

“REACH FOR THE STARS”

Harvard Medical School Commencement Address

Norman E. Borlaug

June 10, 2004

GRADUATING STUDENTS, LADIES and GENTLEMEN:

My heartfelt congratulations go out to the medical and dental students who receive degrees from the Harvard Medical School today. This is an auspicious day! I also salute your professors, the university staff, your parents, families and friends who have helped make it possible for you to achieve this important goal.

As a nonagerian, I marvel at the improvement that has been made by medicine and dentistry to alleviate suffering and improve health. What a different world it is today health-wise, contrasted to the early years of my life! Among my earliest recollections was the panic caused by the 1919 influenza epidemic. I am a product of a one-room country school, where I received the first eight years of education. Disease epidemics were common. I experienced, and survived disease bouts with chicken pox, measles, mumps, pertussis and thus acquired immunity to these diseases, rather than through vaccination as is today a standard practice. I was fortunate to escape diphtheria, tetanus, typhoid, smallpox, tuberculosis and poliomyelitis, although possibilities for infection with these diseases were of great concern during my early years. During my ninety years, I have only once been hospitalized. That occasion, in 1934, at the University of Minnesota Hospital where I was confined with a severe life-threatening streptococcal throat infection. This was before the availability of “sulfa-drugs” and antibiotics, the only treatment I was given was to gargle with warm salt water to alleviate pain. Luckily because of my innate resistance, I narrowly escaped losing that deadly bout to that aggressive bacterium, many others who were not so lucky succumbed. Over the past 60 years, great progress has been made in improving health and quality of life. These results have been achieved through the combined impact of control of infectious diseases and parasites resulting from the widespread use of improved sanitation practices, development and use of vaccines, drugs, including antibiotics, improvements in the control of certain physiological diseases, improved nutrition and better housing and environments. The composite impact of these improvements over the last century has been to increase American longevity, on average, by thirty years, while also improving the quality of life.

But there is no time or place for complacency on the biologic front, whether in medicine or agriculture. New strains of human, animal, and plant pathogens continue to come into being through mutation and hybridization that threaten our health. How well I have learned this lesson from sixty years of incorporating and trying to maintain rust resistance in wheat varieties against shifting air-borne rust fungus of the genus *Puccinia spp.* There is also urgent need for developing effective controls for ancient still, uncontrolled diseases, like malaria, schistosomiasis and trypanosomiasis. New diseases of disastrous consequences like HIV (AIDs) also arise. Research, therefore, must be continued and modified to meet new challenges. That is why the development and use of molecular genetics (transgenics) to incorporate new resistance from taxonomically distant organisms into pharmaceuticals and agricultural pesticides, is of such great importance, in our never-ending battle to protect human, animal, and plant health. That is why the ongoing debate between the extreme anti-science environmentalist zealots and scientists in human and veterinary medicine and plant science must be won on the basis of using scientific data to show benefits versus risks, rather than based on emotions and rhetoric.

Scientists in medicine today are confronted by an explosion of new technology, problems in health-care delivery, and more recently the prospects of bio-terrorism. In your role as “healers” you will need to maintain a strong personal commitment to professionalism and lifelong learning, to the welfare of your patients, and also to the collective efforts to improve the health-care system for the welfare of society. Due to the spectacular advances of molecular genetics, more and more of what we are “by nature” is coming within the reach of biotechnological intervention. These new developments will challenge our self-understanding of the human species in fundamental ways.

I have spent 60 years trying to increase food production in low-income, food-deficit nations. Better nutrition resulting from increased availability of calories, proteins, vitamins and minerals, combined with improvements in medicine, has resulted in declines in mortality, as well as increased rates of per capita income, observed over the past century in the industrialized nations. In the densely populated food-deficit hungry nations such as India, Pakistan and China, Bangladesh and Indonesia, these improvements have occurred only in the last four decades.

Today, the world confronts pandemic diseases, such as tuberculosis (TB), malaria, schistosomiasis, HIV/AIDS and mental disorders. Approximately two billion people are infected with the TB bacillus, and some 5 to 10% of those who are infected with will become ill or infectious at some stage of their lives. Unless control is strengthened, WHO estimates that about 35 million people will die of TB over the next 20 years. Malaria affects 300 to 500 million people a year, and is responsible for more than one million deaths a year, mostly occurring in sub-Saharan Africa. The negative effect of malaria on economic growth is highly significant. Mental illness has now been found to represent a much greater proportion of the total global burden of diseases. And HIV/AIDS is taking a terrible toll, especially in Africa. Twenty-five million have died from AIDS and more than 40 million are currently living with HIV/AIDS. Seventy percent of those infected live in sub-Saharan Africa.

