Professor Sarah Gurr (University of Exeter): "**Major Threats to Global Agriculture: Fungi Challenge Global Food Security**" (Emerging Technologies for Global Food Security Conference), Saskatoon, SK (2016):

Agriculture faces a daunting challenge: to sustainably feed 9.2 billion–the projected world population–by 2050. Of the anticipated increase, 86% will be in the developing world. Professor Sarah Gurr, Chair in Food Security and Head of Biosciences (University of Exeter), spoke at the recent Emerging Technologies for Global Food Security conference in Saskatoon. She identified fungi and fungal-like pathogens as presenting the most urgent threat to international food security. Here are some highlights:

1. **Our food security challenge: How can we feed 9.2 billion in the next 50 years?**

Plant pathogens are clustered in the developing world, where people eat predominantly rice, wheat and maize. Gurr reports that annually, we lose 10 to 23% of planted crops to pathogens and another 10% to various diseases post-harvest. With the population increase, rice, wheat and maize will cover about 40% of the world's agricultural land. Soybean and potato will also be essential. To meet the need, the world will have to double its food production in the next 50 years. This can only happen if we control fungal disease in crops.

2. **Major pathogens: fungi and oomycetes**

Gurr says fungi cause 67% of the crop loss. The five major fungal pathogens that threaten agriculture and food security are wheat stem rust, rice blast, corn smut, soybean fungi and potato late blight. Additionally, oomycetes– "honourary fungi" that are closely related to yellow-brown algae but which act like a virulent fungus –destroy enough to feed 600 million to 4,000 million people, even in a non-epidemic year.

Fungi and oomycetes have recently altered both urban and rural landscapes worldwide, with Dutch elm disease affecting both Europe and Canada; and Chestnut blight and blue stain fungus (carried by the mountain pine beetle) plaguing North America.

3. **Global distribution and movement of fungi and their adaptation to climate change**

Analyzing 2000 pests, Gurr has studied the distribution of 168 crops listed by the UN Food and Agriculture Organization (FAO) and determined that fungal pathogens move in response to climate change. She has discovered that most fungi pathogens move poleward at a rate of about 7.6 km/year, clustering in higher latitudes. Oomycetes are not far behind, travelling at about 5.8 km/year. Gurr has also found that more pests exist on islands than on landlocked countries.

Underreporting is a problem: all nations except France annually underreport their pathogen numbers, and Canada underreports by about 100 species. Countries with low GDP and low or no investment in scientific R&D are more vulnerable to fungal diseases and to underreporting of those diseases.

Saturation statistics of countries and by pathogen activity were measured, and the news is worrying: the US is moving toward full saturation. Canada is following at an alarming rate. Gurr says all of the UK's crops will be saturated by pathogens in about 50 years. Powdery mildew (a fungal disease), root-knot nematodes and oomycetes are the most dangerous offenders.

Global developments, climate change and trade create new disease challenges. Evolutionary drivers for disease include the pathogen domesticating itself in its host, the "hopping" of a pathogen from one host to another, the hybridization of disease (where genomes fuse), and the acquiring of additional toxic genes as a pathogen grows.

Climate change has forced unwelcome new variants of old pathogens to emerge. For example, the fungus *Septoria tritici* blotch (STB) has fast-forwarded to evolve resistance to fungicide and to overcome the disease-resistant gene that was bred into wheat. As a result, European wheat fields have been devastated.

In Canada, there are 10 million hectares of wheat farmed (46% in Saskatchewan). Losing 10% of the crop to STB in a year would mean a loss of $275 -$552 million. Gurr says rust is waiting in the wings for us in Canada as the climate becomes warmer and wetter. Other fungi will follow.

4. The way ahead

Professor Gurr calls for plant scientists to undertake more fundamental research in order to better understand pathogen infection strategies; to find greater insight into genome architecture, so as to evaluate pathogens' abilities to emerge in new variants; to better detect, monitor and quarantine pathogens; to develop antibody and molecular-based technologies that will detect pathogens in virgin lands and on new hosts; and to track populations. New anti-fungal compounds should be developed that will not be so easily overcome by fungal genomes, as single-target site anti-fungals have been.

Gurr also says that plant science needs more government funding–and better assistance to developing countries–to undertake better disease and climate forecasting, develop better epidemiological models, and implement fungal control strategies.

Monoculture farming may produce high yields, but Gurr notes that planting different cultivars can help to resist fungal infestation. She says there should be international enforcement to ensure rotational use of current fungicides that are still so "precious in our fields."

Gurr says a colleague at Exeter University, cell biologist Dr. Gero Steinberg, has managed to tag almost every organelle in fungi of interest with fluorescent proteins. With this knowledge, the research team can now use live cell imaging to understand the infection strategy, as well as the mode of action of various anti-fungals. Gurr is also experimenting with an anti-fungal compound in a low dose that boosts the host plant's immunity.

Professor Gurr asserts that the threats fungi pose to global agriculture can no longer be ignored. She urges both plant scientists and policy makers to take action: effective prevention and timely control are absolutely necessary when no transformative solution – no ‘magic bullet’ – exists.

[940 words]