Proceedings of the
Fifth Annual
Northeast USA Rice Conference

August 2, 2014

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

The Fifth 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.

Table of Contents

Acknowledgements

- Thank you Takeshi and Linda Akaogi for hosting the rice conference once again.
- Thank you Susan McCouch, Diane Wang, Sandy Harrington, Phyllis Odessey, Nick Storrs, EunYoung Sebazco, and Genevieve DeClerck for speaking at the conference.
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- Thank you Putney Public Library for loaning us a projector screen for the conference presentations.
- Thank you Jeanne Kisacky for helping transcribe the audio from the conference presentations.

Mia Murphy
Outreach Coordinator

Agenda

8:00-9:00am	**Registration**
9:00-9:05am	**Welcome** Mia Murphy
9:05-9:20am	**NSF Grant and Cornell Rice Research** Susan McCouch
9:20-10:20am	**A look back at Akaogi Farm conferences and Northeast rice** Mia Murphy
10:20-10:30am	**Break**
10:30-11:00 am	**How does a rice plant perceive and respond to environment?** Diane Wang
11:00-11:45am	**Breeding of purple, aromatic rice for the Northeast** Sandy Harrington
11:45-12:00pm	**Explanation of Akaogi Farm rice paddies** Takeshi Akaogi
12:00-2:00pm	**Lunch**
2:00-3:00pm	**Edible education and rice at Randall's Island Park** Phyllis Odessey, Nick Storrs, and EunYoung Sebazco
3:00-3:45pm	**The future of Northeast rice** Genevieve DeClerck
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.

Diane Wang
Diane is a PhD student at Cornell University working with Dr. Susan McCouch. She is interested in linking physiology and genetics knowledge for rice improvement in changing climates. Diane's dissertation research focuses on understanding the genetic basis for stem non-structural carbohydrate accumulation in rice, a trait that may play an important role in yield stability under non-ideal environmental conditions. Her work involves evaluating the variation found naturally in diverse rice accessions and mapping populations generated from genetically divergent parents.

Sandy Harrington
Sandy is the Compliance Coordinator in the McCouch Laboratory at Cornell University. She received her Bachelor of Science in 1990 from St. John Fisher College and her Master of Plant Breeding in 2001 from Cornell. She has been with Susan's program for 19 years, as a technician, graduate student, Lab Manager, and Compliance Coordinator. She currently coordinates permitting of imported and exported rice in the McCouch program, coordinates greenhouse activities and works with the database group on a LIMS system to organize program resources and data.

Phyllis Odessey
Phyllis is the Director of Horticulture for Randall's Island Park Alliance and oversees all the gardens on the island as well as the Urban Farm. She received Horticulture and Landscape Design certificates from the New York Botanical Garden Program and has spent time abroad to learn from international experts. In 2011, she received the Royal Oak Sustainable Gardening Fellowship and spent three months in the UK at two National Trust Gardens: Nymans in Sussex and Hidcote in Gloucestershire. In 2012, she was awarded a Professional Development Scholarship by Chanticleer Garden to study with Professor James Hitchmough at the University Sheffield in Sheffield, England. Professor Hitchmough is one of the leading experts in creating meadows in blighted urban areas. In 2013 she was invited to be a visiting artist at the American Academy in Rome. As an Artist-in-Residence in 2014 at Artestudio Ginestrelle located in the Regional Park of Mount Sabasio near Assisi, Italy, Phyllis developed an installation entitled "Walk To The Water." In the fall of 2015, Phyllis will be an Artist-in-Residence at the Obras Foundation in the Netherlands. She will develop a project, entitled, "Wayfinding for the Soul" an interactive mapping project for a local Dutch community. She is the author of What the English Don't Know About Gardening. In her non-free time, she designs gardens for Odessey Designs in Marlboro, Vermont.

Nick Storrs
Nick, Urban Farm Manager at the Randall's Island Urban Farm, grew up on a small subsistence farm in New Hampshire. After receiving a B.A. from McGill University he worked in Brazil and Bolivia growing vegetables and coffee, and later apprenticed at the Last Resort Farm in northern Vermont, producing vegetables for local markets. Since moving to New York City he has worked as a gardener for the Central Park Conservancy and obtained a Certificate of Horticulture from the New York Botanical Gardens. He is a contributor to the Five Borough Farm Project, an initiative of the Design Trust for Public Space. Currently, he leads the Randall's Island Park Alliance's Edible Education initiative, instructs at the New York Botanical Gardens and participates in the Slow Tools Initiative, imparting his passion for healthy food to NYC students of all ages while encouraging them to take an active part in their own landscape and health.

EunYoung Sebazco
EunYoung has practiced landscape architecture in Korea and Japan for 15 years. She has managed and developed public, private, and commercial gardens. In 2006, she obtained her horticulture degree from the New York Botanical Garden's School of Professional Horticulture. This added education and experience in horticulture allowed her to combine science and design in her work. Currently, she is the Horticulture Manager at Randall's Island Park and has overseen the ornamental and native plant gardens there for 10 years. She has also participated in RIPA's urban farm program. This has channeled her career path to exploring urban agriculture and sustainability programs.

Genevieve DeClerck

Genevieve DeClerck is a Bioinformatics System Developer on the Rice Diversity Project in the McCouch lab at Cornell University. She received her B.S. in Plant Science from Cornell University and subsequently joined a team of biologists, computer programmers, and software engineers to develop numerous widely used database modules and information systems supporting the collection, integration and analysis of information about plant diversity. Genevieve specializes in the development of tools and visualization software that allow biologists to browse, query and download information about genotypic and phenotypic variation as the basis for creative problem solving. She is devoted to open-source software solutions and the sharing of data and information about natural variation and its value to humans.

Conference Participants

Akaogi Farm
Takeshi (Ogi) and Linda Akaogi

Blue Moon Acres
Jim Lyons

Anson Mills
Glenn Roberts

Cornell University
Peter Hobbs
Lucy Hill Fisher
Gen (Fumio) Onishi

Simcha Farm
Michael Pill

Many Hands Farm Corps
Ryan Karb

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

Welcome: Mia Murphy

Welcome everyone. As many of you may know, probably from corresponding with me, I am Mia Murphy. I coordinate this conference every year at my parents' farm. This is the Akaogi Farm, run by my parents, Takeshi [Ogi] and Linda Akaogi. My father is in the back there. My mother is probably out helping with the parking still. We are very thankful to them for letting us have this conference here every summer. This will be the fifth summer. We have had it here for the last four consecutive years. They are letting us use their farm for this conference, so please be respectful of the area. It is great that we are allowed to use this farm and have access to their rice paddies, which are beautiful. During the lunch break or sometime throughout the day, you had better go out there and check them out. There are a lot of interesting demonstrations and displays out there with the different rice varieties that we will be talking about throughout the day.

First, I want to recognize a few people. First and foremost we have to thank Susan McCouch from Cornell University and her lab. She has helped with the funding through the National Science Foundation these last four years to have the conference and the website, which we will refer to. She has brought several other professors from Cornell with her and some of her students and staff. Many of them will be presenting throughout the day. Maybe we can do a short show of hands. Peter Hobbs is over here. He has presented in the past. Diane next to him will be presenting later this morning. We have Genevieve, she will be presenting at the end of the day. Sandy, over here in the corner, and Randy Barker. And also Gen and Tony. Gen is the greenhouse manager. We are very lucky to have that resource at Cornell, that academic backing and those connections to other rice researchers and people throughout the world.

Because this is a rice conference, I thought I would ask with a raise of hands. Who is actually growing rice? How about people who would like to grow rice or are interested and trying to get information? A few of you. There is actually quite a group and a majority of you who are growing rice or interested in growing rice, which is nice.

I thought I would acknowledge some of the other presenters today. We have a group from Randall's Island Park in New York City who are growing rice. They are probably one of the few people who are growing rice in an urban setting. Maybe you guys can raise your hands? They will be presenting later today. I am doing this to show you who these people are and help put faces to the names in the program. One of the highlights of this conference is the lengthy lunch we leave from noon to two. We have rice featured in our lunch, but this time is also an opportunity to connect with all these other people and the speakers. It has been a really great way for people to connect with others growing rice or are interested in growing rice, knowledgeable about rice. Also these personal connections are what drive this effort.

We have a gentleman in the back, Blake Richardson, from Minneapolis. They are brewing sake. I think he is interested in rice varieties for sake. We have a group from Martha's Vineyard who are

doing education. There is Glenn Roberts from South Carolina. You need to get your nametag. He has presented at a previous conference. There are some people who have traveled far. Probably the one that has traveled the furthest is Davide from Italy. You want to raise your hand? They have a rice farm in Italy and he is staying in New York City working with the group from Randall's Island about education. I thought I would just point out these people so you could seek them out during breaks and lunch.

Finally we have to thank Chris in the back, who is taking a picture. Every year he comes and takes video footage and audio footage. He edits it and puts it on the website, which is a great resource because this information not only goes to all of you in the audience but to a greater web audience of people who cannot come. The videos are really great. Especially if you have not seen the ones from the previous conferences, that is a great resource.

With that, I will make a few notes about the farm here. The presentations will be here in the tent. There are drinks under the tan tent over in that direction. The paddies are kind of in that direction, between the greenhouses. If you have not had a chance to look, they are over there and you will have a chance during lunch. Lunch will also be near the tent with the drinks. The restroom is over along the road. You probably passed it on your way in. One note I will make is that there are a few dead poplar trees, towards the end of these greenhouses here. Behind this little shed here. Please do not spend a lot of time mingling around them, because there are still a few dead branches we haven't had a chance to take care of. We do not want anyone to get hurt. We put the food on the other side for that reason. I think that is it, and I will hand it over to Susan to start us off this morning.

