FROM THE GREEN TO THE GENE REVOLUTION – A 21ST CENTURY CHALLENGE

MEETING OF THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE ON WEDNESDAY 26TH OCTOBER 2005

Dr Borlaug – who is credited with saving more lives than any other person who ever lived – joined the Rockefeller Foundation's pioneering technical assistance programme in Mexico in 1944 where, as a geneticist and plant pathologist, he directed the Cooperative Wheat Research and Production Program. Within twenty years he was spectacularly successful in finding a high yielding short-strawed, disease resistant wheat. He arranged as a practical humanitarian to put the new cereal strains into extensive production to feed the hungry of the world thus providing in his words "a temporary success in man's war against hunger and deprivation", a breathing space in which to deal with the "Population Monster" and the subsequent environmental and social ills that too often lead to conflict between men and nations. Vast acreages of the new wheat were planted with revolutionary yields harvested in Mexico, India and Pakistan – the Green Revolution, which led to the award of the Nobel Peace Prize in 1970.

Since 1986, he has been the President of the Sasakawa Africa Association, and leader of the Sasakawa-Global 2000 agricultural programme in sub-Saharan Africa, along with former US President Jimmy Carter, which has worked with several million farmers in 15 countries of sub-Saharan Africa to increase food production.

From the Green to the Gene Revolution – A 21st Century Challenge

Norman E Borlaug

My career in international agriculture began in 1944, when I joined the recently established Rockefeller Foundation agricultural program in Mexico, the first systematic attempt to reduce a food deficit and increase food production. The Rockefeller-Mexican agricultural program was the forerunner – and in many respects the model – for the network of 15 international agricultural research centers that emerged two decades later, and which today are funded through the Consultative Group for International Agricultural Research (CGIAR), of which the United Kingdom is an active member.

The first two centers – the International Rice Research Institute (IRRI) in the Philippines established in 1960 and the International Maize and Wheat Improvement Center (CIMMYT) in Mexico, first established in 1963 and lately reorganized in 1966 – became the international agricultural research and development leaders in Asia, whose varieties and crop management information launched the so-called "Green Revolution."

Between 1965 and 2000, the area in developing Asian countries planted with new high-yielding wheat and rice varieties increased from zero to 170 million ha. The new seeds were the catalyst for a doubling in irrigated area, a 35-fold increase in fertilizer use, and a 20-fold increase in the use of agricultural machinery, and more than a three-fold increase in cereal production – from 309 to 962 million tonnes. Without these gains, what would have happened to the Asian population, which grew from 1.6 to 3.5 billion people over this period?

Science and technology has had its greatest impact on the lands best suited to agriculture. Over the past 50 years, the world's farmers have been able to triple world cereal production – from 650 million metric tons to 1,900 million with only a 10 per cent increase in total cultivated cereal area. If we had tried to produce the world cereal harvest of 2000 using the agricultural technology of 1950, we would have needed an additional 1.1 billion hectares of land, of the same quality, over and above the 660 million hectares that were actually used. Too often, the environmental critics of modern agriculture fail to see these very beneficial aspects to producing more food, feed and fiber on the lands best suited for these uses, so that other lands can be spared for other uses.

Despite the successes of the Green Revolution, the battle to ensure food security for hundreds of millions of miserably poor people is far from won. Mushrooming populations, changing demographics, failed rural development programs, including those designed to take farmers off the land into other jobs, and environmental abuses have all taken their toll. Enormous challenges lie ahead to ensure that the projected world population in 2025 of around 8 billion people is adequately and equitably fed, and in environmentally sustainable ways.

Over the next 20 years, world cereal demand will likely increase by 50 per cent, driven strongly by rapidly growing animal feed use and meat consumption. With the exception of acid-soil areas in South America and Africa, the potential for expanding the global land area is limited. Future expansions in food production must come largely from land already in use. The productivity of these agricultural lands must be sustained and improved. Central to achieving these productivity gains will be a "Blue Revolution," one in which water-use productivity is much more closely wedded to land-use productivity. Significant improvements in water-use efficiency can be achieved through conservation tillage, planting on beds, and drip irrigation.

Roughly 50 per cent of the world's 800 million hungry people live in marginal lands and depend upon agriculture for their livelihoods. These food-insecure households face frequent droughts, degraded lands, remoteness from markets, and poor market institutions. Investments in science, infrastructure and resource conservation are needed to increase productivity and lower their production risks. Some of the problems farmers in marginal lands face will be too formidable for science to overcome. However, significant improvements should be possible. Moreover, biotechnology can play a major role, through developing new crop varieties with greater tolerance to pests and diseases, drought, and with higher nutritional content.

Africa is the biggest food security challenge we face, although there is still too much hunger in Asia and among indigenous people in Latin America. A twin-track anti-hunger strategy is needed – first, a productivity-led agricultural growth component and second, safety net programs to assist the chronically hungry.