The Commission on Macroeconomics and Health, co-chaired by Jeffrey Sachs and Gro Harlem Brundtland, concluded in 2002 that an investment of US\$ 25 billion per year or \$35-45 per capita in a set of key preventative health interventions could save 9 million poor women, children and men annually from premature death. Low-income nations do not have the money to make such health-care investments, but the rich countries do. In fact, if OECD nations footed the entire bill, it would only amount to 10 cents out of every \$100 of GNP generated.

Change and Neo-Luddites

Change is one of the few certainties of live. It seems that virtually everything changes—either for better or for worse—over time. For example, consider human nutrition, physical exercise and health. In an earlier day, the rich were fat and the poor were thin, and decent people worried about feeding the hungry. Today, the rich are thin and the poor are fat, and one of America's greatest nutritional concerns is now obesity—too much food and too little physical exercise.

In my line of work I often refer to people with extreme conservatism about change in science and technology as “neo-Luddites.” The original “Luddites” were followers of Ned Ludd in England during 1810-20 who tried to destroy new, machine-powered textile manufacturing looms, which marked the beginning of the industrial revolution. In the 1985-2000 period, Neo-Luddites obstructed and delayed the development of new pharmaceuticals derived by the use of molecular transgenic biotechnology in Europe and, to a lesser extent in the USA, by utilizing

an aggressive rhetorical anti-biotechnological campaign of fear unsupported by scientific facts. Today in agriculture, we also have “neo-Luddites” who are trying to stop the application of new knowledge in molecular biology from being applied to enhance efficiency of our food system by development of improved plant varieties and animal breeds. Most of opposition against agricultural biotechnology has come from people in affluent industrialized countries. They are well fed and bodily comfortable, and have more time for leisure and, according to them, protecting “Mother Nature” from the vicious designs of multi-national corporations. They increasingly seem to want a world without risk. It is a rich world argument that is hurting the poor.

Taming the Population Monster

During my lifetime—now 90 years—world population has grown from 1.6 billion to 6.3 billion people—a four-fold increase. Although growth rates are slowing, we are still adding nearly 80 million people per year to world population, most of them, unfortunately, are in food-deficit nations. Population growth, plus increasing incomes that lead to better diets, are the parameters that those of us on the food production front must factor into our work.

Achieving sustainable agricultural production with equitable distribution of sufficient food for the 9-10 billion people likely to be on Earth by the end of the 21st Century will not be easy. So far, advances in agricultural research and production—and the efforts of the world's farmers, ranchers, fishermen and aquaculturists—have kept world food production growing faster than population. Even so, currently the world food situation is not a happy one; at least 800 million go to bed hungry most nights, not because there isn't enough food to go around but rather because they are either too poor to buy it or to produce it, while extreme environmentalist zealots continue to promote their idyllic utopian organic world free of agricultural chemical pesticides, including chemical fertilizers.

I often ask the critics of modern agricultural technology what the world would have been like without the technological advances that have occurred in agriculture over the past 50 years. Had we tried to produce the two billion metric tons of cereal grains harvested today with the crop yield technology of 1950, we would have needed to have cultivated a total 4.5 billion acres of land—of the same quality as in use today—instead of the 1.8 billion acres that were actually used. Obviously,

such a surplus of land is no longer available, especially in populous Asia. Moreover, even if it were available, had we tried to bring an additional 2.7 billion acres of land into cereal cultivation around the globe, it would have resulted in greatly increased soil erosion, loss of forests and grasslands, destruction of wildlife habitat with the resultant extinction of many more wild species of both animals, and plants.

The use of high yield production technology—with its consequent savings in land—has done much to protect the environment. This benefit is rarely acknowledged by environmental action organizations and little understood by urban populations. Technology is not the enemy of the environment; poverty is!!

The Green Revolution

In 1944, I joined the first pioneering international agricultural research and production programs—the Mexican Government-Rockefeller Foundation Program. As I look back on my own career of six decades in agricultural research and food production in the developing world, two major streams of change have had major impacts on my work—one has been unprecedented population growth stemming largely from reduction in death rate resulting from improvements in medicine and health care: the other has been the enormous impact that the application of science and improved technology has had on agriculture and food production.

