which is expensive for smallholders and affects their health.

> laboratory tests using leaves from transgenic plants showed almost full immunity when cultured fungi were applied to the leaves."

"Farmers cannot afford that because they are small and they have few plants. Here, chemical control is not viable, so this approach may be the only available method to manage the disease," Mukasa said.

(Scidev, John Kasozi & Jocelyn Edwards, April 2011,)

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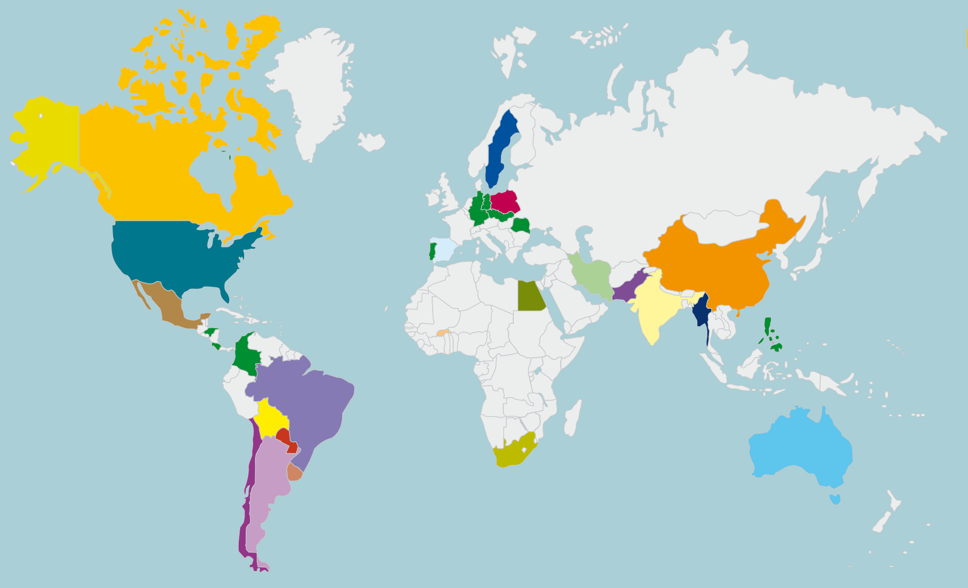
Global Area (million hectares) of Biotech Crops, 1996 - 2010, by Country



50,000 hectares or more	
USA	66.8 million
Brazil	25.4 million
Argentina	22.9 million
India	9.4 million
Canada	8.8 million
China	3.5 million
Paraguay	2.6 million
Pakistan	2.4 million
South Africa	2.2 million
Uruguay	1.1 million
Bolivia	0.9 million
Australia	0.7 million
Phillipines	0.5 million
Myanmar	0.3 million
Burkina Faso	0.3 million
Spain	0.1 million
Mexico	0.1 million

Less than 50,000 hectares	
Colombia	Egypt
Chile	Slovakia
honduras	Costa Rica
Portugal	Romania
Czech Republic	Sweden
Poland	Germany

Source: ISAAA, Clive James, 2010

hope to have the biotech seed ready for farmers by 2014. Kenya's cotton stakeholders are further working on a roadmap to fast-track the adoption of Bt cotton. Uganda is also conducting field trials for virus resistant banana and cassava.

Also within the region is a relatively new partnership geared towards developing drought tolerant varieties using biotechnology as well as conventional breeding; this is under WEMA (Water Efficient Maize for Africa), a project that spans four East African nations: Kenya, Uganda Tanzania and Mozambique and draws support from both public and private institutions. Field trials for the drought tolerant varieties are already in progress, with the backing of the National Agriculture Research Systems of the participating countries.

To the West of the continent, Nigeria has ongoing trials for insect-resistant Bt cowpea and nutritionally-enhanced cassava and is also in the process of passing its biosafety bill into law. Ghana has approved a draft biosafety bill and Mali's cabinet adopted a draft decree which will provide a basis for conducting trials and releasing biotechnology products in the country.

According to ISAAA there are also efforts to engineer some of the continent's most important staples including cassava, sweet potato, pulses and groundnut. These are expected to bear fruit in 2015, by when researchers hope to get the technology on farmers' fields.

So, the pace on the continent may be remarkably slow but Africa is warming up to biotech. Looking into the biotech crystal ball, James concurs with this, "the second decade of commercialization 2006-2015, is likely to feature significantly more growth in Asia and Africa compared with the first decade, which was the decade of the Americas." But for this to happen he says "…there is an urgent need for appropriate regulatory systems that are responsible and rigorous – but not onerous – for small and poor developing countries."

(ISAAA, January 2011)

In BRIEF

ISAAA's GM Approval Database

ISAAA has come up with an easy to use database of Biotech crop approvals for various biotechnology stakeholders. It features the biotech crop events and traits that have been approved for commercialization and planting and/or for import for food and feed use with a short description of the crop and the trait. Entries in the database were sourced principally from Biotechnology Clearing House of approving countries and from country regulatory websites. The database can be accessed at http://www.isaaa.org/gmapprovaldatabase/default.asp

Nigeria Passes Biosafety Bill

The Nigerian senate enacted the Biosafety Bill into law on June 1, 2011, after several years of stakeholders' discussion and debate. The Bill went through the Senate procedure by Resolution and Concurrence after going through three readings. It was concurred without amendments to the draft Bill passed by the House of Representatives on July 20, 2010. The law now awaits Presidential assent upon which implementing regulations will be developed to pave way for its operationalization.

