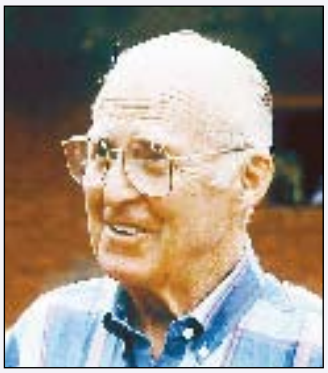
STEM RUST NEVER SLEEPS

By Norman Borlaug



Norman Borlaug.

With food prices soaring throughout Asia, Africa and Latin America, and shortages threatening hunger and political chaos, the time could not be worse for an epidemic of stem rust in the world's wheat crops. Yet millions of wheat farmers, small and large, face this spreading and deadly crop infection.

The looming catastrophe can be avoided if the world's wheat scientists pull together to develop a new generation of stem-rust-resistant varieties of wheat. But scientists must quickly turn their attention to replacing almost all of the commercial wheat grown in the world today. This will require a commitment from many nations, especially the United States, which has lately neglected its role as a leader in agricultural science.

Stem rust – the most feared

Stem rust, the most feared of all wheat diseases, can turn a healthy crop of wheat into a tangled mass of stems that produce little or no grain. The fungus spores travel in the wind, causing the infection to spread quickly. It has caused major famines since the beginning of history. In North America, huge grain losses occurred in 1903 and 1905 and from 1950 to '54.

During the 1950s, I and other scientists, first in North America and later throughout the world, developed high-yielding wheat varieties that were resistant to stem rust and other diseases. These improved seeds not only enabled farmers around the world to hold stem rust at bay for more than 50 years but also allowed for greater and more dependable yields. Indeed, with this work, global food supplies rapidly increased and prices dropped.

From 1965 to 1985 – the heyday of the Green Revolution – world production of cereal grains, wheat, rice, corn, barley and sorghum, nearly doubled, from 1 billion to 1.8 billion tonnes, and cereal prices dropped by 40 per cent.

Today, wheat provides about 20 per cent of the food calories for the world's people. The world annual wheat harvest now stands at about 600 million tonnes.

Not keeping pace

In the past decade, global wheat production has not kept pace with rising population, or the increasing per capita demand for wheat products in newly industrialising countries. At the same time, international support for wheat research has declined significantly. And as a consequence, in 2007–08, world wheat stocks (as a percentage of demand) dropped to their lowest level since 1947–48. And prices have steadily climbed to the highest level in 25 years.

The new strains of stem rust – called Ug99 because they were discovered in Uganda in 1999 – are much more dangerous than those that, 50 years ago, destroyed as much as 20 per cent of the American wheat crop. Today's lush, high-yielding wheat fields on vast irrigated tracts are ideal environments for the fungus to multiply, so the potential for crop loss is greater than ever.

If publicly financed international researchers move together aggressively and systematically, high-yielding replacement wheat varieties can be developed and made available to farmers before stem rust disease becomes a global epidemic.

The Bush administration was initially quick to grasp Ug99's threat to American wheat production. In 2005, Mike Johanns, then Secretary of Agriculture, instructed the federal agriculture research service to take the lead in developing an international strategy to deal with stem rust. In 2006, the Agency for International Development mobilised emergency financing to help African and Asian countries accelerate needed wheat research.

But more recently, the administration has begun reversing direction. The State Department is recommending ending American support for the international agricultural research centres that helped start the Green Revolution, including all money for wheat research. And significant financial cuts have been proposed for important research centres, including the Department of Agriculture's essential rust research laboratory in St. Paul, Minnesota.

Shocking short-sightedness

This shocking short-sightedness goes against the interests not only of American wheat farmers and consumers but of all humanity. It is tantamount to the US abandoning its pledge to help halve world hunger by 2015.

If millions of small-scale farmers see their wheat crops wiped out for want of new disease-resistant varieties, the problem will not be confined to any one country. Rust spores move long distances in the jet streams and know no political boundaries. Widespread failures in global wheat production will push the prices of all foods higher, causing new misery for the world's poor.

Ug99 could reduce world wheat production by 60 million tonnes. But a global crop failure of this magnitude can be avoided.

Before it is too late, America must rebuild, not destroy, the collaborative systems of international agricultural research that were so effective in starting the Green Revolution.

Stem rust, the most feared of all wheat diseases.

The New York Times
April 26, 2008

Norman E. Borlaug, who received the Nobel Peace Prize in 1970, is a professor of international agriculture at Texas A&M University.

arch Review: Ug99

the GRDC, investigates a significant international development which may threaten our wheat industry.