This application of modern science and technology to food production in the developing world came to be known as the “Green Revolution,” This term was coined in 1968 in a speech by Dr. William Gaud, the Administrator of USAID, to describe the rapid introduction and diffusion into India and Pakistan of new types of wheat and rice varieties that had much higher genetic grain yield potential and disease resistance than had ever been seen before. These new seeds were combined with proper fertilizers, irrigation, and improved crop management practices to permit the new varieties to express their high grain yield. When this package of improved practices was widely demonstrated on farms and economic policy incentives were made to permit the adoption of the new technology, tremendous increases in food production were achieved. Between 1965 and 2000 cereal production in the developing countries of Asia tripled—from 300 to 900 million tones—leading to a 25 percent increase in per capita food availability, literally saving hundreds of millions of people from hunger and starvation. I was privileged to have been involved in the development of the broadly adapted disease resistant, high-yielding wheat varieties and production technology, and to have trained and led an international team of young scientists that sparked the so-called Green Revolution in Asia. These wheat varieties were first developed in Mexico, initially under the Mexican Government-Rockefeller Foundation program and later by its successor organization, the International Maize and Wheat Improvement Center (CIMMYT). Today, the high-yielding so-called “Mexican” wheat varieties and their derivatives with improved management technology are grown on 175 million acres worldwide, they have added several hundred million metric tons to the global wheat harvest.

Africa is Our Greatest Challenge

Over the past 17 years, I have been working in Africa with former U.S. President

Jimmy Carter and the Sasakawa family of Japan in an initiative called the Sasakawa-Global 2000 agricultural program. Our aim is to bring a Green Revolution in food production to millions of small-scale farmers. Unfortunately, progress has been painfully slow; and much less than achieved in Asia 35 years ago. Widespread food insecurity and malnutrition persists, and in some areas, has even worsened. African food production remains in crisis, even though our demonstrations on hundreds of thousands of plots on farmers' fields clearly indicates the technology is available to double and triple yields of the major food crops. While technology is available and smallholder farmers are eager to adopt it, unless Africa's rural infrastructure and institutions are significantly improved—especially transport systems, energy, water, schools, and clinics—all other efforts to reduce poverty and hunger, improve health and education, and secure peace and prosperity will continue to falter.

During the colonial period in South Asia, Britain needed an agricultural product, cotton fiber, for its textile industry. Hence, to further increase cotton production and export, railroads were built into the Punjab—the best agricultural region—roads were built to deliver cotton to railhead, and irrigation systems were developed. When the high yield wheat and rice production technology were widely demonstrated in the early 1960s in India and Pakistan and shown to be capable of increasing grain yield per acre three- to four-fold, the main remaining obstacles to increasing production were unavailability of fertilizer and government policies that denied farmers the needed economic incentive to increase their productivity. When these obstacles were removed, following nasty debates at top governmental levels, in which I was personally involved, production soared!

By contrast in sub-Saharan Africa, the main interest of the colonial powers was minerals and not agricultural products—so the railroads were built to the mines. Agricultural development was largely neglected. Development of sub-Saharan countries continue to be hobbled by lack of infrastructure, especially roads. Roads bring schools and public health services.! Soon, bus and truck service begin, and cultural, ethnic, linguistic and tribal barriers begin to break down, and everything begins to change, generally for the better!

Urbanization and the Loss of Our “Agricultural Roots”

The tremendous progress made in agricultural science and technology, education, medicine, public health, communication and transportation during the 20th Century has permitted the majority of people in the industrialized affluent

nations to leave farming and move from the countryside to better paying positions in the city. In most industrialized countries, less than 3 percent of the population is now engaged directly in agricultural production, and less than 20 percent live in rural areas. As a result, most people in the industrialized nations have lost touch with the land, and are ignorant about the complexities and magnitude of producing and equitably distributing food for all who come into this world. They are equally ignorant about the management of our forest resources for multiple uses on a sustainable basis.

Urban ignorance about agriculture, forestry and fisheries in rich countries—indeed about biological sciences in general—has permitted radical environmental elites to capture and distort essential environmental movements and by using fear tactics to confuse the public about modern agriculture. These anti-technology critics argue that humankind is being poisoned by modern high-yield agriculture and should return to traditional organic methods. Of course, this is nonsense. We live longer, more productive enjoyable lives than ever before.

Today, anti-science and technology zealots are trying to retard—and even stop—the application of new science and technology, especially the new transgenic biotechnological tools that offer so much promise for the future. While it is almost certain that they will not be successful, we still must remain vigilant to make sure that such a catastrophe does not happen. I have had the sad experience of seeing—luckily from afar—the monstrous effects that T. D. Lysenko, the leading proponent of pseudo-science in the Soviet Union—had on agricultural science and production. Lysenko-ism contributed enormously to that country's collapse, and also spread this false dogma to many other countries through sponsoring large numbers of scholarships for students from developing nations to study in Soviet Universities.

