2007

Corn to Maize

JoAnn Kirsch
Wesley, IA
Borlaug-Ruan Internship
China Agricultural University
Beijing, China
July 2007

Table of Contents

Brief Synopsis of China Agricultural University and my Cooperating Faculty

In 1905, the establishment behind China's College of Agriculture laid the foundation for today's prestigious China Agricultural University (CAU). Over the past one hundred years, various colleges have combined and merged to create this key national university located in Beijing. Like China, CAU has developed rapidly in recent times, and is now a comprehensive university with agriculture as its distinguishing feature and specialty.

CAU has molded itself into a research-oriented institute in order to better serve China and the world through its rich and highly qualified personnel resources. The academy's attention is being paid to the fundamental researches with focus on high-technologies in the fields of agriculture and biology CAU aims to apply its significant research and prospective projects to national economical development.

To accomplish such goals, CAU has put great emphasis on initiating international programs and activity exchanges in cooperation with foreign countries. It has successfully established international programs with more than 20 countries including United States, Germany, Canada, England, Netherlands, Denmark, and Japan.

There are three essential elements that account for CAU's accomplishments:

- the excellent faculty who understand their responsibility to agriculture and the creation of new ideas
- the fine students attending the institute; their hard work and perseverance keeps CAU moving forward
- the modern facilities in which all the research is being done

CAU's President Chen Zhangliang has taken great pride in preserving and expanding the school's reputation. He has gone to great lengths to insure this grand foundation of education in which CAU is known for. His open arm policy has lead to a number of world renowned scholars to appear as Honorary Professors, including Nobel Peace Prize Laureate Norman Borlaug. Zhangliang heads a highly qualified faculty team of 1,398 members who educate in the 13 colleges composing CAU.

My summer experiments were completed in the College of Agriculture and Biotechnology. The two faculty members who guided me through my internship were Dr. Zhaohu Li and Dr. Jia Chang Zhang, each playing different and crucial roles. Dr. Li heads the College of Agriculture and Biotechnology; I have had the privilege of having him as my mentor for the summer. He truly made my stay and work enjoyable. He did everything in his power to prepare me for my future in college and in my career. Dr. Zhang took it upon himself to find me my own project, and I am very grateful to him. He

is an extraordinary individual who takes pride in his work and family. I was lucky enough to see him in both aspects and could see how he treated the students with the same encouragement as his own family.

Lastly, I need to mention Wu Ting Ting, a graduate student beginning her master schooling. I assisted in her maize transformation project, and learned extensively from her shy and incredibly patient manner. She was model of a diligence and hard work has accomplished many different impressive goals. To her I owe the utmost gratitude.
Hao Jin Jie, another master graduate student, led me through my tobacco project. I found her to be a very outgoing and upbeat person. I enjoyed every minute that I spent with her.

MAIZE TRANSFORMATION

JoAnn Kirsch and Wu Ting Ting

World Food Prize Youth Institute

China Agricultural University (CAU)

Beijing, China

July, 2007

Abstract

Maize is cultivated in every province in China and it plays a key role in the farmer household through its contribution as food, feed, and income. Being one of the primary sources of feed in China, it has played an important position in the rapid development of poultry and livestock industries. However, the local Chinese farmer faces several difficulties in his daily life trying to produce this crop, many of which revolve around environmental stress. Salt loading and freezing are major constraints, but none surmount drought, a constant concern. To eliminate or minimize the effect of these stresses biotechnological solutions are being investigated as the answer. In the recent past, the transformation of maize has been widely studied to induce many different resistant traits. The experiment in which I am assisting, the maize meristem shoots are either being induced with the SOS1+SOS2+SOS3 gene family for salt loading or LOS5 gene for drought resistance. The purpose is for the plant to accept the gene and to examine the efficiency of the transformation method being used. In the long run, the goal is to have enough crops for resistance tests to take place, possibly several plant generations later. In the project pure maize Zheng 58 bred is used; for it is known to have a high performance in growth and yield, which is the foundation to the experiment. From seed to finish, there is a seven step process and the Agro bacterium mediated transformation method is used. The LOS5 gene averaged a 32.3 acceptance rate and the SOS1+SOS2+SOS3 gene family averaged a 23.5 acceptance rate, justifying the gene acceptance and the transformation method.

Introduction

Maize has had a growing history in China and it still continues to expand today. The first written record of its existence appears in *Dian Nan Ben Cao* by Lan Mao in approximately 1492 (Liang and Johnnessen 1987). Originally the usage was as traditional Chinese medicine and not until around 1560 is there a written record of maize as a food crop. Since then maize has been a popular cereal crop cultivated with rice, wheat, and millet. By the early 20th century, maize became one of China's major crops. Now in the 21st century China's maize supply plays an influential role in the world maize economy, coming in second in terms of both area and production (United States in first).

