Making an Impact

International Maize and Wheat Improvement Center- CIMMYT
Mexico

World Food Prize Youth Internship 2000

Leah M. Shultz

My name is Leah Shultz from Charles City, Iowa. I am currently a freshman at Iowa State University majoring in agricultural biochemistry.

In 1999 I participated in the World Food Prize youth program. Before doing the research for the paper, I must admit, I knew the problem of food security existed, but I wasn't aware of the magnitude of the global food situation. I have grown up in Iowa my entire life where obtaining enough food is never an issue. Since then my knowledge has increased tremendously as well as my passion to help those in need.

While listening to the interns of 1999 I was truly inspired. The people who stood before me presenting were so young and had accomplished so much. At that moment I wanted nothing more than to be able to stand in their place and give a presentation about my own internship abroad. I was almost positive that I wanted to do an internship and I was given the confidence and encouragement from my agriculture teacher Mr. Lundberg who was the advisor for my paper.

I didn't have a particular place that I wanted to visit because I was interested in every aspect of agricultural research. I was very excited to learn that I would be spending eight weeks in Mexico working in the applied biotech genetics laboratory at the International Maize and Wheat Improvement Center (CIMMYT).

Before leaving, I didn't know what to expect of the place where I was to live for the next two months. What I knew of CIMMYT was just what I had

learned from Meredith Nelson's paper about being an intern in 1999 and from browsing the CIMMYT web page.

When I flew into Mexico City on June 8, I will confess that I was more scared than I have ever been in my entire life. While looking out over the endless sea of buildings and cars I realized that I was alone in a foreign country. I had left behind the comfort and security of my family and home knowing that I would not be returning for a while.

While traveling to CIMMYT I stared out the window of the car taking in all of the urban scenery I was so unfamiliar with. The immensity of the city was such a contrast to the rural area of northeast Iowa where I had lived my entire life. There were people in every direction I looked as well as political campaign posters hanging from anything they could be attached to. The driving was enough to make you clutch the door handles fearing for you life. I was experiencing a new culture first hand for the first time in my life.

When I arrived at CIMMYT just outside of the city of Texcoco, I was glad to see that it seemed to be a little more peaceful than the hustle and bustle of the city. The next day I was introduced to the program that I would be working with and also CIMMYT in general.

The International Maize and Wheat Improvement Center is a nonprofit, internationally funded agricultural research and training center with its main headquarters in Mexico and outreach offices in sixteen other countries across the world. The goal of CIMMYT is to supply a range of products and services

that will promote the profitability, productivity, and sustainability of maize and wheat systems in underdeveloped countries. The main focus of the work is to sustain maize and wheat systems through the development of technologies that both increase the productivity and protect natural resources.

In the early 1940's, Mexico and the Rockefeller Foundation recognized the global importance of maize and wheat and decided to start specialized research programs dealing with these and other crops. Founded in 1966, CIMMYT can trace it's origins to this program. CIMMYT's early achievements in the development of high-yielding wheats seemed to be a perfect answer to the rising disaster in the Asian Subcontinent, where widespread starvation and malnutrition was threatening millions of people. This great success became known as the Green Revolution. Dr. Norman Borlaug earned the Nobel Peace Prize in 1970 as a result of being an early leader in CIMMYT's wheat research and for the great impact it had made on the world.

Right now CIMMYT employs close to 100 scientific staff from 40 countries and has over 600 support staff. About two-thirds of the scientific staff are located at the headquarters, just outside of Mexico City, Mexico. Around the globe, CIMMYT collaborates with as many as 100 nations, as well as a number of outreach stations in the developing world. Some of these outreach stations are located in Africa, Latin America, and Asia. They all work together to conduct joint research, improve genetic materials and research

results, and most importantly- ensure that the products are suiting the needs of the people who they are striving to help.

At this very minute 200 people are being added to the population and the population increases the size of Mexico City every three months. This tells us that a sufficient quantity and quality of food must be available to feed the world. Of the developing world's basic foods, maize and wheat are two of the three most vital in the diet. On average maize and wheat add up to one-fourth of the total calorie intake in low income countries. This enormous challenge of providing enough food to feed the world is being addressed by agricultural research done at CIMMYT.

CIMMYT and it's expanding diversity of partners around the world are undertaking the challenge to increase food security and lessen poverty by increasing the development of improved germplasm, which is the very source of food grains. This germplasm is the genetic material that forms the physical basis of heredity for a species and is transmitted from one generation to the next. The significance of this improved germplasm is that it will have more tolerance and resistance to a wide variety of pests, diseases, and environmental stresses. This germplasm can then be used around the world to raise the yield potential helping developing countries to obtain food security.

There are five major research groups at CIMMYT that are all working toward a common purpose. These five groups are the Maize Program, Wheat Program, Applied Biotechnology Center, Economics Program, and the Natural

Resources Group. Because of my interest in biotechnology I was chosen to work at the Applied Biotechnology Center (ABC). I would be working on a wheat genetic diversity project for the first month and work in the tissue culture lab for the second month.