NSF Grant and Cornell Rice Research: Susan McCouch

Thank you Mia for all the organizing that you do. This conference would not be possible without Mia's total dedication, really. For many months prior to the conference, all of those details that enable us to have things pretty much operational on a farm where there is no electricity is quite a remarkable feat. We thank Mia, and of course the Akaogis for hosting this year after year.

I will introduce myself briefly. Some of you I have known for many years, but I just want to say that it has been a real pleasure for me. I was first contacted when Ogi came to visit, and Ogi originally I think had contacted Gen. Gen is my research manager in the sense that he grows most of the rice and he had the green thumb and the knowledge coming into this project. When Gen first showed up at my door at Cornell 22 or 23 years ago, I was trying to get my rice program launched. Nobody at Cornell was very good at growing rice. You are an audience, if you will, or a community of people that like me have had to bootstrap yourselves. Whatever I can share with you it is in an academic setting. I am not trying to do this commercially. Some of the things that we have learned and some of the resources that we can share, I hope will be useful to you. You can also provide use with feedback. Let us know what it is that would be most useful to you. As an academic person with some access to funding. It does not come easily. We compete for every penny we get. If we can create an environment in which the resources that we develop are used to drive livelihoods and productivity among a grower community that is in this case innovative and really an experimental growing community. Then we are linking science with agriculture in the way that it should be done. We are trying to respond to interest on the part of people who are innovators themselves. What we do is collect information, gather it, and bring people and resources together. That is our main role as educators. I do not think we are trying to show you how to grow rice. No, of course not. Although

some of the members of our community, Gen, for instance was a rice grower in Japan for many years before he came to Cornell through my good fortunes and through a fortuitous marriage to an American who brought him back to this country. These things happen in life.

What I thought I would do today is talk to you a little bit about information resources. Some of you are off the grid. I know that the internet is not everybody's source of information, but nonetheless, I thought I would tell you about information resources that are available mostly on the internet and as downloadable information. All of the resources I am going to talk to you about are publicly available. What I have done is go through and select things that I thought might have information for getting started or might be useful as consultation. One of the good things about these resources is that there are people behind the. Should you have questions, specific questions, you can often direct them to the sites that I will point you to. These are people whose job it is to try to provide information that you need, gather it or link you to other people.

I have to start out with our own website, because we are in fact funded by the National Science Foundation to do a lot of the science. We are doing a lot on rice diversity. Looking at rice in the genetic and phenotypic sense and trying to identify how to make breeding more efficient for the future. Our website looks like this on its homepage and it is a very simple url; www.ricediversity.org. If you go into that website, there will be pull-down menus so you can find information about the germplasm that we purified and that we are using on the project and that is the foundation for what the NSF has funded us to do. Data sets which include in some cases phenotypic data, especially for the varieties that are grown in this country, but we do not have any phenotypic data on this site yet from the Northeast. It is all from the Southern U.S. We do not have anything yet from you on this website. We are trying to organize that. Most of the information that might be relevant to this conference can be found by clicking on the "education and outreach" button. You get a drop-down menu that takes you into this site, which is the "Ecological Rice Farming in the Northeastern U.S." This is your site, in a sense.

When we first got off the ground, we started with the conference and I think the conference proceedings are available from 2009, 2011, 2012, 2013, 2014. There was nothing in 2010. We just did not have a conference. It is not that we failed to provide the proceedings. Here you will have this year's and it will be downloadable as a video, because it is streaming right now. All the presentations are taped. You can go through them again. You can use them as educational tools should you want to extract them for discussions elsewhere. Maybe the most important thing that we are doing right now, that would be of help for everybody, is we are trying to map the regions where people are growing rice, for those of you who come to the conferences or with whom we maintain some kind of contact, and the growing degree day predictions for your farms. This can tell you which varieties are likely to prosper and flower in your environments. It is not all predictable by latitude, so ecology and altitude and other things of course also play into it. If you can help us by providing information about your growing degree days, you will appear as a dot on our map. I think Mia you will be talking more about that, so I will not pause here to explain it. Mia will be going into that.

This website is going to be the best place where information can both come and go. Our attempt would be to maintain this site. We are out of funding as of the end of July. A few days ago, the project has ended. We are under consideration for a renewal but it has not happened yet. We are looking for sources of funding. We have prepared proposals and we, like any one of you, are looking for sources of funding to keep our people employed and keep the website open. At the moment we can only say that we will endeavor to do that for the next year as we try to transition to another

source of funding. I just want you to know how tenuous it is. Universities are also not funded to do anything. We have to bring in our own funds. We are just small businesses, much like you, only our university takes more than half of the money we bring in as overhead to the university.

We have been very grateful for the Northeast Sustainable Agriculture Research and Education (SARE) support, the grant that originally funded the Akaogis. We are advocating that people in this group attend the SARE conferences. There is one at UMass next week, and you saw all the flyers for that coming in. Then there will be a NOFA conference in New York in mid-winter. We are going to be having a presence at the NOFA conference in New York. Our little group will be having a presence there because we want to try to let the USDA and our funding agencies see us. We will encourage anybody who would like to attend that conference to come and continue to have this kind of forum.

If you go on this site and you want to see the proceedings from this year or any other year, they are both in live video format and downloadable in written form as proceedings. Just so you see what the actual site looks like; this was 2013, last year's conference. You can click on any of the presenters and I think that you will get their full story. You will get the full presentation. That is what that looks like.

I am going to switch over to talk about information resources. The thing that I thought I would do is highlight the kind of information that I, sitting out in the middle of Cornell University, imagine that you, in the middle of your field, want to know. Correct me anywhere you want or help us get more realistic. What kind of information is interesting to you and where can you find it? This is my best attempt to address that. Forgive me if I have completely missed the boat.

A lot of people send us an email and ask us what kind of varieties can grow well in my area? Where can I get seed for those varieties? That is a big issue right now and we do not yet have a reliable seed source. Everybody is doing this, a little bit of bootstrapping. Then what additional information is known about those varieties? Like what are the grain quality characteristics? What kinds of diseases and pests might I run into? What nutritional and water requirements do I need to grow the plants? How can I manage the post-harvest processing? How should I dry my rice? How should I de-hull it? What kind of machinery is available for me to hull? These are the kinds of things that we get as queries from you.

I thought I would just say that when we talk about this group, most of you are growing organic or you at least qualify as small-scale producers and therefore the information resources that you need are very different than the vast majority of information that is available on rice in the U.S. I think GRIN (Germplasm Resource Information Network) from the U.S. perspective is still the source of seed for many of you, where the most variation can be found. It is already in the U.S. You do not need a permit. If you request seed from GRIN you can put it in the ground tomorrow. You will only get a small handful of seed. You will have to be prepared to amplify that seed yourself or in collaboration with somebody who already knows how to grow it in order to amplify that seed.

The International Rice Research Institute (IRRI) is a very good source of information. They have the knowledge bank and I will talk quite a bit about that. They have lots of information on step-by-step production, agronomy guides, decision tools, and training opportunities and they are entirely devoted to the small grower. The vast majority of rice is of course produced in Asia, probably 95% of the rice on the planet is produced in Asia, and the average farm size is less than half a hectare.

People grow almost all the rice we eat on very small parcels of land and most of it is manual labor. The trend is away from that, but that is still the reality.

The rice diversity project, which is our little project, and our colleagues in the SRI (System of Rice Intensification) website at Cornell, between those two Cornell University comes up as a major point where rice is grown because we grow a lot of diverse things under glass. Lucy Fisher is here in the room from Cornell's SRI group. She has done a tremendous amount of work to gather information and there is a lot on their website. After the USDA, Cornell University is the U.S.'s largest importer of exotic rice and we will in fact under relationships or collegial relationships with any of you, try to bring in varieties that you may need. And I will explain what that process entails.

These are probably the sites you would go to if you wanted to learn about varieties and some information about them, but it is very limited. I will tell you what is available, and what I think we can do to inform each other about information that you may have or want to share, because most of what you need is not available in any database anywhere in the world yet.

I also want to mention the Ricepedia. The Sustainable Rice Platform, which is actually an advocacy group. It is not a how-to. It is an advocacy group trying to help change policy. It is very, very, very important and happening at every scale across the globe, from the highest input investors down to the smallest farm, for all kinds of reasons. Then the U.S. experiment stations and extension services, although those mostly in the United States will provide information for the large-scale agriculture.

I am going to show you how to find information on GRIN. GRIN is not a very friendly site. It sounds friendly, got a grin on your face, but it is not really very friendly. If you go into this site, which is ars-grin.gov, you will come to a page view where it says search. I would go into the search, or just go into the search-grin html. This slideshow will be posted on the website. I put the url's in so that you do not have to write them down. You can always go back and find this. The point is you come into something like this, and you sort of peer at it, the pictures are really pretty, but what do you really want to know. I think most of what you want to know is here. It says, I do not know if you can read it, "research crops and descriptor extension data queries." A lot of words. You click on that and it looks ugly, but those are the names of many of the plant species for which there is information in our national information resource system in the U.S. This is the best that the government has to offer you. What the government has to offer you is the seeds, which you really want. If you can get through this, you may be able to get to the seeds you want. I am going to walk you through it.

If you look, you will find rice. It is not *Oryza*. Fortunately, at least they are using everyday terms. You click on any one of these species, should you be interested in anything else, and what comes up are the traits or the descriptors for which there is information. This is basically it. Any other information is simply not available on the government site. But there is information about the biochemical nature of the seed and most of these have to do with the seed quality. I will unpack this in a minute. The chemistry of seed has to do with the stickiness and how it cooks, and all of the things that have to do with whether it is sake rice or long grain or short. Disease resistance characteristics. Growth parameters including, in their case, plant height. Morphology, what it looks like. Other. Phenology, which is days to heading, and that is really important for all of you. And then some about production, which means how it mills. What it looks like after milling and how well it mills. And then an interesting and important trait called ratooning.