This outstanding increase in production of maize and other cereal crops in China during the past several decades is recognized as one of the most remarkable success stories in science and technology and agricultural policy reform (Huang and Rozelle 2006; Lin 1992).

Great developments in technology, increased water availability through government funded projects, the supply and use of inorganic fertilizers along with other farming chemicals, and institutional changes are important factors contributing to the growth in maize production. However, the currently high levels of input use, as well as increasing water shortages and competition from industrial and commercial cash crops has kept China lagging behind leaving it to be classified as a developing country, a classification that is likely ending soon. China still continues to strive to come out on top and in doing so the scientist on working with the latest cutting edge technology.

In the recent past many experiments and projects have been completed to transform crops for a variety of reasons giving hope to developing countries for agricultural improvements. This summer I assisted with the transformation of maize to produce a transgenic crop with resistance to drought and salt loading. The hypothesis of the experiment: It is possible to develop a maize crop that will contain the transgenes for drought resistance and salt loading tolerance. The goal was to produce a yield for a second generation of crops. This project was also taking the Agro bacterium-mediated method into account, judging if it was the best way to transform maize.

I was able to work with every step in this ongoing project; however, it was not my own. It was decided during the second month of my stay that I would conduct my own tobacco transformation project. The methods were very similar and since tobacco has a shorter growing cycle I would be able to see more results in my limited time.

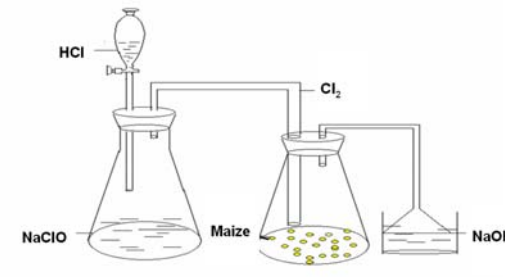
Materials and Methods

Explants

The maize seed line Zheng 58 (玉米自交系郑58) was used, as it is known for high quality yields and being a pure breed along with its high performance in past experiments. To start the experiment explants needed to be formed from the seeds of

the maize. Once these were obtained it was necessary to put them through a sterilization process with Cl_2 gas for three hours. (Figure 1)

Figure 1: Sterilization Process



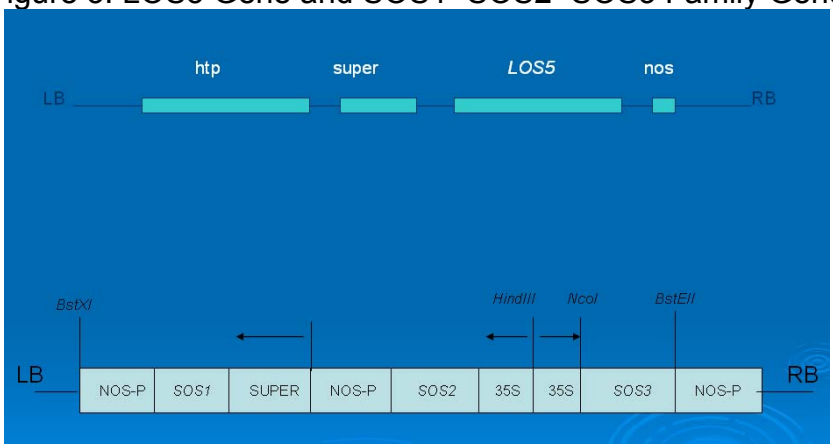
With the sterilization of the seeds complete, the next step was to grow the explants, by having the kernels culture for 5 to 6 days, also known as the preculturing process. (Figure 2) When the shoots or explants became 0.5cm in length, the transformation process can begin.

Figure 2: Preculture

Transformation Method (Agro bacterium)

In the past, maize has successfully been transformed by using two different methods: Agro bacterium-mediated transformation and biolistical transformation. This project solely depends on the Agro bacterium-mediated genetic transformation process using the lines EHA105 and LBA4404 of bacteria. During this process, the bacterium contains the desired transgene for the maize plant which genetically transforms the host (maize) by transferring a well-defined DNA segment from its tumor-inducing plasmid to the host-cell's genome. This project worked with two different mutated bacterium one containing the family of genes *SOS1+SOS2+SOS3* for salt loading and LOS5 for drought tolerance. (Figures 3)

Figure 3: LOS5 Gene and SOS1+SOS2+SOS3 Family Gene



The bacteria grows for twelve hours in a liquid mixture containing LB, antibiotics, RIF, and the liquid bacterium at 28 degrees Celsius while being shook at 200rmp in the dark. The explants or shoots acquired from the seeds then are soaked for three hours in the newly grown bacteria solution also being shaken at 28 degrees Celsius, but only 100rmp. This is the vital step of the procedure where the bacterium enters into the explants to transfer the gene.

