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World Food Prize Youth Internship 2001: CIMMYT-ARMP

It is like an ocean. The pitch and tone of conversation swirl and swell like the crash of waves upon a shore. I feel as though I were simply floating through the current of humanity. People crowd closely around the carts and tables of the venders as though they were the boats in the sea. The ocean here does not smell of froth and foam as others do. This sea smells of frying bananas, spiced curry, and the zest of citrus. This mingles with the smell of the other shoppers, the overpowering odor of durian, and sparkles of flying grease. The tide of this ocean is a myriad of color. The rainbow of colored fabrics, the white steaming rice and the deep mocha of the Thai people around me form a mosaic that I silently stand and watch as it shifts and moves. Then I begin to chuckle. The Pak Chong Market in Thailand certainly is quite different from the Fareway in my hometown in Iowa.

My attention is focused back to the sound of English being spoken a few feet off. Since I am one of the few farang (western foreigners) in Pak Chong, and the only American, I wander toward the voice and quickly locate Pé Ahn, my Thai "mom". Just as I reach her, I feel someone poking me and stroking my hair. I slowly turn and come face to face with…the noodle vender. She begins to ask me rapid-fire questions in Thai, to which my response is the usual smile and nod, as I cannot understand a word she is saying. Pé Ahn speaks on my behalf, using only a few words I can understand. As I watch, Pé Eww whispers some of the translation in my ear. Pé Ahn tells her I am a

seventeen-year-old American high school girl. She quickly wraps up the conversation because we need to return to the farm. As we walk away, I look back and smile. The local gossip is the same whether you are in Independence, Iowa, or Pak Chong, Thailand.

My name is Andrea Neeley but my Thai friends call me Ahn Ah Nong. I am seventeen years old, or sip jet in Thai. I am senior at Independence High School and plan, upon graduating, to the attend college and major in history or social sciences. However, most importantly, I am one of the nine luckiest teenagers in Iowa. In the fall of 2000, I attended the World Food Prize Youth Institute and in the spring, I became an international intern in Thailand. I based my choice to be an intern on my desire for adventure and my love of helping people. I had an adventure and I hope that my work in Thailand will help someone. I know that it truly was one of the best experiences of my life.

The research center I worked with was CIMMYT-ARMP (The International Center for the Improvement of Maize and Wheat- Asian Regional Maize Project). I spent most of my time at the CIMMYT satellite office in Suwan Farm, at Kasatsert University Research Center. Located about two to three hours out side of Bangkok, Suwan farm is located in Issan, the Northeast part of Thailand. The center is devoted to the improvement of maize and sorghum. My focus was maize research in the area of downy mildew infection.

Downy mildew is a fungal infection caused by the geneses *Sclerospora* and *Sclerophthora*. The Sorghum Downy Mildew of Maize (*Peronsclerospora sorghi*) is the only form of downy mildew found in Thailand. Downy mildew infection can begin as early as the two-leaf stage (V2). The wind carries spores from plant to plant during

nights when it is dark and cool. As the spores land on seedlings, they immediately begin to feed off the living tissue of the leaves. A small strip of yellow in the leaves characterizes localization, the earliest form of infection. Following localization the mildew spreads down to the growth point and then spreads through out the plant. Called systemic infection, a total infection's characteristics include a striping of leaves and a lighter green color of the plant in general. Approximately one week later the main and most obvious symptom appears as a white powder of spores on the underside of the leaves that will eventually spread the disease its next victim. Although downy mildew does not kill infected plants, it acts as a parasite, slowly starving them. Plants lack the food to generate ears and only produce nubbins. This can lead to almost one hundred percent yield destruction. It is far too impractical to attempt to cure infected plants and preventive seed spraying with the only effective phantaside (methalaxyl) increases seed price beyond the reach of Thai farmers. Thus, the practical and economic way to deal with downy mildew is to breed maize to be naturally resistant.

The only method of testing downy mildew resistance (DMR) is inoculation. Inoculation is the direct exposure of a healthy seedling to downy mildew spores. The scale of the inoculation can vary. Sometimes, researchers need only screen ten plants per line. Other times, they need to screen hundreds. No matter what the scale, the measure of success is a percentage calculated from total plants divided by infected plants. A line or hybrid considered well resistant has eighty percent or more mildew-free plants. Lines or hybrids considered moderately resistant have about fifty to eighty percent mildew-free plants. Lastly, a susceptible line or hybrid is one with less than fifty percent mildew-free

plants. Checking for DMR is a reoccurring activity at Thai research centers, be it in rows of pots or in rows of a field.

