Proceedings of the Fourth Annual Northeast USA Rice Conference

August 3, 2013

9:00am – 4:00pm
Akaogi Farm
Westminster West, Vermont

The Fourth Annual Northeast USA Rice Conference is a collaboration between the McCouch RiceLab at Cornell University and Akaogi Farm. It is funded in part by the National Science Foundation.

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Acknowledgements

- Thank you Takeshi and Linda Akaogi for hosting the rice conference once again.
- Thank you Susan McCouch, Walt Rockwood, David Mackill, Don Brill, and Conrad Vispo for speaking at the conference.
- Thank you Tatiana Schreiber, Anya Akaogi, Juan Arbelaez, Eileen Ceconi, Christine Diepenbrock, Lyza Maron, and Anjali Merchant for volunteering at the conference.
- Thank you Chris Knight for collecting audio and video footage of the conference for the website and conference proceedings.
- Thank you Shital Kinkhabwala for providing a traditional Indian meal for the conference lunch.
- Thank you Gordon and Mary Hayward for hosting the reception Friday night for our out of town guests and conference speakers.
- Thank you Tristan Toleno for providing a delicious summer picnic for the Friday night reception.
- Thank you Gordon and Mary Hayward, Bari and Diane Shamas, and Tim Merton for hosting out of town guests and conference speakers Friday night.
- Thank you Putney Public Library for loaning us a projector screen for the conference presentations.
- Thank you Asia Rice Foundation USA trustees for coordinating your annual meeting with our conference and being a wealth of knowledge to our audience.
- Thank you Bob Zeigler (Director General of the International Rice Research Institute) for taking the time to visit Akaogi Farm and learn more about Northeast rice growers.
- Thank you Jeanne Kisacky for helping transcribe the audio from the conference presentations.

Mia Murphy
Outreach Coordinator

Agenda

8:00-9:00am	**Registration**
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9:25-9:55am	**NSF Grant and Cornell Rice Research** Susan McCouch
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10:05-10:50 am	**Stress tolerant rice varieties: examples of development and rapid adoption by farmers** David Mackill
10:50-11:00am	**Break**
11:00-12:00pm	**Rice farming in the Northeast: data collection and seed saving** Mia Murphy
12:00-2:00pm	**Lunch** Rice Paddy Tour: Takeshi Akaogi Machinery Demonstration: Don Brill
2:00-3:00pm	**Small-scale rice processing equipment** Don Brill
3:00-3:45pm	**Northeast rice paddy agriculture and conservation** Conrad Vispo
3:45-4:00pm	**Closing and Group Photo**

Speakers

Susan McCouch
Susan manages a large NSF-funded project on association mapping in rice and is a professor in the Department of Plant Breeding and Genetics at Cornell University. She spent 5 years with the International Rice Research Institute (IRRI) in the Philippines before joining the Cornell faculty in 1995. She is well known for her pioneering studies on molecular mapping in rice and the development of genomics-based platforms to explore the extent and distribution of natural variation in rice germplasm. Her early work demonstrated that low-yielding wild and exotic *Oryza* species harbor genes that can enhance the performance of modern, high-yielding cultivars. More recently, her lab has utilized genome wide association mapping to explore the genetic architecture of complex traits in rice and provided new insights into the genetic basis of transgressive variation, with immediate implications for rice improvement.

Walt Rockwood
Walt is currently the treasurer of the Asia Rice Foundation USA (ARFUSA, www.asiariceusa.org) and was Executive Director of the ARFUSA at the time of the 2013 rice conference. He has a background in agronomy and journalism and has worked for University of Vermont (UVM) Extension, the US Agency of International Development (USAID) in Africa, the International Institute of Tropical Agriculture (IITA), and the International Rice Research Institute (IRRI) in the Philippines. He was instrumental in the creation of an affiliate of the Asia Rice Foundation (ARF, www.asiarice.org) in the US. The ARF was started in the Philippines in 1998 to create national foundations in Asia. In 1999 Walt created ARFUSA and in 2000 it started a program to provide grants for young rice researchers in the US as well as students from Asia studying in the US.

David Mackill
David is a plant science manager with Mars Inc. and an adjunct professor in plant sciences at UC Davis. At the International Rice Research Institute in the Philippines, he developed over 25 rice varieties and published research on the genetics of resistance to rice blast disease and submergence and drought tolerance. He and his colleagues identified a gene from traditional rice varieties that conferred tolerance to 2 weeks or more submergence. Over 3 million farmers have adopted the improved tolerant varieties since 2009. In addition to his leadership and research work, he has supervised the thesis research of 22 graduate students

Don Brill
Don is an engineer who was asked by his son, Josh Brill (owner of Breezy Meadow and Orchards in Tinmouth, VT), to develop an inexpensive human powered rice huller for small-scale rice processing. He has been perfecting his designs since 2011 and has developed two types of hullers; one powered by hand or bicycle and the other driven by a bicycle or small motor. His website (www.brillengineering.com) contains videos of the huller in action as well as instructions and a list of parts for anyone interested in building their own.

Conrad Vispo
Conrad received a Ph.D in Wildlife Ecology at the University of Wisconsin-Madison. He then studied the ecology and management of a tropical freshwater fishery with the Wildlife Conservation Society and Venezuela's Fundacion La Salle for several years before co-founding Hawthorne Valley's

Farmscape Ecology Program (hawthornevalleyfarm.org/fep/) in 2003. With that program he has been exploring the role of agriculture in providing habitat for native species and the importance of native (or at least wild) species in providing ecological services to farms. Currently, he is in charge of animal (especially invertebrate) surveys for the Living Land Project and working on pilot project looking at the entomological interactions between orchards and surrounding, uncultivated areas.

Conference Participants

Asia Rice Foundation USA Board of Trustees and Council Members
Randy Barker
Ronnie Coffman
Russell Freed
E.A. Heinrichs
Bob Herdt
Jim Hill
Peter Hobbs
Harold Kauffman
David Mackill
Edwin Oyer
Tim Rockwood
Walt Rockwood

Akaogi Farm
Takeshi and Linda Akaogi

Association of Africans Living in Vermont, New Farms for New Americans
Rita Neopaney

The following proceedings are an edited transcription of the conference. Some of the text may be difficult to understand without the accompanying images from the presentations. Videos of the presentations, which include the PowerPoint slides, are available at www.ricenortheasternus.org.

Proceedings

NSF Grant and Cornell Rice Research: Susan McCouch

I am a Professor at Cornell and I know nobody wants to sit here and listen to a Professor talk about their work so that is not what I am going to do. I just want to say that we are really grateful to have this relationship with the Akaogis because as most things in life it was very serendipitous. One day a communication by e-mail and a relationship began in part because Gen [Onishi] in my program, who works for me and has helped me manage my rice in the greenhouses at Cornell, is a Japanese farmer. Plus, I travel quite a bit, and I tell people that I work on rice and I live in Ithaca and I work for Cornell University. They go, "What!? Why do you work at Cornell if you work on rice?" I mean there is no real reason to do that. You cannot grow rice very well in that area and we have no appreciable production of rice in New York State. I have always been the laughingstock of my department because I do not grow a crop that is important in New York State. Well guess what? When Ogi [Takeshi Akaogi] showed up at my door and said we are growing rice in Vermont, you can imagine the light went on. I thought, "Aha! Now we have it!"

So, actually, I am not going to talk to you about my research. I am here to say we have been really fortunate to have stumbled into this network that is forming and my small contribution is really my interest. Of course, the fact that I am a new Englander by birth and by upbringing and then the relationship that I have with NSF. This relationship has enabled me to suggest to NSF that this was worth supporting and to provide enough evidence to them that it was growing and that it was a new crop. You know what they care about? They are not the US Department of Agriculture. They do not care about your yields per acre or per hectare. They care about the fact that there is a group of people that we could ascribe as innovators. You are by NSF standards innovators. That is what the National Science Foundation in the United States is always looking to support. You have joined the group of people that would be considered rice researchers. You are researching how to grow rice as a new crop. You are trying all kinds of new things. You are inventing machinery. You are interacting with people from around the world like any good scientist would do. Therefore I think that you really have accomplished something as a group. I am proud to be part of this group because I think that it is truly a driver and innovator. I am very excited because I think it is a very open-minded group trying their best to do something that is really new and yet using existing knowledge. We have young and old, we have North and South, and we have Asia and we have America. We have all kinds of people here, just hoping to learn something.

I am going to walk through a few slides, if I could, to tell you about the website in case you have not stumbled on it. The website that we support is the www.ricenortheasternus.org. This is the website. It has a revolving set of pictures. I like that one because it shows that we really are in a temperate zone growing rice with the foliage. I should get one in the fall. On the website we post what is going on this year and we host all of the web presentations from years before. Last year Glenn [Roberts] spoke; we had the farmers' exchange; Anna McClung from Stuttgart, Arkansas was here; a number of people from Cornell, etc., and the chef's presentation. If you go on that website and you click on this, underneath where it says "More Information", you come to this. Click on any one of them. For

example, you can hear Glenn's whole presentation live video streamed thanks to the fact that Chris [Knight] records the conference every year. It is a long thing to watch completely. Maybe you listen to it once and then you remember something and you are looking for just that segment. What Mia does is she actually listens to audio of the presentations and she has given you proceedings that are the written verbatim of what people said so you can find those pieces that you want. You have the hard copy. This is the video stream. Sometimes when people just want to learn a little something, it is really interesting to go in and listen to what the speakers have to say. Because of the way Chris does this, the PowerPoint presentations come up as very nice quality slide shows.

The other way you can get to that website is through the website that I run for my project. As Mia mentioned, this is a small segment of my project, under education and outreach. If you click on education and outreach, we do a lot of different things, but if you scroll down you will see ecological farming in the northeast and that is going to link to that same website I just showed you.

This one is a little bit easier to remember and I amm sorry it has been cut off. It is just www.ricediversity.org. You can also get to that website if you remember my last name and search for "McCouch rice." Those of you who are interested in some of the outreach and education we do specifically, that would be here. If you are interested in the germplasm that we are looking at genetically in the lab, of which a part of it grows in the Northeast and a vast portion of it would never grow in the Northeast, you can learn about it here. This genetic material might come from Nepal, it might come from India, and it might come from Korea. This much broader swath of germplasm we are working with comes from all over the world. You can learn about it and the kind of genome evaluations that we are doing, both phenotypically and genotypically, on our website.

Now briefly, IRRI [International Rice Research Institute]. Everybody talks about it. I'm going to show you two images so you have some idea of where the group of us that associate with IRRI came from. And, I just want to make one small correction. Walt [Rockwood], it is not only the men who were the scientists at IRRI. There has been a generational shift. I did my time there too. They committed me five years. This is the International Rice Research Institute at the entrance gate. This behind, and I will show you in a moment, is the gene bank where we house most of the world's collection of seeds that eventually gets shared with the USDA and gets shared with you. It is an earthquake-proof vault here in the basement of this building. It has its own generator and it keeps seeds at about -20 degrees centigrade with long-term storage capacity and backup. It has backup in the USDA. It has backup up in the Svalbard seed bank, in the Arctic circle up in Norway. These are the world's most precious agricultural commodities when it comes to rice production. This is sort of the source.

IRRI is the center for the gene bank as well as for a lot of research. This is just to give you a picture of the place where we have all spent many years. These are the rice paddies in the front of IRRI. The long-term rice trials that have been going on for fifty years. They plant rice after rice after rice after rice to demonstrate that there is no requirement to rotate crops if in fact you manage your rice correctly. This is the world's oldest monoculture and it does very well if you manage the soil properly. You see the volcanic mountains around it. This is the front view. The IRRI farm is many hectares behind that. This is so you can see it actually has a campus with buildings where the research is carried out. There is agronomic research. There is genetic research. There is social science research, economics, etc. The people in this audience who have worked at IRRI, each of them have contributed to this very large endeavor over the years. This is physically what the place looks like. I just thought I would give you some insight into the place that so many of us talk about.

For those of you who are of course, temperate, we have the rice paddies here, which we have been very pleased to see develop over the years. It is living proof that a bit of careful attention to detail in terms of both the environment and the genetics of the plants you are working with can give you a pretty good return on your investment. I want to introduce a few of the pioneers who have been here. Of course you have heard from Christian [Elwell]. Eric [Andrus] I think is not here today. Eric Andrus is another producer who is growing rice here in the Champlain Valley. Ogi [Takeshi Akaogi] of course is the grandfather of the occasion. We have a lot of people who come to share ideas through the exchanges that take place both on the technology side and on the production side. I have been very, very, very stimulated actually by the way in which this proceeds. This is the after lunch session, so you will hear more today.

I just also want to say that we have quite a bit of work going on at Cornell. I am just going to show you the one bite that has to do with this group. We are making crosses between the Yukihikari, which is the adapted line here, to some aromatic and purple rices to bring aroma and purple pericarp into rices that are adapted for your growing pleasure here. These are the crosses that Gen and Sandy made. Sandy spoke last year. You see the purple pericarp peeking out. These are the F1s after you make the cross. Because you have had to emasculate, you are able to see the purple pericarp on the F1s. This is a white pericarp, but it is an aromatic. We are bringing in aroma and the purple pericarp into what we hope will be eventually a release for you. That is what is going on at Cornell. We are doing that through a back-cross selection program using molecular markers to assist us and help us move very quickly. We hope to be able to do this in another two and a half or three years.

Every year we take a photo. If everybody is going to be here at least until lunch, let us have the photo before lunch. That way we will make sure we have the full range of people who have attended this year. This was last year's photo. This year we are going to have a raffle. We have two shirts to raffle. This has a very small IRRI logo on the back, but it is really kind of a nice generic rice t-shirt. These are both size larges. Very nice, all cotton. This is not about money, but you know, I just thought we would allow some people to have these snazzy t-shirts. These are our options. After the photo, maybe during lunch, we will collect names for the raffle and have that in the afternoon. Thank you very much.

Stress Tolerant Rice Varieties: Examples of Development and Rapid Adoption by Farmers: David Mackill

It is really a pleasure to be here. I have a fairly complicated situation where I am now so I wanted to explain it a little bit. I actually work for a food company, MARS food, which has a rice business, but I am based at the University of California in the Plant Science Department. I also have an association with IRRI. I am a consultant with IRRI on a non-paid basis, but I worked at IRRI until 2011. The work I am going to talk about today is work that was done at IRRI, and I am glad that everybody now knows what IRRI is so I do not have to go through that. I am going to talk about some work that I was involved with at IRRI. It is kind of, as mentioned, theoretical international work in some ways, but I do think it is relevant to growing rice in a place like New England because really what I am going to talk about is farmers who have to deal with constraints in their environment that are not normal to the rice plant. For example, drought, flooding, salinity, and low temperature/high temperature. These are what we call stresses and they are very common in the less favorable environments. In Asia, these environments are often associated with very poor subsistence farmers. This is the nature of the project that I am talking about today. The methods that we can use

now to address these problems are applicable to many different situations and I think Susan already alluded to that in her talk this morning.

As I mentioned everybody knows about IRRI now. This is another picture of IRRI, from the air. The institute, facilities, and experimental fields. This is part of them. It is actually this very big experimental farm based in the Philippines. Walt Rockwood alluded to the Green Revolution, which was the development of the high-yielding varieties that made such a big impact in Asian rice production areas. IR8 was the first variety that was released by IRRI and it was the first in a new generation of high-yielding varieties that really allowed Asian rice farmers to produce enough food to meet their demands. One of the common misconceptions about the Green Revolution is that it forced many farmers to use more pesticides and fertilizers. In fact, the varieties can actually produce higher yields even without high fertilizer levels and pesticides. This was certainly not a requirement for the Green Revolution. In fact, what happened after the development of IR8 was that the new varieties were bred with more resistance to insects and diseases. This would have reduced the requirement for pesticides.