When the soaking is complete, the explants are placed on filter paper to dry before being placed in Petri dishes on a media covered by filter paper to complete the co-culturing process. The shoots on the filter papered media will be set in the dark for 3 days at 25 degrees Celsius. From this point on, the biggest concern or problem is keeping the media and explants clean of bacteria. Whenever the explants or small plants are exposed especially while transferring from media to media, it must be done in the disinfected hood and handled with regularly disinfected tools. Even with all of these precautions done, it is very easy for some unidentified bacteria to take over the media or even for the agro bacteria itself to overpower the explants.

The shoots are then transferred to media that will select the explants out that have accepted the transgene. If the explants does not contain the gene antibiotics have been placed in the media to kill the shoot. This media also induces meristem growth to the explants that are suitable to continue in the experiment. The explants will stay on this media for fifteen days in the dark as well.

After the fifteen days are complete, the meristems are transferred to new media called Definition. This is where the meristems try to shape into young plants with leaves and a young stalk. The process can be completed in fifteen days but if not the meristems will be transferred to fresh Definition media. The Petri dishes go through a normal daylight cycle, fourteen hours light and ten hours darkness. (Figure 4)

The young plant is then inserted into its last media to try to form a strong root, and the young plant usually has to go through two cycles before this is achieved. (Fifteen days in media and transfer to new Root Shaping media for another fifteen days.) The same daylight cycle is used at this stage as was used in Definition. (Figure 4)

Once the young plant has formed a strong root, the time has come to transplant it into a little pot where it will grow for twenty days or until it is strong enough to plant out in the field. When transplanting the young plant, it is very important to remove all the media from the roots of the plant. If any media is left, the roots will rot in the soil ruining hours of work.(Figure 4) Another twenty days in the field, will be needed for the maize to grow and produce cobs with kernels which is the second goal of this project. With the seeds the experiment can continue, a second generation of maize will be grown and resistance tests will be conducted on the plants. (Figure 4)

Figure 4: The Stages

PCR

Lastly to test the hypothesis, little segments of the full grown maize leaf was collected from each plant to extract its DNA. The leaf explants were then prepared for PCR testing with liquid nitrogen and homogenized by grinding. The homogenized plant sample was then used for DNA extraction which was completed using the Nucleospin DNA Purification Kit following the manufacturer's protocol. This was all done to determine if the full grown plants contained the desired genes.

A polymerase chain reaction was performed on the plant DNA that was extracted. The PCR reactions were carried out in a total volume of 25 µl. For PCR analysis of the LOS5 gene and SOS1+SOS2+SOS3 gene family, DNA was denatured at 94 degrees Celsius for 1 minute, followed by 25 amplification cycles of 94 degrees Celsius for 1 minute, 56 degrees Celsius for 2 minutes, and 72 degrees Celsius for 2 minutes, and 1 cycle of 72 degrees Celsius for 1 minute 5 µl 5x SGB to each sample; the DNA samples were fractionated in a 3% agarose gel at 40 mA in 1X TBE buffer for 3 hours, stained in 1 µl/ml ethidium bromide for 15 minutes, destained in dH20 for 15 minutes, and photographed with UV light.

Results

The PCR results show that it is possible for the maize plant to accept the transgenes and grow. (Figure 5 and 6) Only one or two of the finally plants did not have the desired transgene. The figure results (Figure 7) are on the basis of how many meristems were germinated. The numbers were not taken from the amount of seeds that began the project. The statistical analysis allows judgment to be passed on the Agro bacterium-medaited transformation method used.

The last result is the transformed maize is not producing seed. The plants mature early not allowing themselves to grow to their full potential. Many plants do not produce the tassel while the others do not produce a cob and some produce neither. The crop that does grow a cob produces a very small miniscule one that does not even have kernels on it. This proposes a very big problem.

