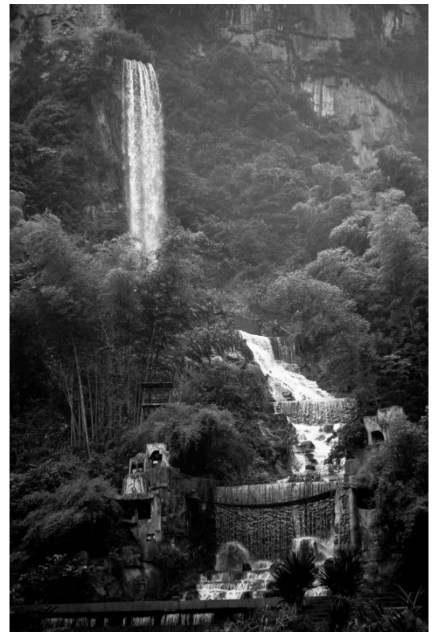
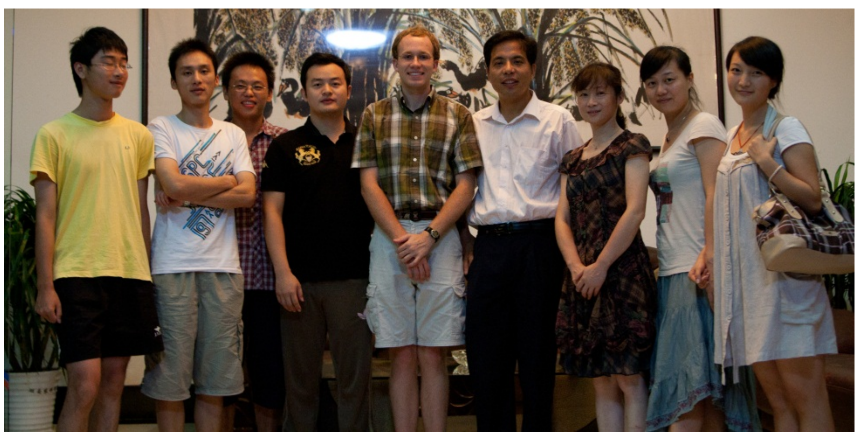
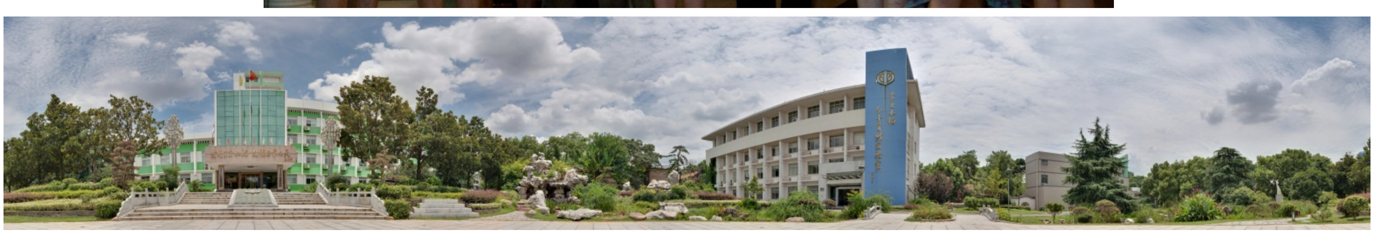
Hybrid Growth



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Introduction

Growing up on a small family ranch, I was constantly surrounded by biology, and its constant wonders of what is, what was, and what can be. It is the “can be” that has driven me through my middle school, high school, and now college years; biology to me was always more than a force of existence that allowed us to continue our lives, it was something to be explored, something to be dismantled, something to be engineered, something to be created, but above all, something to be mastered. That is, mastered as much as any human can master any natural force.

Living on a Texan ranch, I was exposed to cattle, horses, goats, pigs, dogs, cats, chickens, and a whole host of other native species. I wanted to learn about each animal, to understand what made them tick, what allowed them to survive and live the way they did. Forge ahead I did, studying all species of farm animals through a 4-H Veterinary Assistant program, but I did not know much about farming, crops, or the soil. I was much more focused on the mammalian and avian life. My interest in mammalian life over the course of several years slowly morphed into a fascination with bacterial life, its comparative simplicity, its diversity, and its importance to every other species. But I still was largely ignorant of the plant and crop side of agricultural biology.

