'Scarecrow' Gene: Key to efficient crops

WITH projections of 9.5 billion people by 2050, humankind faces the challenge of feeding modern diets to additional mouths while using the same amounts of water, fertilizer and arable land as today.

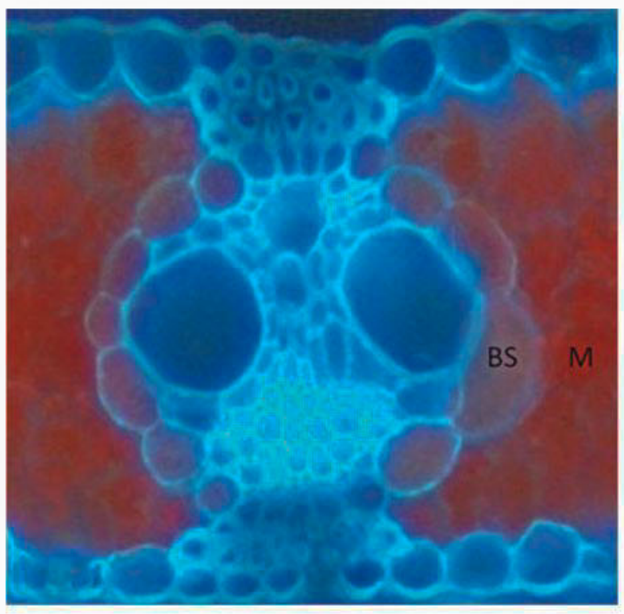
Cornell researchers have taken a leap toward meeting those needs by discovering a gene that could lead to new varieties of staple crops with 50 percent higher yields.

The gene, called Scarecrow, is the first discovered to control a special leaf structure, known as Kranz anatomy, which leads to more efficient photosynthesis. Plants photosynthesize using one of two methods: C3, a less efficient, ancient method found in most plants, including wheat and rice; and C4, a more efficient adaptation employed by grasses, maize, sorghum and sugarcane that is better suited to drought, intense sunlight, heat and low nitrogen.

"Researchers have been trying to find the underlying genetics of Kranz anatomy so we can engineer it into C3 crops," said Thomas Slewinski, lead author of a paper that appeared online in November in the journal Plant and Cell Physiology. Slewinski is a postdoctoral researcher in the lab of senior author Robert Turgeon, professor of plant biology in the College of Arts and Sciences.

The finding "provides a clue as to how this whole anatomical key is regulated," said Turgeon. "There's still a lot to be learned, but now the barn door is open and you are going to see people working on this Scarecrow pathway." The promise of transferring C4 mechanisms into C3 plants has been fervently pursued and funded on a global scale for decades, he added.

If C4 photosynthesis is successfully transferred to C3 plants through genetic engineering, farmers could grow wheat and rice in hotter, dryer environments with less fertilizer, while possibly increasing yields by half, the researchers said.



Cross section of a mature maize leaf showing Kranz (German for wreath) anatomy around a large vein. The bundle sheath cells (lighter red) encircle the vascular core (light blue). Mesophyll cells (dark red) encircle the bundle sheath cells. The interaction and cooperation between the mesophyll and bundle sheath is essential for the C4 photosynthetic mechanism.

C3 photosynthesis originated at a time in Earth's history when the atmosphere had a high proportion of carbon dioxide. C4 plants have independently evolved from C3 plants some 60 times at different times and places. The C4 adaptation involves Kranz anatomy in the leaves, which includes a layer of special bundle sheath cells surrounding the veins and an outer layer of cells called mesophyll. Bundle sheath cells and mesophyll cells cooperate in a two-step version of photosynthesis, using different kinds of chloroplasts.

By looking closely at plant evolution and anatomy, Slewinski recognized that the bundle sheath cells in leaves of C4 plants were similar to endodermal cells that surrounded vascular tissue in roots and stems.

Slewinski suspected that if C4 leaves shared endodermal genes with roots and stems, the genetics that controlled those cell types may also be shared. Slewinski looked for experimental maize lines with mutant Scarecrow genes, which he knew governed endodermal cells in roots. When the researchers grew those plants, they first identified problems in the roots, then checked for abnormalities in the bundle sheath. They found that the leaves of Scarecrow mutants had abnormal and proliferated bundle sheath cells and irregular veins.