This is the backdrop of what I wanted to talk about in relation to stress tolerance. In 1975, IRRI came out with a publication in their research highlights, which I remember reading and it made a big impact on me. At that point they were saying the Green Revolution really has only reached about 1/4th of the rice farmers in Asia. What about the other 3/4ths? What happened to them? It was generally considered that in this other 3/4 of the rice farmers for some reason they were not able to take advantage of the high-yielding varieties. There could be many reasons for this. One of the main ones was thought to be that their rice production environments were not very favorable. They had too many stresses or so forth, and so these high-yielding varieties may not have been suitable for their farms. This is when IRRI started to change the focus a bit to look more at these unfavorable environments. The original focus had been on very favorable, irrigated environments and then IRRI started to change their direction. In fact many of the people here that are a part of the Asia Rice Foundation [USA] were at IRRI during this time, which was actually before my time, and were involved with the projects that I am going to be talking a little bit about.

One of the programs they developed was this genetic evaluation and utilization program. The purpose of this program was to look for sources of tolerance, to these stresses, in the world rice collection and then start to transfer these sources of stress tolerance, these genes, into improved varieties through normal breeding methods. This was a very large program involving many scientists, not only plant breeders but all different disciplines of scientists, focused on this process of identifying the sources of tolerance and then assembling them into improved varieties. As an illustration they came up with this analogy of a cord that has different strands related to the traits they were looking at. This is disease and insect resistance, cold tolerance, tolerance to problem soils, drought, deep-water, and flood tolerance, etc. The idea was to try to weave these different traits through breeding into varieties that were adapted to different conditions. It is a case of developing a variety that is not necessarily for all the farmers, but for specific farmers who have specific problems. I always thought it was a nice analogy, and probably Ronnie Coffman or Harold [Kauffman] was there. I do not know who was responsible for this.
Ronnie: I am sorry you have the date on there but I did not make it.
They were definitely involved with developing this and I think it was an example of a large scale focused breeding effort to address the serious problem of rice production in farmers' fields in Asia. It was quite successful and was still running and doing well until I believe the late 1980s. I think that they were quite successful, especially in finding insect and disease resistance. Many varieties were

developed that had resistance to insect and disease problems and these were adopted by many farmers in the Asian region.

I am going to give a little bit of an illustration of how they went about this and I am going to use submergence tolerance as an example because that is the one I worked on the most. Submergence is a problem in large areas of Asia where they have flooding problems. Of course, tropical Asia is very suitable for rice because they have a monsoon. They have a lot of rainfall. They have heavy soils that don not drain well and so they get a lot of accumulation of water. They really cannot grow other crops easily. Rice is very suitable because it is adapted to flooding. That is one of the reasons why rice is such a widely grown staple crop in these environments. Of course when you have that kind of environment, then it is prone to problems of flooding. If you have too much rain or if you have overflowing rivers, then you get flooding. Rice is not very tolerant to being underwater, totally underwater. It does well when its roots and the bottom part of the plant are underwater, but not so well when the whole plant is underwater. That is what happens. You can see from the picture that many of those fields just disappear during those floods. This is a schematic diagram. In this area where you have submergence most of the time the water level is fine. When you get heavier rainfall or you get a drainage problem and overflowing rivers, then the rice plants become inundated. This causes a lot of damage. It was estimated that about 20 million hectares of rice area in tropical Asia was affected by submergence, which is a big area.

Audience: What is the time frame you are talking about? How long would the rice be submerged? Could it get submerged for a day and then dry out and be okay?

David: Usually for one day you do not have much of a problem, but I would say within about three or four days you are going to have damage. After about a week, it usually kills the plants.

Audience: So it would be within a week of submergence?

David: Within a week of submergence you are killing most of the plants.

Peter: You are talking about submergence tolerance as opposed to deep water rice, which is another type of rice.

David: Yes, anybody who is familiar with Bangladesh or other areas, they have deep water rice. In those areas the water stays for a longer time and it is more of a gradual accumulation of water. You have varieties that can elongate and stay above the water, even if the water is a few meters deep, they can grow through it. In a lot of places they call that floating rice. But I am not talking about that so I am glad you clarified that, Peter. It is submergence for short-term flooding. It is a different trait than the deep water trait.

Also I just wanted to comment that there is an expectation that this problem may increase in the future because of climate change. I have a graph that shows flood incidents/occurrences over different decades. This was a recent publication. I think it was published in Nature. It shows accumulation of these flood events over time. It seems that the incidence of flooding is increasing already and expected to increase. It is a problem that is not going to go away.

The approach to deal with this problem of flooding was the same as I mentioned about identifying the source of tolerance in the gene bank, in the collection of varieties that Susan mentioned this morning, and then trying to transfer those into improved varieties. This work started in the 1970s, early 1970s. Ben Vergara was one of the pioneers who really was looking at these varieties in the collections and screening them for short term flooding. There is a variety called FR13A, which they found in the gene bank collection, that had very high level of tolerance. There were others, but that

was probably one of the best ones. The breeders started crossing this with modern varieties. I think also Ronnie was probably making some of those crosses

Ronnie: FR stands for flood rice.

David: Right. The flood rice was a variety from India. Somebody in India had collected it and figured it out. At IRRI, you probably rediscovered it or you already knew about it?

Ronnie: Ben Vergara discovered it, but somehow we knew the story behind it. I think it was selected by a farmer in West Bengal.

Ronnie: Yes, it was from Orissa.

The only problem with FR13A and with some of the other varieties that they identified was that they were very tall and low-yielding varieties. They had poor grain quality so they were not suitable for large-scale production. They had been selected by farmers in these environments for survival under this condition. The traditional process of plant breeding takes many years. This was done over quite a long period of time, probably a breeding effort of more than ten years. Varieties with high yield and submergence tolerance were eventually developed, however, very few of these actually got to the stage of release and adoption by the farmers. They still had problems with them. The farmers did not like the quality or the adaptation or something. It is quite a long process to try to take a trait like submergence tolerance and end up with a variety that would be accepted largely by the farmers. When you looked at what farmers were growing, in fact, they were growing varieties that were originally developed for irrigated areas, and then spilled over to these rain fed, unfavorable areas. But they were susceptible to stresses and examples include Masuri, Swarna, IR64, and so forth. The farmers were not adopting the stress-tolerant varieties very much. I am talking particularly about submergence but also the drought-tolerant varieties, for example.

I had worked at IRRI during the 1980s and I had been working on submergence and drought and other things. Then in the 1990s, I left IRRI and came to University of California, Davis and I worked on rice genetics. Then in 2001, I returned to IRRI to work again in their breeding department. When I went back in 2001, I looked at these unfavorable rain-fed areas to see what had happened during the time that I was gone from IRRI. I could not find farmers growing varieties that were specifically developed with stress tolerance. They were growing irrigated varieties, basically, but they had problem with stresses. Whenever they had a drought or a flood, they had a lot of damage in their fields. They were growing varieties that they liked because of high yield, good quality, and so forth. These were varieties that spread from favorable, irrigated areas into these unfavorable areas. This was a sign that we needed a new approach of how to improve the tolerance of these varieties for farmers in those unfavorable areas.

In the meantime, I was at UC Davis and we started to work on the genetics of submergence tolerance. We identified that in FR13A there is a gene, a measured gene in this variety, which gives it a high tolerance to submergence. You can see in the corner, a picture. These are the ones that do not have the gene and the ones that have the gene. If you flood them for about two weeks, the ones that do not have the gene die. The ones that have the gene do very well. They recover and survive and do well. We called it the *SUB1* gene because we were thinking we might find others that we would call *SUB2*, *SUB3*, *SUB4*. We never found those other ones. Just the *SUB1*, but it was good enough because it gives a very high level of tolerance. These are some of the people that had been working with me on that project. Kenong Xu did most of the work. He was my graduate student, now at Cornell and based in Geneva. Apple breeders. Rice and apples, you know almost the same. Pam Ronald had been at Cornell.

Susan: They are working on submergence in apples.

David: Is he? Oh good, good, glad to see that. You can see that he got very good training from me to work on submergence.

Audience: David, when you talk submergence tolerance, does the rice then have the ability in those plants to get air by other means?

David: Thanks. That is a good question. I did not say it, but the mechanism of tolerance actually is not something you would have expected. What happens with rice when it is underwater is it has a response of rapid elongation. It is kind of like, "Oh, I am underwater!" and it tries to get out of the water as fast as it can. It grows fast. When it is underwater it starts to grow rapidly, which depletes all its reserves, all its carbohydrates, and it dies very quickly. It cannot sustain that kind of growth over many days. The difference with a *SUB1* plant is it actually goes into a kind of semi-dormant state when it is underwater. Once the water goes down, it is still a normal plant and starts growing again. It is a mechanism of trying to avoid panicking, basically.

Audience: It holds its breath?

David: Yes. We called it *SUB1*. There was another scientist in Japan who discovered the gene for rapid elongation and they named those snorkel genes. That one allows the plant to grow very fast. My daughter is an artist. I asked her to make a picture of *SUB1* for me. She made it like a rice crane and like a submarine and it has the *SUB1* logo in it. We named it the submarine gene as a nickname.

Audience: Yellow submarine.

David: Yes, it is a yellow submarine. Got a propeller and everything.

Audience: Golden submarine.

David: Golden submarine? I do not know. I like yellow submarine better.

What do you do with this kind of information? What we wanted to do is to use this in developing submergence tolerant varieties. Susan mentioned about the back-crossing approach, to introduce a gene from one variety to another by back-crossing. That is a traditional breeding method that has been used a lot. With these markers you can now do this very precisely and quickly. What I had here is a representation of the twelve chromosomes of rice. On the map of the twelve chromosomes, the *SUB1* locus, the *SUB1* gene, is there. We can use that information now to quickly develop a new variety that has that *SUB1* gene but does not have all the other genes coming from the original parent, like FR13A, which were unfavorable. This is not done by DNA transfer or genetic modification. It is really an adaptation of a normal breeding process. It does not result in a GM plant. The good thing about that is we can take one of these mega-varieties like Swarna, which was the one we started with. This variety was grown on probably five or six million hectares. This one variety. In India, Bangladesh, and Nepal. We took that variety. It has very good yields. It has good quality. We introduced this gene by this process. It took us a little over two years to do that. It is very quick compared to regular breeding, which usually takes five to ten years and then you have to do a lot of evaluation.

This is what you get when you go through that kind of process. I will show a picture. This was our first test in 2007, in the field. This is a field at the IRRI farm but it is basically a tank. We can flood it with over one meter of water for three weeks, for eighteen days actually. I think you could probably pick out which ones have the *SUB1* gene and which ones do not. You do not have to be a plant breeder to do that. These are three pairs of varieties. Three of them have the *SUB1* gene and three of them do not. They are the same variety with or without. For example, this variety has the *SUB1*

gene. I think this was IR64 and this is IR64 without the *SUB1* gene. It shows you the big effect you get from this one gene that was transferred by this method I mentioned.

Audience: In that pool, when you are flooding it, is the entire plant actually…?

David: Completely underwater. Yes, completely underwater for eighteen days.

Susan: Then they grow.

David: This is what happens to a normal plant in a farmer's field.

Audience: How many varieties are in there?

David: There are three pairs of varieties here. There is IR64, Swarna and some Masuri, with and without the *SUB1* gene.

Ronnie: Three pairs and three reps, right David?

David: Yes, three pairs and three reps. There are three replications. The replications, I think, go this way.

Audience: The individuals that did survive the flooding, did they have some special resistance?

David: No, they do not. It is a little bit like a threshold trait. You always get a little bit of survival, right? But basically they all have the same genetic makeup. They are identical.

Susan: It is the frequency spectrum of survival that you would get in that population of plants.

David: Normally you get from 0-100%. If you have higher submergence stress, the percentage survival goes down and down but you still get a little bit of survival.

Audience: Those individual plants that do survive, are they tolerant?

David: No, they are not tolerant. If you take the seed from these and plant again, they would be susceptible.

Audience: The frequency is the same in succeeding generations?

David: More or less, depending on how long you submerge them. If you submerge them longer, you get higher death.

We developed six varieties in the initial project, which have this *SUB1* gene. This is all six of them. Basically, each variety is grown side by side with the susceptible version. You can see that it worked in all the six varieties, very well. It took between two to three years over the whole project to develop all of these six varieties. Each of these varieties were popular varieties in different countries that had the problem of submergence. It was a lot of work to do this but we did it because we wanted to have the maximum chance that the farmers would accept them. When you go to the farmers with a completely new variety, they are very skeptical. "Okay, is it going to be better than the one I am growing? If I grow it and harvest, can I sell it?" We wanted the maximum chance that they could adopt that variety without much change in the way they are farming because that would be a whole new variable if we introduce something totally new. When we go to farmers and they are growing Swarna but they have a problem with submergence, we could say, "If you grow this variety, it is basically the same as Swarna. With no submergence, you get the same yields, the same quality, and you can sell it just the same as Swarna. If you have submergence, it is going to survive much better."

All of these varieties that I showed in the last two pictures, those pictures came from our experiment station grown in tanks. We controlled everything. We put the water in for two weeks, maybe three weeks, but what happens in a farmer's field? You are not able to control anything. These are uncontrolled areas. That was the big question. I questioned in my mind how this would perform in a farmer's field where you might get two or three floods in a month. Or you may get less duration or more duration or a gradual flood. There is no control in a farmer's field. We wanted to really test

them in the farmers' fields. That was a challenge because you cannot just order a flood in a farmer's field. You have to put the experiments out and hope that at some point you will get this kind of test. One of my friends at IRRI had a joke that if you wanted to have a good rainfall in a particular field, you should just put a sign saying "drought-tolerant experiment" and you would get good rainfall. Really it seemed like it would go against you. We countered that with numbers. We put out many, many trials; hundreds of trials of paired varieties, submergence tolerant and non-submergence tolerant, over different areas. We tried to maximize the chance that we would get some flooding. Then we found results that were even better than the experiment station. That was a good thing.

This is an example of a field that was submerged in an earlier stage of growth. I do not know if you can see, but the one on the right is going to be a very nice crop and the one on the left is almost gone. Normally what happens here is if the flooding comes relatively early, the farmer over here will replant the field. They will just clear it, try to get seedlings from somewhere of an early variety and replant. They always get low yield because they are out of the calendar season. They are planting too late but they will try to do something. Whereas in this field it is like a normal crop now, just recovered. We found differences of yield. Sometimes we would get four tons under this condition and maybe one or zero under this condition. There is a very big difference in yields between the two fields.

The right side was even more interesting because there we had flooding at the panicle-initiation stage. That is the stage just before heading, before the booting stage, where we did not really expect it to be tolerant because of the mechanism. I mentioned earlier the elongation problem of a plant underwater. At that stage, there was not that much elongation going on. We still saw a very dramatic difference under flooding at that stage. The Swarna plants were completely empty. The grains were totally empty. There was no grain at all. There was zero. Under normal field conditions the plants were producing quite a decent crop. We got very good results under a wide range of conditions.

Another thing we saw was that in some fields the submergence was very short, about four days. When you have four days submergence, you do not get a lot of damage in the field. The intolerant plants will recover and produce a crop. But even in those conditions, the varieties with the *SUB1* were given an advantage of about 1-2 tons per hectare. That is quite a big advantage. We actually did not anticipate that. It was discovered by some of the farmer tests we did, where they had this shorter duration flooding. Even though the plants were recovering, they were still damaged and they were not producing much yield.

The result of this was that by this time (around 2007-2008), the farmers were convinced, the government was convinced, and they were ready for a much larger scale introduction of these varieties to the farmers. Fortunately, the Bill and Melinda Gates Foundation came through with a large grant to help us promote these submergence tolerant varieties, as well as other varieties we were working on that were tolerant to drought. Some of our other breeders were working on drought tolerance and salt tolerance. The Gates Foundation funded this large project, part of that project was to help increase the seed and disseminate the seed to a large number of farmers.

