A Well of Inspiration

A Summer of Exploring Research and Culture

Ellen Franzenburg
Borlaug Ruan Internship 2009

AVRDC – The World Vegetable Center

Shanhua, Tainan, Taiwan

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Introduction

Agriculture has always been part of my life. I grew up on a farm in Iowa. My father grows row crops such as corn and soybeans, like most other farmers in Iowa, but he also cultivates crops that are decidedly non-traditional, including medicinal herbs such as skullcap and milk thistle. He has several greenhouses which he and my mother use to grow vegetables and cut flowers to sell locally. Of course, my brothers and I have spent many a summer day weeding or harvesting.

The thing, though, that most interested me on our farm was the research experiments. My father is a private consultant for life science companies such as Syngenta and Monsanto, testing their seed varieties in the field. From the years 2003-2008, he was the farm cooperator for the Syngenta Learning Center in Iowa, creating and caring for the site where other farmers could come and see the latest advancements in technology. I frequently helped out in the test plots by weeding, harvesting, recording data, and taking samples. This was my first taste of agricultural research.

At the time, I didn't think much about its possibilities as a career choice, but that changed when I went to the Youth Institute my junior year of high school. There I was introduced to the multi-faceted issue of food security. The discussions taking place in the Borlaug Dialogue were fascinating, and I found myself making connections to what the experts were saying from what I had learned while writing my research paper. The discussions and speeches were inspiring and enlightening and impacted the way I would look at the world.

On the last day of the program, I presented my paper to my peers and to the panel of experts. The following discussion summed up and brought together everything I had been hearing about for the last two days. As I listened to the Borlaug-Ruan interns from the year before talk about their experiences, I knew that I too wanted to have such an experience.

After attending the Institute a second time the following year, I sent in my application for the Borlaug-Ruan Internship and hoped. After the application process had come to an end, I at long last learned that I was going to spend my summer at AVRDC, the World Vegetable Center, in Taiwan.

AVRDC – The World Vegetable Center

The Asian Vegetable Research and Development Center (AVRDC) was founded in 1971 in Shanhua, Taiwan to focus on vegetable research and development in Asia, especially Southeast Asia. Since then, the regions in which AVRDC has projects have expanded to include most of Asia, sub-Saharan Africa, and some in Latin America. As the world's leading international nonprofit institute for vegetable research and development, the center aims to lessen poverty and malnutrition. Because of its international status, AVRDC has come to be known as the World Vegetable Center.

The mission of AVRDC is to "alleviate poverty and malnutrition in the developing world through increased production and consumption of safe vegetables." Vegetables are important in the developing world because their production can reduce poverty by providing jobs and income and improve sustainability of agricultural practices by diversifying crops. Also, consumption of vegetables can improve health by providing micronutrients and thereby enhance a person's earning and working capacities. The developing world has a great need for increased vegetable production and consumption, as current levels in most developing countries do not meet the needs of the population.

The AVRDC is an independent, nongovernmental, nonprofit institute. The budget for 2008 was roughly US$ 18 million. The majority of the AVRDC's funds come from national governments and major private foundations such as the Asian Development Bank, Bill and Melinda Gates Foundation, Rockefeller Foundation, European Union, the United States, the United Kingdom, and the Republic of China, to name a few.

The research at AVRDC is divided into five themes: germplasm, breeding, production, marketing, and nutrition. Within these themes, research is divided into crops and disciplines. The vegetable crops on which the AVRDC focuses include solanaceous crops (e.g. tomato, pepper, eggplant), legumes (e.g. mungbean, vegetable soybean), bulb alliums (e.g. onion, garlic, shallot), crucifers (e.g. pak choi, broccoli), cucurbits (e.g. cucumber, pumpkin), and indigenous vegetables. The research disciplines include Bacteriology, Biotechnology, Crop and Ecosystem Management, Entomology, Genetic Resources and Seeds, Mycology, Nutrition, Plant Breeding, Socio-economics, and Virology.

