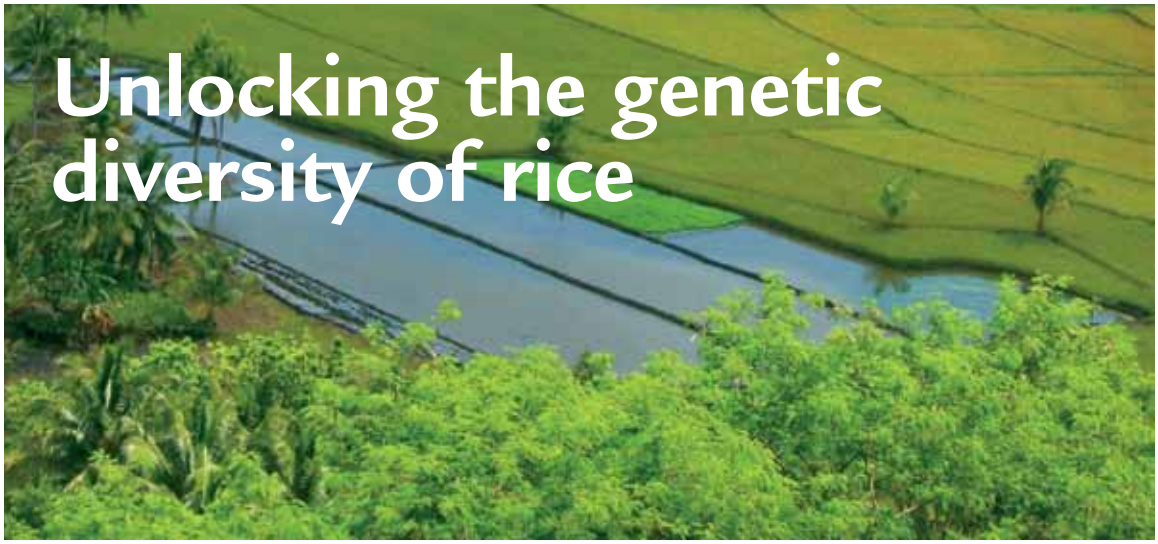
Unlocking the genetic diversity of rice



Rice is one of the world's most important food crops. In this article, ***Gary Skinner*** *explains how, by looking at what different types of rice have in common, a team of scientists is unlocking rice's genetic diversity to help conserve it and find valuable rice genes to help improve rice production. Understanding the genetic diversity and using it to breed new rice varieties will provide the foundation for improving rice production into the future and to secure global food supplies.*

The team of researchers scrutinized the genetic make-up of twenty different types of rice used in international breeding and with a wide range of different characteristics. They were looking for SNPs (pronounced 'snips' and meaning Single Nucleotide Polymorphisms, variations at a single base pair within DNA) which constitute the majority of genetic differences in all organisms, from rice to humans. SNP analysis in humans is telling us a lot about the genetic causes of disease.

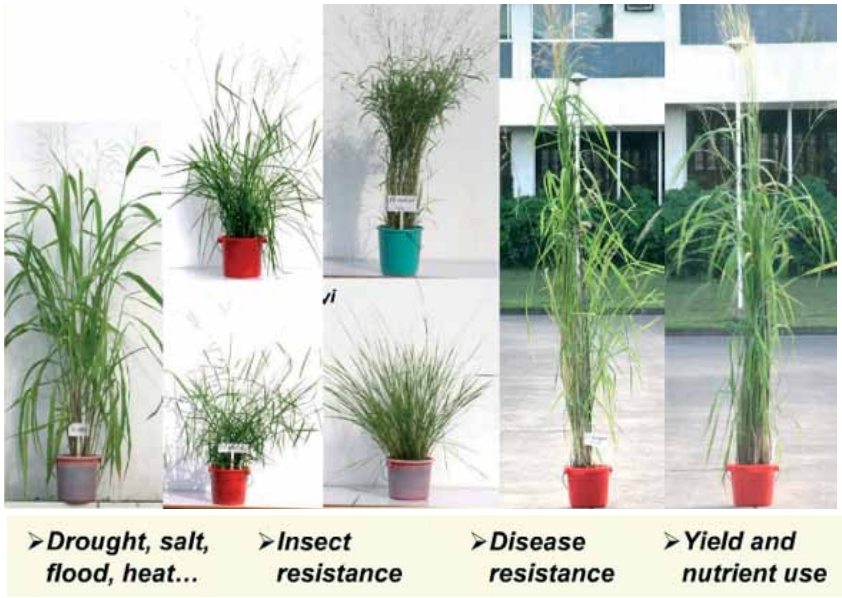
Rice contains tens of thousands of genes, so finding a successful way to hunt through them all is a major breakthrough. The International Rice Gene Bank contains over 109 000 types of rice, yet relatively few have been used in breeding programs. But, if breeders know more about the genetic makeup of rice, they can use it more effectively. As we face more erratic changes in climate, we will increasingly rely on using the untapped diversity of rice to develop new and improved rice varieties. The comprehensive SNP information is enabling the exploration of rice diversity not only for understanding how genes function in a growing and developing plant, but also for improving important rice traits related to disease resistance, drought tolerance, increased productivity, and human health benefits. The work sets the stage for the next phase of unlocking the treasure trove of genetic diversity available at IRRI and other centres for rice breeding.