We called the project STRASA, which means Stress-Tolerant Rice for Africa and South Asia. It was focused in three countries in South Asia (India, Bangladesh, and Nepal) and I think twenty-one countries in Africa. We started the multiplication in 2006. The breeding project started in late 2003, so by 2006 we already had the varieties under evaluation in these countries. By 2009 they were officially approved by the governments after the testing. At the same time we were working on seed

production. Do not worry about the numbers. This shows you the kind of numbers, like 40,000 tons of seed production by 2011. Huge amounts of seed were being produced and distributed. If you look at the number of farmers that were growing them, by 2012 the estimate was three million farmers. That is a huge number of farmers. We are talking about Asia where this is a staples crop so there are millions of farmers. They each have about one or two hectares of farm. There was large adoption, about 1.1 million hectares in 2012, which is more than two million acres. This year it is estimated at two million hectares. That is about four and a half million acres. That is quite a rapid adoption of *SUB1* varieties.

One of the neatest things about the project was that we initially anticipated that the varieties would basically replace the original varieties. Swarna *SUB1* would replace Swarna in the seed chain and production. But our group in India felt that they wanted to accelerate the delivery of the varieties to the farmers who needed it the most. We started to do some satellite mapping of flooding. They were able to map the areas that were most prone to flooding by data that they had available in India. They did this by state and by district. They actually ended up with a list of villages that were identified as submergence prone based on this data. The government funded a large effort to deliver seed of the submergence tolerant varieties to those districts. Some of these were very remote, but at least this gave us a way to prioritize how the seed would be distributed.

I talked a lot about flooding because that is the one I was the most familiar with and it was our earliest success story. I wanted to mention that we were working on other stresses, and drought is a good example. We found almost the same thing. If you look at what the farmers are growing, their varieties are not tolerant to drought. Every time there was a drought, they were suffering quite a bit. There were drought-tolerant varieties available. We started a similar process with that. Those varieties are also now becoming quite popular in areas of Eastern India that have problems with drought. I did have one data slide on that. IR64 and IR36 were two very popular varieties in India. Under severe drought (the red) their yields collapsed quite a bit. They are getting less than about a thousand kilograms per hectare, more or less equal to pounds per acre. Some of the drought tolerant varieties were getting double the yields under those same conditions. These yields are relatively low for Asian farmers, but you have to remember that these are subsistence farmers in drought-prone areas. Really in many cases they are growing rice for their family, for their close friends, and if they have extra, they can sell that to the market. When they have a drought, a lot of times they lose everything. It is very devastating on them. Having a variety that would allow them to get through those drought years could be very useful. These varieties are now being grown.

The issue of salinity came up this morning. We also had some salt-tolerant varieties that were doing well. As Susan mentioned, they are tropical. They are *indica* varieties. Submergence is a special case because the *SUB1* gene has such a big effect. Let us admit it. Not all of these stresses have genes that have such a large effect as the *SUB1* gene. In the case of drought, we estimated that with three of the drought-resistant genes we could get quite a large effect. Now those three genes are being introduced in varieties in the same way as *SUB1*. In fact they are being introduced in varieties that have *SUB1*. Now you have varieties that are going to have submergence and drought tolerance. That is important because a lot of areas are so variable that you can get either stress in any year. We are trying to combine multiple stresses. Salinity is another one. For example a lot of these coastal areas have both salt and flooding.

Audience: And drought.

Maybe the next generation will be the three. This was a little bit later than the submergence story but it is going along well now, especially the drought tolerant varieties. The last time I was at the

meeting, earlier this year, the drought tolerant varieties were in high demand now and spreading quite a bit. It seems the project is having quite a good impact on these three major stresses.

Audience: What is the mechanism with the drought tolerance? If there is no water, they cannot grow. Do they also kind of hold their breath until the drought is over?

David: That is a more difficult question. It is not as well characterized as it is for submergence. There seems to be different mechanisms for the drought tolerance. The main one, I believe, is the deeper root system. I would not say that we are talking about varieties that can produce well without water. We are talking more about varieties that can hold on with a drought-stress and still actually get at water deeper in the soil. They can avoid some of the stress by tapping into deeper levels of water in the soil as the soil is drying out.

Susan: We should say they also have to slow down their growth because otherwise they will compete with each other in the community and they will deplete the water. Depending on how long the stress lasts you will have to have different mechanisms. That is why it is three genes. Post-drought is never one thing. You have to have this combination of mechanisms.

David: One thing that surprised me was that the results were fairly consistent. For example, the group that is working on this at IRRI found very similar results when they tested their materials in India, which was their main testing site. It seems like when you get something that has this drought tolerance, it works fairly well. It works better than I would have expected considering the complicated mechanisms of drought tolerance.

Susan: David, you might mention where the drought tolerance is coming from.

David: *Aus* varieties, I guess, mainly. There are different sources, but probably most of the tolerant donors are a special kind of *indica* variety. You may have talked about this in the past, the *aus* varieties.

Audience: What countries?

David: Bangladesh and India.

Susan: The same region that has naturally evolved mechanisms for submergence has evolved mechanisms for drought and mechanisms for salt, because deep down in the pathway biochemically it is all connected. It is all the same pathway. It is diverged because the plant has to know what to respond to. The signal "drought" or "salt" is different, but the pathway and the plant's response is fundamentally the same for these stresses.

Audience: Is there a relationship then between, for instance, upland rice varieties and this drought-tolerance?

Susan: You would think so, but no.

David: Well the *aus* varieties are kind of upland.

Susan: They are not the tropical *japonicas*.

David: When we talk about upland varieties in Southeast Asia, no they are not. They are a special kind of upland variety.

Ronnie: And sown with the early rains?

David: Right. They are kind of like a pre-monsoon crop. They sow them when it is dry. They are actually designed to give a crop in a very short period of time. They are very vigorous. They compete well with weeds, but they do not yield very much. As Susan mentioned it is peculiar that they seem to be a source of a wealth of stress-tolerant traits. I would not have expected salinity from those varieties, but it does seem to be coming from there too. They are very interesting.

Susan: Just one comment. You might think, "Oh let us just breed for deep roots." That was the simplistic vision before. It does not work because you create new competition. In fact then the plant over invests in a deep root and it does not produce as well when you do not have that stress. It is a combination of much more, the ability of the plant to respond appropriately to the environment rather than to constitutively express something that it does not always need. That is why the understanding of these things is evolving very quickly.

David: Another thing I should mention. When I talk about drought tolerance, especially in relation to this work and the STRASA project, we are talking about fairly severe water stress in farmers who are really subsistence farmers. Many people in the US, especially in the Mississippi delta, have asked me, "Should we have drought-tolerance?" because we have water shortages as well. I never recommend that because these varieties are not going to have high yields. Farmers who are dependent on higher yields may not benefit from this kind of drought-tolerance.

Audience: It is more about survival?

David: It is like a drastic situation. Now there is a different situation, which we call aerobic rice. Probably some people here have actually been doing this even though they may not have known the name. Aerobic rice would be where you are not flooding but you are still giving enough water so that the plants are not really stressed out. That is a different one and there are genes that give tolerance to this situation, but it is different from what I mentioned about the survival under severe drought. For a farmer in the US, I would never say, "Oh you should be breeding for drought tolerance or looking at drought tolerance." because it is really a drastic situation. The best way to solve it is to irrigate, right? These are in areas where they do not have access to irrigation.

Audience: In the salt tolerance, could you characterize what the mechanism is? Is that tidal flooding, or estuarial salt contamination, or irrigation?

David: That is one source, is through irrigation. You would see that more in inland areas, which are a little bit drier, and they irrigate a lot and so you get evaporation. There is also coastal intrusion. They are quite different environments. We were actually looking at both those situations and the varieties would be different in each situation. The varieties for inland salinity, irrigated areas, are different from the ones for the coastal saline areas and they have stress at a little bit different stages. For the mechanisms, it is also very complicated. One of the key ones was exclusion of sodium uptake by the roots. There are varieties that can exclude the sodium but there are other mechanisms. It is not a single gene, like *SUB1*, but it is relatively straightforward to breed for that.

Takeshi: Could you talk a little bit about cold tolerance?

David: This is cold tolerance. I was not planning to talk about cold tolerance because I really do not have a lot to say about it. My student at UC Davis did his thesis on that and there have been major genes identified for cold tolerance. He was looking at the vegetative state. If you grow an *indica* variety in your climate, probably it turns yellow, right? That is what you would see, and the japonica stays green. That is a kind of cold tolerance and it is usually controlled by major genes. Probably a more interesting one is the booting stage, which relates to the sterility. There has been some work in Japan. In a paper published in 2003, they used a variety from Indonesia, a tropical *japonica* from Indonesia, as a source and they were able to

transfer some genes from that variety into Norin 20. They developed a variety, which introduced this gene from Silewah into their variety, and apparently it has a higher level of cold tolerance. Beyond that, I have not seen very much of the approach that we were using for transferring major genes in cold tolerance. I do not know if you are familiar with that or not. There has been a lot of success in breeding for cold tolerance. The California breeders have been doing it. They had some varieties that are pretty good. Of course, Hokkaido is the classic example.

Takeshi: The varieties bred in Hokkaido and California, do they have the same cold tolerance gene or different?

David: I think they would be similar, probably, but I do not think that has been studied. I have not seen very much studied on that. I am not sure.

Audience: Could you spell that variety? Hokkaido?

David: Hokkaido. That is the northern island of Japan.

Susan: Most of the varieties that are being grown by Ogi [Takeshi] are Hokkaido varieties.

David: I was talking about what some people call marginal or unfavorable or extreme environments. Hokkaido is a good example and you are probably also a good example. I used to think California was a good example as well, but now that I have come here, California is too easy. We get very high yields. In California we cannot grow *indicas*. They just turn yellow. In the southern US you can grow *indicas*, although they are not grown much. Here, even the California varieties I was told are not good enough. They are too late or you need a little bit warmer climate, maybe Massachusetts.

Basically I am finished. I always give this acknowledgment at the end, but there are too many so I am not going to read them all. I need to give a thank you to the donors, like Gates Foundation and the German government. Many countries gave us donations to do this work. I also need to mention the farmers. One of the things that really shifted over the last several decades is the participatory research with farmers. We got a lot of support by working directly with farmers in Asia. This is a picture of some women farmers who are going through a variety trial. They vote on the varieties they like and the ones they do not like. They get a few cards and put them by the rice they like. This information is now used in varietal releases in India. It is really a major paradigm shift. Before the scientists developed the variety and then gave it to the farmer. The scientist would have to tell the farmer how to grow it. No more. Now the farmer is involved. This has been done a long time in the US, but in Asia this shift had to occur. We get a lot of support by farmers. Another farmer, on the right, is from India and spread the submergence tolerant varieties on one thousand acres before we ever heard of him. We had no connection. Somebody said, "Oh by the way they are growing a thousand acres in Andhra Pradesh." We never gave them seeds so how did it happen? We went there. This farmer had gotten the seed, started his own program, and started spreading it by himself. We really got huge support from these kind of farmers. They were really tremendous people to work with. It was really a gratifying experience. Thank you very much.

Susan: Can you mention one thing? Is the seed freely available or do people have to request it? How is it distributed?

David: We are dealing with non-commercial seed. It is all done through government agencies or in some cases there are seed companies involved. The price people pay is just the price for certified seed. There are no royalties on any of these varieties. There is no IP on any of these varieties. It is all done through a public system. Once they are available, the farmers can grow it themselves or spread it to other people.

Those things may be changing in the future but at the moment it is pretty open. There is a lot of emphasis on seed production and high quality seed production because that is a serious problem in Asia where farmers keep growing the same seed every year and there is a decline. We are trying to help with maintaining high quality seed production. In our project we had quite a huge effort on that and a lot of people involved in seed production.

Rice Farming in the Northeast: Data Collection and Seed Saving: Mia Murphy

We had our first conference here back in 2009. That is a while ago and since then we have had new growers come on board. We went around the room and we talked about all the different places where rice is being grown in the Northeast. We now have several years of growing rice under our belts and we are getting to the point where we want to keep a record of this information. What each farmer is doing, how they are doing with growing rice, what they are experimenting in, etc. We would like to have a record of what has happened and also so that we can show new growers and new people interested in what is available. We have been thinking about this a lot. I am going to present what we know about growing rice in the Northeast so far and what data we want to collect. Then the second half of my presentation is going to talk a little bit about seed saving because that has been an issue that has come up in the past. We could not find someone to come talk about it. I did the research and tried to get the information so that we could have a talk about seed saving here today. The farmers here in the Northeast do not have a commercial source of seed right now so we are primarily saving our own seed and distributing amongst ourselves. How do we do that in a way that we are not spreading diseases or losing the purity of our seed? I am going to talk a little bit about that and I hope we can have a little bit of a discussion because we do have a lot of people here who know a lot about seed. Maybe we can get to a point where there will be a document that I can put on the website talking all about seed saving.

I am going to cover the Northeast climate and a growing degree day map that we created to explain the climate and how it is different across the Northeast. The climate in Maine is totally different than the climate where Jim [Lyons] is, in New Jersey or Pennsylvania. He can grow varieties that we cannot grow even here at Akaogi Farm. Then how we want to go about the data collection and we have developed a five variety rice panel that we want all the growers to grow. I will talk more about that. It is so we can have data that is comparable and we can compare across the Northeast and then seed saving as I mentioned.

We all know rice grows in a range of climates across the world in different environments, different crop management techniques. There is a whole diversity. Here in the Northeast, we are limited by the climate. The cool temperatures and the short growing season. A tool that other farmers have used to figure out how their crops will fare in a particular climate is the idea of growing degree days. This works really well in our climate because temperature is the main limitation. There are some other limitations that we have talked about, stresses, but climate seems to be a big one. For the rice plant to develop and mature within our climate it needs a certain amount of heat accumulation or temperature accumulation through the growing season. Growing degree days seems to be a good way of explaining how rice grows throughout the Northeast.

There is a calculation up there, but basically you take daily temperatures through the growing season. We use a base of 50 degrees Fahrenheit, which is pretty common to calculate this. You cannot see

this map very well on this screen, but it shows up really nicely on the website. It has not been advertised a lot because we are still working on developing it. But under the growing rice section on the website, this map is available. Thanks to our partnership with Susan, she had two people at Cornell who helped us collect data for I think over 500 sites, weather stations, across the Northeast. This is data I think from 1981 through now, averaged out. Each of these sites is a location. The color is a spectrum. We did a spectrum in increments of 500 growing degree days. This is in Fahrenheit. Going from the coolest, which is the dark blues, so that is five hundred to one thousand growing degree days. To the highest, which is the dark red, three thousand to three thousand five hundred. Even just looking at this you can see that there is a range across the Northeast and we tried to illustrate it with this graph.

Audience: Is there a reference where we can find out what some of those locations are?

Mia: Oh, yes. I forgot to mention this. If you go on the website, we added an interactive feature. If you hover over each of those dots, it says the location. It says the exact growing degrees for that location and elevation, because elevation is also another factor. It is not just latitude across the Northeast. It is also elevation. One interesting location is the darkest blue dot in northern Vermont. We were looking at the data and we were wondering why is that so low? It is a point on Mt. Mansfield. It is probably not where you are going to grow rice, but it is interesting to look at because it is a really high elevation. It shows how much elevation factors into climate.

Audience: Why do you work in Fahrenheit?

Mia: Because we are in the United States and that is what we are comfortable with. Maybe in the future we can add Celsius.

Audience: A lot of people have to convert everything.

Mia: Yeah.

Susan: We can just add a converter.

Mia: Yes, we could. We have not really thought about that. Now that we have people from Canada interested we should probably include that.