This summer I spent the majority of my time in the Virology Unit, but I also had the opportunity to visit the Entomology, Pepper, Nutrition, Genetic Resources and Seed, and Biotechnology, Molecular Breeding, and Plant Physiology Units, where I got an idea of what these units do and how their work contributes to the collective knowledge and goal of the AVRDC.

Efficacy and Efficiency of Simultaneous Screening for Resistance to CMV and ChiVMV in *Capsicum* Peppers

Abstract

Eight accessions of *Capsicum* pepper were screened for CMV and ChiVMV to determine the efficacy of simultaneous inoculation in evaluating resistance to these viruses. Plants were inoculated twice with either CMV, ChiVMV, both CMV and ChiVMV, or sterile water (control). Samples were assayed with ELISA one and three weeks after the second inoculation. Visual observations were recorded periodically. Results of ELISA showed similar percentages of resistance whether plants were inoculated with one virus or both, supporting the hypothesis that simultaneous inoculation is an effective method for evaluating resistance to CMV and ChiVMV.

Introduction

In 1986, the AVRDC added *Capsicum* peppers to its breeding program based on the high consumption and the cash and nutritional value to people in the developing countries. One of the primary constraints to pepper production in tropical Asia is diseases caused by viruses. Therefore, developing varieties that are resistant to viruses is a principal objective of the AVRDC's pepper breeding program.

There are other means of controlling viruses besides the use of resistant cultivars, including selecting planting dates to avoid high populations of insect vectors, use of barrier crops to minimize spread, insect traps and reflective mulches to repel vectors, close plant spacing to make up for yield lost to infection, and use of pesticides and parasites to kill vectors. However, the use of resistant cultivars is by far the most effective, safest, and cheapest method of controlling viruses.

The two most prevalent pepper viruses in Asia are *Cucumber mosaic virus* (CMV) and *Chilli veinal mottle virus* (ChiVMV). The diseases resulting from these viruses can cause 60 – 100 % yield losses when plants are infected early. Therefore, breeding pepper varieties that are resistant to both of these viruses is of high priority.

Cucumber mosaic virus (CMV) is a *Cucumovirus* that is transmitted by aphids in a nonpersistent manner. It is found worldwide and has an extremely wide host range. Able to infect at least 85 different plant families and up to 1,000 species, it has one of the broadest host ranges of any plant virus. Symptoms of CMV are extremely variable. One common disease manifestation is a stunted, unproductive plant with light green foliage that has a leathery appearance. Other symptoms include narrowing, yellowing, mosaic,

and chlorotic or necrotic ringspots on the leaves, and chlorotic or necrotic rings, rough surface, dull color, and distortion of the fruit.

Chilli veinal mottle virus (ChiVMV) is a *Potyvirus* that is also transmitted by aphids in a nonpersistent manner. It is found in solanaceous crops throughout Asia, frequently occurring in mixtures with other viruses. The most characteristic symptoms are mottle and dark green vein banding. Sometimes leaves will be smaller and distorted or have necrotic ringspots. Plants are usually stunted when infected young.

The purpose of this study was to assess the efficacy of evaluating genotypes simultaneously for resistance to CMV and ChiVMV. This includes determining any alteration of the expression of disease resistance or infection, such as masking, synergies, or suppression of resistance. Since virus resistance is tested in the seedling stage, breeders must wait six months between tests for the second generation of seedlings. If the experiment is successful, this information can be used to test new varieties of pepper for resistance to these two viruses simultaneously instead of separately, saving time and making the process more efficient and cheaper.

Materials and Methodology

Before my arrival, seven accessions of pepper with differing levels of resistance to CMV and ChiVMV were planted in 70-cell flats. There were 10 plants of each accession per replication and 4 replications per treatment. There were four treatments, making the total number of plants 1120. In addition, 20 plants per treatment of VC27, susceptible to both CMV and ChiVMV, were planted as a positive control. Varieties were selected to represent a wide range of genetic material while still expressing clear resistance or susceptibility to the target viruses.

