The Life and Work of Norman Borlaug, Nobel Laureate

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It is an honor and privilege to say a few words about the life and work of Norman Borlaug, one of the truly great figures of our day.

The title given to me for this brief address signals what some may assume is the culmination of the life and work of Norman Borlaug -- the receipt of the Nobel Prize. But anyone who knows Norm recognizes that awards, even the ultimate award, the Nobel Peace Prize, are to him a consequence of his real goal -- contributing to more abundant food for those most in need of it. So, receiving the Nobel Prize was one event in the life of Norman Borlaug, a memorable one, but not the culmination of his life.

Borlaug received the Prize in 1970, twenty-eight years ago. That was almost 28 years after he began working to increase food production in Mexico. So he received the Prize at the mid-point of his career. But, it is premature to speak even today of the life and work of Norman Borlaug because that life is still unfolding.

Nearing 84 years, Norm is still going strong, working uncounted hours here in Texas, in Mexico, and in Africa. The life story of Norman Borlaug is a story of hard work and determination to help farmers produce more abundant food for those most in need of it.

Early Years
Born at the beginning of the First World War, Norman learned his early lessons at the one room school he attended in Howard County, Iowa. Supported by a strong family, he came to know the value of hard work and clear goals. More importantly, in his own words, he came "to know right from wrong from his parents, grandparents and neighbors.?

Norman was a teenager during the Great Depression, and one can only imagine the courage and determination it took for him to leave the farm during the depths of that depression and go off to the University of Minnesota to study Forestry.

It must have been during his formative years at the University that he came to recognize the power of science to address practical problems of farmers. After a brief time with the Forest Service, he decided to continue his education as a graduate student under one of the giants in plant pathology, Professor E.C. Stakeman. The influence Stakeman had on Norman Borlaug is hard to overstate. Especially memorable was a

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1938 lecture Stakeman gave where he characterized wheat rust as "a shifty, changing, constantly evolving enemy." (Ch 17, p.7) That view of wheat rust seemed to have stayed with Borlaug his entire life.

A Lifetime of Service

After obtaining his doctoral degree with Professor Stakeman, Norman took a job as a microbiologist with DuPont, but after a few years had the opportunity to join the first international agricultural development assistance program. Through the efforts of Henry Wallace, who had been Secretary of Agriculture and then Vice President in the Franklin Roosevelt administrations, the Rockefeller Foundation had become interested in how it might be able to assist in the development of agriculture in Mexico.

After some discussions, the Mexican Government invited the Foundation to send a small team of specialists to review the situation. In early 1941 the Foundation appointed Professor Stakeman, together with two distinguished colleagues from Cornell and Harvard to study Mexico's needs and answer the question of what to do.

Spending two months roaming more than two thousand miles of highways and byways in sixteen of Mexico's thirty-three states, the commission reported back to the Foundation. The essence of their recommendation was that the Foundation should send a team of four dedicated and competent scientists to cooperate with the Mexican agricultural ministry to breed better plant varieties, improve soil and crop management and increase livestock productivity. J. George Harrar, later to become the Foundation's President, was selected to head the team, and Norman Borlaug and two other scientists were invited to join him. Thus Norman Borlaug began the first phase of his life's work.

1944 through 1960 were dedicated to helping Mexico increase its food production. The first years were learning by doing. Borlaug was the team's pathologist and so was in charge of the all the diseases attacking the fields of all the crops ? mainly beans and corn. But in reality Norm worked on whatever needed doing -- insect control, plot development, planting, and recruiting helpers.

Looking back on it, Borlaug recalls that Harrar "came up with the ideal intellectual platform for launching an attack on hunger. He gave us the freedom to make our own decisions and to exercise our fullest capacities without interference. He managed the program based on four principles: To hire the best people for the tasks; to provide them a lifetime commitment; to shield them from distractions; and to share all research results freely with whomever could use them." Those principles still characterize the Foundation's agricultural program.

Furthermore, Borlaug recalls, "We were to help Mexico solve its own food problems. In other words, alongside our own work we were to train local scientists and ease them into our jobs. Moreover, we were to be neither consultants nor advisors, but working scientists getting our hands and boots dirty, and demonstrating by our own field results what could be done."

But in the process Borlaug had to fight some aspects of Mexican culture, in particular the conviction that scientists were above hand labor or getting dirty. He was told by one of his colleagues in the early days, "Dr. Borlaug, we don't do these things in Mexico. That's why we have peons. All you've got to do is draw up the plans and take them to the foreman and let them do it."

Borlaug lost his temper (it wasn?t the last time). He yelled back "That's why the farmers disrespect you. If you don't know how to do something yourself, how can you possibly advise

them? If the peons give you false information, you wouldn't even know. No, this has to change. Until we master our own efforts, we will go nowhere in this project."