Audience: The only part I know there is western Massachusetts, but you follow the Connecticut River valley, especially down by the Holyoke Range, which is maybe halfway between North and South and there is some of the world's best farmland. You go to where I live, ten or fifteen miles back from the river and you are a thousand feet higher and it is a totally different climate zone and it is very localized. Part of what has helped us is being in an area that has been farmed for three hundred years because it is down in the valley. There are farmers who know exactly what they can grow and what they cannot grow. We are growing rice in what the guy said, "This is the wettest spot. This is worthless. If you want water, try there." I can see this as a guide, but it seems like there is no substitute for talking to farmers, at least in areas where people still farm. How can you quantify that and make it scientific?

Mia: Well one hope that we have to further enhance this map is to add all the locations, like your farm. Where you are growing, what the climate is there, and what varieties you are able to grow. I will talk a little bit more when we get to the data sheet that we want the farmers to help us collect data with. We want to include all those farms. There would be a dot for Akaogi Farm and there would be a pop up and you could get all the information. We want to improve this map. This is just a start. With your support, we want to make this better and make it a useful tool for people from all over. Sometimes I get emails from people as far away as Nebraska and they want to grow rice. This is a tool to help them.

Audience: Perhaps I misunderstood, I was assuming that each of those points somebody was growing rice there, but that is not the case.
Mia: This is just climate data.
Susan: This is what we could do sitting at Cornell without any input from you.
Audience: I see. It was an academic exercise. That is what you are saying.
Audience: Does anybody know enough to say if that is Martha's Vineyard, why are there two dots? Is it because of the uplands and the maritime?
Mia: I am not sure. We would have to hover over the map.

I wanted to use this map to illustrate how it could be used to talk about what rice varieties are able to grow in different locations. The first example I wanted to use is this farm because in 2009 we actually had a weather station here and we collected temperature data. That year we got growing degree days of 1906. If you look at the map it would be one of the light blue dots. There is not actually a dot for it, but it would be a light blue dot. As we have talked about a lot, the rice varieties that mature here are the ones from northern Japan, from Hokkaido. Although we can grow Duborskian here, which is a popular variety because Christian [Elwell] has been growing it for a long time and the seed has kind of disseminated. It is a uniquely different looking plant than many of the Hokkaido varieties because it has a nice long awn, like a feathery end to the seeds. You can actually see what Duborskian looks like because there is a little plot out here in the paddy. We include it because it is a unique rice variety that we can grow in this climate, compared to the temperate *japonicas* that we can grow here.

From this data you can look at this map and pretty much assume that most of the northern half of the Northeast, if you wanted to try rice, you should try these Hokkaido varieties and they would be your best bet. To think more about the southern half of the Northeast, I wanted to include a little data from northern California as a comparison. Jim Hill told me that Rio Vista was one of the cool spots in northern California. I went online and figured out growing degree days at that location. An average for the last few years is around a little under three thousand. It is pretty high. It would be one of the lighter orange-ish dots on that map.
Audience: Can you take one step back and tell us what growing degree days means?
Mia: Growing degree days is degrees of temperature accumulation through the growing season. They have growing degree days for different crops. For rice we did through the growing season for rice here in the Northeast from May to September, which is mainly when they are growing.
Audience: The number of degrees above fifty degrees?
Mia: Yes. It is a base of 50. It is related to how well the rice is going to grow.
Audience: Did you take the temperature at the same time each day or average it over the day or what do you do?
Mia: Usually they use the max and a min for the day and then they average the max and the min.
Audience: Any particular time of day?
Audience: Standard way is to take the highest temperature in the day, whenever it occurs, and the lowest.
Audience: Whether it is light or dark does not make any difference.
Peter: Every day has a maximum and a minimum. You take the average minus 50 and accumulate that.
Audience: I got that. What I did not get was that you do not care about what time of day the maximum occurs or the minimum occurs.

Mia: Right, because night temperatures are crucial to rice plant development too.

In California they are growing some of the mainland Japanese varieties. Sushi rices, like Akitakomachi, Koshihikari, etc. We actually have a little pot of Akitakomachi here that my father grew. You can see the difference in how the rice is developing. They are just starting to head right now, whereas the Yukihikari is fully headed. You can see the distinct difference. Here at Akaogi Farm most years Akitakomachi does not mature fully, but in warm years sometimes it does well. We are thinking that variety, especially, will do well in the southern half of the Northeast. Maybe some of the medium grain, cold-tolerant, early-maturing rice varieties from California will maybe do well in the southern half of the Northeast. We are hoping that through data collection in the next few years we will figure this out, how well they will actually do. That is a wealth of information. If we can take from California then that is a resource. Many years of work that they have been doing that we can tap into.

If you are curious about finding growing degree days at your location, weather.com has a nice interface where you can go, type in your location, it routes to the nearest weather station, and will give you growing degree days. Not everyone has a weather station or is collecting temperature data at their location. I think you can search for the growing degrees calculator and find it.

To further improve the growing degree day map, as I mentioned before, we want all the growers to grow this panel, this five variety panel. We tried to pick from early maturing to what we think will be late maturing here in the Northeast. Yukihikari is one of the earliest. It is a short grain variety from Hokkaido. It is the one that is being used in Susan's lab to breed the aromatic and purple pericarp into. We thought that was a good one. Duborskian because it is a uniquely different plant, a Russian variety. Then these two Akitakomachi and Koshihikari, which are varieties grown in California that are sushi rices. There is already a market for them. If you can grow them, they are good rices. Then we wanted to include a medium grain cold-tolerant rice from northern California. This panel is a spectrum of rice varieties and we would like to see how they fare across the Northeast.

Audience: Where do you get the seeds?

Mia: We are working on getting these seeds available for the 2014 growing season. Some of them are already available through the USDA from the National Small Grains Collection. The only which is not is Duborskian but we have sources from Fedco Seeds and Seed Saver's Exchange so that variety is available through those means.

Takeshi: I think Koshihikari is available from Kitazawa Seed Company.

Mia: We will get that information to anyone who is interested. We are still fine tuning what we want to do for the next growing season. We want to get the growers on board so we can launch this effort and have at the end of 2014 all this data that we can include on the website. This grant is ending in June of 2015, so next year will be our last conference probably.

Susan: What we say is it is up for renewal.

Mia: Our last conference for sure. Hopefully we will have this data for the ending of this grant and maybe it will push further efforts.

Susan: We have to say that next year we are going to invite the NSF officers who will be determining in part the renewal. I think we really want to bring them here. If you buy in, it is your conference and we are trying to serve your needs. If this is something you want to do, that action this year would be profound.

Audience: Can you say more about why this selection? I mean given where I live, I am looking at the five different varieties from northern Japan and thinking I want to select a couple of those to try and yet only one of those is up there.

Mia: This is a way to compare locations across the Northeast. If we do not all grow the same varieties then it is harder to compare. But yes where you are in Maine, probably only two of those varieties will mature.

Audience: The Russian and the…

Mia: Yes, the Russian and Yukihikari.

Susan: We can provide you with recommendations for additional seed that we would predict for you.

Mia: This is just for this effort.

Audience: I want that.

Mia: We can help with that too.

Audience: Mia, are we presuming that this is all going to be flood culture? Or can we do other cultures too?

Mia: There are other cultures going on. Even if you want to help by growing rice in a five-gallon bucket for information, I think that is an aspect we would want to include as well.

Audience: I am wondering how much of a standard protocol that you have for when you do this. Just to give you an example, in California, if you keep your rice non-flooded for the first three or four weeks, there is a delay in maturity of as much as ten days to two weeks. You could really have this data compounded by the different management practices. I would recommend a protocol. Maybe you have that coming up?

Mia: Yes, that will be something we will fine-tune over the winter. Maybe we can develop a couple protocols. For paddy rice, this is the recommendation and we could compare those farms. Then if other people wanted to do other management, they could.

Audience: If we want to be serious for the NSF we should have the protocol.

Susan: That is true. We will develop them.

Mia: We will work on it. It is still a work in progress.

To go along with growing the rice variety panel, we have been working also on a data sheet, a record-keeping tool. There is a one-page, back and front handout of what we have developed so far working with Susan, Anna [McClung], and a few other people. What we think will be relatively easy for people to record over the growing season so that we can have data that we can compare. Basically this means taking some measurements at the beginning of the growing season (germination dates, transplant dates, things about your rice paddy, or your rice field, etc.) and then data during panicle development, which is when it is heading. Because that is a really important time and it is a piece of information that is used to compare rice varieties all over, we are going to talk a bit more about that. Then after harvest and when the grain has been dried, there will be a bunch of measurements to take at that point too.

Quickly, the rice plant. Many of you may know this, but there is a wide spectrum of knowledge in this room so I just wanted to cover that a "tiller" is composed of the root, stem, and leaves. Then some tillers will produce panicles, which are the seed head of the rice. In this plant, this example, there are five tillers and they all have panicles. When you are doing your record-keeping this is one of the things you are going to have to figure out, how to look at tillers. A lot of rice plants if you

look at, even here in the paddy, it is going to be difficult. It may be a little challenging to count all the tillers but that is the basic idea. On the panicle are the seed growing parts of the plant called the spikelets. I do not have a picture, but I will talk about this later.

The heading date is called the panicle exsertion phase. If you look at the diagram on the far right, this is before heading has occurred. It is the booting stage, when it is fattening up and getting ready to come out. The second diagram to the right is what they call partially exserted. Heading date, when you are talking with agronomists or researchers, is when half of the panicles have partially exserted. It is kind of a tricky thing to measure. It will take some experience. I think that for the first year maybe taking the date of when you first start seeing signs of heading would be important. Heading can take anywhere from ten to fourteen days. You can keep on eye on it day to day. When it is completely headed you will have that date. If you do not get exactly 50%, then we can maybe work it out. We need that date to be able to compare the data. The diagrams to the far left are all further along in heading.

One other concept I wanted to go over for the data collection was lodging. This is when the rice plants fall before harvest. There are some good examples of it in the rice paddy here. I did not know that was going to happen, but there are some good examples of it here. Lodging occurred here this year because my father was experimenting. He increased the fertilizer application by 50%. What that can do is make the rice grow quickly and then fall over. You will see some varieties have issues with lodging here at Akaogi Farm. Usually it occurs with rain or wind or heavy weather. You will see this in other areas. It is not as common for those environmental factors to influence lodging here in the Northeast. When we had hurricane Irene a few years ago, there were some farmers who experienced lodging because of all the wind and rain. Then we have a spectrum so it is relatively easy to measure lodging from one, no lodging, to five, completely flat.

Audience: Is lodging normal in normal conditions?

Mia: I think it depends upon the variety and how it is growing. It would be difficult to define normal conditions because it is influenced by fertilizer application and other factors. What I could say is that there are some varieties that do not tend to lodge as much as others, but it is very variable based on environmental conditions.

Susan: Dave Mackill, in his presentation this morning, showed you IR8, which is the high-yielding rice for Asia from the Green revolution. The main feature of that rice was that it dwarfed the plant so that it would not lodge. It was really an anti-lodging thing so that you could still get the yield off those plants.

Audience: When it lodges you lose the yield?

Susan: Usually it goes down. The grain filling is affected and the quality of the grain and everything. I guess it is really an interesting question as to whether it is normal because traditional rice in many, many cases will lodge much more readily whether you fertilize it or do not. Typically, if you fertilize a traditional rice variety it will always lodge. It has always been a limitation for yield. Lodging was the limitation. When you tried to fertilize it to get more yield you just got it lodging. That idea of having a strong stem by dwarfing the plant and breeding for stem strength has also been a key feature of hybrids. Early hybrids that had these huge yields, the stems were too weak to hold up that yield. The breeders are always working with the problem of lodging and fertilizer. I do not know if normal is a word for this problem but for your environment you always have to think about lodging.

Takeshi: This year at our farm, you can go over to the paddies and see lots of lodging. I wanted to see how each variety reacts to fertilizer. I used 50% more fertilizer than I have in the last 6-7 years. Many varieties are falling down now. It is nice timing.

Audience: While everyone can hear you, can you say what kind of fertilizer you used?

Takeshi: I used dried chicken manure.

Audience: Cheep cheep.

Takeshi: No. From a new company in New York State. It has slightly less nutrients but probably very similar.

Audience: Mia, I am thinking if lodging is a piece of data that you want to collect, you should also know what the fertility is. What each person is adding since there is such a direct relationship. Perhaps the flooding timing too because if you dry things out towards the end, then . . . There are so many factors.

Mia: There are a lot of factors and a lot of those are included in our datasheet. I did not want to go over every single parameter because that would just be a little overkill.

Audience: Can I have a simple manual or something for this?

Mia: Yes. We will work on it.

Susan: My group will be building a model once we have enough data. We will try to model this because these are not linear relationships. We are going to try to provide models for different regions and conditions. That is why giving us as much of the detail about your environment and your management practices as possible will allow us to try to start to accumulate that information. That is the kind of thing NSF would like to see, because then it becomes predictive and then you can fine-tune it as you go. Then that helps the breeders. That is feedback for them as well. I think you can start to see that relationships are complex here and at the beginning there are too many independent variables. Once you put them into a model, you will start to see how tweaking one variable has a cascade of effect and on some varieties it will be different than for others.

Audience: For our data to mean anything, we have got to have a guide as to how we are doing it. That is what I am asking because I know nothing about this.

Susan: Let us say we give you a guide, we still need to know what you did because nobody does it the same way.

Mia: I think this all I am going to say about the rice variety panel and the observation sheet and data collection. We will be working on this over the course of the winter and have it ready for next growing season and we want your participation and help with this. We will be in touch.

The second half of my presentation is going to focus on the seed saving. As I mentioned before, this is so that we have knowledge about how to properly save seeds because we are all probably doing it differently right now. I spent a lot of time doing research. Using IRRI as well as a small-scale, seed-saving manual from Uganda. I tried to draw resources from all over and develop somewhat of a format for how to save seed in our climate. Obviously, there is no document that covers that right now. I am not an expert on this. I am learning as many of you are. I just have connections to people who know a lot. This is also a work in progress. We may have a discussion here and talk over some of the things and then over the course of the winter and the next few months, we can develop something that is final that we can put on the website to help everyone.

Rice is, most of the time, a self-pollinated crop. In nature it will breed true to type. This makes it a little bit easier as a crop to save seed from year to year, compared to other crops that outcross a lot.

True to type means that its offspring are the same as the mother plant, in most cases, and I will talk more about that.

Why is rice self-pollinated? This is a diagram of a spikelet, of which there are lots of spikelets on a panicle. It is self-pollinating most of the time because when the pollen falls off the anthers to pollinate the female part, the stigma, most of the time it happens before the spikelet has even opened. There is no way it can get pollen from another plant or another source. Sometimes it occurs at the same time it is opening and a small percentage of the time it occurs after it has opened. If you manage the way you grow rice correctly, and keep varieties separate, then even if it is pollinated by a neighboring plant you can be pretty sure that it is going to have offspring that resemble the parent plant.

Audience: Will you talk about how separate is separate?

Mia: Yes. I will talk about that.

From my research, these seem to be the major areas that need to be considered for growing rice for seed. I am not going to cover all aspects of growing rice because that would take forever and a lot of it has been covered in previous conferences. If it is an interest of yours, you can look at the videos or presentations from prior conferences. I wanted to talk about some aspects that may be a little bit different or aspects that you need to spend special attention to because you are growing rice for seed. These are the areas that I am going to go over.

Choice of land and land preparation. There did not seem to be a lot about this other than that you need fertile land with sufficient water. If you are growing paddy rice, you need soils with high clay content to hold the water and a level rice field. Even for growing rice as a grain crop this is a pretty important issue. It helps keep the water at a uniform depth. If the water is at a uniform depth, it makes weed management easier. Water is conserved. It allows the plants to mature pretty uniformly. This is something you want if you want to have good seed.