After one month, each trial was mechanically inoculated at the 6-leaf stage with one of four treatments: (1) CMV (isolate P522); (2) ChiVMV (isolate P714); (3) a mixture of CMV and ChiVMV; or (4) sterile water. The inoculum concentration was 1 part infected leaves and 4 parts inoculation buffer, blended together, and applied using a cotton ball on the carborundum-dusted four newest leaves. The inoculation was repeated four days later. Plants in the first and third trials were reinoculated with CMV 11 days after the second inoculation when it appeared that the previous inoculations had been ineffective.

Figure 1. Spraying carborundum on the plants

Figure 2. Inoculating the plants

Photos by Ms. Li-mei Lee

One week after the second inoculation, samples were collected from every plant in the first three treatments for double-antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA). Using an 8-channel pipette, 96-well microtiter plates were filled with 100 µl of purified immunoglobulin G (IgG) diluted in coating buffer at a concentration of 1:500 for anti-CMV-IgG and 1:1000 for anti-ChiVMV-IgG. The plates were incubated at 37°C for 4 hours to allow the IgG to adhere to the surface of the wells. While the plates were incubating, the leaf samples were prepared using a grinding machine to crush the samples and diluted 0.01-10% in extraction buffer. After incubation, the plates were washed using washing buffer and filled with 100 µl of the prepared leaf samples. The first column of every plate was left empty to blank the spectrophotometer. Every plate also contained samples known to contain the virus and healthy samples as controls. The plates were then incubated at 4°C overnight to allow any virus present in the samples to bind to the trapped IgG..

After incubation, the plates were washed with washing buffer, then each well was filled with 100 µl of enzyme-conjugated IgG diluted 1:100 for both CMV and ChiVMV in conjugate buffer. The plates were then incubated at 37°C for 4 hours to allow the IgG-alkaline phosphatase conjugate to bind to the trapped virus. After incubation, the plates were washed using washing buffer. In the final step, the plates were filled with 200 µl 4-nitrophenyl phosphate disodium dissolved in substrate buffer at a dilution of 1 mg per ml of buffer. The plates were incubated at room temperature until a yellow color reaction became evident. A Thermo scientific Multiskan EX ELISA plate reader (spectrophotometer) was used to read the plates at a wavelength of 405nm.

Figure 3. Grinding the samples for ELISA **Figure 4. Pipetting samples into microtiter plate**

Photos by Ms. Li-mei Lee

ELISA was repeated two weeks after the first. The positive control samples in the second (ChiVMV) and third (mix) treatments were not tested again as they were clearly positive in the first ELISA.

Symptoms (or lack of) on the inoculated plants were recorded 3, 8, 17, and 24 days after the second inoculation (= July 2, 7, 16, and 23).

Results

The number of plants in each individual repetition found by ELISA to be infected was recorded for both ELISA tests. The percentage of resistance presented (See Table 1 and Table 2) are averages over the four repetitions; 0% = fully susceptible, 100% = fully resistant. The "Model" percentages were obtained from the original resistance screening for each variety.

Table 1. Percentage resistance averaged over the four repetitions for the first ELISA compared to the model (derived from earlier screening of these genotypes).

	CMV			ChiVMV		
Variety	**Model**	**Alone**	**Together**	**Model**	**Alone**	**Together**
PP0537-7513	100	100	100	100	100	100
PP0437-7506	71	100	100	100	100	100
PP97-7126	0	100	92.5	91	85	90
PP9848-4773	0	100	97.5	100	97.5	100
PP0337-7065	100	100	85	0	45	70
PP0537-7558	100	92.5	75	0	0	0
PP0337-7069	0	52.5	12.5	0	0	0
VC27a	0	10	0	0	0	0

Table 2. Percentage resistance averaged over the four repetitions for the second ELISA compared to the model (derived from earlier screening of these genotypes).