I had not heard of the World Food Prize, much less the Global Youth Institute, or the Borluag-Ruan International Internship until the end of my sophomore year of high school. My Physics teacher, Michelle Jedlicka, was mentoring another student, Will Rooney, on his paper for the 2008 Global Youth Institute, and being naturally inquisitive, I started talking to my teacher, and Will, about what the World Food Prize was and what the Youth Institute was. After hearing about the Global Youth Institute that year, and the International Internship, I decided that I was going to apply to attend the 2009 Global Youth Institute.

After presenting my paper on National Food Insecurity in Thailand at Texas’s state level competition, I attended the 2009 World Food Prize Global Youth Institute. At the Institute, I was able to meet several of the most fascinating scientists, politicians, and students, all who had passionate goals and dreams to solve the problem of food insecurity in many nations. The collective intelligence of the individuals at the Borlaug Dialogue was overwhelming at first, but I was still able to learn from some of the brightest minds engaged in rural development and agricultural security. The last night of the Borlaug Dialogues, after the Hunger Banquet, I was able to talk with two of the students at the Global Youth Institute, and one of the 2009 Interns about their thoughts on food insecurity, and their impressions of the Borlaug Dialogue, and how the world was rapidly changing, how the development of advanced technologies gave humanity the means necessary to support increasing populations, and stabilize populations that had been declining due to unsustainable agricultural usage. It was my lengthy conversations that night that convinced me that I would pursue the Borlaug-Ruan Internship.

I was interested in the Internship, for several reasons, the first of which was I would be able to explore a new culture, but more importantly, I would be able to apply my knowledge of biology to begin to solve the pressing issue of world food insecurity. At Pioneer Hybrid, the 2009 Interns all gave presentations about the research they produced and the cultures they encountered while they were abroad, but I was enthralled by Tiffany Stone’s presentation about the China National Hybrid Rice Research and Development Center (CNHRRDC); she used pictures to paint a wholesome picture of both life in China, as well as the significance of the research that was being conducted there. It was the emotion her pictures elicited that singled out the CNHRRDC as the institution I wanted to study at. On the flight home that afternoon from Des Moines, Iowa, to College Station, Texas, I thought about the Internship, and the opportunity it presented, and the importance of improving national food security throughout the world. During those two and a half hours, a realization of the importance of the work of the researchers across the world, not just those at the Borlaug Dialogue, strengthened my resolve to demonstrate my enthusiasm, and desire to contribute to improving international food security. After several months, I became a 2010 Borlaug Ruan International Internship to the China National Hybrid Rice Research and Development Center.

China National Hybrid Rice Research and Development Center

The China National Hybrid Rice Research and Development Center's (CNHRRDC), or the Hunan Hybrid Rice Research Center (HHRRC), mission is to develop high yielding hybrid rice varieties that can support the increasing dietary needs of China as their population increases, and agricultural land decreases. Located centrally in Changsha, Hunan, China, the CNHRRDC was founded in 1984 as the premier rice research center headed by Director Yuan Longping, the Father of Hybrid Rice. During the 1970's Yuan Longping developed the first hybrid rice varieties that were heartier plants that have a much higher grain yield. Since his first development of Hybrid Rice in the 1970's Dr. Longping has continued to devote his life to the development of new varieties of rice that enable the growing populations to have adequate food. The initial success of the hybrid rice techniques has led to the development of both Phase II improvements to hybrid rice, and the development, and testing of the center's Phase III, Super Hybrid species. The super hybrid rice species are able to produce up to approximately 30% more grain than the common rice varieties.

In addition to the development of high yielding rice varieties that produce larger amounts of food, a major emphasis at the center by the other researches is the preservation of the hybrid lines from attacks by insects, bacteria, and viruses. As the yield of the hybrid rice increases, the necessity to protect it from natural disasters, also increases; one of the most important ways to increase the total crop yield of a plot of land is to decrease the amount that is lost to pests and disease. While I was interning at the CNHRRDC, I had the opportunity to work in both arenas; the prevention of disease, and the genetic development of more vigorous hybrid species.

Beyond the research into hybrid rice and the genetic improvement of rice lines, the CNHRRDC trains other researchers and government agricultural extensionists. Integrated into the CNHRRDC, the Longping High-Tech International Exchange Center facilitates the training of international researchers and government officials to assist other countries in improving their crop yields by improving their field techniques. The Longping High-Tech International Exchange Center training course consists of two parts: a classroom based instruction on the CNHRRDC campus for a third of their time in China, and the other third, the trainees travel to a remote agricultural breeding facility in the neighboring city of Changde. There the trainees learn the Chinese method for seeding, transplanting, growing, and harvesting rice. The intent of this program is to teach the trainees an alternative method that they are then able to take back to their home country and incorporate it into their farming techniques, hopefully leading to higher yielding rice paddies. The program teaches individuals from countries all over the world, from those near China, to those near to the United States, and everywhere in between.