In 1944 wheat was Mexico's second most important food crop, and half of it was being imported, at an annual cost of $21 million. Average yields were 11 bushels to the acre, about half the US level, but subject to enormous fluctuations caused by epidemics of wheat rust. It was an obvious target for the Harrar team, and George himself organized the first year's work.

In Borlaug's boyhood, the Iowa home farm had never grown wheat, and Norman's doctoral thesis had been on flax. So when George Harrar asked Norm to take over the wheat program in 1945, he had little background to draw on. But that didn't stop him. And, in some ways, wheat was an ideal challenge for the young plant pathologist because a major problem was wheat rust, the same disease held up by Professor Stakeman as that shifty enemy.

Norm and his small team began by making crosses among five established Mexican varieties and a dozen imported ones. The resulting combinations, by some stroke of luck gave promising results from the beginning, and four selections were later released as varieties, resulting in notable increases in wheat production by the late 1940s.

But the potential for disaster remained always in Borlaug's mind. The constantly shifting enemy, wheat rust, was at bay but not defeated. In the years to come he was to make two innovations that had tremendous payoff. Most plant breeders made a few crosses or a few dozen crosses each season. The many individual plants that resulted each had to be observed throughout the growing season and seeds from the best individuals harvested and planted the next year, with more selections made, and so forth for eight to ten years.

In each generation the numbers can increase and the work of observation can increase tremendously. As Borlaug says, "This hit-or-miss process is time consuming and mind-warpingly tedious. There's only one chance in thousands of ever finding what you want, and actually no guarantee of success at all." (Ch 18, p.1).

Success in breeding wheat means keeping ahead of the ever-evolving rust organism so production doesn't crash. Failure means disaster for farmers, nations, and even in an extreme case, the globe. Borlaug became convinced that only by making thousands of crosses from wheats gathered from all around the world would it be possible to stay ahead of the threat. So he undertook to make many more crosses than any breeder had thought possible up till that time. That meant a tremendous increase in the fieldwork of examining and scoring the progeny. It also meant imposing tougher criteria for discarding plants that failed to measure up. This approach, high volume crossing, was the result of deliberate choice, and a willingness to take on the work implied by that choice.

The second breeding innovation was more a matter of serendipity -- one of those consequences that springs entirely unforeseen from innocent acts. The wheat program, like the other parts of the Foundation's effort was being conducted in Toluca, not far from Mexico City, an area where most farmers were exceedingly poor. It wasn't particularly well suited for wheat production, and Borlaug's attention soon focused on the Yaqui Valley, 1200 miles to the north, in Sonora. The wide, flat Sonora plain, with irrigation from mountain waters promised a much greater potential for feeding Mexico. Despite opposition from several quarters, including the Foundation, Borlaug persisted and gained approval to extend the wheat work to Sonora.

Growing conditions in Sonora were a dramatic contrast with those of in Toluca. Much further North and in a near desert, as harvest time neared temperatures soared, humidity dropped and winds were often strong. Most wheats that had performed well in Toluca just didn't hold up in

Sonora. But Borlaug saw how to use the climate differences to advantage. They would plant their segregating materials in Toluca in May, harvest and then plant that season's selections in Sonora the next October. That way they would be able to advance the generations twice as fast. But it went against one of the dominant plant breeding dogmas of the day -- which was that plants had to be designed for the particular environments for which they were intended.

Borlaug's objective was simply to make the breeding process faster. The segregating populations were shuttled back and forth over ten degrees of latitude and from near sea level to over eight thousand feet of altitude. They were exposed to different diseases, different soils, different climates and different daylights: to winter in Sonora and summer in Toluca. The result was much more than simply a speeding of the breeding process. The plants that survived and performed well were well adapted to a wide range of conditions. The concept of shuttle breeding is now recognized as a way to achieve that kind of wide adaptability.

Student and Teacher

Norman's student years may have begun in Iowa in the 1920s, and formally ended with the award of his PhD degree from the University of Minnesota in 1942, but he has never ceased being a student. In addition to Professors Cheney and Stakeman at Minnesota, he credits many, colleagues, including George Harrar, Ed Wellhausen, John Neiderhauser and Louis Roberts with providing insights and challenges that led him to ever-greater efforts.

But perhaps his greatest teachers were the wheat plants to which he devoted uncounted hours. As he says, he learned "to tell the status of a wheat plant from its look, manner of growth, feel, and movement. Wheat itself was becoming a person. Moreover wheat was the best teacher about wheat." He began to see that different wheats had different "personalities." He could tell them apart at a glance, or "even by the rustle of the wind through their ripening heads." (Ch 18, p11). Like many other pioneering plant scientists including Mendel and McClintock, Borlaug's advances were based on careful observations made during hours and hours of devoted work.