Use Reason in Environmental Protection

Over the past 40 years, we all owe a debt of gratitude to the environmental movement in industrialized nations, which has led to legislation to improve air and water quality, protect wildlife, control the disposal of toxic wastes, protect soils, and reduce the loss of biodiversity. However, in looking to the future, our ecological impulses must be grounded in rationality. Logic—based on scientific data not sentiment—will best serve the interests of nature and humankind.

Protecting the land, water, and atmospheric resource base of planet Earth is clearly central to preserving our quality of life and probably, the long-term survival of humankind. While many continue to argue to the contrary, in the rich, industrialized western world, the age of pollution is nearly over. Aside from armaments, technology is not growing more dangerous and wasteful but cleaner and more resource-efficient. I predict that almost all of the remaining pollution issues will be solved in the lifetime of most of you.

As positive as trends towards clean technology and a better environment are in the industrialized nations, they are negative and worsening in the developing nations that employ primitive traditional health care and agricultural methods. This is why it is so important for Western Europe, the United States, Canada, Australia and Japan to break free from their “doomsday” thinking so that resources can be diverted to ecological protection in the developing world.

In principle, the human population is no enemy of nature. Someday, human population may be several times larger than at present, without serious ecological harm. But today, many developing countries have population growth rates that are too high for current social institutions and technological knowledge to support at adequate standards of living. Thus, short-term global population stabilization, especially in densely populated nations, is desperately needed. Intermediate population projections of the United Nations estimate that the earliest we can expect leveling-off of human growth rate is towards the end of the 21st Century, when world population will be between 9 and 10 billion people with, unfortunately, 90 percent living in low-income developing nations. All of us must strive to bring human numbers to a more satisfactory equilibrium. I believe universal primary education, and as soon as possible secondary education, should be our near-term first step toward achieving population equilibrium in developing nations

Striving for Social Justice and Political Stability

There has always been inequality in the animal and plant kingdoms. From the early days of prehistoric man, tribal hunters that occupied the best grassland environments with herds of large ungulates had access to an abundant supply of wild meat. Weaker tribes of hunters were pushed into drier or harsher environments where wild meat resources were less and more difficult to harvest. These inequities continue today, despite our technological power to assure food security for all that come into this world.

Currently, more than one billion people in the industrialized world, primarily because of contributions of science and technology, enjoy a standard of living that was unimaginable—even in the fondest dreams—of their grandfathers and great grandfathers.

Unfortunately, another nearly one billion people in developing nations remain illiterate, malnourished, hungry, ill, poverty stricken and without hope. Another 2-3 billion live outside formal economic systems, in varying degrees of poverty and want. These environments of human misery and hopelessness are fertile seedbeds for sowing and cultivating seeds of terrorism that is potentially a serious threat to civilization and the future well-being of humankind everywhere.

I urge you not to close your eyes and hearts to the less fortunate, especially the 800 million to one billion people who begin and end each day hungry. These inhumane injustices must be lessened in the decades ahead. Remember, compassion is the greatest of all human virtues. By helping the less fortunate, you serve God and your country.

Knowledge and Lifelong Learning

The late American historian-philosopher Will Durant once said, “Education is a life-long discovery of our own ignorance. Sixty years ago, when I was 19, I thought I knew everything and my father knew nothing. By the time I was 29, I was amazed at how much my father had learned. Now at 79, I realize I know nothing.”

Will Rogers, the late cowboy, humorist, and philosopher, put it more simply, “We are all ignorant; the difference is that we are ignorant about different subjects.” To this I might add, as we become more specialized in our knowledge, there is an ever-present danger of our gene for common sense becoming seriously eroded. So try to read broadly and across disciplines. Don’t be ignorant of history, since it can teach us many lessons of relevance today.

Reach For the Stars

In closing I urge all of you to apply yourselves to the fullest, and to adhere to the highest levels of professionalism. Never be satisfied with the status quo or mediocrity. Reach for the stars! Although you can never touch one, if you stretch yourself, you will get a little “star dust” on your hands and with this as a catalyst,

you will be surprised what you will be able to achieve for yourself, your families, communities, nation, and indeed the world!! God bless and speed you in your chosen fields of specialization. And once again, my heart-felt congratulations.