My Internship

Arrival

Before the World Food Prize Global Youth Institute, I had not flown on a plane, but less than 9 months later, I was on a flight that would take me to my home for the next two months, a place I had only read news articles about, and talked to friends who emigrated from there. As my flight from Beijing to Changsha began its descent, I saw small lights dotting the landscape to the horizon and beyond. Slowly, the pinpricks of light resolved themselves into patterns, the downtown metropolitan area shown like a beacon, the residual glow emanating for miles around it. As Dr. Lou drove us back to the CNHRRDC, I eagerly looked out the window, seeking a view of the new world I had entered. looked out the window of the car, I immediately began to gain a new insight into the problems of poverty and the issues with food insecurity that nations around the world face in growing proportions. As I looked out the window, the car's headlights illuminated the drastic differences from my country life in Texas, unveiling small hints that would manifest themselves later during daylight.

My first day in China I was introduced to the impressive, and immersive Chinese culture. Dr. Yuan Longping invited me to attend China's Dragon Boat Festival, one of most important Chinese festivals. The Dragon Boat Festival captured the persevering Chinese spirit that has lasted throughout the ages, bringing hope of a better tomorrow for every individual, from the poorest of farmers to the wealthiest of businessmen. The Chinese preservation of their culture demonstrated their concern for events past, present and future, underlining their commitment to sustaining and enhancing the quality of life of the Chinese people through increased food security.

During my acquaintance period at the CNHRRDC, I was shown around the center's grounds, the surrounding town, and even taken on a few forays into downtown Changsha, where I discovered that Chairman Mao was extremely influential during his youth. But even though I was exposed to a Chinese Culture at large, I felt most steeped in Chinese culture when I was at the center itself; there I was able to talk to people, and participate in both traditional and contemporary Chinese customs. Each of the individuals I met at the center adopted me into their "family" for my stay during the next two months. In addition to being adopted by the Chinese mentors who worked at the center, I was adopted by the English Speaking African Nations, and the Developing Nations, training group from the Longping Hi-Tech International Exchange Center. Each of my three families made me feel at home, despite not living with a host family, I had an entire center that supported me, providing me with ample opportunities to explore China, and explore the other cultures of the world through

Developing Nations Training Group

the individuals who had come to China to learn just as I had. During my extended stay I was able to meet individuals from Jamaica, the Philippines, Vietnam, North Korea, Nepal, Thailand, Nigeria, Ethiopia, Ghana, Malawi, Liberia, as well as many others from numerous other countries.

Research Projects

Project Introduction

After becoming acquainted to the center, I met with Dr. Lou and Dr. Huang Zhiyuan, my professor, to discuss and plan out the project I would be working on for the next two months. Dr. Huang was mainly concerned that I would not be able to get a very broad overview of all of the different types of research that CNHRRDC carried on during my two months, so a plan was devised that would give me an overarching project to work on throughout the summer, as well as allow me to assist in a smaller capacity on several smaller projects during the downtime of my central project. That first day of work, I went out to survey the fields with Dr. Huang, where he was checking on the growth of several test varieties of genetically engineered rice. While he was inspecting them, he decided that it was time for the seedlings to be transplanted to the adjacent field where they would be able to grow to maturity for harvest later that fall. Not wanting to be left out of the fun, I quickly stripped off my shoes and socks and jumped down in to the knee deep mud to help out. That soon began a ritual that Dr. Huang and I would continue throughout the remainder of my adventure. I would ask Dr. Huang for something else that I could do to further the research we were working on, and he would give me more to work with, and I would ask for more, leading to several intellectually stimulating discussions about the differences between workaholic American corporate culture and the Chinese respect for the importance of rest and relaxation.

Dr. Huang Zhiyuan

Intellectual debates aside, my project began as three components: first, I would be studying genetic resistance to Rice Blast, a fungal disease that wreaks havoc with rice crops each year. Secondly, I was to study resistant genes to the Brown Plant Hopper, an insect that feeds on the rice plant's stem and leaves. Thirdly, I was to study the effects of heterosis, to ensure that the hybrid plants the CNHRRDC were developing were indeed growing faster and stronger than native varieties, as well as checking that they produced more grain than native varieties; however, I was unable to assist much in this area of research due to both the time constraints of my internship, as well as the slow growth rate of the rice plants. The second data collection was taken before I arrived, and another was taken after I left, so I was unable to do much beyond analyze a small portion of the data. As the end of my internship began to draw to a close, I helped begin a study of messenger RNA in rice panicles during the eight stages of development, so that scientists can understand the genomic differences between hybrid rice and native rice varieties that create hybrid vigor.