Now for you in the Northeast, you do not care about ratooning because the season is so short. In the southern U.S., and probably Glenn has a lot of experience with this, there is a subtropical zone. It is not tropical. We cannot get two growing seasons. But we can get a season and a half if we take the first cutting in September and let it regrow on the stubble, because like any grass it is still perennial. In the U.S. we typically take a second cutting, sort of like what we do with hay, on the regrowth after about a month or six weeks of regrowth, depending on where you are in the southern U.S. Ratooning is the ability to regrow quickly after cutting to give you a second crop in the southern U.S. Ratooning ability is interesting. Fascinating for most people because they do not realize that we grow rice as a perennial and we take two cuttings in the southern U.S. Third, because as a northeastern grower, you absolutely do not want to breed for ratooning because you want all the energy to go into the grain and it can die after that. If it ratoons, it withholds energy and Diane will talk a bit about this. It holds energy back in the stem in order to have that re-growth. It does not deposit it all quickly. There is an evolutionary strategy and you do not want it.

If you click on the descriptor, you will get a definition. Most of these, as you see, you could not interpret just by reading. This is the problem we have with the way government is presenting the information. We cannot interpret it at all. If you click on it, then you will find something. I am going to go under chemical, so that you see how the descriptor works. This is what you get when you click on that and ask what does that mean, "alkalized spreading value." Many of you won't be able to interpret that, but it has to do with rice quality. The amylose, whether it is aromatic, the gelatinization temperature, etc., protein, and disease. What I think is critical here is even if you click on that, you are not going to get any more information. If you need more, you will have to go into Google and find out what it means. This is as good as it gets from that perspective.

Now if you know you want aromatic rice, it is a yes/no. It is a categorical trait. If what you want is a certain percent amylose, which determines the stickiness of the grain after it is cooked, then you need to know something about the percent amylose that you are looking for. Many of you may know that already, but in the U.S. this is one of the key characteristics of the grain. Let's say you want to go into GRIN and there are thousands of rice varieties and you know you are looking for ones with a particular type of amylose. If you are doing sake, you want a particularly low amylose. If you went into amylose, you could say equal to or could click down less than or more than and give a percent amylose, and it will search for you only the varieties that have the percent amylose that you are looking for. The beauty of this system, once you can interpret it, is that you can home in on just what you are looking for out of those thousands. You do not have to scroll through and look for them. But if you do not know what you are looking for, then you might just be looking at what is there.

Here is an example of what is there. This is coming out of the rice quality lab in Beaumont, Texas. What they are telling you is that they have evaluated all these traits, which are under biochemical traits, and this is how many rice accessions have been analyzed. They have information on six or thousand accessions for grain quality, almost the entire collection has been evaluated for grain quality. It is the critical thing that everybody really needs to know about the rice they grow. You can go in for almost anything, grain size, grain shape, amylose, etcetera. You can find out what the entire GRIN collection has, or at least the seven thousand that they are offering you, in terms of grain quality.

This is what it would look like if you click on amylose, which is what I clicked on, and on accessions. What it opens up is the accession number. If you wanted to order it from GRIN you could order it

by this number. This is the number of accessions that have this name and which are available as seed. If it says zero, that means they do not have any seed available, but they still may know what the amylose is. Oh, sorry, the zero is the amylose score. Now for those of you who do not know zero amylose would mean it is sticky rice. It is what we call glutinous rice. Most of you are not looking for glutinous rice, but it is near what you need for sake. You probably need the 1 to 2 percent. Most of you do not grow really low amylose rice. I am showing you a range here. This is the complete range of what is available. I have cut out the middle section to show you this. Twenty-nine amylose is really, really dry. It is a really hard grain, really dry and very light. What most of you probably want is somewhere in the sixteen to twenty-three percent amylose depending on whether you want the drier grain or the wetter grain. The lower the amylose the stickier it cooks up. Specialty rices come in all kinds of amylose content. However, the vast majority of rices are between twelve and twenty-three. These are the extremes. You can click on them and you can order them. Will most of them grow in your area? No. Most of them will not flower in the Northeast. Most of these are tropical rices. You do have to then look over at flowering time or something else. That means you are going to be scanning through a whole lot of data to find out what the flowering time is because you cannot go from the fact that they have screened six thousand rices for amylose and find out which ones they have done for flowering time. It is not that easy. It is a government site, right? Here is the amylose, showing what the distribution is. Between nine and twelve percent amylose, they have ninety-two accessions. Between twelve and sixteen, they have 900 accessions, and on up many thousands of them. In this very high amylose, which would be almost like eating chalk, there are two. But those are mutants. Those are things that nobody would want to grow.

Aromatic. This is interesting for many of us. Many people want aromatic rice. The number of aromatics is a yes/no code. That is what this means. They only have 130 out of those 7,000 that are aromatic, in the United States. If you go to IRRI's database, they have hundreds and hundreds of aromatic varieties. The U.S. just simply has not specialized in importing aromatic rices. I just put down here to show you that sometimes it is yes/no and really easy and sometimes what should be easy, like awns, does it have the whisker or not, that is not easy. It has a zero to nine scale for awns. You can have no awns. You can have short and partially awned. You can have short and fully awned. You can have long and partially awned. And you can have long and fully awned. You would think that awns would be yes or no? No. Awns is zero to nine. Once you know that, you can see what the distribution is. If you are interested to know, for instance, something that is very pretty to grow in an urban garden you might want awns, you might want purple awns, you might want pink awns, or you might want white awns. You sort of have to go through and struggle through this site, but there is a lot there, and the seeds are connected to this information.

Days to flowering is critical. You need something certainly in the first 86 up to 96 days, not more. How late is your flowering that you are still getting seed? Ogi how late is the latest flowering that you still get seed?

Takeshi: Around right now.
Susan: Which is how many days?
Takeshi: From transplanting?
Susan: Yes.
Takeshi: Two months and one week.
Susan: So something in this category.

These will be the early rices, and usually they will be the ones that are also cold-tolerant. Earliness and cold tolerance typically go together.

This is if you click on kernel length. What is really interesting is that we have kernel length from 3mm, tiny little round pearl grains, all the way up to 12mm, which is a fantastic thing because there is much more variation for kernel length in domesticated rice than there was in the wild. Humans have selected on a range of kernel types, because it also cooks up differently. If you want to look, this is the mid-scale, these are all the 8's (mms), but you can find which varieties have really small grains and which have really large grains. Those kinds of things may be interesting to you if you are interested in trying to brand your rice. You want something that looks different and people can actually see that. That is the kind of thing that we can help breed with you for because you can select on it.

Pericarp color is one of the traits that Sandy will be talking about later. We are actually involved in a participatory breeding scheme with Ogi and Linda here. I wanted to show you that there is a really interesting range of bran color types and this is the number of accessions that are available. We have chosen an accession that we are breeding with, but this is the color chart that they give you so that you can understand what they are talking about. They do not always have visuals. White, light brown, speckled brown, brown, red, variable purple, and purple. These are all brown rice, not polished. We are breeding a purple sticky rice with Ogi. I do think that things that are visual are very compelling to the public. For most of us here, we are interested in the producer side of something that will grow and flower. We are also really interested in our consumer market, because if we do not have a consumer market that brands us, then we look like any other rice on the market. I happen to believe that we should be thinking a lot about these highly visible traits of the rice in the market. This is the kind of thing that can be done in a genetically simple way. Turns out it is never as simple as you think, right Sandy?

Then there is literature on the National Plant Germplasm System (NPGS) website. Of interest to you may be these things. This is where to go to look for information about variety release. Every variety released in the United States is released with a crop science registration publication. Registration of Gulfmont. Registration of Lemont. Registration of Newrex. Registration of… Every U.S. variety released comes with a registration. It is published usually in Plant Science. It is available also with a click on the website. I just thought I would show you that in terms of information you also see our group, because we have done quite a lot of work on our panels. We also come up as providing information about rice that is present in the National Germplasm System. Some of the kinds of things that we have been providing information for are rices that are the most widely requested because there is more information about them. What we see is the more information there is, the more people use the rice. That is why we also want information back from you. It is much easier once we assemble information to figure out which ones we should put our dedicated effort in, in terms of seed production.

I am going to switch over to IRRI's information sites. I think these sites are very, very valuable and they require a bit of study. They are the kind of thing you should probably think about accumulating and doing in the winter. They are not easy to just quickly hop and I do it. It is not like I am in the moment of which disease do I have? "How should I prepare a paddy," takes a little bit more preparation. What I like about this is that they start out with attaining rice. This is the Knowledge Bank. How to attain rice from IRRI? I will talk briefly about that, and then we will go on to some other things. What they tell you is that IRRI provides small quantities of rice, free of charge, on demand, to any individual or organization anywhere in the world for the purposes of research, breeding, or training. If you are commercial, you start to get into a little bit of issue with them and I will tell you why. What you normally do is you get me to import the rice, from IRRI, as a research

system, and then I provide it to you. There are a number of reasons why that tends to happen. It says we share the rice seed stored in our international rice gene bank according to the international treaty on plant genetic resources for food and agriculture. I am going to talk briefly about that. That is the main stumbling block for many of you in dealing with IRRI right now.

This is their seed prep room. You have probably seen pictures of their actual seed bank. But their seed prep room looks more like what a community seed bank would look like. If we decide as a community that we need to start producing seeds, we are going to need to have a space that is dry and cool. Even after our seeds are dried down, but before they are packaged, bar-coded, and put into their oxygen-free envelope, we have to have places to store them. You can store them in these hanging bags, as long as there is good airflow and they are really dry. This is not a hugely expensive thing to do, but it has to be quite dry and maintain a cool temperature. I think we should just collectively understand it does take a little bit of resources to do it.