The downy mildew work I participated in mostly revolved around inoculation and screening for DMR. Most of my time focused around four main projects. The projects I played a role in were: an inoculation technique evaluation, an experiment in spore concentration, the screening of several Quality Protein Maize (QPM) lines, and a heritage study. My responsibilities usually included labeling, irrigating (I watered 10,000 plants every morning), collecting data, and calculating the DMR. When we needed to inoculate plants, I helped with the preparation of spore suspension. In addition, since there were some plants infected with downy mildew near our experiments, it was important that none of their spores contaminate our experiment and make our results questionable. Therefore, every evening I covered our plants with plastic bags and every morning removed them.

The first project I helped with was an experiment in spore concentration. Used in inoculation, the current recommendation for number of spores per ml of water is 40,000. This experiment compared it to 80,000 spores per ml and 20,000 spores per ml. In order to study the spore suspension concentration we first needed to make suspension.

The making of spore suspension begins with gathering infected leaves from the field. After cleaning, the leaves fill around twenty buckets. Each bucket has about 10 cm of water in the bottom so there will be enough moisture for the mildew. Then the buckets are covered and allowed to incubate for eight hours in a dark air-conditioned room. When removed, the leaves have a thin coat of spores. Workers then remove these spores by hand into a basin of water. Once all the spores are in the basin, the solution is taken to

the lab and the spores are counted using a hemacytometer and a microscope. Once we know the number of spores per ml, we dilute the solution until it is 80,000 spores/ml. Then, we dilute again to 40,000 spores/ml and 20,000 spores/ml. In this experiment, we sprayed these different levels of concentration on forty plants each and then allowed growing normally.

The results of this experiment showed all three levels of concentration to have over ninety percent infection. These findings indicate that suspensions need fewer spores per ml. From our work, Mrs. Orakit thinks 20,000 spores/ml should be the new recommendation. With the lower recommendation, the amount of infected leaves needed drops. This equals infecting fewer field rows with downy mildew, which frees up valuable research area. Additionally, since there are not as many leaves needed, fewer workers will have to remove spores. So, by lowering the recommendation, inoculation becomes easier and less costly.

The next project was an evaluation of five different techniques of inoculation and the most important work I helped with. The technique currently used is effective, but costly and time-consuming. This experiment was to determine if there is another technique with an equal level of infection. The criteria used to evaluate the techniques included amount of time needed, amount of night work, amount of infected leaves needed, amount of labor needed and the percentage of plants infected. The seedlings used were from two susceptible inbred lines so that infection would only be a matter of how well the inoculation worked. It is important to remember that although percentage of infection is very important, the logistics of inoculation are what will decide how useful it is. Spore suspension is costly and time-consuming to make so the less needed the

better. The five techniques evaluated were direct, spreader row, pre-soaked, leaf, and sandwich.

Direct inoculation is the most straightforward of the inoculation techniques. Once planted, the seeds germinate and upon reaching the V2 stage, workers spray each plant with spore suspension. The spores collect on the leaves and infect the plant. This method is not as simple as it sounds, though. Spraying the plants with spores must take place at night when it is cool and dark; otherwise, the sun will kill the spores before they can infect the plants. One row takes from forty to sixty buckets of infected leaves and six to eight workers to carry the sprayer knapsacks (each weighing more than twenty kg) in the field.

Spreader row technique is the currently favored method of inoculation. It is like direct inoculation, except it requires less spraying by using the wind. A spreader row is a row of susceptible inbred line planted a month before the lines needing screening. Sprayed with spores at the V2 stage (as in direct inoculation), the spreader row will become systemically infected and begin to produce spores. A month later, inbred lines and hybrids fill in the rows adjoining the spreader and when they germinate, spores will cover them. The down side is there is still need for so many workers to make spore suspension and spray, as well as the fact that an entire row of field space is lost for testing.

Pre-soaked technique is a promising alternative to the spreader row or direct techniques. After soaking for seventy-two hours, the endosperm of the seeds is softer, making it easier for the mildew spores to infiltrate. The softened seeds then move to a petri dish where the inoculation takes place. Sprayed with spore suspension and covered,

the petri dishes incubate in a dark cooler for eight hours. Removed from the cooler and planted, the seeds will germinate already infected with downy mildew. On a larger scale the seeds would soak in buckets at a time and the incubated on in large trays instead of petri dishes. This technique requires only about two liters of spore suspension.

Leaf inoculation is a relatively new inoculation technique. When the plants reach the V2 stage, instead of spraying spores on to the plants infected leaves are placed on top of them. During the night, spores fall from the leaves onto the seedlings. By the morning, the mildew covers not only the plants, but also the soil surrounding them. The mildew that fell on the plants infects them and the sun kills the spores on the soil. This technique requires incubation for the infected leaves and placement at night, but it does not require spore suspension.