Despite the wide variation in my projects, and differing aspects of biotechnology I was introduced to, every scientist in the Center maintains a singular goal: to develop improved rice varieties that yield larger harvests to feed a growing population through any means available. Each scientist contributes to the goal, by developing disease resistant rice strains, developing current Phase II hybrid species into the Phase III Super Hybrid rice, or conducting genetic analyses to uncover the hidden switches that will leap frog current developments along the path to feed the world.

Rice Blast Resistance

Of the diseases that plague rice farmers in Southern China and elsewhere, rice blast is one of the most detrimental. Currently in China, Rice Blast wipes out approximately two percent of the nation's rice crop, causing a production loss of approximately $55 million USD each year (Dean 2005; Kuyek 2000). Despite the large economic losses currently caused by blast, they pale in comparison to the losses that ravaged Southern China and the rest of world. In 1980, China alone lost fourteen percent of its national harvest, far less than Thailand's sixty percent rice harvest loss due to rice blast in 1992 (IRRI). However, in China, the development of hybrid rice strains has helped to decrease the total loss due to Rice Blast due to their increased vigor, but the hope for eliminating the destruction caused by rice blast lies in the development of genetically modified rice lines.

Presently, the development of genetically engineered hybrid rice species is carried out through a complex process owing to the complex production process of hybrid rice. The CNHRRDC use a rice breeding system that utilizes three genetically different rice lines, one of which is a male sterile line, to produce the final hybrid rice line. Most of the genetic enhancements are made to the non-sterile line, and are then back crossed with the male sterile line in order to produce a hybrid seed. The back crossing with the male sterile line, while necessary to achieve the hybrid vigor that provides hybrid plants with a thirty percent larger yield, also creates sterile seeds. That is, the hybrid rice plants grown in the field produce seeds that can't be held onto to plant the following year, necessitating that new seeds must be produced each year by re-crossing the cytoplasmic male sterile lines (CMS) with the genetically enhanced fertile lines. This disadvantage, while still outweighed by the sheer increase in yield, makes it difficult for poor farmers to continue to use the hybrid varieties since farmers have to purchase new hybrid seeds every growing season rather than saving a small portion from their harvest. This eats into the poorest farmers' incomes, decreasing the ability of the farmers' to pull themselves out of poverty.

At CNHRRDC, my mentor Dr. Huang, has been working on the development of genetically resistant hybrid rice lines for several years. The process began with the isolation of the resistant gene in native varieties. Once the gene was isolated, it was removed and transferred into a series of genetic plasmids can then be introduced into higher yielding rice varieties. There are two primary routes used to introduce new genetic material into the plants, the first involves the use of viral vectors, the other the use of agrobacterium vectors. Viral vectors have the plasmid with the gene of interest added to a modified virus's genetic makeup. Typically, the viruses have been modified to decrease or eliminate the virulence, but retain their rate of infection, ensuring that the viruses can "infect" as many cells of the plant as possible with the altered gene plasmid while eliminating the ability of the virus to kill the plant, which would defeat the purpose of infection. A second route is the use of agrobacterium to infect plant cells with the plasmid that contains the desired genetic modification. Traditionally, agrobacterium insert tumor inducing plasmid randomly into the host plants DNA sequence, causing a tumor to develop when the gene is expressed. Modern technology allows the use of other genetic tools to remove the tumor inducing portions of the plasmid and inserting the gene of interest, allowing the gene of interest to be inserted into the cells genome, where it is expressed, conveying resistance to the rice blast disease.

When I arrived at the CNHRRDC, Dr. Huang was already deeply involved in the development of a rice line that was resistant to rice blast. The resistant gene had already been isolated and incorporated into a plasmid that could be inserted into rice plants. Furthermore, the desirable high yielding rice lines had already been inoculated with the transformation vector (either agrobacterium or virus), and were currently small seedlings growing in a test plot. That enabled me to then begin the analysis phase of the project, I was able to test the samples and evaluate the effectiveness of the transformation, to determine if any of the rice lines had incorporated the plasmid into the plant's DNA.

Procedure

Each inoculated species' seedlings are planted in small test plots, approximately three feet by three feet, raised until a young maturity. Once the plants developed several leaves, a few leaves from each plant are removed and stored in a freezer until the extraction and analysis of the genetic material in the leaves.