Obtaining rice from IRRI involves the Standard Materials Transfer Agreement, or the SMTA. You have to sign off on this agreement if you are going to request seeds from IRRI and the agreement requires that you practically have a lawyer to read it. It has turned out to be a stumbling block now for the entire CG system in providing seed. Step 2 is choosing the right type of rice, because you are going to go through a lot to get it into this country so let us make sure it is what you want before you start ordering it. It is not cheap or easy to order seed anymore. It is a difficult thing to do. You go through and you find out what you want. Now IRRI's system for finding out what you want is not going to have too much information that is relevant to rice in the northeastern U.S., but maybe the location where it is grown, the location where it is from. We know that if it comes from Hokkaido or the northern part of China it is a pretty good predictor. You also can look at what is called the International Network for Genetic Evaluation of Rice or INGER, because this is the international system that circulates seed all over the world. It does trials in forty to fifty different regions of the world and provides information about performance back to IRRI. You can find out how well something has done in many parts of the world, but it is mostly tropical.

Step 3 you submit your request. You send your request in writing, and by the way you have to tell roughly what you are going to use it for, who you are, and show that you have a permit to import it into the United States. Most of you will not want to maintain permits with the Federal Government. I do maintain permits with the Federal Government. Sandy spends half her time maintaining permits for the Feds, the State, the University, the Bio Safety, and it goes on and on. For all of you, once we can bring some seed in and provide it to you, I want you to understand it is not cheap, easy, or free and let us be careful about what we ask when we try importing the seed.

INGER, the International Network for Genetic Evaluation of Rice, has their own website, inger.irri.org. It has lots of information over the last forty to fifty years about rice with the same varieties grown all over the world, but as I say it is mostly tropical. What I like about INGER is that it is a good example about how the smaller network is working here. We take five varieties, we have asked all of you to try and grow the five varieties and send us back information on whether they flower in your environment. If we could get that information with growing-degree days, we could start to make predictions about other varieties that would probably grow in your area. We are a very, very, very, small group of people compared to INGER but the idea is the same, that collectively you get more back and you share more if you are willing to do a few things communally.

The knowledge bank itself, the Rice Knowledge Bank (knowledgebank.irri.org), has lots of very important information that I think looking at may be useful to you and some of you already know this. It has information about pre-planting, growth, and post-harvest. They have frequently asked questions. You can go into the rice doctor, the crop manager, quality assessment, etc., etc. I think IRRI's superbag, which is a very useful thing to know about, is a very important way of storing rice so that it will keep for a long period of time at very low cost. Popular items that people want to know about. Information for many of you who have an interest in machines and small machinery. As I said, the average plot size in Asia is less than a hectare, less than a half hectare. That is the place to go to find out about machinery. The problem is getting that machinery into the U.S. That is not so easy.

Rice Doctor. Just briefly, the Rice Doctor has lots of information some of which may be useful to you. Jim [Lyons], when you used to email us and say, "What the hell is this?" if I didn't send it to Anna, I used to try to check it out here. I have no idea how to predict growth or what is going to afflict the rice here. Nobody has done it before. On the Rice Doctor they give you images. They will talk to you about armyworms, which for instance can be a problem; bacterial leaf streak; blast; bacterial blight; rhizoctonia sheath blight, which is a big one in the U.S.; and snails, good, bad or indifferent. Some snails are really problematic and some snails are just fine. Birds are a huge one. Many of you have already encountered that problem. How do you deal with birds? Well, you deal with them by breeding for awns. If you put the awns back on the seed, the birds do not like it anywhere near as well. But, not everybody wants awns. If you are going to do machine threshing you do not want awns and you will have to deal with birds in other ways. Anyway, a variety of pests and diseases.

There are fact sheets that you can download and print, if you want to keep them for reading later. They are on land preparation, nutrient management, management of other crop problems, planting, pest management, etc. Many of these fact sheets are fabulous as starting points for all of us. They have videos. Now, if you go into this video, you are going to think you are in kindergarten. But if you listen up, you are going to learn something. The presentation may not be attractive to you at first, and it has a very Asian flavor to it, but I think there is information there. They have done a good job to try to make it palatable. If you have broad-band, you can download and listen. Some of these are seminars. For instance, Roland Hirsch is one of the world's most knowledgeable people about rice nutrient management. Here is one of his lectures. You can hear really good information. You can listen to it. You can disagree with it. But it is a very nice source of opportunity for you.

I think some of you are involved in preparing paddies and this might be very helpful for you. They have step-by-step information. This is in an Asian context where everybody knows what a rice paddy is so it may not actually address some of your concerns, especially if you are on very sloping hillsides, etc., where you have to terrace first. A lot of it talks about the rationale behind paddy farming. Why do you puddle the soil? Why do you have to work the soil so much? Well, because the nutrient availability is all about how well you manage that soil. The soil in a paddy is managed very differently than an aerobic soil that most temperate farmers are used to. If you zoom in on something like this one, step 5, which looks absurd, perform secondary tillage. It will explain why they do not till once. They till once, they let it sit for two weeks or two and a half weeks, and then they till again. Why? It is very important actually if you are trying to equilibrate your soil. They talk a lot about their rationale and it is very disciplined. It leads to a certain type of predictable result. You see the size of the rototillers? These are floating rototillers that you can use in a flooded soil. They

have pontoons and we use that kind of tiller in Asia. We also see larger machines coming in. But this is a size that might be attractive to many of you.

They have a post-production section. This is a really important thing and we have not covered it that much because I am more on the genetics side. Did you know that in many developing countries, between 25 and 50% of the total value of rice grain is lost after harvest? If you are not managing your post-harvest, you are going to lose quality. Many of you may have noticed already that if you are not storing your rice very well, rancidity creeps in and there are a lot of issues with brokens and pests. I think post-production is a very important section and you might as well just try to read up on it. There are lots of sections in this. I just highlighted those two.

You can download the rice production manual if you want as a PDF. They talk about things like matching equipment to farm size. They talk about a variety of opportunities and where the blueprints for the machines, if not the machine itself, are available. IRRI used to maintain an engineering section and they made all the blueprints available so that every village in Asia could produce their own machines and manufacture them using spare parts from old motorcycles and things that were in their villages. I think you will find this website really useful, if you go at it with an eye to the innovative nature of what you need, and pick and choose.

This is the Sustainable Rice Platform. As I said, it is mostly an advocacy group at this point but I wanted to let you know that this is coming from a sort of NGO platform. This is the Sustainable Rice Platform that everybody at least needs to be aware of so that we can be supportive. This is what it is going to take to move from the UN and FAO all the way down through our countries and our localities, and to think of the future in a more sustainable way. We cannot just do it locally. We have to do it at all levels. I thought it would be useful for you to know what is happening.

Let us look briefly at some of the grain quality issues. They have something called a rice quality assessment kit. I am not going to read all of this. You can get the assessment kit if you want or you can look carefully at those tools and probably find them here. One of them is a magnifying glass, for instance. The rice quality assessment kit is designed to provide you with the ability to evaluate things that are critical to commercializing your rice. All about how you get a sample weight, grain moisture content, grain temperature, which is important. Grain temperature is going to have to do with how you store the rice. A bunch of things related to visual checks: cracking, milling degree. Then the calculated parameters that come out, which anybody needs to be able to report as a statistic if they are actually producing something of commercial value. So how do you quantify purity? How do you quantify head rice recovery, for instance? It is all there for you and it tells you how to calculate it.

Now I am going to move over to show you a few other resources. It is at the far end of the other extreme. How many of you are familiar with RiceTec? RiceTec is the only company in the U.S. currently that actually sells hybrid rice. This is where all of the hybrid rice is coming from that is planted in the U.S. Almost 60% of the rice that the U.S. exports commercially is now hybrid. Hybrids are extremely high-yielding. They come in on the mark in terms of their mean amylose and all of the grain quality parameters, but the variance in the performance of a hybrid is high. They are very resilient in the face of climate change. Many people believe that hybrids are the way of the future for a lot of reasons. They are not as pure as an inbred line and the quality is more variable. What is happening is that the U.S. rice, which used to be considered very high quality because it was inbred, is now very variable. In some years it is really good. In some years it is really bad even though the mean performance is good. And that has to do with the way in which we evaluate and

think about it. But this company has a website. They are growing faster, in terms of getting their varieties out, than any other source of rice varieties right now in the United States. So, I thought you might want to take a look.

When you go into their home page they are advertising their Clearfield varieties. Everything with XL is a hybrid in this country. When it says Clearfield it is a certain type of non-GMO, weed-resistance. It is a mutation, a natural mutation that they have bred in. It is a patented genetic trait and it provides herbicide tolerance, but it is not GM. It is not Roundup. You have to use the Clearfield form of herbicide. If you want a non-GM but patented form of weed tolerance, if you will because it is herbicide resistance, that is what the Clearfield does for you. The grower can expect very high yields, very big machinery, and very large plantation size agriculture. But the important thing is, when it says Clearfield that means you are going to use Clearfield herbicide. It is a chemically driven production system. The information on the website is the kind of information that we need to provide for each other. Try to look beyond all of the things I have just told you for a minute. Look through them and look and see the information that is useful. A thirty-one bushel, 1400 pound, advantage over the previous inbred line. Excellent ratoon potential. Best straighthead tolerance. Straighthead tolerance is for arsenic in the soils. More consistent performance on clay soils. And it tells you when you should harvest it. You should harvest it between 18 and 20 percent moisture at first dry down to help maximize grain quality and grain retention. They are very cued to the grower. The information on their site is very cued to the grower. It tells you all kinds of information that you would need if you were going to grow those varieties. These are the non-Clearfield. These are the non-herbicide tolerant hybrids. What they say, for instance, is it is a later-maturing traditional hybrid, which means it does not have the Clearfield in it, that pairs well with other hybrids by allowing growers to plant timely and maximize harvest efficiency. You can double plant. You can get one out of the field and this will mature a little later. You can move through. Even our most high tech hybrid industry is looking at a) diversity in the field and b) they are obviously keyed to growers. There is lots of interesting stuff on the website. I think what we are trying to glean from it is what kind of information do you want? Well, if you take a look at this and you say, I would like to know that about the varieties we are planting, that could be useful for us.