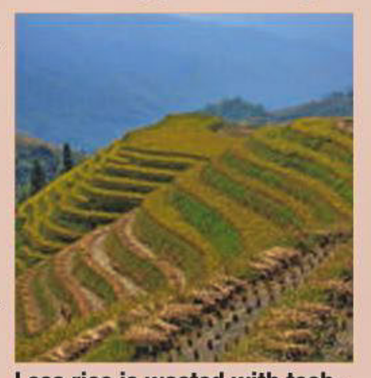
In all plants, an enzyme called RuBisCo facilitates a reaction that captures carbon dioxide from the air, the first step in producing sucrose, the energy-rich product of photosynthesis that powers the plant. But in C3 plants RuBisCo also facilitates a competing reaction with oxygen, creating a byproduct that has to be degraded, at a cost of about 30-40 percent overall efficiency. In C4 plants, carbon dioxide fixation takes place in two stages. The first step occurs in the mesophyll, and the product of this reaction is shuttled to the bundle sheath for the RuBisCo step. The RuBisCo step is very efficient because in the bundle sheath cells, the oxygen concentration is low and the carbon dioxide concentration is high. This eliminates the problem of the competing oxygen reaction, making the plant far more efficient.

The study was funded by the National Science Foundation and the U.S. Department of Agriculture.

Source: **Science Daily**

FARM-TO-MARKET

Supply technology is key



Less rice is wasted with technological advances

THE modernisation of farm-to-market supply chains is important for increasing farmers' income, alleviating poverty, cutting food waste and improving the affordability of food staples, according to the authors of a book.

The Quiet Revolution in Staple Food Value Chains: Enter the Dragon, the Elephant, and the Tiger is a joint project by the Asian Development Bank (ADB) and the International Food Policy Research Institute (IFPRI) that was launched last month.

The book examines the movement of rice and potatoes from the farm to the consumer known as the 'value chain' in three Asian countries: Bangladesh, China and India. Rice and potato are food staples in Asia.

Thomas Reardon, a professor in the Department of Agricultural, Food and Resource Economics at Michigan State University, United States, and one of the book's authors, says that the study also has lessons for South-East Asian and Pacific island states.

He says that all three countries have found ways to modernise the value chains of these staple crops. He adds that the changes had been introduced at the grassroots and brought about mainly by mobile phones, the use of improved crop varieties and technological changes related to rice milling and potato storage.

Reardon says the rapid rise of modern cold storage facilities for potatoes, which enable them to be supplied out of season, had led to more stable prices and higher incomes for farmers.

These facilities have also helped cut the amount of food wastage along the supply chain. According to a World Bank study which the authors cited between 30 per cent to 40 per cent of the food costs is due to the food wastage in the supply chain.

Source: **SciDev.Net**

SHY PHANTOMS

Heart of the matter

A golden age for the neutrino is dawning.

A few decades ago, these shy phantoms that flit nearly unfelt through the interstices of the universe seemed mere leftovers in the world of physics.

Near Daya Bay in China, detectors record the faint flashes produced when antineutrinos hit.

They outnumber all other particles of matter, whizzing away everywhere many of them arising in droves from nuclear reactors and nucleosynthesis in stars. Their characteristics made them, to be sure, vitally important building blocks in the 1970s and '80s for theorists who put together the standard model of physics, describing how fundamental forces and particles fit together. Yet, for decades, neutrinos seemed nearly incapable of doing a lick of work. They were like clowns pouring from a circus car, entertainment for theorists but without important jobs in keeping the cosmos running smoothly.

It is about time for the neutrino to add gravitas. "When I first learned about it in the early 1950s, the neutrino had an odd role in nuclear physics, like that of a sort of crazy uncle who was not all there," physicist and science writer Jeremy Bernstein wrote in an essay in the March-April 2012 issue of American Scientist.

When asked how the neutrino stacks up today, he says: "It is a wonderful particle. It played an important role in the early universe. I mean, everything about it is mysterious. But back in the 1950s, nobody even gave a goddamn. Maybe I learned about it, but nobody was studying it."

While neutrinos have been rising in mystery and thus stature for some time, their most recent big break occurred last March. It stemmed from measurements made deep inside a granite mountain not far from Hong Kong.

Source: **Science News**

DOWNSTREAM EFFECTS

Watering fields boosts rainfall

FARMERS in California help make it rain in the American Southwest, a new computer simulation suggests. Water that evaporates from irrigated fields in California's Central Valley travels to the Four Corners region, where it boosts summer rain and increases runoff to the Colorado River, researchers report online January 12 in Geophysical Research Letters.

This climate link may be crucial to the 40 million people who depend on the Colorado River for drinking water. That number could nearly double in the next 50 years at the same time that droughts are projected to become more common in the Southwest. Since the Central Valley's supply of irrigation water faces an uncertain future, it's important to examine how shortfalls in California might affect climate change in the region, says study coauthor Jay Famiglietti, a hydrologist at the University of California, Irvine.

"We have to understand these connections better to deal with changes in water availability," he says.

The Central Valley is one of the world's most productive agricultural regions. More than 50,000 square kilometers of the valley are irrigated, equaling one-sixth of all irrigated land in the United States.