DNA extraction was achieved by using liquid nitrogen to flash freeze the cells, lysing their cell walls. This allowed the cells to be broken down by physical grinding by a mortar and pestle to release all of the cells contents, and make the DNA more accessible to the solvents that would be added to aid in the extraction. Once the cells were lysed, a buffer, CTAB, Cetrimonium bromide, is added to help stabilize the solution and allow the contents of the cell a solution to dissolve in. The solution of cell parts is incubated in a water bath, and then centrifuged to separate cellulose from the solution with the DNA (and other cellular parts). Chloroform is added to the supernatant, and it is centrifuged again, further reducing the impurities in the solution with the DNA. The remaining supernatant is then precipitated with either absolute ethanol or isopropyl alcohol to separate out the DNA. DNA is insoluble in alcohol so it falls out of solution as a stringy white precipitate, which is then isolated using centrifugation, and a series of washings to ensure the DNA is clean and pure. The DNA is dried, then suspended in DNase free water (distilled deionized water), and stored at -20°C until the testing takes place.

In order to detect the presence of a particular sequence of amino acids out of the globular mass of DNA extracted from the plant's leaves, a technique called polymerase chain reaction (PCR) is used to isolate the particular sequence of DNA that is desired; in this case the desired DNA sequence is the gene that conveys resistance to Rice Blast, and replicate it thousands of times, increasing the quanity of the desired fragment of DNA by several orders of magnitude so that humans can visually detect the different genetic sequences by using gel electrophoresis. The principle behind PCR is thermal cycling; the PCR process continues through multiple iterations, using a sharp thermal increase to separate DNA strands, allowing primers to attach to the DNA sequence that correspond to the resistant gene. A primer is a series of base pairs that is complementary to the genetic sequence of the resistant gene (or any other genetic sequence); thus, during replication, the primer attaches to its particular genetic loci, and waits until a DNA polymerase arrives to attach the primer to the single strand of DNA, and continue to add base pairs. Each primer is constructed in laboratories throughout the world; some are isolated from other organisms, but often then are synthesized in the laboratory for a particular genetic sequence. When purchased, the primer arrives in a concentrated form, and small portions are diluted as need throughout the experiment. To detect rice blast resistance, two sets of primers were used, YL183/187 and YL 155/187. The YL183/187 primer set detected the absence of the genetic resistance, a negative control, while the YL 155/187 primer set detected the presence of the resistant gene. Both primers were used for redundancy, both a positive check and negative check were needed to ensure that each plant that was tested only showed positive under one primer set.

Once the extracted DNA had been run through the polymerase chain reaction mechanism, the DNA is run through a procedure called gel electrophoresis. The principle relies upon two basic concepts, the first that DNA is negatively charged, and that large objects can not fit through small holes. The substrate in gel electrophoresis is a one percent solution of agarose. Agarose, a derivative of agar, a polysaccharide from the cell wall of red algae, is poured in a mold that has a comb placed to form holes for the PCR products to be added. The agarose solution is a uniform mixture throughout the entire gel; however the DNA fragments that resulted from the PCR process are different sizes. Each of the PCR products has a marker dye that is added to the solution before the products are placed in a well of the electrophoresis gel, after the gel has been placed in an electrophoresis tank. Then an electrical current is applied to the DNA, causing it to move away from the negative pole to the positive pole of the electric field. As the current flows through the agarose gel, it carries the DNA fragments along with it, until they get stuck in the agarose gel and are unable to proceed any further. The larger fragments get stuck closer to the top of the gel, while the smaller pieces get stuck lower down.

Once the gel electrophoresis was finished running the gel was soaked in Ethidium bromide, the ethidium bromide binds to the marker that was added to the PCR product. The Ethidium bromide fluoresces when exposed to ultraviolet light, allowing the bands of DNA to be detected. The image of the fluorescing gel is captured for later analysis. Locations in the gel with high concentrations of DNA fragments show up as bands, the strength of the bands increases according the concentration of the DNA located at that spot. Once the bands have been identified, the location of the bands are compared to a positive and negative control to ensure that the bands matches up; if a plants band in the experiment matches up with the positive control, then the plant contains a genetic resistance to the rice blast disease.

The plants that test positive for the rice blast resistance are then taken to the next step of the testing process. The next step in testing is the propagation of the line that is shown to contain the resistant gene. Once there is a large enough population of plants that are supposed to contain the resistant gene, the plants are separated into different groups. One group has its DNA analyzed after different multiples of generations to ensure that the genetic resistance is being passed down through pollination and propagation. This test revels whether the test plasmid was actually incorporated into the host cell's DNA, or if it was just being expressed in plasmid form. While expression of the plasmid does convey disease resistance, it does not do the farmers any good since future generations of plants will lack the resistance. The second test performed is exposure to the rice blast disease, allowing the researchers to determine which plants possess potent versions of the gene that will perform best in the field. Then once the genetic resistance is determined to be both effective, and stable genetically in the development line, it is backcrossed into a high yielding variety. The high yielding variety is then used to produce hybrid seeds when crossed with a male sterile line, in accordance with the tree line system.