Rice shows great variety in two ways, both of which might be helpful in the future. Within the most commonly cultivated species (*Oryza sativa*) there is much genetic diversity. The screenshot shows the seed diversity page at http://ricediversity.org/ and there are nearly 800 records in it. The other figure is a 'Garris diagram' showing all the varieties within the *indica* group of *O. sativa*. Similar diagrams can be drawn for four other groups. In addition, there are over twenty wild species of rice which may contain genes useful in the future.

Three of nearly 800 different types of rice depicted in rice diversity's seed photograph resource.

Key to 20 Oryza SNP varieties on pages 10-11:

1 IR64-21;
2 Swarna;
3 Sadu-cho;
4 Pokkali;
5 Suan-Huang-Zhan-2;
6 Minghui 63;
7 Zhenshan 97B;
8 Aswina;
9 Rayada;
10 FR 13 A;
11 N 22;
12 Dular;
13 Dom-sufid;
14 Moroberekan;
15 Azucena;
16 Cypress;
17 Lijiang XIn Tuan Heigu;
18 M 202;
19 Tainung 67;
20 Nipponbare



Wild species of Oryza: the resource to meet tomorrow's challenges

Catalyst

www.catalyststudent.org.uk

1
2
3
4
5
6
7
8
9
10

Rice genome diversity reflects the landscapes where rice is grown, from hot lowland paddy fields (top) to temperate uplands (bottom). Key to varieties on page 9.

Artwork conceptualized by K. McNally, and photography courtesy of Chrisanto Quintana of IRRI.

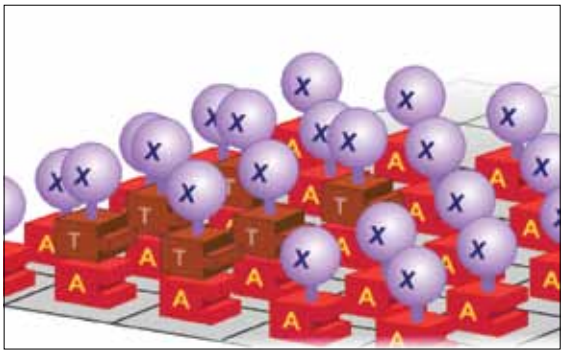
Trial plots of rice hybrids at the International Rice Research Institute in the Philippines

How are SNPs analysed?

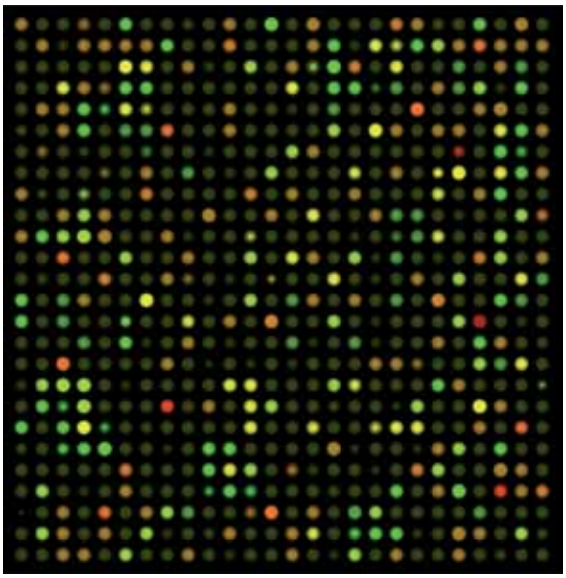
There are a few methods by which SNPs can be detected but this work used the GeneChip produced by Affymetrix in California. The method involves building an array of different polynucleotides on a glass slide. In the Affymetrix method this is done using a technique called photolithography.

A Gene Profiling Array, or gene chip. The square chip itself is about 3 cm wide.

A single nucleotide (a DNA building block) is fixed onto a glass slide. On each nucleotide in this array there is a protector group (X in the graphic, below). Light will remove this protector group, so a mask is now placed over the slide and light is shone to remove the protector group where it penetrates the mask. The next desired nucleotide (A, G, C or T) is now added and the process repeated again. The next nucleotide is only added where the light has removed the protector group. This process is cycled many times to build up specific, desired polynucleotides in little dots all over the array.



Building up polynucleotides on a gene chip. A and T are single nucleotides; X is a protector which prevents further nucleotides from binding onto the sequence.



A typical result on a DNA Microarray

When a gene is 'switched on' in a cell, it is transcribed to make messenger RNA (mRNA). This can be extracted and used to make a more stable form, cDNA. This cDNA can then be labeled and added to the microarray. Where it 'finds' polynucleotide stands on the array which are complementary to it, it will bind; it will not bind elsewhere. The array can then be washed leaving only the dots which have bound, labeled cDNA attached to them visible. This allows specific genes in the original organism to be identified.

Gary Skinner is Biology editor of Catalyst.

Look here!

You can watch a detailed explanation of how a gene chip works at *http://dnaftb.org/36/animation.html*