The passing of the bill was welcomed by stakeholders, who had expressed concerns earlier on the possible delay in passing the Bill, due to possible changes in the government after the May 2011 elections. It was among those highlighted by the Nigerian Bar Association last December as needing passage before 29 May 2011. The passing of the bill is a major step towards the safe and responsible use of biotech crops in the country. Currently, Nigerian scientists and partners are conducting field trials on genetically modified cowpea and cassava.

(Crop Biotech Update, 3 June 2011)

Mali Meeting Births African Seed Testing Network

A pan-African network of seed testing laboratories has been established by the African Union (AU) and the African Seed Network to speed up the harmonization of a continent-wide seed market in traditional and non-traditional crops. The new Forum for Africa Seed Testing (FAST) is to be initially based in Nairobi, Kenya, and has been established with the support of the UN Food and Agriculture Organization (FAO). FAST was established in March at a meeting of African seed experts organized by FAO in Bamako, Mali.

Besides speeding up the implementation of harmonized seed regulation laws in different African nations, FAST will promote seed testing and quality control, including the drafting of seed testing protocols for major crops for both public organizations and private companies. FAST will also help to increase the exchange of germplasm and the use of technical innovations among seed laboratories in Africa. "Inadequate supply of quality seeds for both food and cash crops is one of the biggest bottlenecks to food production on the continent, contributing to food insecurity, impeded economic growth, reduced seed trade amongst countries and created a dependence on seed and food," said FAO's Robert Guei. Amongst other activities, FAST will provide the first regulatory framework for a number of important African food crops such as a black nightshade (Solanum nigrum) and Cleome gynandraor African cabbage.

New Program to Provide Grants to Bioscientists in East Africa

A new program, the Bioresources Innovation Network for Eastern Africa Development (Bio-Innovate), will provide grants to bioscientists working to improve food production and environmental management in eastern Africa. Bio-Innovate was launched March 16, 2011 at the headquarters of the International Livestock Research Institute (ILRI) in Nairobi, Kenya. The five-year program, funded by the Swedish International Development Agency (Sida), will be managed by ILRI and co-located within the Biosciences eastern and central Africa (BeCA) Hub at ILRI's Nairobi campus. Bio-Innovate will be implemented in Burundi, Ethiopia, Kenya, Rwanda, Tanzania, and Uganda.

Kenya Opens up to Biotech Crops

Kenya is now open to the production and importation of genetically modified (GM) crops. A legal notice published by the Higher Education, Science and Technology Minister, Hellen Sambili declares 1st July, 2011 as the date on which the Biosafety Act 2009 shall come into operation. Kenya now becomes the fourth country in Africa to embrace advanced biotechnology after South Africa, Egypt and Burkina Faso. A related Gazette Notice soon to be published by the National Biosafety Authority (NBA) containing regulations for the implementation of Kenya's 2009 Biosafety Bill, will complete the process allowing for full utilization of this new technology. Kenya has already conducted trials on biotech cotton with research on drought tolerant biotech maize in progress. But immediate use for this newly implemented piece of legislation will be in the importation of biotech maize to help mitigate a food crisis occasioned by a shortfall in maize production in the country.

Peru to Field Trial Transgenic Papaya

Plans are set to have pilot field trials of genetically modified papaya in Peru in 2012. William Daga Ávalos, fruit specialist of the National Institute for Agrarian Innovation (INIA), said field trials are necessary due to decreased papaya production.

Diseases such as the papaya ringspot virus have caused much damage in fruit growing areas. The fruit specialist explained that in order to save the papaya crop in the areas of Chanchamayo, Satipo, and Pucallpa, genetically transformed seeds should be sowed to save production and productivity of the fruit.

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The researchers examined the development of domesticated rice by re-sequencing gene fragments from a diverse set of wild and domesticated rice varieties. Using new modeling techniques, which had previously been used to look at genomic data in human evolution, their results showed that the gene sequence data was more consistent with a single origin of rice.

In their study, the investigators also used a 'molecular clock' of rice genes to see when rice evolved. Depending on how the researchers calibrated their clock, they pinpointed the origin of domesticated rice at possibly 8,200 years ago, while *japonica* and *indica* split apart from each other about 3,900 years ago. These molecular dates were consistent with archaeological studies.

In the last decade, archaeologists have uncovered evidence for rice domestication in the Yangtze Valley beginning approximately 8,000 to 9,000 years ago while domestication of rice in the India's Ganges region was around about 4,000 years ago.

"As rice was brought in from China to India by traders and migrant farmers, it likely hybridized extensively with local wild rice," explained biologist and study co-author Michael Purugganan. So domesticated rice that we may have once thought originated in India actually has its beginnings in China.

The study comprised a team drawn from the New York University Center for Genomics and Systems Biology and its Department of Biology, Washington University Department of Biology, Stanford University Department of Genetics and Purdue University Department of Agronomy.

(New York University-Center for Genomics and Systems Biology.)

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