For seed preparation, if you want to have good seed you have to start with good seed. This is probably one of the harder parts for us here in the Northeast because we do not have a source of commercial seed. We have a few. You can get small packets of seed through the National Small Grains Collection, through the USDA. For varieties like Duborskian there are some commercial seed distributors that are distributing seed, like Fedco Seeds and Seed Saver's Exchange. I know a lot of us are growing seed and distributing it amongst ourselves. If we try to make that seed truthful and preserve it as best we can, then that is a good way of getting seed.

These are some of the aspects of good quality seed: fully mature, well-filled. You want nice full grains, uniform in size. Healthy, so no diseases, no discoloration. Pure, that refers to genetic purity. You are trying to keep the varieties pure. High viability. You want seeds that have a high germination rate and grow prolifically. One aspect of it is the moisture content of the seed when you are storing them.

Audience: Mia, I am wondering if anyone else has had this experience with the USDA and their seed. I have just noticed periodically looking over my field, I will have a variety with 100 or 200 plants or whatever it is that I have got in there, and all of a sudden I will see one that is twice as tall and is clearly not the same variety. Are they imperfect in their seed collection and what not?

Mia: I do not know. I am not sure about that.

Audience: How do you keep it pure? I mean you are always going to get some cross-fertilization, even a little bit, right?

Susan: I think that the USDA is just conserving what they were given. If they were given a mixed bag, you are going to get a mixed bag. Everything comes in and breeders try to purify it and there is some risk that it is going to outcross and you have to rogue it. That is the easiest way is to pull out the off-types and do not let them go to seed for the next generation. If you are a seed producer, you have to rogue in order to continue to produce the seed or it will cease to be.

Audience: Because rice is not open pollinated in the sense of most plants, is there no minimum number of plants that you collect from for a good genetic mix?

Mia: Yes, so that is something that we have had discussions about. We have talked about growing six plants, a row, and saving from a subset not all the plants. Or growing in a plot and then saving from the middle of the plot. Hopefully there is an edge buffer and if the plant is cross-pollinating with a neighboring plant, if it is from the middle hopefully it is from the same variety. There are strategies to ensure pure seed. Distance is also important between varieties. Try to maximize the distance between varieties if you are doing a single row. It is not going to work the same for every farm but there are ways of trying to make sure we keep our seed purity.

Audience: Is your question about bottleneck possibly? What is the minimum tipping point where you start regressing the line.

Audience: Yeah, where you do not get your genetic range back.

Mia: We have talked about it in prior conferences. Susan said six plants a while ago.

Susan: Well we are talking about inbred varieties here. If you are talking about populations, it is a completely different game. We are just restricting this to varietals, which are inbred varieties. What all of you hope as farmers is that if you ask for Yukihikari, you get Yukihikari. Because if you ask for Yukihikari and what you get is some mixture of Carolina Gold, Yukihikari, and something else that happened to be in the field, you are not going to be able to repeat what you expected. You would have gone to all the trouble of planting it before you realize it will not grow or it will not flower. What we are trying to talk about here it just maintenance of pure lines, meaning inbred varieties, so that you get what you expect. There is a whole another dimension which we could talk more about, which is when you make a cross or you talk about traditional varieties which are populations, but these are inbred lines.

I wanted to go over seed certification a little bit because it is a major factor in seed distribution throughout California, Arkansas, all over the world. There are classes of seed. Here in the Northeast of course we do not have it. There are different classes. The breeder seed is of course the seed that comes directly from the breeder. It is grown in an institution. It is probably the product of a breeding project and the seed that they develop. Foundation seed is the offspring of that. Usually it is an institution or something that is growing the seed out and there are protocols they are following. They are getting inspected. There is a whole process of preserving that seed. Registered seed is the progeny of foundation seed. It is usually grown by select farmers for seed companies, to distribute. Then certified seed is usually grown for commercial distribution to give to the farmers. It can be progeny of foundation or registered seed. It is a little bit above what we need to know for the moment, but there are protocols out there in other rice-growing regions of strict guidelines of how they save their seed. We are just hoping to keep at the certified or just a little bit below that level with managing how we grow rice so that we are not spreading diseases or reducing genetic purity.

Audience: Each of those is a further generation?

Susan: Should anyone want to make a business out of certified seed, a good grower can have a certified seed production farm where they grow the seeds that the community needs and their costs should be covered. You pay for the certified seed because it has been grown, rogued, and managed. It is certified to be the quality and the identity that we are trying to preserve. For any of you for whom entrepreneurship is your game, think about becoming a certified seed person. I do not think your market is very big yet, but you could learn a lot by becoming a certified seed person.

Once you have your seed, there are a few steps that you can take before planting. One of them is seed cleaning. Usually if you are getting it from a reputable source, you probably do not have to do a lot of removing of debris from your seed. But one aspect you might want to do is remove poorly filled grains because we want the grains that are fully developed. There are a couple of ways you can do this. You can put them in water, the seeds that float are the ones that are poorly filled. The ones that sink are the ones that you will want to plant. If you wanted to do it even more accurately, you can use a saltwater solution and then rinse off the saltwater before you go to the next step.

I was trying to find a way that maybe we could help prevent disease. It is not a big issue at the moment, but there is some research about disinfecting rice seed using hot water. If this is a concern, you can prevent many seedborne diseases by using hot water. There is a certain temperature range that you need to keep the water at. You soak the seed. It should be around 140 degrees Fahrenheit and after five minutes you cool the seed and you can either dry them in the shade or go on to the next step if you are already planning on pre-germinating.

Susan: I will just mention that every single seed that comes into the United States from overseas goes through a hot water treatment of five minutes or ten minutes at 62-63 degrees [Celsius] and is then dried. Everything you get into the US has already been through this process. In addition now, those of us who are the quarantine stations for these seeds, we have to grow those seeds out when they come into the country. They have to be grown out under quarantine conditions and we have to harvest seed off of a plant grown from those seeds before it can go in the field. The US has very strict quarantine and containment to be sure that we are not introducing new diseases and new pests. I also mention that to assure you that your seeds will germinate after you do this. It does not affect germination. To give you one more little input, when it comes to me because I am a quarantine grow out, I get the seed that has been dried down after it has been heat treated. I have to put it in the freezer at -20 degrees for 48 hours and then thaw it out before I plant it. It is amazing what seeds, if they are dried correctly and they should be dried before they are ever sent, can go through. You can boil them in hot water and then freeze them and they still germinate. It is just sort of interesting for everyone to realize that is what they have been through before you get them.

Audience: Do you mean boiled because you are only at 140 degrees?

Susan: No not boiling.

Audience: You are heating. You want the word heat, not boiled.

Audience: That helps explain the Fed who came to my door last winter. I was trying to figure out where to get rice seeds and I saw some on Ebay and I bought them. About three weeks later this guy comes to my door identifying himself as a USDA investigator and there is a backup guy standing in the driveway. He wants to know who I am and is it true that I am the same guy who bought seeds on Ebay. I took out everything I had and he walked away with it. He was very nice. About two weeks later, he came

back and he said he had sorted seed that was basically shipped from Thailand totally illegally from some that he had determined were from American sources, which must have complied with everything you are talking about. Those he gave me back.

Audience: How could he tell?

Susan: Tracking.

Audience: That is true. The only ones I got back were the ones that had names of an American company on the envelope. Everything else, if in doubt, he grabbed it. Some of it he had tracked all the way from Thailand through the Ebay source. Then he apparently went to Ebay and essentially shown them his badge and said we want the names and addresses of everybody who bought this seed. I do not know what he did to try to shut down the source in Thailand. He was really serious.

Mia: Yes, it is a serious issue.

Audience: Is this to protect just the rice growers in the US or all grain growers?

Susan: Well all grain growers. Everyone goes through the same thing, but rice is much more heavily quarantined than other grains. Much more heavily quarantined because we have a very, very vulnerable rice production system where our genetic diversity is low and we have no native diseases for rice. We have had some introduced and we had to deal with them but we are trying to keep them out.

Audience: Susan, is this disinfection by heat distinct from by freezing? Can one do either or?

Susan: This is for mostly fungi and bacteria and the freezing is for the panicle mite, which has an egg that is resistant to this temperature but is not resistant to freezing. I do not really know. I know why we do both, but I do not know whether the freezing would be enough to get rid of this, but this happens at the border.

Audience: Have people around here that have been growing rice in the Northeast had to deal with mite or disease and are these some of the practices that people are doing right now? Is it happening on this farm?

Takeshi: I do not know. I have not noticed it yet.

Audience: Do you go through these steps, where you heat it and then put it in the freezer?

Akaogi: I only do the water treatment and remove the floating seeds, but I am thinking of doing the disinfection by heated water.

Susan: I think if you do certified seed you will have to do all of this.

Audience: Apart from all of this, how many years does rice generally stay viable in seed?

Mia: From what I read, rice loses viability significantly after eleven months of storage.

Susan: That depends on what the storage conditions are. We usually dry them down to fourteen percent moisture and then as long as you keep them dry and cool, they will store fine. At Cornell, I dry my seeds down to fourteen percent moisture. I put desiccant in the containers and then I keep them at four degrees because I do not have any long-term storage. At four degrees they will probably keep for five years.

Audience: Four degrees centigrade?

Susan: Yes.

Mia: Do they lose any viability in that time?

Susan: After five years you start to see that go down.

Audience: What dormancy is attendant in that routine? Any?

Susan: There is no dormancy.

Audience: No induced dormancy?

Susan: No.

Audience: Susan, for a home grower, what is the best way to dry down rice?

Susan: Many people dry it in the sun and hold it and then it is good to the next year. Just do not keep it in a humid environment. In this kind of environment is fine and in a cool shady spot or home but not near attics. Not where it is going to get hot and cold and hot and cold.

Peter: One very simple test is called the "tooth test." Dry the rice, hopefully below 14% moisture, put it between your teeth and if it cracks that means it is dry enough. Then you put it in a cool place for storage.

Audience: If we are just saving seeds from our own gardens, should we be doing this before we plant seed the following year?

Mia: If you want to be safest, yes. You could do these things. The idea for this presentation is more for distributing amongst ourselves. To make sure that we are not giving poor quality seed to others because that is how a lot of seed is being distributed in the Northeast at the moment.

Rita: I have some farmers [Bhutanese farmers living in Burlington, VT as part of the Refugee Resettlement Program] and they have experience in rice for forty years. They said they never tried this treatment of hot water and freezing. They just set the seeds and then before they put them in the ground, they just do put them in the muddy water. It grows nicely. We planted last year at our farm, in New Farms for New Americans in Burlington, VT. We had like this much seeds. We did not do anything, just put in the greenhouse and transplanted in the field. We had a quarter acre. This year we have a quarter acres of seeds, rice that grows so well and so nicely. These folks, they are saying that they want to save that seed for next year and plant five acres. Hot water and freezing they have no experience with it.

Susan: As long as you have no diseases and as long as you have no problems.

Rita: We did not have any problem until now. Last year we saved that seed and we do this year and still the fill looks very great.

Susan: Right. If you ever get a problem, you do not want to ship it to someone else. This is more for people who want to share seed and they want to be sure they do not inherit a problem. We do it for everything.

Audience: I had a question. It does not sound like the problems are very common. Is there a resource on your website that shows how to scout for problems, where it would be obvious, or is this something that we need to know what you are looking for?

Susan: The rice panicle mite is a transparent microscopic insect that gets in the seed and punctures the seed when it is very young and then fungus goes in. One of the things you see is discolored black spots on seeds. Many people think its rhizoctonia, but anyway there is a fungal thing that gets in because the mite is there. For years, we did not know how to handle it. We started these protocols and we now have really nice clean seeds. I can tell you that what happens in the beginning when rice is new and we do not have diseases, everybody thinks it is fine and easy and you pretend everything is always going to be fine and easy. If you introduce these early, you will avoid those problems. We got shut down, along with every other rice production greenhouse facility in the country, about five years ago. I cannot remember, for this rice panicle mite because it was discovered. Once we understood what to do and we started implementing, our seed production is much better quality now. All I can say is, I have come through it the hard way and I suggest that this community start these things now. If you start this practice and you are careful, then you can exchange seeds and you are not worried about it because you will all have good practices. You will be much better off than if you wait until you have a problem.

Audience: Can we get this protocol, or maybe it exists somewhere, in writing?
Mia: We can do that. Yes, so this idea is to make this presentation into a document that we will have on our website.
Audience: On Northeast rice website?
Mia: Yes.
Audience: I just have two questions. You were freezing at crazy low temperatures. Would regular freezing work?
Susan: Yes. We are doing it at that temperature because of the equipment we have but a regular freezer would work.
Audience: When you are getting seed from USDA, I noticed that there were some acquisition dates. For one of my seeds it was 1947. Is that seed truly from then? That particular one, I got two different versions. I got a 1980 version and a 1947 version of this risotto rice from Italy. The 1947 one did not germinate very well. The 1980 one did pretty darn well. That seed is not that old?
Susan: It is maybe that they have not amplified it since 1947, but they kept it in cold storage. The cold storage that the USDA or that IRRI keeps should last fifty years. They think that is probably right on the edge, but they probably have not rejuvenated it.
Audience: It might have been from '47?
Susan: Yes, every fifty years.

I guess we will continue on. Usually here in the Northeast we are pre-germinating our seed, soaking them, until they are pipped or there is a little shoot coming out. This increases germination and how well the seedlings establish. You submerge the seeds in water, until you see shoots. You could do this in a pretty broad range of temperature. It seems to be optimum around 80, but you could just use room temperature water. We have had discussions about this. You can use room temperature water.
Audience: It is like sprouting?
Mia: Yes, like sprouting your seeds.
The only concern is going above 107 degrees, but you probably would not be doing that, that damages the seed. Then drain the seed before sowing the seed.

Planting seedlings in rows seems to be a pretty obvious, but it really helps with managing weeding, being able to rouge off-types, etc. For seed management it is a way to be able to look at the plants. I do not know if this is applicable to this area, but for the Uganda certified seed protocols they are recommending at least 8" apart between rows and 6" apart within the row. That is pretty close but that is for a single variety grown in a section. I know that a lot of people are growing rice at further distances apart so that works too. Then if you are planting multiple rice varieties, we talked about this already a bit. If you want to grow in rows, make sure that the plants are not touching between rows. The best way probably is to grow little plots of each variety and collect seeds from the center of the plots.

A major part that we have talked about already too, is field inspection and roguing off-types. You need to monitor your field regularly so you can see how the plants develop and grow. It is important to be able to make visual comparisons between the rice plants and to be able to understand how this variety grows or how it develops over the growing season so that you can be able to identify plants that may be off-types or may not be what you are looking to save seed from. It recommends rogueing these off-types at least once before flowering, which happens around heading time, and then once after.

I will not go over all these traits, but for rogueing off-types, there are a whole list of characteristics that you can use. A lot of them are visual, so you can see them in the field. Some of them you would need a lab, but we can focus on the easier ones when we are trying to rogue the off types. Like Jim was talking about, if you see that plant that is growing distinctly different than the other ones in the row, you probably want to remove that one right away.

Audience: What is awn?

Mia: If you look at the spikelet, some rice varieties have a little thread at the end of the grain. For example, Duborskian has a long awn. A lot of the Hokkaido varieties do not have an awn. That is a way you can distinguish varieties from each other.

The first part of seed processing is determining when to harvest. There are several ways you can determine when to harvest. When 80-85% of the grains have changed from green to straw color or when 20% of the grains in the lower part of the panicle are in the hard dough stage. If you are able to measure moisture content, you can figure out moisture content. Or if you just take a grain and hand dehull it, take off the husk, and it is clear and hard, then that is a way to determine when the optimal time is to harvest.

