Elizabeth Roche
Metro Early College High School
Columbus, OH
Uganda, Factor 1

Wheat Stem Rust in Uganda: A Reemerging Disease

Uganda is a landlocked country located in Eastern Africa, west of Kenya. Before the 1900s, Uganda was full of different kingdoms and tribes scattered across the land. Until Europeans started looking for slaves, the tribes lived generally simple and peaceful lives as hunter-gathers. In 1888, Britain began to colonize and take over the country of Uganda. As colonization occurred, a wide range of different ethnic and political groups were forced to live together which caused havoc in the country. Uganda achieved independence in 1962 from Britain. From 1971-1979, the dictator Idi Amin (1971-1979) was responsible for about 300,000 deaths, guerrilla warfare, and human right abuses. Although it is currently listed as the Republic of Uganda, Uganda's current president Lt. Gen. Yoweri Kaguta Museveni siezed power in 1986 and is both chief of state and head of government. Since his rule began in 1986, the country has gained relative stability and economic growth. The government, however, does not provide an adequate health care system for its people.

There are over 32 million people living in Uganda, and approximately 1 million of these people suffer from AIDS. There are about six children born into each family in Uganda, even with an infant mortality rate of 65 deaths per 1,000 births. Comparatively, in the United States the infant mortality is 6 deaths per 1,000 births. The life expectancy in Uganda is only about 53 years. Common diseases affecting Ugandans include hepatitis A, diarrhea, typhoid fever, malaria, schistosomiasis (parasitic disease), and African trypanosomiasis (sleeping sickness). Many of these diseases result in death, even though they are preventable and/or treatable. Unfortunately, most Ugandans do not have access to proper health care to prevent or treat these diseases. Public-private partnerships have helped to control disease in Uganda, and help to provide most of the health care in Uganda. However, not enough care is being provided to fully eradicate and prevent disease. Currently, non-governmental organizations (NGOs) are the only source of health care that the Ugandan people have. But the organizations cannot help everyone in the country due to lack of funds and hands-on help. One of the factors that cause high disease rates in Uganda is the lack of food and resulting malnutrition.

Wheat is a food source not only for Ugandans, but for the world. The climates in Uganda range from tropical, as well as semiarid in the northeast area of the country. Some of the common foods in Uganda are cassava, bananas, meats, and bread (from wheat), milk, fish, and yams. There are two dry seasons; December to February and June to August. These dry seasons are difficult for farmers, and approximately 82% of Ugandans rely on agriculture for a job. There are currently many environmental issues in Uganda witch effect agriculture. Uganda's wetlands are being drained for agricultural use, deforestation is occurring, and there is a lot of soil erosion. One of the main issues is plant disease. Plant disease lowers the yield that a farmer can harvest, causing food shortages. One of the major plant diseases in Uganda today is Ug99, known as wheat stem rust. This fungal disease was discovered in 1999 in Uganda, after being nonexistent for almost 50 years. This disease causes the wheat to become inedible, therefore limiting food supplies. The disease is currently spreading up Eastern Africa and into the Middle East. It may reach the United States in the coming decade. This disease currently affects and will continue in the future to affect the global food supply, resulting in adverse effects on health, including malnutrition.

Stem rust of wheat is caused by the fungus, *Puccinia graminis f. sp. tritici*. Stem rust attacks cereal crops such as wheat and barley in Uganda, and across the world. Stem rust is a major plant disease that greatly affects the wheat crops and works mainly by damaging the stem of the plant. After decades of successful management of wheat stem rust, the disease has once again emerged. A new strain of the stem rust fungus was discovered in Uganda in 1999 (Ug99) and has spread through Africa and into Iran. It is predicted to spread to India and China. It threatens to spread across the Pacific Ocean to Mexico and the United States in the near future. If this happens before new resistant varieties are developed and planted, the world's wheat production will again suffer major yield reductions, potentially causing starvation in countries that rely mainly on wheat for nutrition. Wheat is a

staple crop in the United States, and is a major source of food for Ugandans and millions of other people worldwide. This issue has major importance, and cannot be overlooked, as it could affect the whole world.