CMV				ChiVMV		
Variety	**Model**	**Alone**	**Together**	**Model**	**Alone**	**Together**
PP0537-7513	100	95	100	100	97.5	97.5
PP0437-7506	71	100	100	100	100	100
PP97-7126	0	100	95	91	85	90
PP9848-4773	0	100	100	100	97.5	100
PP0337-7065	100	100	100	0	30	65
PP0537-7558	100	82.5	75	0	0	0
PP0337-7069	0	7.5	2.5	0	0	0
VC27a	0	0	0	0	0	0

The second ELISA shows the final results of the inoculation.

Visual observations:
Symptoms observed in the CMV-only treatment included mosaic, ringspot, and some

mottling. Symptoms observed in the ChiVMV-only treatment included mottling, mosaic, and banding. The symptoms observed in the CMV+ChiVMV treatment included banding, mosaic, ringspot, and mottling. Only two plants that tested positive for infection with CMV by ELISA did not show symptoms of being infected. Numerous plants also showed signs of yellowing in the leaves that appeared to be unrelated to the virus infection. This is possibly due to the heat, or to the small cell size of the trays in which the plants were grown.

Discussion

The percentage of resistance for almost all varieties (with the exception of PP0337-7065) when inoculated simultaneously is very similar to the percentage when inoculated alone. Therefore, simultaneous inoculation with CMV and CVMV appears to work as well as separate inoculation for screening *Capsicum* peppers for resistance to these two viruses. This is in agreement with Mohan (1993), who observed only a minor reduction in susceptibility of 11 susceptible accessions of pepper to a mixed inoculation of CMV, ChiVMV, and *Potato virus Y* (PVY) compared to separate inoculation in the same accessions.

In this experiment, there was some divergence from the model in varieties PP97-7126 and PP9848-4773. According to the model, these varieties should be susceptible to CMV, but when inoculated either with CMV alone or with CMV+ ChiVMV, these varieties showed nearly 100 percent resistance to CMV. The reason for this is unclear, but the original characterization of these accessions should be reviewed. There may have been a mistake in recording the original results for these two varieties, or the original tests may have taken place in a higher ambient temperature than this experiment. Several studies on other plant species have indicated that a higher temperature may allow higher rates of systemic infection (e.g. Kobori, *et al.*, 2003). Also, the plants in this experiment were not inoculated until one month after germination due to differing germination rates among the different varieties. The plants in the original tests may have been inoculated earlier, before "mature plant resistance" had begun to operate (see Garcia-Ruiz, & Murphy, 2001). These elements may also account for the slight increase in resistance observed in variety PP0337-7069.

To pursue this line of investigation further, the effect of temperature and seedling age on the resistance of the varieties being used should be evaluated. It may also be helpful to go back to the freezer stock of the virus isolates to ensure the viruses have not lost some of their virulence through repeated passage through very susceptible multiplication hosts (though this does not appear to be a common occurrence with CMV). A larger pot size should be used to reduce the likelihood of the plants suffering nutrient or drought stress.

Other Research Opportunities

While at AVRDC, I was able to help with two other projects in the Virology unit. I assisted Mr. Wen-shi Tsai in the diagnosis of a *Begomovirus* infecting yard long beans in Indonesia and Dr. Dennis Knierim in the detection of *Poleroviruses* in various plants. I also spent a week in the Biotechnology, Molecular Breeding, and Plant Physiology Unit learning some of the procedures used there. The following is a brief overview of these projects.

Begomovirus detection

Figure 5. Bean field infected with virus

Figure 6. Yellow mosaic disease

Photos courtesy of Mr. Wen-shi Tsai

In West Java, Indonesia, a virus causing yellow mosaic symptoms to occur is infecting yard long beans. ELISA testing for several different viruses that are known to cause these symptoms showed that the plant samples were positive for a *Begomovirus*.