Results

As my primary project throughout my internship, I processed hundreds of sample plants, all testing to determine whether any contained genetic resistance to rice blast. Out of the hundreds of samples I ran, there were about four plant lines that actually contained the resistant gene, these four plant species would then continue through the vetting process to determine their ability to resist the actual disease. Despite the low number of positive results, the process narrowed down the number of test plants that Dr. Huang and the other researchers will have to test in order to develop a viable option that can protect a world's crops from blight, providing food for an enormous number of individuals.

Brown Plant Hopper Resistance

The brown planthopper is a small planthopper that feeds on rice plants. The plant hopper is analogous to a grasshopper, or locust, in the United States, due to its similar appearance and consumption of plants for its diet. The initial search for the genetic resistance brown planthopper began after the 1990's when wide spread outbreaks began damaging central and southern China's rice producing areas (Huang 2000). A scientific study discovered that there were four different biotypes of brown planthoppers, though only Biotypes 1 and 2 were present in South East Asia, including China, the other two types were in India and the Philippians. A search was conducted to locate any gene that conveyed resistance to the brown planthopper, and has since located at least fifteen genes that convey resistance to particular biotype of brown planthopper. A genetically resistant cultivar is preferred to the use of insecticides because of the lower long run cost, as well as the smaller environmental impact. In addition to reducing environmental impact, recent studies have noted a correlation between the frequency of brown plant hoppers disasters and the beginning of the Green Revolution (Visarto 2001). As part of the Green Revolution, farmers began to apply both inorganic fertilizers to their fields and pesticides to increase yields, however, the Brown plant hoppers fertility rate increases when large amounts of nitrogen fertilizer is added to a field. The additional nitrogen spurs plants to grow larger, it also increased the populations of brown plant hoppers which contributed the hopper burn (decimated sections of land where the brown plant hoppers have destroyed the harvest), additionally the study by Visarto notes that the increased use of insecticides removed many of the brown plant hoppers natural enemies, enabling them to reproduce at much higher proportions than they had been able to in the past. Genetic resistance is critical because it will enable farmers to continue to use inorganic fertilizers to boost their cropoutputs while not having to play a deadly game of chance with the brown plant hoppers growth rates.


Brown Planthopper

Research

At CNHRRDC, I worked with the resistant genes *bph14* and *bph15*, determining if certain species of rice contained the resistant gene. The procedure for the extraction of the DNA and the process of gel electrophoresis and the UV radiation were the same as when I was testing plant varieties for genetic resistance to rice blast. Rather than just running multiple samples through to discover which plants were resistant, part of the task was to discover what settings in PCR would produce results that were visible in the agarose gel.

Polymerase Chain Reaction consists of a cycle of three steps, a hot denaturation step, and then the samples are cooled in an annealing step, followed by a heated elongation step. The cycle of these three steps is repeated for a set number of cycle to obtain enough DNA to visibly see it. However, because the work with these genes, and the primers being used, was relatively new, there were no conventional or even common settings to automatically set the PCR machine on and let it extend. Each of the three steps had a particular time and temperature it ran at, and so much of my experiments were modifying the variables on of time and temperature to produce a sample that contained the DNA sequences we desired.

If the DNA is run through the denaturing step too long, the DNA begins to degrade, making replication impossible, while if the denaturing step is too short, then not enough of the double helixes separate, reducing the number of fragments of the desired sequence that are replicated. Likewise, if the annealing step is too short, then not all the primers can attach, further reducing both yield and quality. And finally, if the elongation step is too short then only half completed DNA strands are produced, reducing the effectiveness of the PCR.

When the PCR products have been clearly run through a proper set of timings, and the plant contains the desired gene, a clearly defined band will emerge, that remains separate from the rest of the DNA that is present. However, if the PCR timings are off, then all of the DNA clumps together and it is impossible to obtain any useful information about the genetic code. By the time I had left, Dr. Huang and I had developed a set of timings and heating temperatures that would produce a distinct band indicating the presence of genetic resistance to brown plant hoppers.