Stem rust can be identified by orange-red rust colored oval lesions, called pustules, found on the stem of the wheat plant. Pustules may also develop on leaf sheaths, blades, and on the glumes of the wheat spike. Occasionally, the rust fungi will also affect parts of the head of the plant. As the pustules develop, they tear the outer layers of the epidermis, and reveal a rusty red powdery substance, known as uredospores. After a few days of the first sighting of the rust-colored lesions, the uredospores will be exposed. Uredospores are blown by wind from Mexico and South America each year in late spring and early summer. The size of the tears in the epidermis average about 10 millimeters long by 1 to 3 millimeters wide. As the wheat plant grows and matures, the fungus produces teliospores, causing the pustules to turn black. The spores are also blown from the alternate host of wheat stem rust, barberry (*Berberis*). Uganda is home to many types of barberries, one of the reasons the disease is so hard to eradicate in Uganda. The spores spread through rain splash for short distances, and by wind for long distances, usually occurring during the late summer. Severely infected plants will eventually die.

The stem rust fungus is generally found in prairies and grasslands. The fungus develops best under warm, wet, humid conditions. The best temperature for the fungus to infect the wheat is about 59° F to 75° F (15° C to 24° C). In order for the fungus to infect wheat it is necessary to have at least six hours of leaf wetness and plenty of sunlight. However, too much sunlight can kill the spores. Spores develop every 7 to 14 days during these wet conditions, and then spread to other wheat plants. The fungus typically causes the most damage during the late summer. The fungus cannot survive during the winters in America. But with a year round warm climate in Uganda, the fungus can survive year round. The fungus will switch its host to barberry during the winter, or in Uganda, the dry season.

Because of the many strains or races of the stem rust fungus, it is difficult to treat wheat rust. In the past, wheat was crossbred to find genetically resistant varieties of wheat. Elimination of barberries was another method, which reduces sexual recombination of the stem rust fungus. Eliminating barberries minimizes the opportunity of new races of the wheat rust fungus to emerge. Sexual recombination makes treating the disease very difficult. Fungicides are also a way to prevent wheat rust. Fungicides prevent the spores of the fungus from penetrating the wheat plant. Fungicides are effective in protecting the wheat plant, however fungicides may need to be applied multiple times and many are only effective if applied at the correct growth time. If applied too late, then the spores of the fungus will have already penetrated the wheat plant. Fungicides have a cost associated with them also. Most Ugandan farmers can not afford the fungicides that prevent wheat stem rust. Also, since Uganda has a lot of barberry, the disease keeps mutating and overcoming previously resistant varieties of wheat.

Several epidemics of wheat rust swept North America between 1900 and the 1950s. These epidemics caused problems with United States grain production in the Great Plains, Midwest, and Canada. Stem rust usually caused about 30% to 40% yield loss to the wheat crop. Different varieties of wheat were bred to resist the fungus. However, the fungus was continually able to adapt, therefore allowing it to overcome these varieties of wheat with the effect of reducing grain yield and quality. Sexual recombination enables the fungus to gain genetic variability, and this variability helps the fungus to overcome the resistance of wheat varieties.

Norman Borlaug was an Iowan who developed wheat that was resistant to the stem rust pathogen. He worked in Mexico to breed resistant wheat. He used a shuttle breeding technique that allowed for his resistant wheat to be grown almost anywhere. Shuttle breeding is where a crop is grown for two successive plantings in two separate locations, in order to grow more crop faster. He developed disease resistant varieties of wheat that were grown across America, India, and eventually China, Africa and other areas. Wheat is now a staple crop is those areas. He saved millions of lives from hunger and famine through his work. He won a Noble Peace Prize in 1970, but he did not stop fighting against hunger throughout his life.

Today, wheat rust has reemerged. There needs to be a focus on managing the wheat stem rust disease. Currently, researchers from the United States and other countries are researching how this disease works, how it mutates, and how we can control it. Fungicides are one of the ways to eliminate the fungus. However, fungicides are too expensive for most Ugandan farmers. One way that the United Nations, non governmental organizations (NGOs), research organizations and the government of Uganda can help control this disease is develop and improve the

fungicides. They can develop the fungicides to make them cheaper and easier to use. This will allow more poor farmers access to the fungicides to keep their wheat healthy and prevent further spreading of the disease.

The Ugandan government could also fund a barberry eradication program. Barberry is an alternate host for wheat stem rust, and allows the disease to perform sexual recombination, or mutate. These new strains of stem rust can overcome previous resistance to the disease. The new strains can infect the Ugandan farmer's wheat crop and lower his yield, even if he planted resistant wheat from last year. The farmer then loses money and may not be able to feed his family. If we can eliminate barberry, we can eliminate potential new strains of wheat stem rust. In the 1930s, the United States eliminated barberry across the country. Government organizations killed barberry throughout the Midwestern states. For a period of time, it was illegal to plant, own, or grow barberry in the United States. If Uganda had a similar program to eliminate barberry, then new strains of wheat stem rust would be much less likely to form. This would save farmers both time and energy, as well as money.