The first step in the process of identifying the virus was to extract the viral DNA from the samples. After extracting the DNA, I assisted in preparing a Polymerase Chain Reaction (PCR) of the samples and afterward an electrophoresis gel test. The bars in the gel that resulted from the electrophoresis test were cut out and the DNA was purified again. A ligation was performed to recombine the DNA into a plasmid.

The plasmid was then used as a vector for transformation of *E. coli* bacteria. The bacteria cells were heat-shocked to force them to accept the plasmids. The transformed bacteria were then spread on agar plates containing X-gal and IPTG and allowed to incubate. During the incubation period, the bacteria replicated the DNA of the plasmids as they would their own. Bacteria colonies of two different colors grew on the plates. The blue colonies did not contain the recombined plasmid, while the white ones did. Several white colonies were selected from each plate and the plasmid DNA was eluted from the bacteria.

The DNA was then sent to a facility for sequencing. When we received the results of the sequencing, Mr. Tsai showed me how to search for the sequence in GenBank, a database for DNA sequences. The top result of the search that was most identical to our sample was *Mungbean yellow mosaic virus*.

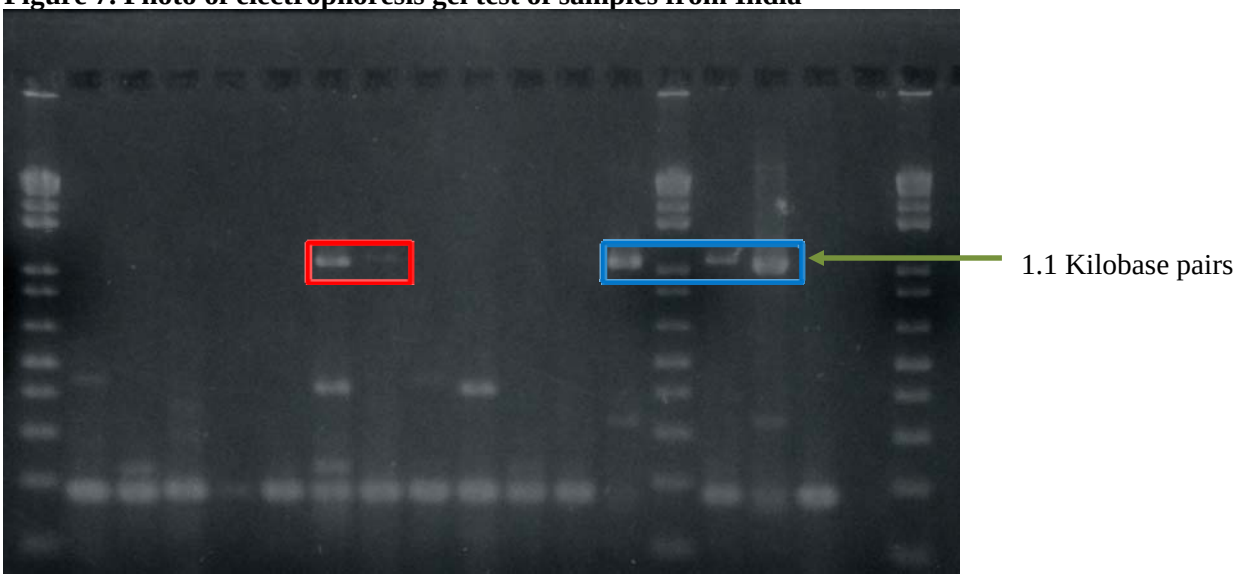
Polerovirus detection

Dr. Knierim was testing plant samples for *Poleroviruses*. I assisted him with preparing the samples, extracting RNA (because *Poleroviruses* have RNA instead of DNA), and then preparing a Reverse-Transcriptase PCR (RT-PCR). I also assisted in performing electrophoresis gel tests using the product of the RT-PCRs.