The untold story of Norman Borlaug?s life is, however, his career as a teacher. In the very first days of his assignment to the Rockefeller Foundation?s program in Mexico he encouraged young Mexican technicians to learn the secrets of plant breeding -- crossing and selection -- the critical steps that most plant breeders kept to themselves. Throughout the Mexico period he gave young people the opportunity and responsibilities to learn.

But learning from Borlaug wasn?t easy, and didn?t take place in an air-conditioned classrooms. It involved preparing land, planting seeds, taking observations and making notes, making crosses, making more observations, harvesting, keeping records, and doing analyses of the notes. And, after the invention of the shuttle breeding approach this process was a year-round effort, unlike most places in the United States, where the winter season is used to analyze and plan the next year?s work.

International Dimensions

By the late 1950s the cooperative program had made such a contribution to Mexico's food production that the Foundation concluded Borlaug had succeeded in working himself out of a job. Leadership of the national Wheat Program was turned over to Mexican scientists.

In 1959 neither Norman nor the Foundation had a solid idea of what he might do next. But the Food and Agricultural Organization of the UN had assembled a team of scientists to advise on its wheat work in the Middle East and North Africa. Norm joined the team and made his first trip outside the Americas, beginning the international phase of his life and work. Under the UN flag the team traveled through Algeria, Libya, Egypt, Jordan, Lebanon, Afghanistan, Pakistan

and India. In each place they visited agriculture ministries and experiment stations, observing wheat and barley research programs.

Returning to Rome after the visit Norman mused on the situation he had seen. Half of humanity was going to bed hungry. Many of the countries had virtually no agricultural scientists, but even in those that did the local scientists who were being paid to do something about the food situation weren't fired up about it. They were government servants with secure jobs and little incentive to address farmer?s problems. In many cases they couldn?t even recognize farmers? problems.

Borlaug concluded they needed training and inspiration to address real problems. And he saw that the same program of training that had helped so many young Mexican scientists to assume leadership of that country's agriculture could be used to train and motivate young scientists from the middle East and South Asia. He took on the task of training the new candidates, not just in genetics but also in agronomy, soils, irrigation, weed control, plant pathology, entomology, cereal technology and more. Trainees toiled in the fields twelve hours a day. They had to level and lay out sample plots, sow the crops, and apply water and fertilizer. In this way they got a solid grounding in hunger fighting from the front lines.

As part of the training program Borlaug established the international wheat yield trials that he had recommended in his report to the FAO. The first year they sent out twenty-five types of wheat. After that it seemed that each year more and more people wanted to test more and more different types of wheat. In the second year fifty types were sent out, then over one hundred. Eventually one hundred twenty five wheats were being sent to one hundred and fifty locations worldwide (Ch 27, p.7).

In 1963, Mexican President Adolfo Lopez Mateos made a trip to Southeast Asia and while in the Philippines visited the International Rice Research Institute. When asked about IRRI's origin, Bob Chandler, the Director, replied that it had its roots in the Rockefeller Foundation program in Mexico. Lopez Mateos was so excited by what he saw that on his return to Mexico he met with Harrar and Borlaug and suggested that something like IRRI could be established in Mexico. It would focus on maize and wheat and become the vehicle for taking what had been learned and projecting it from Mexico to the rest of the developing world. A partnership of the Ford and Rockefeller Foundations funded CIMMYT, Ed Wellhausen became its founding Director, and Borlaug became director of its wheat program.

Through the 1960s Norm took dozens of scientists from South Asia under his wing. Some came to Mexico for formal training at CIMMYT, many more learned from his visits to Asia. By the mid-1960s the semi-dwarf Mexican wheat had won over the hearts of plant scientists in the region and were being fairly widely grown by progressive farmers in North India and Pakistan. In February of 1967 Norm made a trip to India, where, as was his practice, he visited the experimental plots at various places around the country. A new University had been established in the state of Uttar Pradesh at Pantnagar, about 5 hours drive from Delhi, and scientists there had planted a trial with the wheats from Mexico, other international breeding lines, and crosses made by Indian scientists. Norm?s visit was the occasion for a gathering of local agriculturalists from much of North India, including some of us from the Rockefeller Foundation New Delhi Office.

Scores of wheat varieties had been planted in small observation plots. The morning was cool but bright, one of those perfect late winter days in North India when the summer heat is still weeks away. Norm arrived with the university Vice Chancellor, the head of India's wheat program, and dozens of scientists trailing along. The field was a checkerboard of short, intermediate, and tall

wheats, some beginning to mature and others still fairly green. Most looked healthy and many of the semi-dwarfs promised copious yields.