Figure 5: LOS5 PCR Results

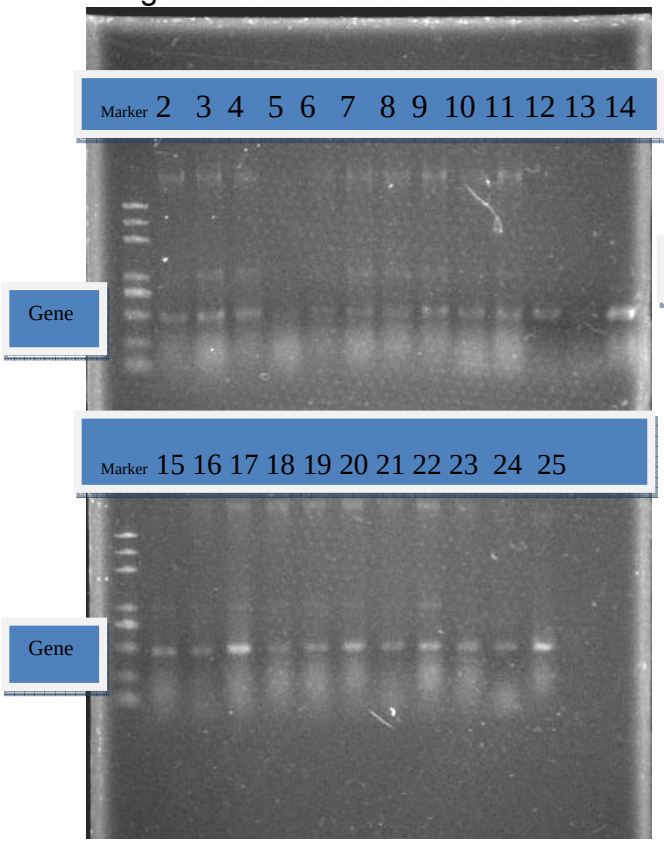


Figure 6: SOS1+SOS2+SOS3 PCR Results

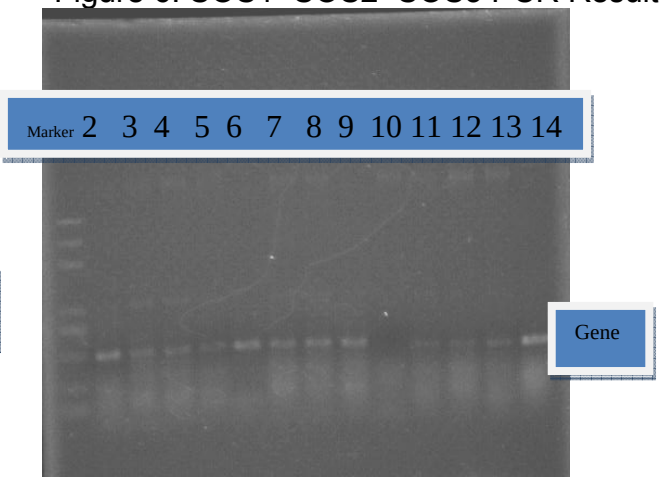


Figure 7: Number Results

Gene	Meristem count	Successful plants	Successful %	Average %
Los5	160	59	36.8	32.3
Los5	113	36	31.9	
Los5	220	56	25.8	
Los5	131	45	34.3	
SOS1+SOS2+SOS3	168	24	14.3	23.5
SOS1+SOS2+SOS3	108	38	35.1	
SOS1+SOS2+SOS3	182	37	20.3	
SOS1+SOS2+SOS3	110	26	24.1	

Discussion

The PCR showed a very positive result that proved the hypothesis right,(It is possible to develop a maize crop that will contain the transgene for drought resistance and salt loading tolerance.) and the average of plants to succeed was a reasonable percentage drawing a conclusion on the transformation method. It is a proven successful method, but a very difficult one to keep under control, many explants and young plants were lost due to the Agrobacterium taking over the culture.

However, when the transformed plants are not producing a yield a major problem has surfaced, bringing along with it many questions. Why is the plant not forming seeds? Could it be the method? Could it be the soil? The answers are unclear and the only way to determine them is conduct more testing. While the transformation of the genes was successful, the success of this overall project is incomplete without seed for a second generation. As mentioned earlier, the goal of this project is to continue to produce transgenic plants to conduct actual resist tests in the future. These tests will be justifiable evidence to how beneficial transformed maize is to China.

This country's environment is changing through droughts, floods, early frost, urbanization, and more, so if the Chinese people are going to continue to move forward they will have to develop new transgenic crops to survive in the new environment.
It is only a matter of time before this technology is mastered. When it is, China is going to have to disseminate the newly-achieved technology and knowledge to the local farmers. China also will have to keep the cost down of seed and the markets open for the farmers. With the frequency of droughts increasing and limited quantity and quality of farmland, China will benefit from new technologies such as this transgenic maize. However, appropriate governing policies and agricultural education are essential to Chinese success.

Tobacco Project

I conducted this project on my own to better understand the first steps of the process of transformation using the Agro bacterium-mediated method. Since the stages were very similar to the maize, I will only describe the differences between the two.

The tobacco explants are gathered from the leaves of the plant instead of from the seeds. The explants must be a very small section of the leaf while being without any large leaf veins. Instead of soaking for three hours the leaf explants only set in the liquid bacterium solution for ten minutes before starting them in the co culturing process. All the media used in tobacco transformation is comprised of the same elements that are used for maize transformation.