To prepare the samples, I measured out roughly 100 mg of each leaf sample. The samples were then finely ground over liquid nitrogen to keep the RNA frozen. I then extracted the RNA using the RNA extraction kit protocol. I prepared the RT-PCR with the extracted RNA samples, then loaded them with loading dye into an agarose gel for electrophoresis.

The following are the results of one of the tests with which I assisted.

Figure 7. Photo of electrophoresis gel test of samples from India



The bars outlined in red indicate the two positive samples. The bars outlined in blue show the positive controls.

Table 3. Results of *Polerovirus* detection

Number	Source	Extract Date	Plant	Result
1	India	09/07/09	Eggplant	-
2	India	09/07/09	Sponge gourd	+
3	India	09/07/09	Cowpea	-
4	India	09/07/09	Bitter gourd	-
5	India	09/07/09	Bitter gourd	-
6	India	09/07/09	Ridge gourd	+
7	India	09/07/09	Chilli pepper	+
8	India	09/07/09	Eggplant	-
9	India	09/07/09	Sword bean	-
10	India	09/07/09	Sponge gourd	-
11	India	09/07/09	Bottle gourd	-
12	Taiwan	Positive control	Melon	+
13	Taiwan	Positive control	Bitter gourd	+
14	Taiwan	Positive control	Melon	+
15	Taiwan	Healthy control	Squash	-
16		Negative control	Water	-

Three samples were identified as being positive for a *Polerovirus* in this test. (Sample 2 did not show up very well on the electrophoresis gel, but was determined to also be positive in a subsequent test.) *Poleroviruses* do not normally infect chilli peppers; therefore, sample 7 may contain a new strain of *Polerovirus*.

Molecular Markers

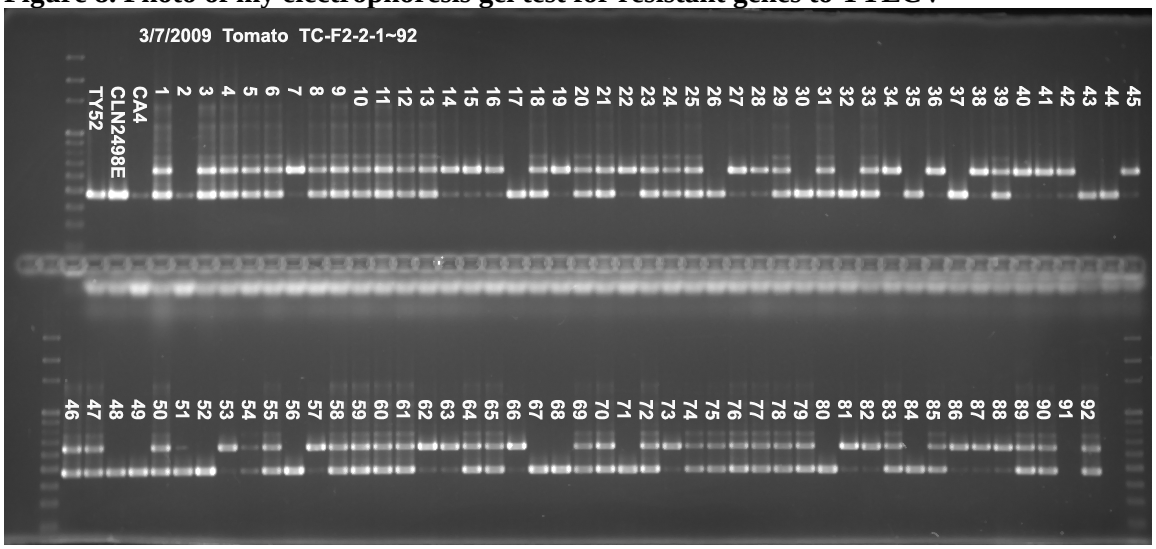
I spent one week in the Biotechnology, Molecular Breeding, and Plant Physiology Unit learning more about the research they do and some of the procedures in their lab. In the procedure I helped carry out, molecular markers were used to determine if the tomato plants had inherited certain genes from the parents.