There are sites in Japan. Oryzabase is a site we use quite a lot. It has lots of cool information about phenotypes that are unusual. These are all non-GM phenotypes and we have used some of this to breed into our varieties. Some of the purple, some of the sticky, some of the aroma, some of these unusual traits we get through this site. They are Japanese varieties and they tend to be good for your area. They are temperate rice. We can use them as breeding donors of a trait, if that is something we want to introduce. It is not a site for growers. It is a site for genetics.

Anybody hear of the Ricepedia? It is just a very interesting site. Ricepedia is basically all cool information about rice. If you are going to prepare a presentation, I thought of you in Martha's Vineyard doing education, go there and check it out for all this really interesting cultural information about where rice is grown and how. I recommend it. It is a wonderful site. Our experiment stations have massive numbers of recommendations, but I have checked through them all. I do not find any that are particularly relevant to the United States organic growing community or this small-scale of producer. They are mostly for high-input agriculture, but they may actually have things of interest to you if you sort through.

Now, I am back to our rice diversity site and I am ending here. Help us make it better. Any comments that you make we try to register them and then we will prioritize them within the

resource boundaries that we have and see if we can provide better information in the future. At the moment, the place that you find information that is relevant to you is under education and outreach. Look for the Northeast Rice Growers and that is where we will be posting it. A little bit buried, but that is because we envision a change in the source of funding and we did not want it to necessarily be linked always to the NSF. If we get funding in the future we will be off and running, and we may in fact be able to be more responsive than we have been in the past. Thank you very much.

Mia: Are there any questions for Susan? Maybe we can take a few if there are, but you can also ask her during breaks or lunch.

Glenn: What is the standing of the U.S. worldwide given the high incidence of hybrid rice export? Where were we before it hit, and where are we now? Does anybody know?

Susan: Well, we are still in the top 5 of exporting countries, but I think the quality estimate of our rice is slowly being eroded by this change in the quality. Still rice exports are in high demand and there are not enough of them. It is not like we have any problem exporting it. The export market is changing and the biggest exporting countries are out competing in some sense if there was competition, but right now there is not much competition. There is more demand than there is supply in the export life because China is importing now. China is the largest producer, India is the second largest producer, and Indonesia is the third largest producer. Many countries that were once self-sufficient are now importing rice. There is a demand for rice in the export market so that other countries can import and it is not as discriminating a market as it once was.

Jim: I am just curious, what was your motivation for this thing at the very start? Early on, years and years ago, when I grew rice, I think I had heard a rumor that people at Cornell joked that some of their rice got out and some farmer got it and they were messing around with it. Do you have an ultimate dream of what might be down the road for the Northeast in terms of growing rice?

Susan: So you are asking two different questions, one, how I got hooked and then what the vision might be. I got hooked when Ogi came to visit me and if you had come to visit me, you would have hooked me too. I think the main thing was that I had worked for a long time in an environment, in a local environment, where nobody really cared what I did. Internationally, everybody cared and knew me and there was a lot of interest, but nationally there was, I won't say no interest because I am funded very well, but I am saying in my own area, in New York State, there was no interest at all because I was considered irrelevant. Everyone knows what it feels like to be irrelevant. You do something that is very important to others, but not to people right in the area. For me it was a chance to say, look, there is demand. Local demand. I never went out and tried to proselytize, here you can do something with some vision to try to sell. I never did that. Never ever did that. Maybe it is not in me. But when somebody came with demand or with interest, I feel so gratified, you know, that something I do would be of interest. So, I have tried to respond. That is how I have, in the local sense, got involved.

Jim: Are you unique at Cornell with regard to that? If we had approached other people there, would they have kind of said, "This is kind of a joke."

Susan: Well it depends, really. I think most academics are thrilled when somebody has questions for them that they can try to address, but I suspect there are not so many people that are interested in a growers network. That is a whole different thing. They might want to answer your question, and not necessarily try to convene a group. So

my vision actually has grown with this group. It is not external to you. It is more that I think collectively it feels like there is some momentum and interest and excitement around all the ways in which innovation actually fundamentally drives our country. I am often surrounded by people where innovation is usually constrained by intellectual property protection. I have always played outside that system. I think this is a very good example of a community that if there is demand there is a lot that can happen. It is especially our rural communities that are places where innovation is not easy and we are not tapping into innovation with that level of potential very often. This is one way in which it spreads by itself. But it will not happen unless all of you are committed. It will not happen because I have ambition that is for sure. I guess the next step will be that we try to collectivize this and formalize it a little bit and go to the NOFA conferences and create some sort of forum so that we have the people in different types of production environments contributing and accessing and supporting that network. Then we can respond. But that network has to have some commitment from the inside as well.

Audience: I was curious if anyone, or if you guys are doing any grain quality testing of the rice? What the protein content is, the amylose content, and other properties like those?

Susan: For certain types of varieties?

Audience: Yes.

Susan: Are they varieties that are already done in GRIN, because maybe they are…

Audience: I was just wondering if any of the…

Susan: The ones that we are distributing?

Audience: Yes.

Susan: Yes, so we were talking about that actually yesterday with Ogi. I think we will get that done and will use the Beaumont rice quality lab. Or maybe they moved that now to Arkansas. Anyway, we will use the USDA's quality lab to do it along with a million other samples that we are doing. And we will make sure that the varieties that we are recommending have that information. In fact I was just talking to Genevieve earlier. We are going to change the way we post information so that you will be able to access all the information we have on the varieties that you are growing. We will extract that and we will make that much easier to find. That is a no-brainer but it takes some effort on our part to do it.

Audience: Thank you.

Audience: Could I just get a sense of scale about the number of acres people in this group are growing?

Mia: It is a wide range.

Audience: And what would that be?

Mia: Very small scale, like a 1/10th of an acre similar to what we have here at Akaogi Farm ranging to a few acres, I think. I do not know what the largest is. Jim, what are you growing now? Three acres. So that is probably the largest. There was a gentleman in the Champlain valley that was envisioning five acres. I do not know if he got that far yet. Then we have Glenn, who is from South Carolina, and he is growing a lot more. There is a diversity in this audience. Probably in the Northeast a few acres is where we are at for a maximum. I do not know the total acreage yet. It is a group that is spread out a lot. Michael? Did you have a question?

Michael: Yes, that leads exactly to my question. We have ten acres of wet pasture, actually 12 acres. With dry land growing we are bumping up at a quarter of an acre. I have the money to build the greenhouses. With what we are growing we could do the seeds. Ryan Karb does the work (he is three seats over here) from the Many Hands Farm Corp over in Amherst. He framed the question on the way up here, which is "The land that is wet enough to grow the rice 'dry land' is also so wet that Canary Grass, I believe, is basically running us out of the field." We cannot direct seed it. What Ryan and I were wrestling with on the way up here is, do we go to paddy? But, what you have made clear is rice paddies are a world that agriculture in the Northeast knows nothing about. What I have been trying to do is take the approach of, in the Northeast we know how to do dry land agriculture, the yield may be a lot less, but we also have a lot of wet fields that are basically next to worthless for hayfields, which would be great for rice if we can control it. What I cannot figure out is how do we go from our quarter acre to planting that whole twelve acres? Right now it is purely a problem of mechanics, of weed control, and of seeding. The equipment in Asia is great but we cannot get it here and have any assurance that it is going to be reliable, that we are going to be able to fix it. Those are the problems that I have and frankly if I could figure out how to deal with those problems, we would be growing ten or twelve acres. Then the idea would be to go on from there, because believe me there is plenty of wet hayfields that people would rent or sell cheap.

Audience: Are you a farmer?

Michael: I am a farm-owner. I am a lawyer. Ryan Karb, with Many Hands Farm Corp, three seats over, he is the farmer.

Ryan: I shake my head at twelve acres.

Audience: I grow two-and-a-half acres of rice, and 250 acres of certified organic grain. I have been doing it for 20 years. I have been growing rice for five years and I do not understand the nitrogen cycle, between aerobic and anaerobic. Those are questions I have. I understand paddy style. I understand direct seeding. I do them all. Glenn help me out will you?

Glenn: Just very briefly, to address both things from a farmer perspective. We are doing dry land or moist groundwork in what would be a wet hayfield. We have Nutsedge. You name a nasty grass and we have that invasive in any place that stays wet. It will come through two layers of the thickest black plastic mulch out there on our SRI plots. We have to go back there with a weed eater. What we decided was to get rid of the black plastic mulch and have twelve-inch rows, French harrows. We are running a French harrow RMV on a five-acre field on moist ground with no mulch and no bed up. I do not even have to have a Rain-Flo transplanter. I can direct seed it, but we have to have 12 inches between the rows because I cannot drive any better than that. And so far, it is looking good. We have mitigated all, just like tilling corn. We have made passes until we lay it by. When the canopy is over we are done.

Audience: What state is that in?

Glenn: That is in South Carolina. I have plenty of degree days, so I can go in early get ahead of some of that stuff.