Figure 8: Explants

Figure 9: Liquid Media

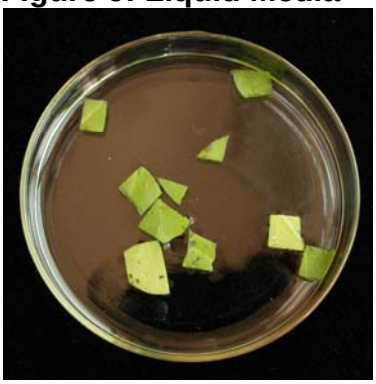
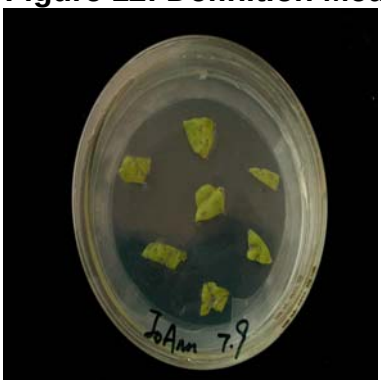


Figure 10: Drying Explants

Figure 11: Co-culturing

Figure 12: Definition Media



I was unable to complete my tobacco project; however, one of my fellow lab mates will be taking it over. I was only to the Definition media when I took my leave.

These are the ingredients to make-up each media.

Liquid Media
Half MS:
- I. 12.5mL
- II. 1.25mL
- III. 1.25mL
- IV. 1.25mL
- Sucrose 7.5g/500mL

Ph 5.8
RIF. 37.5µL
Kn. 15µL

Co-culture Media
Full MS:
- I. 25.0mL
- II. 2.50mL
- III. 2.50mL
- IV. 2.50mL
- Sucrose 15g/500mL

6-BA. 3mg/L
NAA. 0.2mg/L
Ph 5.8

Definition Media
MS (same as above in full)
6-BA. 3mg/L
NAA. 0.2mg/L
Cef. 500mg/L
PPT. 500mL
Ph 5.8

Root Shape Media
MS (same as above in full)
CB. 500mg/L
Kan. 100mg/L
Ph 5.8

Works Cited

Gilbertson, Larry, et al. "Agrobacterium-mediated Transformation of Seedling Derived Maize Callus." *Genetic Transformation and Hybridization* (2005): all. *Springer_Verlag.* July 2007 <www.agrobacteriumres.com>.

"He Kang." *1993 World Food Prize Laureate.* <http://www.worldfoodprize.org/laureates/past/1993.htm>.

Huang, J. and S. Rozelle. 2006. China: Polices, trade and incentives. In *Maize Policies in Asia*. Eds. Ashok Gulati and John Dixon. Forthcoming.

Liang, Y. and C. Johnnessen. 1987. Literary and Physical Evidence of American Crop Plants in Asia Before 1500.

Lin, J. Y. 1992. Rural reforms and agricultural growth in China. *American Economic Review* 82: 34-51.

Kasuga, Mie, et al. "Improving Plant Drought, Salt, and Freezing Tolerance." Editorial. *Gene Transfer of a Single Stress-Inducible Transcription Factor* (1999): all.

Meng, Ericka C. H., et al. *Maize in China.* First. Mexico Cily: CIMMYT, 2006. July 2007 <http://www.cimmyt.org/english/docs/maize_producsys/china.pdf>.

Sairam, R.V., et al. "Shoot Meristem." *An Ideal Explant for Zea mays L. Transformation* (2003): pg. 323-329.

"Science." *Beijing Offices.* 2003. Unesco. <http://www.uesco.org/ext/field/beijing/scienceb.htm>.

Personal Background

At an early age, my attention was captured by what I term “barnyard nature”, and my small farm family upbringing groomed my interest in agriculture, but of course, small children rarely see their future clearly. I was convinced my destiny was in the spotlight dancing as the world famous ballerina, or the life-saving doctor shown on television. In my mind, I was destined for greatness and nothing was going to hold me back. Perhaps we should strive to keep a naïve mind, for as I matured and reality kicked in, my destiny of greatness became something I no longer contemplated. Only recently did my original glow and excitement for my future contributions to society return. It became so vividly clear, like the dirt that I’ve always had on my very own hands.

Initially my involvement within the agriculture spectrum was a requirement, the daily chores of my life. Growing up on a small family farm north of Wesley, IA, I accompanied my father every day and night by his chore requests. Over the recent years, my obligations have become my education and preparation, but my father, who started me on my insightful path to hopefully a very fruitful future in modern agriculture, still expects me to make his chores easier.