KILLER FUNGUS COULD SPELL DISASTER FOR WHEAT

Ug99 crops could strike south Asia's vast wheat fields two years earlier than research had suggested. The fungus has spread from Africa to Iran, and may already be in Pakistan. If so, this is extremely bad news, as Pakistan is not only critically reliant on its wheat crop, it is also the gateway to the Asian breadbasket, including the vital Punjab region.

Scientists met earlier this year in Syria to decide on emergency measures to track Ug99's progress. They hope to slow its spread by spraying fungicide or even stopping farmers from planting wheat in the spores' path. The only real remedy will be new wheat varieties that resist Ug99, and they may not be ready for five years. The fungus has just pulled ahead in the race.

Ug99, a virulent strain of black stem rust (*Puccinia graminis*) was identified in Uganda in 1999. Since then it has invaded Kenya and Ethiopia and, last year, Yemen. From previous fungal invasions, scientists expected the prevailing winds to carry Ug99 spores to Egypt, Turkey and Syria, and then east to Iran, a major wheat-grower, buying them some time. But in June 2007, Cyclone Gonu hit the Arabian peninsula – the worst storm there for 30 years.

"We know it changed the winds," says Wafa Khoury of the UN Food and Agriculture Organization in Rome, because desert locusts the FAO had been tracking in Yemen blew north towards Iran instead of north-west as expected. "We think it may have done that to the rust spores."

This means, she says, that Ug99 has reached Iran a year or two earlier than predicted.

The fear is that the same winds could have blown the spores into Pakistan, which is also north of Yemen, and where surveillance of the fungus is limited.

There could be more unpleasant surprises in store.

On mature wheat, the fungus reproduces asexually to release billions of identical spores. But if the spores drift onto a barberry bush (*Berberis vulgaris*), they switch to sexual reproduction, and so could swap genes with other stem rusts to produce completely new variants. And Iran is a hotspot for barberry.

Why Ug99 took hold

Scientists have now found out how Ug99 took hold, says Rick Ward of CIMMYT, the wheat breeding institute in Mexico. "It turns out most of Kenya was planted with a wheat variety that contained only one gene for rust resistance, SR24."

"We advise at least two resistance genes," says Rick. "Wheat with the SR24 gene alone gives any Ug99 strains resistant to SR24 a huge advantage, just as misuse of antibiotics selects for antibiotic-resistant bacteria. Farmers then switched to using wheat with other resistance genes and the same thing happened."

Ug99 is now resistant to the three major anti-rust genes used in nearly all the world's wheat. "The real solution is disease resistance that relies on a number of genes," says Rick.

Wheat with multigene resistance does not so much destroy the fungus as slow it down. The hope is that with several genes involved it will be much harder for the fungus to become resistant and there will be less selection pressure for it to do so.

A breeding program by CIMMYT and others has now uncovered some wheat types which "show promise" in tests against Ug99 in Kenya and Ethiopia, says Ronnie Coffman of Cornell University in Ithaca, New York, who chairs the program.

The problem is that crop breeding is slow. It usually takes at least five years to cross disease-resistant lines with wheat varieties adapted to local conditions in the world's wheat-growing countries, then grow enough seed to plant fields threatened by Ug99.

Debora MacKenzie
www.newscientist.com

CIMMYT researchers have uncovered some wheat types which "show promise" in tests against Ug99.

AUSTRALIAN RESEARCH

International collaborations involving the GRDC-funded Australian Cereal Rust Control Program (ACRCP) include the Global Rust Initiative, which was established in the wake of the emergence of Ug99. More recently, an Australian Centre for International Agricultural Research (ACIAR) project screening Australian and Indian germplasm for resistance to the killer stem rust was also established.

While by no means the only rust of concern to researchers, Ug99 is attracting particular attention because it has defeated many rust-resistant wheat genes including Sr31, which is one of the world's most widely deployed rust defences.

Testing of 75 Australian wheat cultivars in Kenya has established that 17 are vulnerable to the Ug99 strain. A further 12 Australian varieties are susceptible to a newer derivative of Ug99 that has overcome the Sr24 gene, which also previously provided rust resistance.

GRDC crop protection manager Dr Rohan Rainbow says Ug99 could be a serious threat to Australia over the next decade. "It could come here faster than we expect," he says. "That's why some of the new molecular technologies – including genetic modification – for fast-tracking resistance and improving the durability of resistance are important."