Audience: I have a quick question. Maybe we can answer it quickly or settle it later. It is related to the same things. I grow mixed vegetables and I do soil tests through extension services at UMass, and I was wondering if those tests are applicable to wetland production or paddy production. Also, even for dry production, if rice can be

comparable to other grains that you can get information for from these tests. I can get a test and recommendations for growing oats and rye and wheat. I was wondering if any of those are applicable to the rice.

Susan: But you are not growing your rice in anaerobic soil?

Audience: It is not anaerobic soils. In that case, could I compare? Could I estimate how much nitrogen, for example, I need from a soil test and ask for recommendations for oats and have it be the equivalent for rice?

Susan: Peter? You want to answer that?

Peter: I think so, as long as it is aerobic. The problem is when you go from aerobic to anaerobic, you go from nitrate to ammonia and that is when you have the problems. The nitrate leaches through the soil and you have problems. Ammonia gets fixed to the clays so you are not losing it. Then you have the whole link with organic matter and nitrogen availability and methane. It is complex. But there is information on the Knowledge Bank.

Susan: I would just make sure you stay small until you manage that better. You can do it with the other grains because we have a hundred years of experience. It is very difficult here where there may not be information for either the variety or the environment. You have to do it empirically.

Peter: I want to make one other comment. In Asia, where you get most of the rice, a lot of the rice is grown by transplanting. But because of transplanting labor problems and water problems, they are having to find ways of growing rice with less water and less labor. They are looking at direct seeding. And with direct seeding, there are major problems.

Susan: The major problems are weeds and growing season here.

Peter: But controlling weeds organically is not an easy thing to do.

A Look Back at Akaogi Farm Conferences and Northeast Rice: Mia Murphy

What I thought I would do with my presentation because we are coming to the close of one funding cycle with the National Science Foundation is to take a look back at the previous conferences. I know many of you are new and have not come to these conferences before, but there are some regulars. Take a look back, see some of the things we have covered, and talk a little bit about the story of why there are rice paddies here at this farm. I tried to put in references to the presentations or the proceedings from previous conferences or the speakers, some of them are here, so that if you have more interest you can go to those resources. There is no way I can cover everything we have done in the last four years in a short presentation. This is just to reflect a little bit about the last few years and what we have done.

These are some of the topics I will cover. I will talk about the paddies here. Some of the issues that we have already been talking about, short-season, cold-tolerant varieties that are necessary for this climate. Water management and some of the issues related to that and that are connected to wildlife, which are important to my parents here at this farm. And then talk a little bit about the Northeast growers and what that means, and what we might think about for the future.

These are the paddies, here. This is a photo taken back in 2011. It is a good photo because you can look down at the paddies. It is a whole system. Three paddies and a pond or reservoir above, to collect the water, hold it, and distribute it among the paddies as needed.

We have talked a little bit about this, but one of the key reasons why my parents decided to do rice here, was because they had a wet section in their farm that they could not use for other crops. You can see that whenever you dug in the soil, water collected. They were thinking that this would maybe be a good place to grow something like rice. My father had experience growing rice when he lived in Japan, so he had a little bit of background knowledge. Also the knowledge that rice is being grown in Hokkaido, Japan, which is the northernmost island, with a similar latitude to where we are in New England. He was thinking this could be a possibility. A way to use this land that we have a lot of in the Northeast, the edges of cornfields, etc., that are not very productive. Rice can be very productive in this environment.

This is a picture of the first rice paddy. He started in 2006. The summer before it was basically just a dry field. It would get really wet in the spring and the fall, depending upon how much rainfall we would get. He just dug, I think by hand, the first paddy and planted a variety called Koshihikari, which is a very popular sushi rice that is grown in northern California and mainland Japan. He just wanted to try and see if it would work. What he found out that first year was that it grew really well, but it did not flower. He did not get any harvestable grain from that first crop. That winter he contacted Susan, talked to Gen, and was able to get a few varieties of temperate japonicas, varieties from Hokkaido, the northern island of Japan, that are cold-tolerant, early-maturing. That year, in 2007, he actually harvested his first crop of rice. I think in the front here, the tall one, that is Duborskian. He got some seed from Christian Elwell. Duborskian is a Ukrainian variety, seems to be doing very well in this climate and has become pretty popular through different seed exchanges. I will talk a little bit more about that later on. Some Hokkaido varieties and Duborskian in that photo.

From those first few years, my father began to understand that the type of rice variety was really important in this environment. Over the years, since 2007, he has tried over a hundred varieties. He has received seeds from sources that Susan talked about in the U.S. from the USDA, some like the Duborskian originally came from Cornell University many years ago, and a panel of seed that we were able to import, through Susan, from IRRI of Chinese varieties which are displayed in the paddy today. I will talk more about those later on too.

The USDA sources of rice varieties from Idaho and Arkansas he was planting in 2008 and 2009. I think in those two years he planted over 60 varieties, 30 each year. The information about that is available on our website under the Northeast SARE grant reports. This was funded by Northeast SARE, but it is information that might be useful to some of you who are starting out and want to know what varieties are out there that are available through national sources.

Duborskian I wanted to talk a little bit about. It is a variety that Christian Elwell, owner of South River Miso Co. in Conway, Massachusetts, has been growing for the last 30 years. In the 1980s, he wanted to grow rice and connected with a Professor at Cornell University, John Peverly. John Peverly gave him seed for what he called Duborskian, because we think it might have been originally called something else. We do not know. At that time it was called Duborskian, a short grain, Ukrainian variety that has a really long awn, which Susan was talking about, the whisker at the end of the grain. You can see that in the field today. It is very beautiful but you run into issues with post-harvested handling with that variety because of the long awn. At this time, Duborskian is being sold through Fedco Seeds, which is a company in Maine. There is a woman there, growing Duborskian in that environment. Her description of Duborskian is saying it grows between 20 and 24 inches high, which is quite short. If you look out in the field here today, that Duborskian is much taller. Christian had experience with it growing much higher. Other people have as well. This photo is the panel of

Duborskian or Duborskian-related strains from various places in the Northeast that were planted together because we wanted to see if they were actually different or maybe it is an environmental relationship. Maybe Diane will talk a little bit about how the plant is reacting to the environment, because it is growing much taller here than it is in Maine. This is a strain that my father has been growing since 2007, or 2006 when he got the seeds from Christian. There is the strain from Fedco seeds. We purchased the seed from there to see if it was different. Over here is a variety that we got from Anna McClung in Arkansas, which is called Dubovskij 129. It looks very similar so maybe we can do the genetics and find out exactly. It seems to be flowering at the same time and that is a reliable source of seed. Maybe if people want that, we can make that available. On the far right is what we are calling Duborskian-South River, which is the strain that Christian has been growing for the last thirty years in Conway.

We were very lucky to have a visitor at the 2011 conference, the head of the IRRI genetic resources center [Ruaraidh Sackville-Hamilton]. He came here. He saw the group. He got to see the paddies and see many of the varieties that he works with and maintains in their bank in the Philippines, and was very excited about that. We thought, "We do not have a lot of Chinese varieties and there must be some that are cold tolerant and able to grow in this climate." We talked to him about importing some of those and through our relationship with Susan we were able to do that. In 2012, at the end of the year, we were able to import 80 plus varieties including high elevation (above 1900 meters) and some northern Chinese varieties. In 2013, Susan in her greenhouse because she is a quarantine facility grew them out for us, and they did the initial screenings. They harvested seed from forty-seven of those varieties. Today we have these forty-seven varieties grown out in the paddies out back. We handed out a map of the paddies so you could see where all these different displays are. There are ten high altitude varieties and thirty-seven northern China varieties. You can see that many of them are flowering. They look beautiful today. I was here two weeks ago and maybe half of the northern China varieties were flowering and now most of them are. They have all different characteristics, which Susan was talking about. A lot of them have different color awns, different lengths, different grain colors, different leaf colors. It is really interesting to see that genetic resource that we have here now through Susan's help and her relationship with IRRI. Whatever interest you have we can maybe work on with those varieties.

The final resource for seed is this ongoing project we are doing with Susan, and Sandy will talk more about this. This is the breeding we are doing. They took a variety that does really well here, a cold-tolerant variety from Hokkaido, Yukihikari, and they used it as the cold-tolerant base to try and breed in aroma, purple pericarp, which is the grain bran color, and a longer grain. This photo, it is a little hard to tell, but you can see out in the field what it looks like. These are the parents of the breeding. In the middle is the Yukihikari. My father took this a couple weeks ago, and at that time it was starting to head already. The parents on either side, this is the purple pericarp parent and then on the right side is the aroma parent. You can see they are growing really nicely, but there is no intention of flowering in this climate. This is why it is really great to have the greenhouses at Cornell, where they can plant the different varieties in a way so that they flower at the same time so that they can actually do the crosses in the greenhouse, which we could never do out here in the field in the Northeast. Hopefully through this, and maybe through the help of some grow-outs or participation from some of you other growers, we can develop some new varieties with some interesting characteristics for this climate.

Then, one final source. I added this slide because last year I talked a little bit about saving seed. Many of you have been distributing seed amongst yourselves because we do not really have a

commercial source of seed. You can get Duborskian from Fedco Seeds and if you live in the southern part of the Northeast, you can grow some of the northern California varieties. You could get them from there. But there is not really a source for these cold tolerant varieties. We have been saving seed and distributing amongst ourselves. If you are interested in how to do that in a way that would prevent the spread of disease or pests, or so that you can provide high-quality seeds to get good yields, there was a presentation about that in the last conference.