Heterosis and Panicle RNA Studies
Hybrid rice is known throughout the world for its increased vigor and bountiful harvests. Despite hybrid Rice’s critical place in the world’s production of food, little is known how or why the hybrid plants enjoy such a large advantage over normal cultivars. Scientists currently speculate that hybrid vigor results from over dominance of certain traits, however very little is known on the subject.

During my internship, Dr. Huang traveled to Beijing to Peking University and China Agricultural University, where he was working with several graduate students to study and understand how the expression of particular genes created hybrid vigor. The first stage of the process, the collection of rice panicles was to take place at CNHRRDC, over the later part of July and the early part of August.

The rice panicle proceeds through eight stages of development, and at each stage, different genes are activated and deactivated, providing a window into understanding what happens genetically in a hybrid plant that allows it to out produce native varieties.

As part of the experiment Dr. Huang, the graduate students and I would collect several five gallon buckets full of maturing rice plants and bring them back to the center where we would spend the day removing, measuring and storing the panicles. Each of the rice plants contained a single panicle that had to be isolated at the base of the stem and then removed from the surrounding tissue by the use of a scalpel and high powered microscope.

Since it impossible to determine the exact stage of growth of the scalpel based on visible characteristics, the panicles were separated based upon their size in millimeters, based on the assumption that the panicles around the same size were approximately at the same stage of development. In addition to isolating the growing panicles, I visually tracked the growth of the plants themselves to provide corresponding data that will help to deduce the phenotypic expression of the genotypic construct.

The ultimate goal of understanding the phenotypic effects of hybrid genotypes is to graft these genetic changes into normal fertile cultivar lines to produce a fertile cultivar that retains the vigor of a hybrid. This is critical in developing countries; farmers currently are required to either purchase new hybrid seed every year or to use non-hybrid cultivars, which reduces their grain production. However, if scientists are able to create hybrid vigor in fertile plants then it would allow the production of larger amounts of food by all farmers, feeding the world's population and help developing countries to become industrialized and not have to worry about providing a basic necessity to their population, instead both the governments and people will be able to develop their culture and economy.

Graduate Students Removing Rice Panicles for Genetic analysis

When I left the CNHRRDC, Dr. Huang and the graduate students were still working to collect as many panicles as possible. However, one the panicles have been collected, the graduate students will return to Beijing, to their respective Universities, where they will sequence the RNA in the panicles at each stage of development. This sequencing process will hopefully enable breakthroughs that will increase rice yields yet again, as well as bring hybrid vigor to fertile cultivars.

Research Effects

Throughout the duration of my internship at the CNHRRDC, there was one continual thought that continuously rang throughout my mind: I was actually helping to make a difference in the global fight on food insecurity. Living on a ranch in Texas, I had always assumed that most of the world got by with what they were given; life wasn't all chocolate and roses, but that everyone managed to get by. However, once I arrived at the Center, I soon discovered how naive I was, even after attending the Global Youth Institute the previous October and researching food insecurity in Thailand, and hearing about food insecurity from missionaries abroad. I traveled to a couple of different cultural and natural centers on the weekends while I was there, but the most eye opening sight I saw was on the trips to those places. I saw for the first time the effects that food insecurity has on an individual, a family, and a nation. Constantly having to worry about providing food for your family creates a desperation that is hard to conceal.

But the research that I had completed in my short two months at the China National Hybrid Rice Research and Development Center showed me that as long as there are individuals who continue to seek the solutions to problems that plague our world, that everybody has both hope and duty. A duty to continue to persevere and help out in any way possible, and a hope that eventually through their work that their children may be able to have a better life.

As I was walking around the fields at the center one day, one of the researchers pulled me aside and began to dig up a rice plant where he showed me the nest that a larva had made at the base of the rice plant, and was in the process of slowly spinning silk to close the entire leaf up to provide a good habitat for the pest. That pest had infected a large number of the plants in the plot, causing them to begin to slowly die. However, in the plot next to it, all of the plants were healthy and insect free due to the genetic resistance that had been incorporated into the plant. While I did not have the privilege of seeing the physical effects of my research be played out in such a rewarding manner, I assisted in the beginning stage of the process, making a contribution to the fight against hunger.

The eventual tangible effects of the research I did at the China National Hybrid Rice Research and Development Center will help to provide food to millions of people who now go hungry as they cannot combat natural forces that are beyond their scope of comprehension. The development of a rice line resistant to rice blast will not only help out the impoverished Chinese farmers, but it will also help every other farmer whose crop is destroyed because of blast. The wide reaching ramifications of rice blast resistance would feed several hundred million individuals, freeing them from worrying about their next meal, to allow them to improve both themselves and their communities. Similarly, the development of both a fertile rice line that exhibits hybrid traits, and rice genetically resistant to the brown plant hopper will both help to improve the lives of millions of individuals across the globe.