The first step was to gather leaf samples from the tomato plants in 1.6 mL micro centrifuge tubes and freeze-dry them. Then I placed some glass beads in each tube and put the tubes in the Mini beadbeater, which grinds the leaves to a fine powder by shaking the beads in the tubes. I then extracted the DNA according to the lab's protocol. After extracting the DNA, I ran a PCR to amplify the sections of DNA we were looking for.

When the PCR was finished, I loaded the wells of a 0.8% agarose gel with the DNA and loading dye and ran the electrophoresis machine. I then stained the gel with ethidium bromide and took a picture of it over an ultraviolet light. The photo below is the result of the test.

The first three wells are samples of the parents of the next 92 samples. We were looking to see if the tomato plants had inherited their parents' genes for resistance to *Tomato yellow leaf curl virus* (TYLCV). Each bar indicates a gene that corresponds to a parents' gene.

Figure 8. Photo of my electrophoresis gel test for resistant genes to TYLCV



Culture and Travel

On June 12, I said goodbye to my parents, knowing that I wouldn't see them again for two months, and boarded the plane that would take me the farthest away from my home that I'd ever been. I wasn't as nervous as I thought I'd be, though. I had been waiting for this opportunity for a long time – though it still seemed a bit unreal to me that I would be spending my summer in Taiwan at an international research institute. I arrived at Kaohsiung International Airport in the middle of the night and met Lydia Wu, in charge of training at AVRDC, who greeted me saying, "You're so short! I thought you would be tall!" which I thought was amusing because she was several inches shorter than me herself.

Hiking in the mountains

At first I was worried about not having learned enough in high school to be able to do everything I needed to do, but I soon found that my mentors in the Virology Unit were always willing to explain things to me. They were patient with me when I was starting out with the procedures and couldn't go very quickly and when I made the occasional mistake. I started out knowing the basics of biology and the scientific method, but by the time I was through I knew far more about virology and, most importantly, gained more experience in the research process. I had known only one side of research before I came from working on my father's farm, but this time I was able to see a project through from beginning to end. It didn't go perfectly smoothly, but I realize now that that is the nature of research. You usually won't get perfect results, and there are many setbacks and problems that researchers have to deal with along the way.

Though my work in the labs was my main focus, I also had many opportunities to explore the places and culture of Taiwan. On the weekends I had the opportunity to travel with others from AVRDC to various places in southern Taiwan. I saw traditional houses in Lugang, a baseball game and a theatre troupe in Tainan, went to a hot spring and on a short hiking trip in the mountains, and to the beach and the World Games in Kaohsiung.

Dragon and Tiger Pagodas at Lotus Lake, Kaohsiung

Though I attracted many stares because of my white skin and blonde hair, I found Taiwanese people to be very friendly and welcoming to me. My mentors were willing to help me and show me around Shanhua, and I enjoyed talking to and hanging out with my new Taiwanese friends. I had a lot of fun playing volleyball,

jogging, or going to yoga class with others from AVRDC. I also made several friends at the Jiankang Baptist Church in Tainan that I attended with some other people from AVRDC on Sundays. The Taiwanese people I met were very hospitable, and I was thankful for their kindness to me—even when they kept getting Iowa mixed up with Ohio!

Food at an aboriginal restaurant

The food, of course, was very different from what I was used to. It took me a while to get used to the fact that rice was served with every meal, and the vegetables were always stir-fried, usually in some kind of sauce. Each of the towns I visited on the weekends seemed to have their own local specialty. It was fun to try the local food and eat at restaurants that served meals in the traditional style, which is to have the dishes on a rotating wheel in the center and everyone serve themselves what they wanted into their own bowl of rice. One of the most interesting food venues are the night markets, which, as my friend Jen put it, are like "a mini state fair." There were many different food stands (usually selling fried food) alongside carnival games and vendors selling clothing, jewelry, toys, and pets. Night markets are very popular in Taiwan, and I came to be well-acquainted with the one in Shanhua. I made a rule for myself to try the dishes that came my way at least once. I was not, however, adventurous enough to eat a chicken's foot.