So one of the common traits we have talked a lot about, cold tolerance. I spent a lot of time looking at all the presentations and the proceedings. We have talked a lot about this in prior conferences, so I thought it might be good to just conclude some of the things related to it. Rice generally, and a lot of the tropical varieties are like this, does not flower until day length gets shorter than twelve hours. The time between sunrise and sunset is shorter than 12 hours. Here of course in our growing season, the day length is much longer. Those varieties will never flower here, which we have found. What they have found with some of the temperate and especially the temperate japonicas is that they have bred out that sensitivity to photoperiod. These varieties are more photoperiod insensitive but they are sensitive to temperature extremes. Some of you through your experiences may have found this, that when it gets too hot in the early vegetative state it starts to head or flower prematurely. Also, and the next slide will talk about during the reproductive phase. If it is too cold at night, which can sometimes happen during the reproductive phase of rice growth, it can cause sterility in the panicle or in the seeds. Also if the temperature is too high it will do the same thing. It will look like the panicles are developing but they will all be empty.

One of the things we have found here in our climate is that water can help mediate temperature a little bit. Water can provide a heat-holding medium, so that in May and June when you have these small seedlings in the paddies and you get a cold night, you could maybe bring in a little more water during the day to warm up and you could provide a little bit of a thermal bubble around the seedlings so that they do not get any damage from the cold. I have heard from some farmers that have been participating in our rice variety trials, that they had some severe weather in May and June when their seedlings were very small. Now they do not have any rice plants left because of hail or strong winds. It is unrelated to the sensitivity issue but water could help with that as well. Maybe raising the water provides a little buffer. Seedlings are very tolerant to a little bit of daily rise and fall in water level. It can provide a little buffer or protection for severe weather, high winds, cold winds, those kinds of things.

A little note about warm versus cold water. One of the reasons why here at this farm they created this paddy system with a pond or reservoir to hold the water, is to warm it up. Warm water will have a positive effect on how the rice plant develops, versus cold water. I think my father found this out pretty clearly this year, in the furthest paddy. I do not know if it is as obvious, but two weeks ago it was pretty obvious to me. He had used water straight from the stream to water, and right around where that water entered there was an area where it looked to be maybe a week or more behind developmentally than the other areas where the warmer water had been used. We are working in such a marginal climate that these little things can have a big influence on how quickly your plants develop, whether or not they will mature within the season we have.
This has already been talked about, weeds. A benefit of having a flooded paddy is that it helps a lot with weeds. If you are growing in dry land or aerobic conditions, you have the added task of dealing with weed management.

Because we are talking about water and using water, this is a slide I think from 2011, from my father's presentation. There are many ways to deal with water, even if you are using the paddy environment. When you add water. When you let the paddies dry down. Here at this farm they try to maintain water level and water in the paddies as much as possible, and I can explain in a minute why that is. There is SRI, which is the system of rice intensification. If you are interested more in that methodology you can talk to Lucy [Hill Fisher], who is over here. They try to do a system of wetting and drying to help with plant growth. That is a strategy. None of these are right or wrong, you just pick and choose what you are interested in. There was a gentleman back in 2011, Erik Andrus, in the Champlain Valley and he was trying to raise ducks and grow rice. There are different ways. If you have ducks in your rice paddies then you need water at certain times as well. These are different methods of using water in your paddies and it is related also to wildlife.

What my parents have found here is that when they made these paddies, all of a sudden the dry land/pasture/hayfield became a whole different environment. They started getting these animals that they never had before: frogs, turtles, insects like dragonflies and damselflies, birds, shore birds, and wetland birds. There became issues with how they managed their paddies in relation to the lifecycles of these animals, especially the amphibians and the dragonflies, because they are using this paddy now as their home. They are coming in the spring, laying their eggs, especially the frogs and salamanders, and their lifecycles do not always coincide with what you want to do with your paddy to grow rice. Here at the farm they try to maintain water in the paddies as much as possible to help allow the frogs and amphibians to lay their eggs, develop, mature, and leave before they need to dry it down for whatever reason. If you go out to the paddies today, you may actually see the Gray Treefrog, which is kind of like the token amphibian for the rice paddies in the Northeast because it is such a charismatic creature. I think maybe in 2009 or 2011, Christian Elwell talked about his relationship with his paddies and how it has changed when he discovered the Gray Treefrog for the first time. He has been growing Duborskian for a long time but it has been dry land. Several years ago he made a paddy and grew Duborskian and started seeing and hearing the Gray Treefrog. There is the adult. It is kind of gray. It stays in the trees for most of its life cycle, but it comes to these wet areas to breed. You might see a few of those little ones emerging. We saw some yesterday. They are very small tiny little things on the rice plants. A lot of the dragonflies will mature within the rice growing season so we do not have to worry too much. The ones that we have to worry about are the frogs that need more than one season for the tadpoles to develop and mature. Bullfrogs and some of the other ones that need more time. We focused on presentations about wildlife in 2011. There are presentations from Jim Andrews, who is the herpetologist for Vermont, and Mike Blust, who works a lot with dragonflies. If you are interested in the wildlife aspect, you can go back and check those videos out.

A lot of us have been talking about the Northeast rice growers as not one single thing. There are many scales of rice growing in the Northeast. There are many ways of doing it. In 2012 we had some growers come and talk about what they are doing. Some who had some experience. I thought I would go through some images because some of them are very different from what it looks like here, but it is still growing rice in the Northeast. For those of you who are interested in starting, you can try to visualize what your options are, what you might want to do for your area.

This is the gentleman I was talking about in the Champlain Valley. He [Erik Andrus] is in Vergennes, VT. He has very flat, clay-rich, wet soils and in 2011 he came and he talked about trying to raise ducks with rice. I do not know how much he has continued that but, he has lots of wet land and he was growing rice at a pretty large scale for the Northeast.

This is Christian Elwell's place. His paddy and his Duborskian. I added him because his paddy is very aesthetically pleasing. His Duborskian has been a source of seed for many growers in the Northeast as well.

Jenny [Thorne] is not here today, but she was growing rice at 1500 feet, which is a very high altitude for paddy rice in the Northeast Kingdom of Vermont. She had success with that. It can grow in different areas.

This is Josh Brill. This is around Rutland, Vermont. I think he is pretty high altitude as well, but on a steep slope. I think somebody mentioned interest in doing terraces. He has terraced three paddies on the hillside there.

Sjon and Elysha Welters. They are the owners of Rhapsody Foods, if you are familiar with their tempeh, in Cabot, Vermont. They have been growing paddy rice at pretty high elevation as well.

Rhode Island. Paul Kile has a few paddies as well in a shaded cooler climate. Although it is further south than we are, he is still dealing with cold issues because of the spot where he is.

Michael [Pill], you are here, and Ryan [Karb]. This is their dry land, aerobic rice. You can actually see the corn in the back there. A wet part of the field with saturated soil where they are trying to grow rice without irrigation.

Jim [Lyons], who is over here. His operation is in New Jersey/Pennsylvania. He is growing rice dry land, kind of like another vegetable crop. He has used raised beds, and it is an interesting way of looking at rice in the Northeast.

An aspect of growing rice that I am really interested in personally, because I have a background in environmental education, is growing rice and connecting that to education. I am very happy that today we are going to have a group from Randall's Island talk about that aspect. We can grow rice as much as we want, but if we do not connect it with a consumer, we are never going to have a market for local rice. For many of us, it is important to grow for our local community. We are never going to compete with Arkansas or California, so our market for rice is this local foods movement, people who want local grains for their lifestyle. I just learned about this a few weeks ago, we have a group from Martha's Vineyard who through funding and support with Glenn are doing a Farm to School program where they are growing rice. That is very exciting to hear about. It is important to connect not only where are food comes from but who is eating it.

We have always tried to add this component to our conferences, and we focused on it in 2012. We had a morning of presentations talking about rice cuisine internationally and how that connects to growing rice. With our lunches we always focus on rice. We like to connect that aspect. As I said, it is important to grow rice, but it is also important to find that market that will eat the rice.

Work we are doing now, that Susan alluded to, is developing our own climate and agronomic data. I was very fortunate to have one of Susan's graduate students, Christine, put together an explanation that we recently posted on the website about growing degree days. What it is, what it means, and how we are hoping to use it as a tool for the Northeast. This is the webpage. The map is something that has been developed and I will talk about it more later on.

This is a slide from prior presentations and I think where this idea started. In the beginning, and even now, we would get lots of questions about what varieties do well at a particular location. We wanted to connect rice varieties with climate and we tried to do that with growing degree days, which the definition is on the bottom. We collected data at Akaogi Farm in 2009. I do not think you can see it, but it was around 1900 growing degree days in that year. Growing degree days, if you do not know, is the number of degrees Fahrenheit above 50 within a given day accumulated over the growing season. We used May 1st to September 30th. It was 1900 in 2009 here at the farm. This table is a comparison of some of the locations throughout the Northeast. To give you a little bit of perspective, in northern California they are looking at growing degree days around 3000. They are between 3000 and 3500 even in their coldest areas, which is a lot warmer than here. There are some places around the Great Lakes around the St. Lawrence River that are pretty warm and we have had some interest from people in Canada who want to grow rice.

This is the map that I was talking about. This is something that Genevieve put together and another woman, Darcy, was also very instrumental. They collected climate data from weather stations. These are not actually places where we are growing rice. We hope to have a map with places where people are growing rice, but this is just climate data and what degree days look like in reference to rice here in the Northeast. Although maybe the color gradations are arbitrary, when we first put this together it was very intriguing to me that you could really see that there is a range of climate here in the Northeast. Varieties that might grow well in the northern half are going to be different than the southern half. The southern half might be able to grow some of the varieties that are grown in northern California. I will just mention briefly, there is a blowup of this map out on display. You can take a look at it later, during the break.

Susan: Genevieve, do you want to mention where the information comes from?

Genevieve: I think it is from an entomology group at Oregon State that collected climate data from 30 years.