A study in 2011 showed that watering the area's crops cools local temperatures and increases humidity. But the work didn't find any larger climate ties outside the region, because it relied on a regional climate simulwation, which has trouble estimating conditions along the boundaries of a study area, Famiglietti says.

Irrigation in California's Central Valley affects the climate of the American Southwest, a new study suggests.

To overcome this problem, Famiglietti and Min-Hui Lo, now at the National Taiwan University in Taipei, simulated global climate over a 90-year period. They added in 350 millimeters of water coming from groundwater and surface reservoirs to the Central Valley between May and October each year. The researchers say that's a realistic amount of irrigation based on published agriculture and climate data.

The simulations revealed that evaporation doubles in the Central Valley when there's irrigation. That water vapor circulates to the Southwest during the summer monsoon season, which naturally brings rain to the area. "The monsoon is like a big campfire burning away over the Southwest," Famiglietti says. "The irrigation acts as fuel on the fire." In addition to bringing more water to the atmosphere, the water vapor brings more energy. And it changes the regional circulation, drawing in even more water vapor from the Gulf of Mexico.

Together, these changes intensify the monsoon season, resulting in a 15 percent increase in rainfall in Utah, Colorado, New Mexico and Arizona and a 28 percent increase in runoff to the Colorado River compared with simulations lacking irrigation. Some of the water returns to California via the All-American Canal, which brings water from the Colorado River to Southern California, the simulation suggests.

"It's a nice first step," says hydrologist Michael Puma of Columbia University. "And it's a link that we need to investigate quite a bit more." Many other variables, such as sea surface temperatures, also influence climate in the Southwest. To better estimate the strength of irrigation's effect in the real world, more complex simulations that take these other factors into account are needed, Puma says.

The study also highlights the importance of investigating irrigation's role in climate in other parts of the world, as well as other ways in which people's use of water might have unintended consequences, Famiglietti says. "What we do with water management really has an impact on climate locally, regionally and globally."

Source: **Science News**

ALL's NOT LOST

Extinction rates not so bad

CONCERNS that many animals are becoming extinct, before scientists even have time to identify them, are greatly overstated, according Griffith University researcher, Professor Nigel Stork. Professor Stork has taken part in an international study, the findings of which have been detailed in "Can we name Earth's species before they go extinct?" published in the journal Science.

Deputy Head of the Griffith School of Environment, Professor Stork said a number of misconceptions have fueled these fears, and there is no evidence that extinction rates are as high as some have feared.

"Surprisingly, few species have gone extinct, to our knowledge. Of course, there will have been some species which have disappeared without being recorded, but not many we think," Professor Stork said.

Professor Stork said part of the problem is that there is an inflated sense of just how many animals exist and therefore how big the task to record them.

"Modern estimates of the number of eukaryotic species have ranged up to 100 million, but we have estimated that there are around 5 million species on the planet (plus or minus 3 million)."

And there are more scientists than ever working on the task. This contrary to a common belief that we are losing taxonomists, the scientists who identify species.

"While this is the case in the developed world where governments are reducing funding, in developing nations the number of taxonomists is actually on the rise.

"World-wide there are now two to three times as many taxonomist describing species as there were 20 years ago."

Even so, Professor Stork says the scale of the global taxonomic challenge is not to be underestimated.

Source: **Science Daily**

The rate of species extinction may not be as bad as first thought, but recording of species is still a mammoth task.

FRACTAL DIMENSION

Puzzling plumage

Red-legged partridges have fractal patterns in the black-and-white plumage on their chests.

SOURCE: **LIVE SCIENCE**

A new study found that the complexity of fractal patterns on a bird's chest communicates the animal's fitness to potential mates.

Scientists studied male and female red-legged partridges (Alectoris rufa), which both display complicated black-and-white patterns of plumage on their chests. The size, shape and complexity of these patterns can be quantified by what's known as fractal dimension (FD).

epeating patterns that show the same structure when zoomed in and out. Fractals are found throughout nature, from seashells to mountain ranges to broccoli, and apparently, the plumage of red-legged partridges.

In a new study, scientists found that the healthier a bird is, the more fractal-like its plumage becomes.

DID YOU KNOW?

What is Pareidolia?

Pareidolia is a psychological phenomenon involving a vague and random stimulus (often an image or sound) being perceived as significant. Common examples include seeing images of animals or faces in clouds, the man in the moon or the Moon rabbit, and hearing hidden messages on records when played in reverse.

A satellite photo of a mesa in Cydonia, often called the Face on Mars.

The word comes from the Greek words para ("beside, alongside, instead") in this context meaning something faulty, wrong, instead of; and the noun eidôlon ("image, form, shape") the diminutive of eidos.