The language barrier, while not usually a problem at AVRDC, was difficult to get used to. I knew very little Mandarin Chinese, and outside of AVRDC, not many Taiwanese knew English. I had to rely on my friends to translate for me for the simplest things, like ordering food or getting a train ticket. Being illiterate and unable to communicate was frustrating for me. I now understand what it must be like for immigrants to go to another country when they don't speak the language. When you don't know the language or how to read, being independent is nearly impossible. Doing simple things like running errands is more nerve-wracking and takes longer when you can't understand what's written on the packaging or how to read your receipt. It also isolates a person by only allowing communication with the few other people who happen to know one's language.

Night market in Tainan

I'm very glad that I was able to experience Taiwanese culture as I did instead of as a tourist. I feel that I really learned a lot more by living there instead of just visiting all the

tourist traps. Learning about the culture was a very important part of my internship because when doing research or a project in another country, it is important to understand the local culture. I attended two seminars at AVRDC about project management. The speakers were candidates for the position of project manager in the Solomon Islands. What I found most interesting is that they both emphasized how important it is to become familiar with the culture and really involve the local people that the project will benefit in the project itself. Knowing their culture allows the researcher to work with the people more effectively because the researcher understands and knows more about the people's lives and the problems they face. Being aware of the culture also makes it easier to integrate the people into a project, which is important for the sustainability of the project. Understanding culture can be just as important as the research itself.

Sunset over Kaohsiung

Conclusion

Taiwan has so much history and culture. There are temples, traditional houses, dragon boats, landscapes from beaches to mountains, and much more. But one of the most meaningful things that I saw in Taiwan is what amounts to a mud-filled hole in the ground, surrounded by bricks.

The half-side well is not very prominent—in a narrow street, shops on either side, in a very old town called Lugang. It would be easy to pass it by. It is no longer usable and has long since been filled in. But it remains. It endures. It may not be much to look at compared to a temple, but it has far more significance to me.

In the time this well was built, only the rich could afford to dig a well. The owner of this well had it built so half of it was inside his yard, the other half in the street, where anyone could draw water from it. Above his gate is an inscription inviting anyone to use it. This gesture shows the traditional virtue of generosity, and certainly strengthened the relations in the neighborhood.

As I looked at the well and thought about its story, I came to realize that this well is like a living metaphor for my whole summer of research and for the research institution itself. The researchers at AVRDC have wealth—a wealth of knowledge and technology that they are sharing with farmers around the world who need it, strengthening the world

community through its innovations. With its ‘well’ of resources, the World Vegetable Center has improved the lives of people around the world.

On a more personal note, this well proves that a thing as small as where you dig a hole can have a huge positive impact on society. The well has been preserved by the people of Lugang for hundreds of years, which just goes to show how important they all felt it was. It reminds me of the power we all have to do something good for others. We all have our own ‘well’ that we can share.

Before this summer, before I went to Taiwan, many people told me that this experience would change my life. Now that I have come back, I can see that they were right. Though I know that there is a lot that I have yet to learn, I feel that I have a clearer view of the world and my place in it. International travel changed me by giving me a different cultural perspective. Not only that, but I see my own culture differently since experiencing another.

Learning and working at AVRDC has been unlike anything I have ever done before. I had read about AVRDC and its projects before going there, but actually seeing the way projects progressed—from the idea, to testing it, to giving the technology to the farmers and teaching them how to use it—and actually having the opportunity to participate in that process, has really been the most valuable of my experiences. I am most thankful to have had this unique opportunity, which is part of the foundation for my own ‘well.’

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