Norm strode through the field barely glancing at one outstanding plot after another. He ignored the efforts of first one and then another proud scientist to explain the lineage of this or that line. Finally he found what he was looking for -- a sorry, disease-infested plot of disreputable appearance. Pouncing on that plot he launched into a warning of the potential dangers of pride and complacency. At any time, new races of that "shifty, changing, constantly evolving enemy," wheat rust, could descend on South Asia and devastate entire regions, just as that unfortunate plot had been devastated. It was the job of wheat scientist to be ever alert to that possibility, to anticipate it, and to have breeding lines incorporating alternative sources of resistance ready, so if such a disaster threatened seed could be multiplied and made available to farmers.

Few of those attending could forget this lesson imparted by a gifted teacher with a burning mission.

In 1979, at age 65 Norm completed 13 years as Director of the CIMMYT program and became a Senior Consultant to CIMMYT. That sounds like a kind of semi-retirement position, but Norman Borlaug is not the ?retiring kind.? The 1980s opened the third phase of his life, when formal teaching came to occupy ever more of his time. In 1983 through 1985 Norm served as Cornell University's A.D. White Distinguished Professor at Large. For several weeks each year he enlivened the Ithaca campus with his forthright views on agriculture, environment, and development.

In 1984, Norman became Distinguished Professor of International Agriculture here at Texas A&M University. Each fall he moves to campus from CIMMYT and teaches a regularly scheduled class. In between times he took up the lecture circuit, hammering away at the need for constant attention to the global population problem, the need to increase food production, and the short sightedness of misguided environmentalists who fail to see that fertilizer, pesticides and science stand between humanity and starvation.

In the mid-1980s Norman was settling into the role of senior statesman to the world food community. The crisis spots of the 60's were enjoying an abundance of food the pundits had never imagined. Indonesia, Pakistan, India, and China, were all producing food in abundance. They no longer could be held hostage to other countries more fortunately endowed with productive capacity.

Africa

But a new element had entered the world food scene. Africa. In the 1960s Africa was exporting food to other regions. It was seen as a potential granary by the former colonial powers. The leaders of the newly independent nations certainly believed they had no reason to fear problems on the food front. After all, Africa was a place of abundance.

But that confidence failed to understand the impact rapid population growth could have. Just as Latin America and Asia had experienced a ballooning of population, by the 1970s population growth rates in Africa had reached explosive levels. By the 1980s country after country was experiencing episodes of shortages. Then came the much-publicized famines of Ethiopia and Sudan.

The story of how the billionaire Ryoichi Sasakawa contacted Norm one day to inquire why there was no Green Revolution initiative in sub-Saharan Africa has been told many times. Norman replied that he didn't know anything about sub-Saharan Africa and anyway, he was too old. The

next day Sasakawa's response came back, "I'm 13 years older than you are Dr. Borlaug. The central Africa initiative should have been done much sooner. No excuses, lets get to work.? Borlaug agreed to help organize a conference to address the Africa food problem, and launched into the fourth phase of his life?s work.

Sasakawa managed to get former President Jimmy Carter and other luminaries like Father Theodore Hesburg to the meeting. A few months later, Global 2000, Inc. was established, and Borlaug was once more off on a campaign to help overcome hunger. Ghana was one of the first countries to adopt the Global 2000 approach, the Sudan another. There, civil war cut the program short, but maize production prospered in Ghana under the Global 2000 program. More recently, Ethiopia has been the latest country to show that the Global 2000 approach can make a dramatic difference.

According to Dr. Gebisa Ejeta, a Purdue University Professor born in Ethiopia, the recent changes in Ethiopian agriculture are extraordinary. In his view, "the significance of the agricultural change in Ethiopia is that it was made possible through a conventional approach of extending modern agronomic practices...The success of the Norman Borlaug approach proves that there are niches in African agriculture that can be effectively addressed through conventional science and traditional approaches, provided that a concerted effort is made in the development and extension of an appropriate technology -- to be implemented under the right policy environment.'

The Borlaug approach that Ejeta finds has been so effective amounts to the tried and true elements Norm stressed in Mexico, India, Pakistan and elsewhere: high-yielding, well-adapted varieties created by plant breeding, appropriate fertilizer, and stable, remunerative prices to farmers. In one country after another, Norman Borlaug has helped governments to see that these elements are the keys to increasing food production.

Ever the student and ever the teacher, Norm has used hard work, a clear focus on worthy goals, and science directed at solving problems throughout his life. He has stressed the need to tackle problems rather than pursue disciplinary knowledge. He has lit a spark in the minds of young agricultural scientists in many parts of the world, in the conviction that this spark will develop into a flame that will motivate these young people to try and make life a little more tolerable for the less-fortunate. That is the culmination of the life and work of Norman Borlaug.

Thank you.

[1] Most of the quotations contained herein are taken from Norman Borlaug's Memoirs. I appreciate his willingness to make the material available, and the assistance of Chris Doswell in providing me with other information..