Sandwich technique is a combination of all the other techniques. After soaking for seventy-two hours, the seeds move to an infected leaf-lined petri dish. This "sandwich" of infected leaves and seeds then incubates for eight hours in a dark cooler. When removed from the cooler, spores already cover the seeds. After planting, the seeds germinate infected. On a larger scale, trays lined with leaves take the place of the petri dishes. This technique does not require spore suspension and is limited to less than an hour of night work.

The results of this investigation showed that, as expected, direct inoculation and spreader row were most effective on a strict percentage evaluation with both having one hundred percent infection. Since they were equally successful percentage wise, the other criteria showed spreader row technique to be preferable to direct as it required less time, less night work, fewer infected leaves, and less labor than direct inoculation. We were

disappointed to discover that pre-soak technique did not have the percentage infection we would have hoped. Only twenty-two percent of the plants were infected. Hopefully, with some alteration of procedure, there will be a higher percentage infection and this technique will become practical as it scored so well in the other criteria. The leaf technique was successful percentage wise with ninety-two percent infection. Unfortunately, it is impractical for field use. Sandwich technique looked promising at fifty-eight percent infection. We concluded that spreader row is still the best method for fieldwork, although leaf technique is the best when working with pots. Sandwich technique scored the best overall, but due to its low percentage of infection it cannot yet replace spreader row. Hopefully, with a slight alteration of procedure, sandwich technique will increase to one hundred percent infection and start saving the research centers time and money.

The third project I played a smaller role in concerned QPM. QPM is extremely important to poor farmers because it contains three times the amount of protein than in normal maize. Unfortunately, it is impossible to make use of in it Southeast Asia, as it is not resistant to downy mildew. CIMMYT scientists have crossed QPM lines with normal resistant maize in hopes to create DMR. In this experiment, we screened forty-six QPM lines for downy mildew resistance. Using direct inoculation, all the plants were exposed to downy mildew. After a month, Mrs. Orakit and I counted the total of infected plants. From the percentages, we determined that four lines had excellent DMR, and three lines had decent DMR. After the experiment completes, these seven successful lines will move on to the field and be self-pollinated. After five or six generations they will be

crossed with other QPM inbred lines to eventually create a hybrid high in protein and completely resistant to downy mildew.

The last of my major projects involved a heritage study, sometimes called a generation mean analysis. This study begins with two parent plants (P1 and P2). One parent (P1) is resistant to downy mildew, while the other parent (P2) is susceptible to downy mildew. When crossed they produce F1. F1 seeds are planted and the plant produced is F2. F2 is backcrossed to both original parents (P1 and P2) to form BCF2P1 and BCF2P2. We planted all four generations in this experiment and exposed all to downy mildew through direct inoculation. The results of this experiment directly contrasted with those of a previous experiment. So, it seems that the experiment will have to be conducted again.

Some work I played a minor role in was the selection of opaque seeds and good modified seeds. The opaque-two gene is the one that gives QPM extra protein. It makes the seed a lighter color and softens the endosperm. The lighter color does not cause a problem but the soft endosperm makes QPM more susceptible to insects. Thus, QPM is crossed with regular maize so it will keep the opaque-two gene, but also have a hard endosperm. At the F2 generation there is segregation among the produced seeds. Seventy-five percent will not contain the opaque-two gene. These seeds are removed leaving only the twenty-five percent opaque seeds. One of my jobs was to help in selecting the opaque seeds. The opaque seeds are planted and self-pollinated for several generations. Once the researcher is positive that line contains the opaque-two gene, again seed selection takes place, this time looking for those which have hard endosperm. I helped the workers with both types of seed selection. These seeds are taken, planted and

backcrossed (usually four-five generations) until eventually the line contains opaque-two but also has hard endosperm. I was not very good at seed selection, so I opted to help by counting the seeds and sacking them by the five hundreds.

In addition to my projects, I was able to help CIMMYT-ARMP with some photo cataloging. I brought a digital camera and a laptop with photo editing software. I have some experience with digital imaging from working on the high school newspaper so I became for a few weeks quite the photographer. I photographed around thirty maize lines, the heritage study, and the downy mildew screening process. These photos will be used when papers on the work are presented. In addition to all the photo work, I used my laptop to create spreadsheets of the data we collected for each project. I also did some mean calculations with data from a field test. The last way I was useful to the people I worked with here was simply because my native language is English. Several DOA and KU publications must be in English and I helped them revise a little so that the text was easier to understand.