The ABC was founded in 1990, and is comprised of researchers from around the world helping to apply biotechnology to increase the effectiveness of maize and wheat improvement and to conserve and use the genetic resources from those crops. Insect pests, drought, infertile soils, and crop diseases are all challenges faced by maize and wheat farmers in developing countries. The goal of the ABC is to establish research partnerships, publications of research, and technology transfer that will help agricultural scientists in developing countries to apply biotechnology to help address these challenges.

I will admit that at first I was a little intimidated about working at the ABC because I was not sure if I would be able to understand the genetic work that was being done. I had only had general biology and chemistry courses in high school and I thought that I might need to have more knowledge than they had provided. After meeting and talking with Dr. Marilyn Warburton, I realized that I was not expected to know every aspect of genetic processes. Dr. Marilyn Warbuton was the molecular geneticist that I worked under for the first month.

The first month I worked on a wheat genetic diversity project with a graduate student from Germany who was supervised by Dr. Warburton. This

genetic diversity project focused on fingerprinting historical wheats from CIMMYT's germplasm bank.

Wheat breeders have been increasingly interested in DNA fingerprinting because they want to determine the amount of genetic diversity between different wheat lines. The diversity of plants and animals is important, especially the diversity of food crops, because a small amount of diversity can lead to a higher susceptibility to insect pests, drought, and environmental stresses. One of CIMMYT's goals is to maintain and increase the genetic diversity of the maize and wheat that they are breeding. The importance of this project is it will allow us to see if the modern breeding of cultivars (cultivated varieties) has lead to genetic uniformity or if it has maintained or increased the diversity.

The widespread use of a small number of cultivars can lead to the extinction of important gene resources. Some of these gene resources include wheat landraces, which is a wheat variety that has evolved over generations of selections by farmers, and wild relatives that have adapted to specific regions of the world over thousands of years. These cultivars may possess traits that could be very useful in the future of wheat breeding. Preserving genetic resources and genetic diversity is fundamental to sustaining wheat production in the future.

A way of testing the genetic diversity is to use molecular markers. These are DNA signposts that allow crop geneticists and breeders to locate on

a plant chromosome the genes for a trait of interest. The project compares molecular data with the pedigree of the different wheat lines and also compares the morphological and phenotypic traits of the cultivars of the past and present. This helps to obtain a better picture of the lines and their relatives.

The first part of the project was the harvesting and extraction of DNA from 150 wheat lines from CIMMYT's germplasm bank. I worked in the greenhouse cutting six leaves from each wheat line and then putting them into small packets. We then went to the laboratory and used an extractor that would remove plant material that contained the DNA. From there we performed numerous steps that removed protein, cell components, and RNA, so that we were left with clean and pure DNA to use in testing.

We used a spectrophotometer along with an agarose gel to test the quantity and quality of our newly extracted DNA. This basically showed us how well the extraction process went.

I was also introduced to a computer program called Oligo 4.0 that designed primers, a small stretch of RNA that initiates the synthesis of DNA. These primers were an essential part of the project because of their use in PCR, which was the next step in the experiment. Working with the program required a great deal of knowledge about genetics and I found myself doing quite a bit of reading to be able to understand what was being done.

PCR, or Polymerase Chain Reaction is a technique that is used to amplify a large number of copies of a specific region of DNA, in order to produce enough DNA to be adequately tested. This was the process in which we prepared the DNA to be analyzed. My first few days getting acquainted in the laboratory I watched a PCR being prepared. I remember thinking that I would never be able to do something as complex as PCR, but by the third day under supervision, I had completed a Polymerase Chain Reaction entirely by myself.

Using the DNA from the PCR, I helped to make an agarose gel for electrophoresis. The first step is to make the agarose gel which is somewhat like a plate covered with a very thin Jell-O-like substance. Then the DNA from the PCR is mixed with a colorant that makes the DNA visible when the electrophoresis is done. The DNA is then inserted into the gel in the electrophoresis rig. The electrophoresis itself is summarized by the movement of DNA due to the influence of a magnetic field. When it was done it showed the amount of amplification of DNA in a banding-like pattern. It also showed which genomes in the wheat were amplifying.

This was what I did for the for the first month at CIMMYT. The project was just at it's very beginning when I arrived and due to the length, I didn't get to formulate any conclusions about the research. I would suspect that this research will be continued over the next year or so.

The second month at CIMMYT I worked in the tissue culture lab for Dr. Alessandro Pellegrineschi, who is a cellular biologist from Italy.

Tissue culture involves transferring genes for traits of interest into maize and wheat from other organisms and controlling the expression of such genes. The new DNA is inserted directly into individual plant cells. From there a new fertile plant is grown from the genetically transformed tissue. This newly incorporated gene in the transgenic plant can make the plant, for example, resistant to pests or improve grain quality. Genetic engineering of this kind is relatively new in plants and for the fist time we are not limited to the pool of genes available within a particular crop species. It is very important because it could help create new varieties that will exceed the qualities of those in the past.