In middle school, my focus was already in the science. Looking back now over numerous school and 4-H fair projects, a line can be drawn connecting dots leading up to where I stand today. In eighth grade, one essential project consisting of black soybeans introduced me to the World Food Prize for the first time. After entering my diligent work at my local county fair, I earned the opportunity to take my exhibit to the Iowa State Fair. Besides the usual rewarding ribbon, I came to find that I had received three tickets to attend the World Food Prize Awarding Ceremony. At this point, I had no idea what this organization was or what it consisted of.

With my parents at my side I entered the C. Y. Stephens Auditorium at Iowa State University to witness the awarding process of Dr. Pedro Sanchez for his life achievements. I was awestruck by the achievements of the laureate along with the members of audience present and even embarrassed about my ignorance of the program. The annual symposium is what society needs to disseminate the knowledge of world problems and successes. Leaving a lasting impression, the event sparked a new fresh awareness of the world’s future and my own at the same time.

My further involvement with the Youth Institute was postponed until the summer before my senior year of high school. I received a letter in the mail describing my summer requirements to prepare for the fall semester advanced biology course at Bishop Garrigan High School. As a side note the teacher, Mr. Bode, mentioned the World Food Prize Youth Institute and describing the necessary paper to participate in the Symposium. I jumped on this unbelievable opportunity not quite knowing what I was in for.

With Mr. Bode's guidance and persistence, I managed to prepare myself for the October Symposium with a paper on the very controversial issue of the Venezuelan Land Reform Program. Between strategically planned dinner seats at laureate lunches and meeting diplomats and peers, I was overwhelmed, but left yearning for more. My ambitions that had been lit in eighth grade had resurfaced with a new intensity and refused to be ignored. These renewed emotions came at a very crucial point in my life when confident answers were most desperately needed.

Seniors in high school are faced with countless questions about the future and life goals. What will be your contribution to the world? At first I faced them as clueless as the next student, but with my recent work and experiences with the World Food Prize Youth Institute, I have found an unfailing resolution in the agriculture field. A place I had been all my life was now being viewed with a new set of eyes.

After attending the Symposium and listening to the past interns with their exciting experiences, I became assured that the Borlaug Ruan Internship was in my near future. I truly felt it would be the beginning to my lifetime career and commitments in agriculture and biotechnology. With great deliberation and effort, I was given the opportunity to travel to Beijing, China, to study at the China Agricultural University for the summer of 2007.

My Experiences

My year-long anticipated extrusion finally started on an early restless Thursday morning in a family packed van traveling to the airport. With all my good-byes said and the airport hassles completed, I ventured toward the plane with farewells being called in the background leaving me to face the reality of the prolonged and agonizing ride of waiting. Keeping my mind open for the normal complications and small mishaps, I took my seat on the first flight. I managed to arrive in Tokyo, Japan, and boarded the plane for my last flight with a minimal amount of difficulties. However, the adventure was to continue. The plane was emptied and hotels were accommodated, leaving me with another sleepless night of excitement and anticipation in Tokyo!

Late Saturday afternoon, I finally stepped on Chinese pavement and entered into this new world. As the glass doors opened to the bustling crowd of welcomers, I managed to stumble across my name held by two of my new lab-mates. They greeted me with open arms, grabbing my belongings, rushing me towards the exit, and giving me no chance to pause to soak it all in. Once in the taxi, I began to realize what my summer was going to entail with the language barrier. Here is where I sat through my first Chinese conversation, basically an eavesdropper wishing to get involved but without knowing how.

This was also my first glimpse of the city from ground level, and in truth it is hard to find a comparison. My very first view of the streaming streets and highways truly stunned me. I found myself staring out the window at the endless flow of miscellaneous vehicles and means of transportation. The streets held a vast variety of buses and taxis to the

bicyclists and people on foot. What I would consider dangerous and perhaps even life threatening in Iowa was a regular occurrence for the Chinese. The easy going nature of the motorists or bicyclists, weaving in and out of the mass of automobiles, was hard to believe. It is very common to come upon a parent with their child straddling the back of the bicycle strolling along or even a couple with the man on the seat and woman on the handlebars holding the umbrella in the rain. What is against the law in the United States is sometimes a way of life in China.

There were many times when I stepped back and waited for an accident to happen, but it never did. To answer my own curious mind as to why this is, I have drawn a few conclusions. First, the size of automobiles in China is considerably smaller than the average American vehicle. Secondly, the usage of the car horn or bike bell- in the United States the practice is either in jest or mainly in anger, but the Chinese's frequent blaring or ringing is done to warn their fellow travelers of their presence. Perhaps it can be considered their main safety system for travel.

After a few days or even a few hours, I concluded that I never would have been sufficiently prepared for my arrival, no matter how much research and reading I had completed. The personal experience is the only way to actually understand the message the text has tried to spell out for you.

I soon became accustomed to stumbling daily over a new eye opening discovery, but at the same time I was confronted with several similarities, which took me by surprise in the beginning. Almost immediately, similar objects and customs gave me an entirely different outlook on the world. It emphasized how small the world is and how each country's difficulties can be shared across global boundaries.