Why hasn't a Green Revolution taken off in Africa? I don't think the reason is one of technology, although Asia certainly had more of its farmlands under irrigation. I think the principal difference between Asia and sub-Saharan Africa is the infrastructure. One World Bank estimate predicts that it might take another 20 years for Africa to reach the road density that India had in 1960. This is unacceptable. Adequate transport is central to commercial agriculture and rural development. Roads also bring indirect benefits – schools, clinics, transport, and improved communications between different ethnic groups. They are a tremendous catalyst for positive change.

Since 1986 I have been engaged in a small agricultural development project in Africa, financed by the Nippon Foundation of Japan. Former US President Jimmy Carter is part of this effort. Several million demonstration plots – mostly maize – have been grown by smallholder farmers, employing a relatively simple package of recommended technology. Average yields have been two-to-three times higher than national averages. But without roads, the cost of bringing in fertilizer is 3-4 times higher than what farmers in other regions pay. Thus, African farmers are unable to apply even modest amounts of fertilizer to their crops, less than 10 per cent of the world average.

I am especially proud of our promotion of quality protein maize (QPM), with much higher levels of the amino acids lysine and tryptophan, which measurably improve nutrition for humans and monogastric animals in maize-dependent diets. CIMMYT scientists were instrumental in developing QPM as a viable crop. African researchers in 10 countries have selected QPM varieties which are grown by farmers on upward of 400,000 ha.

Over the last 20 years, biotechnology based upon recombinant DNA has developed invaluable new scientific methodologies and products for food and agriculture. Recombinant DNA methods have enabled breeders to select and transfer single genes, not only reducing the time needed in conventional breeding to eliminate undesirable genes but also allowing breeders access to useful genes from other distant species. So far, agricultural biotechnology has mainly conferred producer-oriented benefits, such as resistance to pests, diseases, and herbicides. But many consumer-oriented benefits, such as improved nutritional and other health-related characteristics, are likely to be realized over the next 10 to 20 years.

Despite formidable opposition in certain circles to transgenic crops, commercial adoption by farmers of the new varieties has been one of the most rapid cases of technology diffusion in the history of agriculture. Between 1996 and 2004, the area planted commercially to transgenic crops has increased from 1.7 to 81 million ha, and will likely surpass 100 million ha in 2005. Herbicide resistance is revolutionizing soybean production. The use of genes from a soil bacterium, *bacillus thuringiensis*, or Bt, confers excellent resistance to several classes of damaging insects in maize, soybeans and cotton.

The Bt cotton story is especially impressive. Some nine million hectares and six million small-scale farmers in China, South Africa, and India are growing Bt cotton, greatly improving their yields and profitability, and significantly reducing their use of insecticides.

Today, the world's wheat farmers face a dangerous situation. For the last 53 years we've had no major change in stem rust organism any place in the world. But in 1999, first reported in Uganda, then in Kenya and now in Ethiopia, a new race of stem rust has evolved that is capable of severely damaging perhaps half of the world's bread wheat.

The publicly funded international disease screening and testing system we had 25 years ago has broken down, partly a victim of the malaise that has led to steady declines in real public sector research funding. We had better wake up before it's too late.

Despite the formidable challenges to meeting the Millennium Development Goals, look at where the world's governments spend too much of their money – US$ 900 billion annually on armament and military.

We still have close to 900 million adults who are illiterate – and nearly twice as many women illiterate as men – and 150 million primary school-age children still not in school. This is appalling in this day and age.

Lest we forget, as the late Lord John Boyd Orr, the first director general of FAO so aptly said, "You can't build peace on empty stomachs," to which I add, "or human misery."

In discussion the following points were made:

The grossly exaggerated fear of genetically modified food has seriously delayed its introduction to the UK and Europe. Bird flu has had no impact on people in the UK yet, and may never do so. The public tend to respond negatively to science-driven change while still acknowledging that science and technology are important. The British press have described GMOs as "Frankenstein Food" and this may reflect the fact that our more senior scientists are not speaking in public in defence of science and technology. In spite of these apparent problems human longevity is still increasing. What message should be prepared to indicate to the public, for the future benefit of mankind, that all GMO food is safe to eat provided ethical issues are addressed? For example, what possibility is there for the technology transfer of sugar cane to sub-Saharan Africa in support of a new bioethanol industry? The gene for common sense appears to be missing among the decision makers. Pakistan became self sufficient in 7 years in wheat and rice and India in 10 years, arising directly from the importation of modified crops. In spite of this success Swaminathan was attacked without any justification. There is an urgent need for people who know how to integrate all relevant techniques and how to work together across disciplines with support from political leaders, leading to commercial production.