Each of the small projects that I contributed on will eventually culminate in a world in which food insecurity has been transformed into global food security that extends to all individuals, so that everyone can reap the benefits of a bountiful harvest, not just those who have been privileged to be born in a certain geographic location.

Personal Growth

China was an eye opening experience for me, both in exposure to research and culture. I had not had the opportunity to be involved in any research until I traveled to China. Throughout the entirety of my trip, I came to the realization that a hero is not just someone who discovers a cure to a disease, but rather a hero is anyone who devotes their life's work to a goal that improves the lives of individuals across the globe. I was only able to see a small part of the research that took place at the CNHRRDC, but that small portion demonstrated the passion with which all of the researchers at the center as well as the researchers that were a part of the training program. Both groups of individuals were passionate about their work; they were dedicated to improving the lives of their countrymen just as much as everyone else.

Each day I woke up I was surrounded by individuals who were motivated to keep working no matter how hard the work became, or how many times the electricity went out, ruining the latest batch of experiments, the thing I continued to see, day after day was a spark of determination in everyone's eyes. When I arrived, I was awed at their determination, their perseverance, but I soon learned only through determination would the millions of impoverished be raised up and given the ability to maximize their potential.

When I attended the Dragon Boat Festival, I got my first glimpse of both sides of China. I saw the center as an example of what individuals can do when they see a need that us unmet and is given the means to meet it. But on the way to the Dragon Boat Festival, I saw the deprivation that consumes individual's lives when they don't have the means to support themselves; instead they are left to scrape by on an existence that they have little hope will change by the time their children grow up. In their eyes is smoldering defiance that screams to the world that they will not give up their hold on the land; they will continue to persevere despite the odds.

Beyond seeing the dedication with which everyone completed their jobs, the cultural immersion I received from both China, as well as the home countries of the researchers revealed to me the importance of making connections with individuals wherever I go; I don't know where I'm going to be in ten to twenty years, what things I'll be doing, but I do know that I'll be working on something because of the people I've met throughout the years.

I arrived in China a High School student, awed at the magnitude of the Chinese: their culture, their country, their people, their way of life, but while I was working there, I felt less of a visitor in a foreign land, and more a member of the increasingly diverse global community. My internship was my first foray into the global community, and through it I realized the importance of working with other individuals to peruse a singular goal. Everyone has something to contribute to the task at hand, it takes more than one brilliant individual to solve the problems that have arisen today. Rather, it takes a people, each of which is dedicated to the critical nature of the task at hand. I was but a small part of that process, a process which I felt as if I made a significant contribution to the development of a stable food source for people who desperately need it.

While a Borluag-Ruan International Intern, I felt like I was both an ambassador and an intern; people I met, and still meet, ask me what a Borlaug-Ruan International Intern is, and I get the privilege of explaining to them the importance of what the World Food Prize does in seeking out researchers and individuals who have devoted their lives to the cause of increasing world food security. There is no greater honor than being able to identify the work that some of the greatest men and women in the history of the world have done, feeding millions of people, and inspiring thousands more to continue in their footsteps as a way to continue to make a difference in individual's lives.

As the world becomes closer together through globalization, national food insecurity will become less of an issue, while international, global, scale food insecurity will begin to take precedence. It doesn't matter which country produces the technology that enables farmers to provide for their families and communities, but what matters is that individuals in every country are willing to devote their life's work to studying the greatest problems that have faced our world. Global efforts to raise awareness to the issue of food insecurity are critical to the development of networks to bring the technology to individuals who can use it.

As I entered into my first year of college following my summer abroad, I returned to an ignorant population, one that barely saw beyond their problems, and were unable to understand why somebody would devote themselves to helping the lives of individuals they had never met. It was then I realized the feeling that had come over me during the summer: I had a desire to become a part of a movement bigger than myself, bigger than my nationality, bigger than my race, a movement that encompassed the globe. It is this desire to continue to help my fellow man that drives me to continue to study biology and to enlighten people about the importance of working with groups that improve the lives of others regardless of where they live, or why they need help.

My Borlaug-Ruan International Internship to the China National Hybrid Rice Research and Development Center was an experience that will drive me to continue to make a difference in the world around me. I will strive to improve the lives of farmers so that everyone is able to devote their time and energy into the subjects that interest them, and not be bound by the trappings of poverty that prevent them from understanding new mysteries and exploring the great unknowns of our universe that each individual deserves an opportunity to enjoy and discover.

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