The lectures I had heard at the Symposium began to come alive, accompanied by my personal revelations. My experiences have come with a new understanding to the importance of international relations and how the perspective view of the world's problems needs to be taking on as one. The very simple but still revolutionary Olympic slogan for 2008, "One World, One Dream," states the truth on, several different levels, concerning this matter.

As I made my daily walk from my apartment to the campus, I could see how Western culture influences China. However, it would be untrue to state that the Chinese people are completely adopting Western ways. But for the lack of a better word, I have come to say that they are adapting. The citizens take new, appealing ideas that have been introduced to them and make it their own. For an example, in Chinese fashion, it is easy to identify the Western culture in their clothes by the logos and images; however, the style and size of the garments have their own Chinese twist. It is a mixture of the new Western ways with the Chinese customs and culture sewn into it. It is not only in the city that this trend is apparent- when I stayed in a rural farm area, I still could identify the new mixture to which has become the modern day Chinese culture.

My rural stay, consisting of only a couple of days, impacted my trip. It brought consciousness to how each country deals with world problems differently. It brought out the individualism I was unable to see in the city.

When I was told of this adventure to the countryside, my mind was picturing a town full of misshaped houses with dirt floors and bare walls with people working in the rice fields. I was filled with anticipation, but my thoughts were still in the past about Chinese farming and countryside. Of course I did not realize my foolishness until I arrived. As I set out on the train for the village, I laid goals down for myself, such as working in the fields, helping out with household duties, and absorbing it all in. Stepping off the train, I was faced with a whole new view. I found myself in yet another tourist area. I had arrived in a farming community, but the residents of the village had learned to take advantage of tourism.

During my stay, I was able to see the very poor Chinese that I had always heard about from my childhood. I found this very difficult to handle because I was staying in what the homeowner called a “folklore hotel,” a very carefree life in comparison. No matter how hard I tried to experience the pain and misfortune I had so vividly seen, I later discovered I could not. One sad realization I came upon was all of the less fortunate I was introduced to were elderly and disabled. They could not take care of themselves or their households anymore. I had seen and read so many things about the starvation and poor conditions in developing countries, but experiencing them actually hit the nerve. I felt horrible and repulsive for living the way I do. Even while I was there I still had privileges and things beyond my needs.

What will I take away from this summer? Gratitude. I realized how miserable I make my life. I am never grateful. I am always looking and wanting for more. I have seen so many happy people who own less and eat less than me while keeping a smile on their face. Secondly, I have been able to see how closed minded the U.S.A. is. China has a 24 hour international television station which discusses issues in countries around the world. The United States on the other hand only publicizes news that contains some importance or relevance to the nation itself. I feel that as a country we need to create better international relations. I am not making this statement solely toward our government, but I am challenging citizens to take interest and show they care about the world.

I also became very aware of how patient everyone was with me and the language barrier, an aspect that I was a little embarrassed about. As a foreigner, I felt it was my responsibility to be learning a new language. However, the Chinese have been learning English since elementary school and they wanted to improve their English. I was very fortunate and wished the United States would take a more pro-active attitude toward learning a second language. They are so many unseen benefits to being able to speak with someone in their native language.

I was able to see how the dispensing of knowledge and discoveries from the United States along with several other countries have helped guide the developing China to

where it stands today. Present day China is laying its foundation for the challenging but promising future, and in the recent past the Chinese have made several tremendous moves forward in addition to numerous life saving accomplishments.

I had the privilege of dining with a former prime instigator, who is accredited for many of China's recent decades of work in agriculture. As China's former Minister of Agriculture, he is recognized for implementing the reform polices that allowed China to become self-sufficient with basic food needs for the first time in modern history. Dr. He Kang is the World Food Prize Laureate of 1993, and I felt honored to have a meal with such an esteemed man. His political career has ended, but his agriculture involvement and excitement are still treated with the same young energetic intensity. It is men like He Kang and Norman Borlaug that inspire the young generations to continue their call for poverty reduction and food security. Both of these individuals have earned a place of honor in society and have become great role models for me.

As I left for the airport, I could not believe that my time was at an end. I was packed into a taxi filled with my new life time friends. The trip was quiet and solemn for none of us wanted to admit that this might be the last time we would see each other. The good-byes and getting on the airplane were a blur, my mind trying to figure out and organize everything that had happened to me. Once I arrived back and was able to stay awake, I began to see the affect the trip had on me. I have a whole new look on foreign relations and confidence in my choice for a life career. Before this summer, I was still hesitating about entering the biology field to eventually work with biotechnology research in agriculture. This internship has given me the insight I needed to reassure myself that my goals for my future are attainable and will be enjoyable to achieve. I have seen the needs for this technology first hand and all doubts in my mind about my future have been vanquished, thanks to my Borlaug-Ruan Internship.