Since the wheat stem rust disease has recently reemerged, another option that NGOs, and the United nations can support is research. Researching the disease will help us to better understand the disease, and eventually control the disease. Researching wheat stem rust allows us to understand how the disease functions, spreads and infects the wheat. With research and communication, we can also help farmers in Uganda understand the disease, how it spreads, what it looks like, and how to take precautions for it. We can use the findings to help prevent the spread of wheat stem rust, and to prevent farmers from losing their crops, and to keep many people from starving. Many Universities across the world are beginning to study this disease. If NGOs and the United nations support their research, we can help farmers to help combat wheat stem rust.

Uganda needs our help to stop wheat stem rust. There are currently over 32 million mouths to feed in Uganda, and the loss of wheat caused by wheat stem rust reduces the amount of food that can reach the millions of hungry Ugandan people. With prevailing human and plant disease, environmental problems, and poverty hindering Ugandan farmers, many people are left hungry and without food. We can help combat hunger throughout the world by managing wheat stem rust. Ug99 is spreading from Uganda to Eastern Africa and the Middle East. Soon, it will spread to India and China, who also rely on wheat as a staple food source. Then it is predicted to spread to Mexico and the United States, where it will destroy the North American wheat crop. Wheat is a food staple in the United States, as well as in Uganda. Imagine eating no bread, crackers, pizza, cookies, cereal, and other wheat-based products. Imagine how much less food there will be, and how many people will be left hungry. We need to manage wheat stem rust, and find a solution to the problem. We need to continue to support research efforts so that we can find this answer. Wheat stem rust is causing many people in Uganda to starve, and will cause many more people across the world to starve in the future. Wheat stem rust is a serious plant disease that still doesn't have an answer. We need to continue to work to find that answer and, like Norman Borlaug, save billions of lives from starvation.

Works Cited

Agriculture Research Service. "What Stem Rust." *ARS : Home*. Main Cereal Disease Laboratory; USDA. Web. 21 Aug. 2010. <http://www.ars.usda.gov/Main/docs.htm?docid=9910>.

"CIA - The World Factbook: Uganda." *World Fact Book*. Central Intelligence Agency (CIA). Web. 22 Aug. 2010. <https://www.cia.gov/library/publications/the-world-factbook/geos/ug.html>.

Dorrance, Anne E., Landon H. Rhodes, Pierce Paul, and Dennis R. Mills. "Ohio Field Crop Disease." *Ohio Agricultural Research and Development Center - Home*. Web. 9 Apr. 2010. <http://www.oardc.ohio-state.edu/ohiofieldcropdisease/>.

Dr. Paul, Pierce. "Wheat Stem Rust." Personal interview. 2010.

"Culture of Uganda - Traditional, History, People, Clothing, Women, Beliefs, Food, Family, Social, Dress, Marriage, Men, Life, Population, Religion, Rituals, History and Ethnic Relations." *Countries and Their Cultures*. Web. 27 Aug. 2010. <http://www.everyculture.com/To-Z/Uganda.html>.

"Global Fight to Preserve Daily Bread." *International Atomic Energy Agency (IAEA)*. International Atomic Energy Agency (IAEA). Web. 20 Aug. 2010. <http://www.iaea.org/NewsCenter/News/2009/stemrust.html>.

McMullen, Marcia, Samuel Markel, and Jack Rasmussen. "Rust Disease of Wheat in North Dakota." *NDSU Agriculture*. NDSU. Web. 27 Aug. 2010. <http://www.ag.ndsu.edu/pubs/plantsci/smgrains/pp1361.htm>.

"Ohio What Diseases." *Ohio Agricultural Research and Development Center - Home*. The Ohio State University: Department of Plant Pathology. Web. 20 Aug. 2010. <http://www.oardc.ohio-state.edu/ohiofieldcropdisease/wheat/wheat1.htm>.

Quinn, Kenneth M. "Dr. Norman E. Borlaug - 20th Century Lessons for the 21st Century World." *The World Food Prize*. 2007. Web. 10 Apr. 2010. <http://www.worldfoodprize.org/borlaug/borlaug-history.htm>.

"Wheat Stem Rust Situation Update." *Rust Spore; A Global Wheat Rust Monitoring System*. Food and Agriculture Organization of the United Nations. Web. 26 Aug. 2010. <http://www.fao.org/agriculture/crops/rust/stem/rust-report/report-archive/en/>.