Threshing, a lot of the literature says you should thresh immediately after harvesting, before drying. I know that my father dries it first and then threshes it. It is I think a matter of preference. The reason why they recommend threshing immediately after harvesting is they do not want you keeping the rice grain in piles where they could be discolored or get some kind of damage before you store the seed.

Drying, you need to dry to below 14% moisture content. This is probably not a concern here if you are drying out in the air, but if you wanted to use a mechanical method of drying, you do not want to go above 109 degrees. Once you get into the high hundreds you can cause fissuring in the seed and it damages the seed.

Storage needs to be airtight. Protect from cold, moisture, and pests. They are recommending if you want to do longer term storage, more than a few months, that you decrease the moisture content in the seeds. It is a little bit of a greater degree of specificity in the moisture content but it just depends on what you have available.

Lunch

Lunch included a traditional Indian meal provided by Shital Kinkhabwala (Shital's Indian Vegetarian).

Small-scale Rice Processing Equipment: Don Brill

You can see this list here. I was in the process of trying to make these machines and there is a lot of trial and a lot of error. I was going through a lot of paddy [rice with hull attached]. I was buying paddy from California and because it is seed, I was paying $10 a pound. I spent $200-$300 on nothing but paddy and then they ran out. I sent her [Mia] a note, and Anna [McClung] sent me 50 pounds of paddy and Paul Kile sent me 15. Sjon Welters, Sjon stand up. He saved my life. He said he was more than willing to send rice in exchange for a small tabletop huller. We will go into that later. Then Erik Andrus, he gave me about 30 pounds. He saw the very first one where I used spur gears. Technical help, Andy Cloud in the back, stand up. Come on, stand up. He looks like he is

standing but he really is not. My son Josh, his girlfriend Meadow, and my wife Becky. She is over in the corner.

I got done with one project for my daughter and her partner and then Josh said, "Dad, I have a problem. I am growing rice and I do not know how to process it." Everything I see is between $5000 and more for a good huller and then for a separator you are looking at $10-12,000. For those of you growing rice, that is a hard step because you might not be growing a lot. Maybe you guys will figure out some kind of cooperative. After I talked to Josh, I did a little research. I was at Jan and Andy's house on New Year's Eve-ish for a little get-together and I showed up with the first huller. That is how I got him hooked trying to help me solve this problem of how to build a huller that people can afford. If you are growing 200 pounds of rice you are not going to spend $20,000 to process it.

All I am trying to remove is the husk, right? Here is what we developed. We have a thresher. That is over there. Turns out there are two over here that are probably better than this one. This one you could build yourself and I will show you how for $50 in parts. I put hulling, dehulling, dehusking, because these words are all interchanged. We have developed a hand one, a bike one, and a small motor. Winnowing, we are just using either a household fan or a blower. I will show you the two kinds of fans. A blower is very directional. I use a dryer motor as an impeller to actually suck air through my system. For separating, it is very difficult. When you go in and look at the patents and the history of rice milling, separating is their slow spot. They always have to have a lot of separators. We did work on it.

Thresher. This thresher is basically some 1x4, 1x5, now we think this wood is too wide. You want to go look at the one in there and match it. I think we are going to narrow this down because when the rice is hitting this, we are not getting this edge effect. We would like to have gaps in here and I am powering it with a bicycle. I am not using a treadle. This was just real simple.

Now, I wll show you how to make that circle because that is the difficult thing. At Lowe's, they sell these for $8. It is already a circle. You do not have to cut plywood. You buy two of these. You have $16 into your system. You take this thing and it has a nice edge. I am sure it is machine made. You measure it and then pick your center. You might have to measure it a couple times. For this one, I am using 5/8" rod, right out of the store. I run it in here. The wood that is on there is from your lumber store. I lay this down, cut a whole bunch of pieces and lay them around the outside so I know where I am going to put them, then I cut a straight edge with my saw. My other piece, I put this on top of it. I mark it A or B, so all of these cuts are more or less close. I do not have that good of skills, so I did that. We have this rod coming through. One of the ways is to take a pulley attach it on the inside. Now see I have a set screw here. I can drill through this and lock it in. This would be the rod. It goes in the shaft, like that. I can have this inside if I want to. My source for pricing everything and delivery on this was McMaster-Carr, which everyone has access to on the internet. These are sleeve bushings. You get a sleeve bushing, you drill this hole out to match the 3/4" lead bushing. This goes in, then your shaft goes in here. Then that is all the frame. That is pretty obvious. I will not go through that. For the wire, we had some political campaigns. I repurposed the wire from political signs. I probably have 50 of these now. You take this, cut it to your length and bend it. You run it through your holes. I practiced. I ran it through the holes and bent it on the inside and now it cannot come out. Pretty simple. That is the thresher. You can still buy it and there are a couple out there that are treadle, that are really good.
Audience: There is one of those out there.

Don: You brought one, a treadle?
Audience: What did that cost?
Audience: With shipping it cost about $1000.
Don: This is yours, this is the one you brought? This brand?
Audience: Yes.
Don: And it works, right? Works well?
Audience: Yes.
Don: This one is not going to work as well as that. If I were you, if you wanted to build your own, go look at his, match this with the wire. Make it thinner wood.
Audience: What the guy said was he took a Chinese design. He bought some Chinese ones that were not made very well but had a good design. He and a local mechanic had sold about 200 of those. It seems to be true. They got to the point where it was pretty well made.
Don: The one on the farm here has some kind of flywheel in it and it is phenomenal for power.

Centrifugal hullers. They exist. I have wired a guy in India. This company, I wired them a little over $1000 at the end of April to get it here by this conference. August 25th, it was supposedly put on a slow boat from India. Takes a long time but we might actually get it. We are not sure. I am going through a friend of mine who imports. Supposedly it will do oats. Josh wants to do oats and oats are tough. I just wanted to say it does exist and at the next conference if Josh has it, he can bring it.
Audience: I have one of those too.
Don: Oh yeah and what would you say? Good? It works well?
Audience: It works.
Don: How tired do you get?
Audience: That works very well. Your model may be better fabricated. It looks the same, but it is pretty flimsy the one that I have.
Don: This may be heavy. It may be cast iron. I am assuming they have got a foundry and they keep making the same thing for a hundred years. We will see. What we would do, we would try to hook a motor up to it. The one you have could you hook a motor up to it if you wanted to?
Audience: I have not, no.
Don: But could you if you wanted?
Audience: Well, one could.

Here is this part about the huller. On the huller, these things are really important it turns out. It is not my fault if the machine does not hull his rice because he has a lot of immature rice in there. I just wanted to say, that is my caveat. I have an excuse. Here is the principle of it. Both of these, all three of them, work on opposing rollers. You can read it there, one going a little faster than the other. It is pretty straightforward, and the industry likes this one. Opposing rollers is what the big mills use. These rollers would come off a commercial unit. This one is 6". They tend to run all the same on the width, about 8 3/4" (which must be some metric number) and 10". They will run these at 1700rpm, 3500rpm.
Audience: They use two wheels of different diameters at the same speed rather than two wheels of the same diameter at different speeds?
Don: Same diameter. Different speeds.
What I found, which was not intuitive to me, is that the one that you are running fast is actually doing all the work. It is doing 99%. I am running this one at 4-500rpm. It is trying to pull this. You

have to have them both running to draw the rice down. But this one is going a little slow, so you get a shear effect.

Audience: What is the ratio, do you know?

Don: Some people were at 70%. I made up going 50 because I got a better yield. I am running at about 90% or greater and that took running this thing slower and slower. It means the volume is lower.

Audience: Basically one pulley drive is half the size of the other?

Don: Exactly. We have got a pulley set up and that is exactly how you do it. That is why I was saying to the people I talk to, once I show you how to do this, you will go, "Ah, that is pretty clear. This is how we do it."

This is the only literature I found that could claim how long one of these rolls would last and it is hard to believe. I have a 6" roll. They are saying 200,000 tons. It is a nonsense number. To say we would do 200,000 tons, well that is not happening. They will last a long time, but there is no way they are doing 200,000 tons. Somebody made a mistake. I give this person credit. Do the math. There is just no way. Now we are going to go over the handhuller. I will just leave this up here. This is how much it costs for parts.

Handhullers. These machines, all of them, have the same basic design. The only difference is the rollers. Everybody has a small one. This is the drive one. This will be my fast one. And you have one basically twice the size. Here I have an idler. These are called idlers out here on the end. What it did was it separated. What I was able to do here by using a chain, I could get this gap set. I can do a one person system. I will explain this one and then I will be able to go quickly over there, because this will be the basics. We have our two opposing rollers. This rod here, has a nut here and a nut here. It is a threaded rod all the way through. When you go to buy these, you want to get the ones that have the little plastic insert or they will come loose. This sets my gap. I can adjust the gap by moving this in or out. If this thing gets overloaded, the spring will allow this plate (this plate is attached, this one is actually floating) to open momentarily and then it will spring it back. Turned out, I was reading the literature, it is not common, but some manufacturer bragged about the fact that they had a spring-loaded constant tension so that they could absorb that if some pebble came through, some bolt, something you do not want. Otherwise these things could lock up or they could rip their unit apart, their rollers. This side, this handle, this came from a boat supply place. When want to pull your boat in, $8 for the handle. I am going to show you this, but I am going to explain this a little later. This is the polyurethane. When these guys bring in their boats, there are rubber rollers and there are polyurethane rollers. The polyurethane rollers are $23 for a foot long. It will not mar their boat. It turns out the durometer on this is very similar to these rolls. These rolls are much harder than I thought. I want to pass this around. When we first started this, Andy knows about this, Cat, a company out of California and I am assuming they are out of Japan really, shows a little tool that when you are in the field you can crank this. Open it and there is your little rice so you can see where you are at. This is $100. I had to buy it because we did not know how these things worked. We took it apart. Andy took it and got the durometer of these rollers, which are softer.

Audience: What is durometer?

Don: The hardness of the rollers. We took it apart. Then we saw spur gears and how they did it. You put the rice in.

Audience: That does not really separate? It sends everything to the bottom so you have to separate it?

Don: Yeah. It does not have a winnower or anything. No, no. It just goes through and it does not do it all, so you just turn it over and you do the other side. The idea was that is where I started. I had nothing, right. You should feel sorry for me.

See the pricing up there? What was interesting was, I thought this should be cheap. It turns out everything on here except the rollers is identical to over there. I still have to have the gears, the chain, I have to have sprockets, and I have to have the idler. Initially I tried to adjust the gap to feed my rice and turns out that does not work. We did it over at Sjon's [Welters] and he ran 70 pounds of paddy through the initial huller. We were set up a little differently with the belt driving my feeder. I had one big belt. I adjusted the gap but it was feeding fast so I kept closing it down. It went so fast that it eventually ate out the wood. It was just abrasive. We had to redesign that. Now what I have done is added another pulley, and again differential pulleys, whoever mentioned that. Now I can put a bigger pulley on here and I can slow this down even more. I will not go into the details of this, but I need to control that flow, especially when you are doing it by hand.

The feed system. We have shafts. This is a precision shaft. You do not need to use these for the hand hullers. You could get 5/8" rod. Get the one that has zinc oxide on it, that they have covered, otherwise everything gets black. This right here is the sandpaper. I take a rod. This is 5/8 hose for a clothes washer. Then I took epoxy and I glue this to the surface. Most of you saw this running out there. What happens is, my rice is collected here, this pulls it up and into my slot, and that is how I control the feed. Then it all just goes through my rollers and out this slot. That is why it is $200. We tried. Sjon, Josh, and Paul, all got my $30 version. Josh, basically said it fell apart. It did. It just ripped apart. Sjon was a little bit more polite, he said, "Well you got some work to do." Paul Kile, he must have learned if you cannot say something nice do not say anything at all. Okay, I might go back there if we are really inexpensive and change some parts to plywood, but it is $200. I cannot get it any less. That is what it is going to be, unless you go find your parts from a different source. My pricing is all based on McMaster-Carr internet pricing.

Audience: It is all brand new everything?

Don: Absolutely. Everything in here is brand new, off the shelf.

Now we are going to talk about the hullers. You have to have this shaft perfectly centered with the outside of this roller. The inside of these is actually not controlled very well. The diameter goes in. This side is wider than this side. I believe they probably make these and then turn them on a lathe to make them true. I think that is how they do it because the outside dimension is not exact. Here is what I did to solve my problem. I make this spoke. I then have three set screws. I am doing that on both sides. I take a right angle and I measure this and just slowly turn these screws. Just think about putting up a Christmas tree, I am moving this back and forth. Then I do this side until both sides are perfect. There is a wooden plate that I screw in. That is not done yet. Then I have a little stage, and I put a plate in front of it and I spin my plate. It has to be basically perfect. You are looking at a grain that is only a couple millimeters in diameter. If you are off a millimeter, it is not going to work. Half of it is going to be wrong. I do this and it takes me now, I am getting pretty good, about 20 minutes to center one of these. If it is your first time, it might take an hour but you just have to do it.

Now that I say I am centered. I take this wooden plate that is already inside there and I screw this all together. Here I have notched this. I use this epoxy. This is an industrial grade epoxy. Takes about 15-20 hours to cure. If you do not think the epoxy will work, do a little research. I sold it in 1973. It is very strong. This will break down before it does. This is a shear force this way and a compressive force this way. I do not have any tensile so I am good. I fill these slots with the epoxy and then this

shaft has been flattened on a couple sides and then I fill this with epoxy. Now I have shear force, shear force. I have this, but because I have flattened it on a couple of sides, in order for it to break loose, it would actually have to shear all that epoxy off. It is not going to do it. Our loads are quite small. Is that clear? This might sound like a lot of work, but you can do it. We have the rollers. When you go to build this, you know the size of your rollers. You know you have to have a gap above and below it. You know that the wood has to have a gap so that the rollers can come together.

We will go over here and go over this one. This one is not quite set right. This is a bike off the side of the road. Josh's girlfriend, Meadow, found it and said, "Let us repurpose a bike." This one I have set up so that I can run it off a bike or I also have a motor that sits on the ground and comes up here and matches this framing right here. That is another side. Josh has wind and solar panels. When he has electricity, he wants to run it with a motor. When he does not, he wants to run it with a bike. He has to have that option. You got to please the customer, right? We are can run this off a motor, that is why this is low. This is my high speed, small. These belts are called double "A"s. Most belts have a "V" belt on one side. This one has it on both sides. This belt goes up like this. It is going this way, so that makes this one go like that. Now that is coming down, up, and around, you will see this one goes. This one is going about half the speed. These are your idlers. This is my feed system. I have a small one and a much bigger one. I have to control that speed. Here is a tip. If you ever have to buy a "V" belt, all you have to do is take one of these tapes, because it is always an issue, and you just go to the outside. This is a 27" and this is a 27" belt.

Audience: There is an adjustable belt, too, at farm supplies.

Don: The ones that have links? Yeah, they are phenomenally expensive. This is $5. I did buy a lot of belts. These are like $5 and those are like $25.

Audience: Throw them in the trunk of your car and you always have a spare belt.

Don: That is a good idea, just in case. Those are the good old links. Get yourself an adjustable belt so that when you figure out what size you need . . .

Let me first say, when you go to get a fan, this is your normal fan. The air gets dispersed like this. If you want to winnow and you do not want to use what I am using there. These are blowers. They are like $60 or $70. Lasko makes everybody's. Stanley does not make these. They will give you a real nice directional airflow. That one over there. We were always blowing and that is a real problem because now you are blowing husks all over. You try to do it inside and you have husks everywhere. I woke up one morning and I am saying, "Well where is a cheap motor? All right, dryers have cheap motors." I bought a $25 dryer, took it apart. I have a cut off wheel, $20 you can buy these handheld cutoff wheels. I took the dryer apart and I just cut this right out. This section. It takes maybe ten minutes and you can cut this out. Somewhere it says, use motor only in clothes dryer. That is a message. If you want to call that a clothes dryer…

This is the part. Your little drum is up there, the air gets sucked in here, and it gets blown out here, out of your house, right? It is 1/3 hp, draws about 350 watts. I have a little amp meter so I could verify that. Turns out electric motors you would think start drawing higher as they go under load, they drop. I have a one horse power motor. It draws 6 amps whether it is under loaded or not. That was another learning curve. Why get a one-horse power motor, if you are never going to use that much horse power? This 1/3 hp motor, some of them could probably get away with 1/4. I had this and I was starting to take it apart, and all I was going to do was use this motor because it is already mounted for me and it has some flex. Then I all of a sudden I said, "Well, wait a minute, I have an impeller here. Can I use that?"