The work I helped with was interesting, and I learned a lot, but the people I met were by far the best part. Surinder K. Vasal is the team leader of CIMMYT-ARMP and so I was under his care for my entire internship. He is a maize specialist and one of the 2000 World Food Prize laureates. He is a wonderfully kind man and always was watching out for me and working to make my stay as comfortable as possible. Mrs. Orakit Balla was my daily supervisor. She is a senior research assistant, a plant pathologist, a breeder and the CIMMYT coordinator of the Farm Suwan station. According to Thai tradition, I called her by her nickname, Ahn, proceeded by Pé, which

is a term of respect and literally translates “elder sister”. However, Pé Ahn was more than just an elder sister, she was my Thai “mom”. She fully adopted me. She taught me about her work, her culture, language, and was my friend. She is a completely amazing person and I can hardly wait until she comes to visit America so I can try to be half the hostess she was to me.

One concept Pé Ahn demonstrated to me everyday seems to be the foundation of Thai culture: Respect. Coming from America where mocking the government and its officials is practically a nation sport, the complete lack of public cynicism was very foreign and in truth, refreshing. The Thai people respect the king, past and present. Royal pictures hang in homes, businesses, even around the necks of the Thai. No one ever questions the king, and normally considers it rude to even mention him in polite conversation. Everyday at eight a.m., and again at six p.m. the national anthem is broadcasted over all the media stations, and in public places. As I learned from personal experience, it is important to pay attention, and when you hear the national anthem, to stand and remain silent. Otherwise, the Public Safety Officer will ask you many questions in faltering English about who you are and where you are from.

Respect filters down from the national level to all citizens. Thai people are very respectful of elders. The younger person always greets the elder first. Younger people should always refer to an older friend or family member as “elder sister or brother”. When greeting anyone one older or unfamiliar peers, all polite Thai will “wai”. The “wai” is form of bow made with the palms pressed together and raised to the face. The higher the hands are the greater the respect. Hands placed at the forehead level is a sign

of respect reserved only for images of the Buddha, a common sight in a nation where 93% of the population are practicing Buddhists.

Buddhism plays a big role in all aspects of Thai life. A Thai person never points their feet at anything or anyone, because the feet are the lowest point of the spiritual body and thus unclean. Statues of Buddha are not the only ones in Thailand though. There are shrines to Indian gods and the spirits of the dead that lived upon the land. Thai people build miniature homes for the spirits, provide them with bottled water, and give them food daily so they would have good luck. Although knowing Thai cuisine, it is the spirits that are the lucky ones.

Thai cuisine is a combination between Indian and Chinese. Surprisingly, Thai people do not use chopsticks, as there are in many American Thai restaurants. Thai people eat with a large spoon in the right hand and a fork in the left. A Thai dinner is eaten family style with many people eating from the same dish. A typical Thai dinner is composed of spicy soup, one or two curries, several fried dishes, and fruit for dessert. In addition, Thai food is characteristically very spicy and through trial and error, I discovered that several spoonfuls of rice would cure a burning tongue. Thai food is amazingly good and it seems the whole world will soon know it. Thai restaurants are the second most popular genre of ethnic foods in the world. This just illustrates how Thailand and her culture are becoming a big player in the world of the twenty-first century. Thailand is a developing country but rapidly moving toward a place in the roster of developed nations. In fact, Thailand is now doing so well that CIMMYT-ARMP is moving its offices to Madras, India where there is a greater need.

So how has my experience in Thailand changed my view of food security? I have had the opportunity of seeing what happens when foreign assistance works and when it is time for foreign help to leave. Thailand has always been an independent nation, but due to governmental problems in the last half of the twentieth century, they have suffered through economic problems. Although the problems are not yet totally resolved, Thailand is growing stronger everyday. Thailand is self sufficient in food and now the only nation in Asia to be a net food exporter. Recently, Thai farmers began to make the switch from staple crops to cash crops such as fruit, sesame, and rubber. Moreover, with the dedication of King Bhumibol to agricultural concerns, there is no doubt that things will continue to improve for Thai farmers. CIMMYT's move to Madras leaves many things in the hands of the Thai, but the Thai Department of Agriculture and Kasatsert University are both well run and fully ready to handle Thailand's agricultural demands. Thailand still needs help from CIMMYT, but only as an assistant and not as the leader. In the twenty years, that CIMMYT has been in Thailand, it has succeeded and I am glad to have been one of the people here to witness it.

So, after such an amazing summer what did I come away with? The answer to that begins a little farther back. After my acceptance to the internship program, I expected to be assigned to an area where my interest in social sciences and my love of communication would be most useful. I instead interned at a center that focused on scientific research and where most people did not speak my language. Nevertheless, it may have been the best thing for me. I grew and expanded my horizons, but in a different way than I expected. Instead of making many friends, I made a close few, Instead of using my verbal skills, I developed new ones. Instead of socializing, I learned

introspection. I learned to how to make decisions, how to manage my money, and my time. I came back a person more in touch with myself than I had ever been. Yes, I did learn a lot about agriculture and food security and I feel to be a better person for that, but the most important things I learned were about myself.