In the tissue culture lab I learned and took part in the various steps that are associated with producing transgenic plants. I worked mainly with wheat, but I also worked with maize.

The first step in tissue culture is to harvest your plant materials. Relatively small green seeds were removed from the wheat seed head and sterilized. Then we would excise the immature embryos and put them in a petri dish and let them incubate in the growth culture room for 4-5 weeks.

The next part of the process was microprojectile bombardment of the embryos (inserting of the gene into the embryos), which is the very basis of

tissue culture. To do this we used a gene gun to shoot the new gene onto a small petri dish containing the embryos.

After the incubation period the petri dishes were removed and a callus formation of cells had formed. I would then transfer these calluses to a different growing medium and then return them to the growth room for 2-3 weeks. These calluses would then start to grow into new plants. When a substantial amount of roots and green shoot formation was observed, I would remove them from the growing medium and transfer them to soil. After planting them they would be taken to the green house to grow to maturity.

This tissue culture is an ongoing process and is much like an assembly line. I got to do all of the steps, but then I specialized in the transferring of the embryos at different stages to new media and planting.

I did not participate in the actual testing of the new genetically engineered plants, but they did exhibit the desired traits of the newly inserted gene. This genetic engineering will make it possible to use a wide range of genes to improve plant qualities that will suit the environments and conditions in developing countries. For these countries, it will be a large step in the direction toward food security.

Last October at the 1999 World Food Prize conference I wanted so much to be given the opportunity to tell about my own internship abroad, and here I am today telling you about my experiences in Mexico. This past summer

has been one of the most incredible and unforgettable of my life. A year ago I never thought that I would have accomplished something as remarkable as my work at CIMMYT before I had even entered college.

I would have to say that I am a person who does not generally like change. I embarked on this trip knowing that I would be experiencing change, but I had no idea just how much.

Living in Mexico has opened my eyes to a new culture that is very different from my own. Surprisingly, I did not find it hard to make the adjustment and I think that I would attribute that to the warmth and friendliness of the Mexican culture. I found that in the beginning my few years of high school Spanish were not sufficient enough to be able to speak with others, but with everyone's patience and kindness I began to speak the language without even thinking about what I was trying to say.

I saw many economic and political differences in Mexico that I was not aware of before. I had never in my life seen a person begging on the street. I saw farmers trying to make a living off of fields a fraction of the size of one in Iowa. I witnessed the first change in political power in Mexico in over seventy years and the people's reactions. I never would have understood the magnitude of these situations if I had not seen these things with my own eyes.

Another cultural aspect of my trip was the fact that CIMMYT is an international center with people from all over the world. During my stay I not only experienced the Mexican culture but I also learned a lot about other

cultures of the world. Working in the ABC I became friends with people from Mexico, France, Germany, Sweden, and many other countries. Each of these people contributed greatly to my expanded view of the world. These people were one of the most important parts of my trip because with them I experienced Mexico. They are forever in my heart and I miss them tremendously.

The researchers that I worked with contributed a wealth of knowledge about how they are making a difference in the world with the work they are doing. They are wonderful people who always took the time to explain the basic processes of their work, and I know that they truly cared about my understanding of it. I felt honored and fortunate that I could be a part of their ground-breaking research that is helping millions of people to obtain food security. I had the chance to work with people with a passion to help others. These people have instilled their passion within me. After working in the ABC, I am considering changing my major to genetics.

Living in Mexico has also taught me a great deal about my own culture. To hear that the culture you live in takes many things for granted is one thing, but to actually see it is quite another. You never really realize how fortunate you are until you see those who have close to nothing.

My trip was a life changing experience. I realize that change is good because it makes us better people with a broader view of the world. My perspective on life has changed through this trip and I have grown

tremendously as an individual. I am now more aware of the issues concerning food security and what needs to be done to achieve it.

I cannot thank the World Food Prize Youth Institute enough for allowing me this opportunity. Without them I may have never realized the extent of the importance of one of the worlds most pressing issues. I would like to thank Dr. Marilyn Warburton, Dr. Alessandro Pellegrineschi, and everyone else at the ABC for taking so much time to educate me about their incredible research. Everyone has helped to make this past summer the most amazing and enjoyable experiences of my life.

References

Consultative Group on International Agricultural Research home page. Http://www.cgiar.org

“Molecular Markers and Plant Breeding.” McGill University. Http://www.genome.agrenv.ca/breeding/markers.htm

“Plant Tissue Culture Research.” University of Minnesota. 1999. http://www.agro.agri.umn.edu

Reeves,T, Rajaram,S, van Ginkel,M, Trethowan,R, Braun,H, Cassaday,K. New Wheats for a Secure, Sustainable Future. International Maize and Wheat Improvement Center pp. 2-7

Wheat Genetic Resources at CIMMYT: Their Preservation, Enrichment, and Distribution. CIMMYT, 1992 pp. 2-5