For those of you that saw it run, all of the mechanism is back here and on this one I am using a chain rather than a serpentine belt. What happened to me was I stopped getting high production, because I can get about 90% when I run it through. All of a sudden I was getting 70%, 60%, and I did not know why. Everything is spinning and usually it is the gap. Turned out if this belt loosens at all, this, the slow one, will start going as fast as the fast one and now you are just pushing it through. It is not hulling. They are just going through. To solve that problem, because it is going to my son and he might not tend to it as well as he should, I said, "Well, what if I put a chain on it?" It is not going to loosen. The prices may be $20 more, but with the chain, you set it, you forget it, and you do not have to worry about your belt stretching.

That is what is back here. We are going to run it through, it is going to come out. Down underneath here, the rice is coming down and it has energy, so we have a couple of plates where the rice comes down and bounces off. What I have done with the vacuum, with this dryer, is underneath here. This is just ductwork that you get at a hardware store. I have a gap. I have air blowing in this way and up and I can adjust the air coming up from the bottom because I only want to pull out husks and immature grains. I do not want paddy. I do not want rice. I set this and it just sucks the husks up. If I want to test it, I set everything up and let it blow into a container and then I see if I have rice or paddy in it. If I do not, then I know I have it set correctly. Here, I left this open just because it is good show and tell. It is the impeller. The husks come up. Back here, I have a PVC pipe that I run. The dryer motor is protected by some mild steel with a screen on it. Then I have this PVC pipe that is here so it is drawing air in to keep this motor cool.

That is about it. We talked about the separator. For $50, you can buy one of these motors. This is a vibrating motor. The initial idea was, we will have something with holes in it, we will put this on it, and we will vibrate it. It does work. The rice goes through and you shake it with your hand. That is what I was going to put on here. Then, this was probably a week ago, I went, "Well, wait a minute, I have enough energy to run a separator." A separator almost needs nothing. I had these 1/8" holes, which works for my son's rice. As this turns, it is going to pop this up and down and then the rice slowly goes down, the rice drops through and the paddy goes off. That is pretty much everything right there.

This is my dust collection. You can buy this. This came from Rockler. Any of the people that sell woodworking stuff, they want to collect the dust. I just bought one of those. We tested it today, it did 60 pounds an hour. This one the clock did not work, so we do not know. This one, because you are running it with a bike, it is maybe 20 to 30. To get 40 you really have to work. You would need an athlete.

Josh: The thing that you did not mention about the bike one, is that you can be running that huller and a thresher at the same time. Even if you are not threshing, the thresher is really nice because it is a big flywheel. I pedaled it for an hour and I did not get tired at all. You just keep going because the flywheel wants it to go.

Audience: What about when you are threshing?

Josh: When you are threshing you cannot really tell that you are doing it. Once you start going.

Don: Yeah, that was surprising about it. It almost takes no energy to thresh rice because you are doing this. It might take a watt, but you are actually putting in 20 or 30 watts. It takes no energy to knock the rice off.

Audience: Are you going to go open source with this design and put some details on-line and stuff like that?

Don: This is going to go up either, probably on their webpage. This was the test to see if it was worth it. Based on your response, then we will put the effort in to say well here is how you can really make it.

Audience: What were the pre-industrial ways of hulling rice?

Don: You pound it with a stick. I am telling you they still do it and they think it is great because they love broken rice. If you asked a farmer today who said they are going to grow 300 pounds of rice to stand there and do this, they might not want to do that.

Susan: Do not forget the women did that.

Don: Are you saying that is okay then? Well, in that case…

Audience: That is why it worked.

Audience: I have a question about scaling this up. It seems like the bicycle-powered thing is quite functional, works great. Do you think that you could use a 12" roller instead of a 4" roller?

Don: It takes a certain amount of energy. I have two problems. The ones you see at commercial mills, the motor's run at either 1700 rpm or 3500 rpm. Asia it might be different. That is our normal rpm range. When they build it, they build it with very nice balance. The bearings are really good and everything is heavy, so it can spin. I am spinning at 400rpm and the slow one is down around 250-300. If I start adding more rice, I got to put in more watts. A human cannot do that. A human is good for 1/8 hp. I have heard Lance Armstrong is 1/4 hp. It is not a lot of power. What I would suggest would be if you are doing it with bikes, I would take that thresher idea and make a bigger flywheel. Once you get that, if you are really gentle and get that thing going, then you might be able to do more. We were thinking with his motor, I could build one and I could tie the next one, couple it directly to it. No more of the other pulleys. Now I have two running.

Audience: A three-speed bike and a fifty-pound flywheel or something like that?

Don: Yes. Why not? Well, I am using the sprocket. Another little thing you are going to find out. This is a bike chain. It is 1/2" length between. These are 1/2" so that makes it a number 40. Then you go, "Well hold it, I want to use my bike to drive that. I am going to go and just order a sprocket. Right?" This is a bike sprocket. It is like that. This is what you are going to buy on an industrial level. It has got to run at 1000 pounds. I actually started trying to grind it, to see if I could get this to work. That was not such a good idea. Let me hold up this chain. This chain, this is probably $8 worth of chain. That is the difference. This chain is much wider here, but it is still 1/2". This is a number 40. If you buy a number 40 chain, it will go on the little sprocket of a bike. Then it will fit all these sprockets off of an industrial level.

Audience: The one you ordered from India, what led you to pick that particular company and model?

Don: It is the only one I could find. Any of you who have started to do this search, you will find that it is just hard. It is just not there. A two-man huller. Ben Falk has a video of him using the huller. I sent that to this company saying, "Is this what you have?" They responded with, "We think it is very similar."

Audience: You bought it in April and you are still waiting for it?

Don: I gave them money in April. It was, you send us money and we will ship it in three weeks. I may never see it. It could be lost money. A friend of mine that does the importing, he thinks they are legitimate, but we are not sure. There, they can go without electricity for a week but they do not answer the phone like a company. We will see.

Audience: They supposedly put it on a boat in August?

Don: I asked for my money back four weeks ago. I said you did not meet the deadline, wire us the money back. A friend of mine, Mike, this is what he does. He imports from India and Vietnam. He said, "All right, we want our money back." No paperwork, nothing. We get a response two days later, "Oh yeah, it has been shipped. It is on its way to a port in India." Then it goes onto a tender ship that takes it to the big ship. We do not know. My ship may have sailed. I had no choice and now it is going to come into the New York Harbor. I do not have any company to send it to me. I do not know what we are going to do when it gets there.

Audience: Do you have a bill of lading or any documentation?

Don: I am counting on Mike to save me on that. We do not know. It should. Normally you have freight forwarders and everything is set. I did not get any of that. Throw your money.

Audience: Just to clarify, you were looking for hand-powered that was not like the motorized ones for $5000 to $20,000?

Don: Right. What we also need is for those of you who have purchased. You bought a really good huller and if we tried to buy his huller, we are going to spend close to $10,000. I talked to them and they would not give me much more than, "Look, it is $12,000." I said, "No, I want an inexpensive one." "It is $12,000." You want a separator, another $12,000. Now there is a centrifugal one back there, that Calibration Plus sells for $5,000. It is an impeller style. They are available.

Audience: What is the scaling on those hullers, the Back to the Land's one or even that one? Do you have any sense if you want to do that for an acre, or a half an acre? Does anyone have any knowledge on that?

Don: Are we talking about the thresher or the huller? Or the whole idea?

Audience: The thresher.

Don: You have a thresher? How many pounds?

Audience: The Back to the Land people say that they think their machine is suitable for up to an acre. They figure you are going to get pretty tired if you try to use it after that.

Don: Now could that one be hooked up to a motor? Does it have a shaft?

Audience: I have no idea.

Audience: It works on a rotary principle, but if they make it like a treadle…

Don: You should be able to. That is what I would do. I would say, "I have a lot of rice, I am going to get one of these low-power motors, because for that, 1/4 hp. You can get a dryer motor easy for free and drive that forever. It would not even see the load. You could actually blow air across while you are threshing and get rid of the chaff that comes in.

Audience: That whole thing with Satake and Yamamoto, it is the same thing as Calibration Plus. I was looking at it and you were looking at about $11-12 grand. I contacted Mia and she talked to her Mom and Dad and they had paid significantly less. What really got me going was I had actually talked to Calibration Plus last fall. He gave me a price

last fall, which fortunately I had saved that price. When I called him again, after the yen has probably dropped in value upwards of 30%. I am thinking, I am going to get a much better deal. Well the price went through the roof. It went way up to $12 grand.

Don: That is not the table top one?

Audience: That is like one very similar to what Takeshi has. I am trying to figure out. I ask a friend of a friend to check out the price, what does it cost in Japan. It is $2700 dollars to purchase it in Japan. I talked to another guy who actually makes this little combine harvester. He is in Massachusetts. Eddie Qi. Eddie said he could have it landed in Manhattan for me for $3600.

Don: Now we are getting into a price that is reasonable.

Audience: Something is wrong with Satake in Texas and Calibration Plus. I do not know what they are doing but they are taking advantage.

Don: Right. My idea was that I had to be 10% of the true cost. Once you are down to $3500, a farmer might want to do it. They would start out at this low, low level, then that would be the next one. Have you ordered it?

Audience: It has not happened yet. I wanted to come here first. I thought Eddie was going to be here today, but he is not.

Audience: There is also a company in Florida that imports a rice dehuller that also polishes. It does about 1000 pounds per hour and you pay $5000 for it. You can just buy it directly from this importer in Florida.

Don: It always polishes, though, right? It will not give you brown rice?

Audience: No it will. It will. It will dehull it. It is an upright machine and it has several stages. You can put in the paddy rice and then it will dehull it. You can let it go further and it will also polish it.

Don: So you can break it out? The guy I talked to that you can get these rolls from, he said no, it polishes. That is it.

Audience: You can check on-line and they have a diagram of the machine.

Don: Was that $5000?

Audience: The smaller size was $4200 and the bigger size was $4600 but that was two years ago.

Audience: What is the company?

Audience: I will have to email it.

Audience: You mentioned Eddie Qi? Mia, do you know Eddie Qi?

Mia: I have never met him. I have only communicated with him through email.

Audience: Do you know people who have done business with him?

Mia: His contact information was given to me by someone at the Kneading Conference. His machine/combine can be used for wheat as well. It can be used on any grain. He has been working with people to get the machines to wheat growers.

Audience: He has some kind of a track record in this country?

Mia: I think so. I do not know anyone personally who has gotten anything from him.

Audience: Does he have a company name?

Mia: I think it is EQ Machinery. I think if you Google it, you will find it. I can also email it.

Audience: These threshers are really nice. They work really efficiently, but for a small-scale operation it is really very easy to take a trap, put it on the ground, put a big rock in

the middle of the tarp, and then just beat the whole stalk onto the rock. Then throw away the straw when you are done. It is not difficult at all. For small scale, I think it makes more sense than using the threshing machine.

Don: If you have only a little bit that may be the was to go. Ben Falk shows doing it in a canoe.

Audience: I think if you are dealing with 1000 square feet or more a threshing machine is probably really not necessary, you can just do it on a rock. These guys were mentioning to me traditionally before the pre-industrial technique was to mush it underfoot. I have never seen it done that way.

Don: Hulling it underfoot? I talked to a guy, who is here, whose parents own a plantation in India and he said labor there is extremely cheap. I said, "What do they do?" Initially he said they would just walk on mats. I said, "But your feet are pretty soft." He said what they did was then he called or talked to somebody, and they would have a brass cap and they would walk around and just pound it. There are so many people and labor is so cheap, that they just walked around and did it.

Audience: Also, for separation too. If you take a large plate, it is called nanglo in Nepal, a woven basket and sort of toss it and beat it on the bottom at the same time. You can really quickly separate the grain from the chaff.

Don: Here we have a fan. That is not separation. That is winnowing. The question is then, when you are at 80%, if you still have 20% paddy in there, that is not saleable. What people tend to do is keep running it through their system, which is polishing it and that is not good. You do not want to do that. That is why you need a separator. You are winnowing, but with a separator you are separating the paddy from the rice.

Audience: I think typically the larger scale mills have a fan as part of the machine while it is separating.

Don: Just like what I did. You just suck the air through.

Audience: Right just like what you did. Then it ends up it comes out very clean in these larger mills.

Don: Then what they do is have a separator afterwards. You look at it, go on the internet, you will see in mills. You can buy, each one is like 20,000 or 50,000, and they stack them up. They will go huller, winnower, and then at the bottom they will have a separator. That separator is either a compartment style, sieve style, or oscillating. It is really complicated. They do a great job. Andy and I might work on that. A separator for home use because who wants to spend $15,000?

Takeshi: If you thresh using traditional methods with a big stone it may work well with some varieties that easily come off of the stalk. However, some newly bred varieties tend to stick more strongly to the stalk so that they do not fall off during the process of harvesting.

Audience: Are different varieties of rice going to change the diameter of the hole that your separator would be? You would need various separators depending on your grain?

Don: A normal separator is not a sieve. You do not use these. It just so happened that the rice that these guys are growing, happens to fit an 1/8" hole. I drilled holes to figure out which one it was. Then I just bought a stainless steel sheet for $57 for a car. We have a polymer one.

Audience: They make a wide range of hole sizes?

Don: No they do not. If you are at a small scale, you can buy drills that go in minor sizes. We are talking 1/1000 of an inch different. This is polypropylene with 1/8" hole,

$17. If you are growing this variety, then you can use that. When Andy gets done in developing the compartment style… Satake makes one where there are two plates. You have them all stacked up. It is going like this, shaking, and it has little indents that match your rice. The rice climbs up the indents and your paddy (they want it to be 80% or less) floats over the top and back. Your indents have to match your rice. If you have long grain and short indents, that is a problem. There is a compartment one where we have not figured out how they make it work. They cut it at an angle. They go back and forth. The rice falls and the paddy climbs, but you have to have the right oscillation and the right pitch. It will separate any rice. If we are going to do it, that is the one we would try to develop. Andy went out and bought a DC motor with a variable frequency on it so we could adjust the speed to whatever we want. If we could do it, I think it would help a lot. It is just going to be difficult.

Audience: Have you tried any varieties, like Duborskian with long awns?

Don: I only built for my son. That was the number one project. Then it was alright, I have done this for Josh, and I contacted her and put myself in the spot of going, "Oh, I really got to do this." That is why it is just one variety. Hulling you would just adjust the gaps. You look down and say I am going to adjust this gap. If you are ever going to do this go wide, not close, because if you start close you are going to crunch it and you are going to wear your rollers out. Go wide and then I actually drop rice kernels in and see when the rice just stops and I start there. Because the wider the gap the less wear.

Northeast Rice Paddy Agriculture and Conservation: Conrad Vispo

I have some good news and bad news. The bad news is I do not know anything about rice. The good news is I am not going to talk very long, so you do not have to worry about that.

After seeing this presentation, I thought I should bring some of my own equipment. It is not quite the same degree of complexity, but at least you see we use it too.

Our program is down at Hawthorne Valley Farm, which is in eastern New York State. We do a lot of looking at how nature and agriculture interact. I never have worked with rice, but I am going to talk a little bit about how we approach that. A few thoughts about rice paddies and how they might fit into the ecological landscape and then talk a little bit about the project that Takeshi and I have been trying to think through and see if there is any interest. If there is no interest, we will not do it. If there is interest then maybe we can think about it.