1. A beautiful traffic jam

2.CAU's old school entrance

3. Vicky and me on the Great Wall

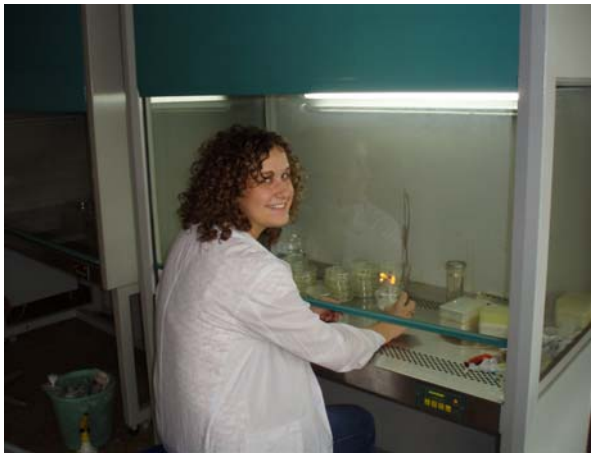
4. I saw real bamboo for the first time

5. Me by a garden in the Summer Palace

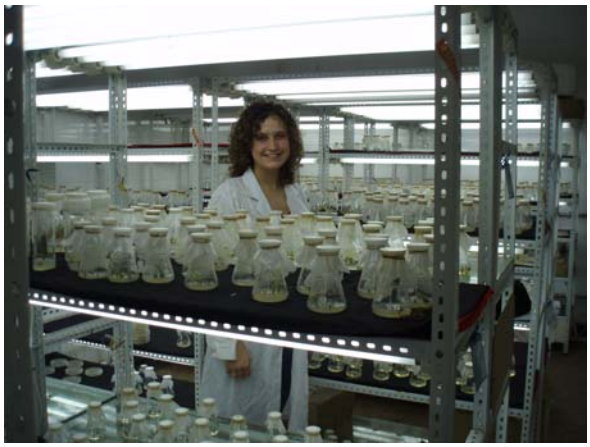
6. The One Song Concert

7. Dr. Chen, me, and Dr. Li

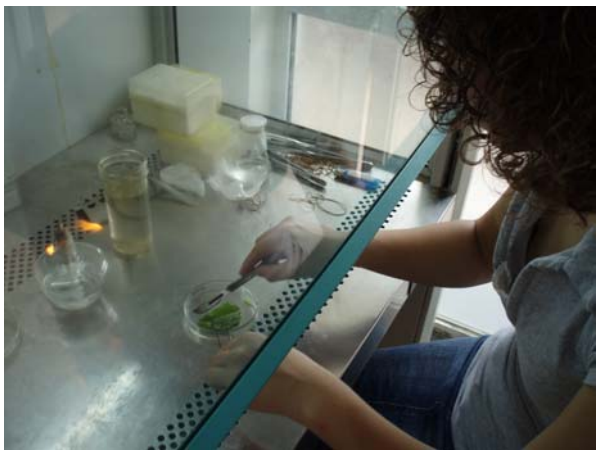
8. I am washing the dishes



9. I am working in the clean hood



10. Where all the explants were cultured



11. I am making tobacco explants

12. The transformed maize

13. The village street

14. The height of the mops and brooms

15. A picture on the Great Wall

16. A man taking his afternoon nap

16. My birthday party

17. A picture of the Great Wall

Acknowledgements & Thanks

- **The World Food Prize Foundation, Dr. Norman Borlaug**, Nobel Peace Prize laureate and founder of the WFP, **Mr. John Ruan**, Chairman of the WFP, and **Ambassador Kenneth M. Quinn**, President of the WFP, for giving me this life-changing opportunity
- **Ms. Lisa Fleming**, WFP Youth Programs Director, for her guidance and support as my second mother for the summer
- **Dr. Zhaohu Li**, my supervisor at CAU, for allowing me to work in his laboratory and his supervision over my project
- **Everyone at CAU**, for their kindness; but especially to **Wu Ting Ting**, for letting me assist in her graduate project. **Zhong Boh** for explaining everything to me, especially when no one else would, or perhaps could.
- **Ms. Beany Bode**, my high school biology teacher and World Food Prize mentor, for getting me started and guiding me through all of my work.
- My father, **David Kirsch**, for teaching me about the environment and truly showing me what agriculture is about. I am blessed to have you guide me and support me.
- My mother, **Susan Kirsch**, who has taught me to do what I feel is right. You are always the shoulder I lean on.
- **My other family, friends, and local businesses**, for their encouragement and support.