If you have any questions, just go ahead. Some thoughts and questions. I do not have any answers.

This is a background that I want to share, that I think is probably obvious to most people, but it took me a while to figure it out. You throw the ball up, you get older, you throw it up again it lands on your head. Finally it has dawned on me. All I wanted to say is that it has taken me a while to perceive the obvious and the obvious in this case, to me, is there is one view. I come from a conservation/biology background, and there is the view that well the important thing in this landscape is the nature. There are some other things going on here. You get pretty pictures like this.

Or there is the other view, well the important thing that is going on here is the farming, and there is some other stuff around it. There are all these reasons for doing farming.

All I want to say is that both of these are in the landscape. I am not going to try to stand up here and say you want to justify farming from a nature/conservation perspective or that you want to justify the nature/conservation from the perspective of the benefits it provides to agriculture. They are both in the landscape. If you agree these both have value and you are not going to say that one is more than the other, how do you find the synergies? That has been the philosophy that we have been trying to work with.

How do we emphasize the synergies? Of course, there are ways that it interacts. Some of these habitats in the cultivated land actually are important for nature/conservation. Some of the wild species that you have up here do provide services to the agriculture. How can you accentuate the positive, essentially?

You have an agricultural habitat, be it a rice paddy, be it a grain field, whatever. How do you think about that fitting into the landscape ecologically? This happens to be some mapping we did. This is Hawthorne Valley Farm. The farm is actually here. This is more or less what it looks like today. You have Taconic State Parkway here. You have forest. You have fields. You have other forest here. This is maybe what that same place looked like 500 years ago. The question becomes, where did the organisms that live in this landscape, where do they live in this landscape?

As you think about this, you realize that 500 years ago, there were certain habitats that existed in this landscape that you do not see very much today. For example, there is a hill over here. The farm is actually here right now. This is a high, fairly dry soiled hill. It burned relatively frequently in all probability. We do not let it burn. We actually had a fire this year, right here and the volunteer fire department was on top of it. It did not get very big. It got about the size of this room, maybe a little more. There used to be a lot more beaver. We have beaver now, but not nearly the number we had historically. They have a huge effect on the landscape also. There were some habitats that existed 500 years ago, that we do not have today. Likewise, today, we have some habitats that did not exist 500 years ago. We have things like a lot more manmade ponds. We have a lot more agricultural fields.

The question becomes can you actually find some ways in which those new habitats, for some organisms, can replace some of those old habitats. We are not talking about restoration, what we are talking about is called ecological analogies. You would have had in that historical landscape, post-fire shrubland. The fire comes through, the vegetation gets burnt down, and you get shrubbery coming back up. There are certain native species that are used to this. This is not the same thing, but a post-cow shrubland offers an analogy that works for some species. Not all of them. It is not the same thing, but for some species it works. That is the idea of the ecological analogy. They are not the same, but for some species it works ecologically.

This is another example. This is a beaver pond. You have the beaver dam, the surrounding wetlands, and the surrounding pond. This is a cattle pond. There are no beaver in there. It is not the same thing. For example, some of the dragonflies you might have around the edges, you also find here. Okay, we want to work with both of these, how can we work with the agricultural habitats and provide some analogies that work for certain species? Does that make sense? The question here, where do these organisms find a home? The answer is the ones that are still around (some are not

because they could not find a home), where do they find the analogies? Between the beaver meadows here, the wet areas there, the burn, and maybe some of the dry pastures (the thin soil pastures).

The question then becomes, what is the analogy that we are working towards or can we conceive of for rice paddy? How can you have production and yet perhaps also benefit some species that are looking for habitat? Is it a vernal pool? How many people know about vernal pools? A vernal pool is a seasonal pool and I was actually reminded of vernal pools in one of the presentations. What was the name of the rice, aus? A very short growing season rice. It is called vernal from Latin for spring of the year. It fills up in spring and dries out in autumn. You have certain frogs and salamanders that rush in to this, try to grow really quickly, which was what reminded me of the rice variety, and get out before this dries up. What do you suppose the advantage to the frog is of trying to have that lifestyle?

Audience: No fish.

Conrad: No fish because it dries out.

Are some of the organisms that are associated with these sorts of pools, is that an analogy? Might that be occurring in some of the rice paddies? Or is it the beaver meadow? Again, do you have some organisms that might live here that you might be able to find or encourage in a rice paddy?

For whom? Who are the species that this works for? This is what I spend my day doing, so you have to suffer through some butterfly slides. These are all wetland butterflies. If any of you are baseball fans, where do you suppose this might be named? It is actually Baltimore, the Baltimore checker spot. This is a bronze copper. This is a mulberry wing with a cross on it. These are just some of the organisms that you might be getting in these habitats. A ribbon snake. Have any of you actually seen spotted salamanders? Have any of you seen them in rice paddies? Toads. This happens to be leopard frog in our area. Those are the beautiful dragonflies. I was just out in the rice paddy here I do not know how many of you saw them that were flying around. The answer in terms of what is the analogy, is we do not know. We have not looked at it yet. That leads to the thing that Takeshi and I have been talking about, a study to look at this.

I told you this would be quick. I should give a plug here. This happens to be Yong Yuk's paddy. They live up the road from Hawthorne Valley Farm and they are growing rice here. He talks about when he was a kid looking at the dragonflies occurring in his rice paddies.

Audience: How big is the rice paddy?

Conrad: He has two of them now and maybe each of them is twice the size of this room. Something like that.

Takeshi: I think twice the size of ours.

Conrad: He has this one and then he has another one over here.

Apart from the fact that I like nature, I think it is a neat time to be talking about this. Because as Susan was saying earlier on, rice growing is novel in this region (of course it is not novel historically) and there are models still being formed and there are public expectations being formed. It is a chance to say, "Okay, let us see if we can bring a little bit of this in now, as things are starting up." Wetlands are definitely rare and declining in the Northeast. If you look at different states, I do not have exact statistics, but it is 80-90% decline historically in the amount of wetlands for a variety of reasons. And finally here, we have what I would say would be the geographic and cultural space to do this. In the sense that you have culturally a population that is interested in local food and

interested in the environment. There are some possibilities of actually getting support this way. Although the land is relatively expensive, it is fairly abundant. You have a little bit of room to play.

The components of this study that we have talked about are three. What do experiences elsewhere, especially in temperate regions, have to tell us about rice paddy ecology? What native organisms do we currently find in regional rice paddies, what roles do they play? From what we know to date, how might one design an ecological rice paddy system? It is not that anyone is going to take that blueprint and say that is exactly what I am going to do, but it is to help you think about some of these things.

What do experiences elsewhere have to tell us about rice paddies? I made sure to put this in here. This is the rice paddy on Mont Blanc. What are the natural niches of native species that use rice paddies elsewhere in the world? There has been so much work done, can we learn from some of that as we go into this? What roles, positive or negative, do these play in rice paddy production? These being those native species, how do they interact with rice paddy ecology, and has anybody else really studied the role of rice paddies in biodiversity conservation. There was a professor here from UC Davis talking about the waterfowl and rice paddy interactions in California, where they have actually done a lot of work trying to accentuate that. That is the first component.

What native organisms do we currently find in regional rice paddies and what roles do they play? Just finding out that answer. We just do not know around here who is going to be coming to this. We can make some guesses. The hope would be, can we put together field guide so that if you have a rice paddy, (you are not going to spend all your time doing this, for sure) what frogs are you hearing? What dragonflies are you seeing? What salamanders are you seeing? What butterflies? Just giving you the tool so that also you can give feedback and say this is what we are finding. That helps us. Okay, here is something we can accentuate. Here is something that we can encourage.

Finally, and I am sorry Takeshi I stole this photograph from you. That is actually for a reason, because Takeshi would actually be very important in this part. I have no experience in designing rice paddies. Based on his experience, the shared experience here, and what we find in doing some of that initial work, can we put together an easy to follow and illustrated set of tips, designs, for what might make the rice paddy system most ecological. Where do you put it in the landscape and how do you design the different components. I wanted to put that up there and see if you had any questions or comments. Does this seem useful? It would be a matter of putting together a set of collaborators.

Audience: I have been thinking about this. I am from New Jersey and in New Jersey we have lots of laws about wetlands. Wetlands are really protected. I do not think that with any pre-existing wetland you would be able to have any success convincing your town that you should grow rice in it because of the amount of species you find in the few healthy wetlands left in New Jersey. But I am wondering if there are any other examples of wetland agriculture, whether it be wild rice or cranberries, to use as a precedent as an example to say, "Well the cranberry bogs cause this sort of pollution or something like that." There is an analogue within agriculture to rice that could be used to set the precedent. If I wanted in my home town to plant rice and the environmental person is like, "You cannot do that." Is there any sort of analogue in agriculture that you could think of that would be appropriate to compare?

Conrad: There may well be that I do not know of. I would say the one that comes to mind immediately, which is not quite the same. In the southern part of the region where

we work, there are fens. These calcareous meadows. If you did not keep those grazed, they would grow back up into forest. You would have wetland forest, which would be interesting. However, there are certain species, endangered bog turtle, that occur in those open meadows, and if it was not kept open by grazing or you could do it some other way, those would not be there.

Audience: Bog turtles actually rely in some way on cattle being there, right?

Conrad: It relies on it being open and cattle could do that. That is one of the ways.

Audience: I have also heard of bog turtles using the footprints for nesting.

Conrad: Could be.

Audience: I can answer his question, but only as to Massachusetts because that is the only state I am authorized to practice law in. The answer to the question in most states is probably a legal one. In Massachusetts the answer to his question is, do not go anywhere near a wetland or the conservation commission and the state department of environmental protection and possibly the Army Corps of Engineers will collectively turn your life into a living hell, unless you are fortunate enough to be a local person in a small town where nobody gives a damn. Legally in Massachusetts, for example the field where we are growing rice, I have no doubt is an historic wetland. Because it has been farmed for 300 years, we can do basically anything we want without regard to the Massachusetts Wetlands Act. We, for example, could do what you are suggesting without running the risk that the environmental butterfly people (excuse me) will land and say, "Oh you have created this beautiful environment. Do not ever set foot with your damned rice again. We are going to preserve it and it is legally protected." Whether that sort of exemption for agriculture exists in other states, I do not know. But if somebody, who was my client came to me and with your idea, I would say the first thing is make sure you are not going to create a wetland environment that is going to destroy your agriculture.

Conrad: Right and I am not at all encouraging you to go into a natural wetland and do this. I think that is part of what Takeshi and I would be working on.

Audience: In Massachusetts your idea is a great one.

Conrad: In New York State it is a bit looser, for good or for bad, but it is still obviously a concern. From an ecological perspective, I would not suggest you replace a natural wetland, because you are never going to get that good in terms of an ecosystem. But in situations like this, the question becomes, you know you have an area that has been in agriculture, it is a wet meadow, how can you make that better for ecology while also having your production?

Audience: And you are right about replication. In Massachusetts the law provides for replicating up to 5000 square feet of wetland and it is a standing in-joke because everybody who is involved with it knows that it is absolutely impossible. Wetlands are replicated, consultants and plant and animal breeders make a fortune, and everybody walks away knowing it is never going to work but it satisfies the law and it is sad.

Audience: I was actually trying to cover this already thinking the opposite, which is that you might want to look at to what degree a rice paddy conserves some of the natural functions of a wetland, like filtering water, in addition to creating habitat or storing carbon, or those kinds of things, or flood control. That if you could find that out, that would be a much better case for converting agricultural land to rice paddies. I am totally not advocating altering wetlands. I think that would be an uphill battle no

matter where you did it. But if you could find out if the rice paddies can perform some of the natural functions of wetlands, then I think you could make a very good case for actually using that to improve water quality, to store carbon, etc.

Conrad: This is one way of looking at the ecology of rice paddies, certainly some people have done that. Correct me if I am wrong, but some of that has been done at the international scale. It is certainly another way to go. It is not where I have come from, but it has lots of value.

Audience: I agree with what you just said and I think there is a lot of interest. I just came from this agro-ecology course up at UVM and we talked a lot there about the potential role of rice in flood control and also in holding water when we have these heavy rainfalls. Preventing the water from going somewhere else. This whole idea of multifunctional agricultural systems, I think could really be promoted. I just wanted to add the thing that I was mentioning to you earlier, that I think the collaborative idea is great and it would be great if it could be linked somehow to the marketing aspect of the rice, of our Northeast rice. Try to market it as an ecologically grown rice. I think that fits in with our whole image in New England where we are being up front on environmentally sound practices in general and we are growing this rice that is not only using organic methods, but it is really keeping in mind the larger ecological issues. If we can cooperate on that, and somehow promote our rice in that way, I think it would be really great.

Audience: We are about ready to embark on our rice cultivation adventure and we are including an ecologist on our team who will be doing benthic monitoring of the pond below where we will be growing. Doing a baseline study first and then monitoring to see what changes might come about through the flowage that we might be impacting.

Conrad: So you are talking about looking at the macroinvertebrates?

Audience: There is a pond at the base of this system, that Ducks Unlimited helped us build and he is going to analyze what is going on in there.

Conrad: If you are not aware and you have not seen this, there are ways of assessing water quality by looking at the different kinds of larva that live there. By looking at the ecology in this pond at the end, you are starting to get a little of that water quality.

Audience: The US Geological Survey has ground truthing for vernal pools. There is already a network of people who are catching frogs, can you tap into that data?

Conrad: I do not think they are counting in rice paddies.

Audience: No, they are not counting rice paddies, but I wonder if those people would be willing to also do ground truthing in rice paddies.

Conrad: Conceivably, especially if you get the tools together so you know what you are looking for and you can make it simple. Say this is what we want you to do and here you enter the data.

Audience: When I think about designing an acre or so or acre plus of rice paddies on the land that I am on, some of the questions that I have been thinking about and you have brought up with trying to make it more in line with a natural ecosystem. It is great that the rice paddy can absorb water too, but lets say that you are giving it a lot of fertilizer or even organic nutrients and then you get a huge flood from there, then that is going to flood into your water stream. Even thinking about past the paddy system, whether it is a pond or it is bushes or something. I know for us, if we were

to have a lot of nutrients, then that is just going to flow into the Kennebec River if we get a flood or something. That is something I was thinking about. If we just made an acre and a half of rice paddies, okay that is going to create a big pond. It would be nice to have a few different paddies and a ten foot or twenty foot area between paddies where you are growing native shrubs. Some area where there is not rice paddy and not grass either, but something that has diversity.

Conrad: I know that Takeshi was talking about the whole hydrological system and how it works.

Audience: You may not be ready for my question yet, but how do people that have attended here today get a hold of each other to chat or if we wanted to have an ongoing dialogue? Do we just show up next year?

Mia: A lot of the speakers have websites. There is contact information for them there. I get a lot of the emails with questions so I field a lot of that. We have not even attempted to do any kind of social networking for this group. It has mainly just been the conferences and an email dialogue with me. I do not know. It could be something that we work on, if that is of interest to people. If we want, and everyone is willing, I could ask if everyone wanted to give their contact information.

Audience: Couldn't you easily just create a Facebook group?

Audience: Or Meetup or something?

Audience: Have people join who want to join.

Audience: A Google group or Yahoo group? So we could all ask questions and combine answers I think that is much more helpful than Facebook.

Mia: We can think about it. We have not even attempted to do Facebook, but maybe it is something to think about.

Conrad: If you might be interested in participating this, let me know either now or you can email me.

Closing and Group Photo

After the final presentation, participants dispersed to talk in small groups with speakers and others in attendance. A majority of the participants were able to be present for a group photo.

Fourth Annual Northeast USA Rice Conference Group Photo