Susan: It is satellite data. Satellite data from weather stations and airports and things. It is not necessarily on your farm. It is the nearest weather station to you, hopefully.

We hope to improve our data resource for the Northeast. In the last couple years we have been talking about having growers in the Northeast grow a panel of varieties, and I think a few of the people who are participating in this are in the audience. The panel includes four varieties that range from what we think will be early maturing to late maturing in the Northeast. We have asked participants to grow these varieties to see how they fare in different locations and hopefully we can connect that with the temperature data. Over the years, maybe, we will be able to give some recommendations to the Northeast growers. This is the panel we picked: Yukihikari, Duborskian-South River, M-102, and Koshihikari. Duborskian because it is early and available in the Northeast. M-102, which is an early maturing variety from Northern California, one of the earliest. Koshihikari because it is a popular variety. We have about thirty growers participating, which is more than I thought we would get. We will see how much data we get back.

I just wanted to give some faces to the prior conferences and these are the faces of the Northeast rice growers. We started in 2009 with a group maybe of forty? It has grown a little bit. Last year we had a lot of people because we had the Asia Rice Foundation USA board members and we had a large group from Burlington. It has been nice to see this group grow and different people, new people, coming every year. This group may seem small, but there are a lot of people who have come

to the prior conferences who still keep in touch and there are people who just reference the website and the videos there.

I will end with the website, which Susan talked a lot about. This website we hope will be a resource for you into the future. We do not know where the future will be, but hopefully we will all keep in touch and continue this project further.

Audience: Is anyone doing any research on the effects of climate change and how that is affecting the growing degree days in New England? I know that at least up until the last year or 18 months, the USDA has been slow to update their growing degree information.

Diane: So far not for the Northeast, but we are beginning to look at exactly that for the southern rice growing regions. It is not actually that much to do the same sort of modeling that we intend to do for those states for your regions up here. I hope to be able to talk a little bit about that during my presentation.

Susan: By the way, almost any grant that you put in these days has "climate change" as the motivator. Probably everybody says they are doing research on climate change, but your question is more targeted, "Can we update the growing degree day recommendations?" That is an important one.

Audience: Why wouldn't corn growing degree days be relevant to rice? They have all kinds of charts and information on corn for the last fifty years, seventy-five years.

Diane: To me, recommendations have to be data driven. The environments that maize is adapted to are totally different than rice in terms of the temperature threshold that is suitable for maize.

Susan: We have the climate information. We just do not have the crop information to make the recommendation. We are trying to match the rice crop with the climate and this is the group that is doing it. There is no one else doing it. You will help us put those varieties into those growing degree days. You know how the corn varieties do, but you do not know how the rice varieties will do in the same growing degree days.

Peter: This is a really complex thing because many different things affect the climate, El Niño, La Niña, what type of year it is, weather patterns and things. It is always interesting. In your map there growing-degree days are not the same every year. They vary from year to year.

Mia: This table is interesting in that the red highlights the highest growing degree day year in the last ten years and blue is the coldest. You can see 2009 was one of the colder years. Since then it seems like the temperature has become a little warmer.

Peter: This is why you have the public confused because they say, "Global warming, well what the heck? Global warming? It is getting colder." You have to take long-term trends. Over time things are getting warmer and climate is changing.

Linda: I just want to make a comment. Thank you for going over this. There is a lot of information on that website and we are grateful to have all those videos up there. Peter Hobbs has a lecture in 2009 about nitrogen cycling, if you are interested in that. Susan and Peter had a discussion about dry land vs. wet land. There is a lot of information on there. Please use all those proceedings that are written up thanks to

Mia and Susan and the group. There is a lot of information. It is a little difficult to find what you want sometimes.

Takeshi: I have one comment about the fluctuation. It really changes year to year. From the grower's point of view, we have to focus on the coldest year as a guideline in order to get a reliable crop. Even in the last ten years, there is that much of a difference. We really have to focus on the coldest situation because this climate is really cold, actually.

Audience: How about the economics of all of this. What is for instance the ideal yields per acre?

Mia: It depends on your perspective and what you want. You can get pretty high yields, comparable with international and national averages. There are a lot of factors that go into the yield of the crop. It can be quite productive, but there are a lot of factors that go into it.

Audience: Is there data available for varieties for temperate climate? For organic vs. non-organic?

Susan: Not in the temperate. It is all southern. The problem we have is that there is not a large enough community here. In Japan there is no organic certification. The place that you would expect to have that comparison, which is most like ours in terms of environment, does not have a certification process and therefore organic does not mean anything specific. I would say for the temperate zones, northern California. California has its stuff, but none of our northeastern growers can grow the California varieties. For our zone, the answer is probably no. We better do it. If we want it, we are it. We are the ones that are going to produce the data, and I can help organize the data, but I cannot do the production data. All we are trying to do is limit the number of varieties at the beginning so we can have something comparable. So that we can put variety, development, phenology, into the growing degree days that are available for the zone based on five reference varieties. If we had that, then many people could say, "Oh, in my area all these varieties head at the same time as this one." We know how this one does in each of your places, then we can line up behind it all the ones within that same growing-degree days that mature at the same time. We will be able to produce an atlas that is quite substantial. I do not think that this environment is represented anywhere at the organic level to provide us with information. I think we are the ones that have to provide that information, but we can look to the South to see what kind of information they are providing to their growers. We can look to see what kind of information would be useful, but we cannot get information to map into our zone right now on rice. I do not think. I have looked.

Peter: I just want to add also that there are two components of economics. One is production and that is where you can help us by providing us the data. The second one is how much money you get for the rice, and that means branding it, where you sell it, and what markets you can find. That aspect of it is important as well.

Audience: Is anywhere in the country growing aquaponics? Using aquaponics for rice production in a controlled environment, in a greenhouse.

Susan: Oh, in a greenhouse. That is kind of like what we do. We do a lot of that, but not for production. Just for research. Come visit. I will show you what we do. Cool stuff. It is a controlled environment.

Audience: Is it safe to assume that the seed I raise this year will be better adapted to my environment and growing conditions next year?

Susan: Interesting.

Audience: It is true with many other crops, for beans and squash.

Susan: That is a really interesting question. If in fact you select year by year, you will be selecting for genetic strain that is adapted but you will not in any really predictable way alter the genetics from one year to the next. I do think that what you will probably be able to potentially do is do like what I think Mia was talking about that Ogi does with the water. It is like blanketing it. Put the little rice seedlings in a little extra water that night that it is going to be cold. Nestle them in with a little warm water to fend off the cold. I mean those things, that environmental management, with the right variety is probably best. I do not think epigenetics is going to do anything for you in one season.

Audience: With beans and squash you can really select and next year's seeds will be better than this year's seeds.

Susan: I think if next year's seeds are better than this year's seeds, it is a self-selection process for vigor. Because if you are doing a good job, your seeds will be robust. Whereas if you get your seeds from somewhere else, they may not be as good.

How Does a Rice Plant Perceive and Respond to Environment?: Diane Wang

I just wanted to first say a huge thanks to Mia for doing all this amazing organizing and to her parents. It is a great venue and it is really my pleasure to be here. I have not been here since 2009 so it is really cool to see some of the changes as well as see the rice, which is as beautiful as ever.

As Mia said, I am a graduate student with Susan McCouch at Cornell University. My dissertation largely focuses on trying to understand the genetics underlying how rice stores reserved carbohydrates in its stem and how it utilizes that for things such as grain filling. My project is sort of a hybrid between physiology and genetics. Today I have been asked to talk to you about how rice plants perceive and respond to its environment. I hope it is not too much basic science and I hope that it is interesting to you.

What is physiology? It is basically the study of how plants function. I like to think of it as the interface of the genotype or variety with its environment. When we think about physiology, we think about phenotype and a lot of the research revolves around stresses. We think about phenotype by environment interaction and the role of the environment in how a trait expresses itself. More specifically, physiologists study reproduction. When your rice plants flower, how many seeds set, which is really important for growers such as yourselves. Photosynthesis, this is the process that allows the plant to take inorganic carbon that is stored up in the carbon dioxide that we breathe out and make them into plant, and eventually into the grain we eat. They study resistances against biotic and abiotic factors like pests and disease as well as climatic stresses, and basic metabolism. It runs the whole gamut of things you could ever study about a plant. I had a really hard time trying to figure out what I wanted to share with you today. I decided on three stories. The first, I will talk about two tales of rice tolerance to flooding. Water management is really important when growing rice. Secondly, I would like to discuss how environmental variability may affect your crop. Third, Susan asked me to share a vision for rice for future climates.

We will start with the water. There are different types of flooding that we observe. This depends on how much it rains, how long it rains, the geographical features of a region (like topography, whether you are in a real low region or whether you are up higher), and of course the nature of the soil. The first main type of flooding is a flash flood. This is something that appears suddenly. It can damage rice plants, especially at the seedling stage when they are really young and not too sturdy yet. Rice seedlings normally respond to this type of stress by growing up, because they are trying to breathe. It does not want to drown. They are really small at that stage and it uses up a lot of energy. Then when the floods recede, they basically wilt and die because there is nothing left in them. They are totally spent. These flash floods typically last no longer than a few weeks. They are real quick.

The other type of flooding is deep water and if you are really interested in it you can talk to Peter [Hobbs] because he lived in Bangladesh for six years. These are large-scale floods that occur for prolonged periods, and they are more predictable. The water levels range from a few to several meters and this may continue for several months. It is typical in Bangladesh and parts of Southeast Asia. In fact there is a special season for this, and they have special rice varieties that are adapted particularly to this deep water situation. They are known as deep water rice.

We can first talk about submergence stress, which is the first type of flooding, the flash floods. In an ideal situation, you have your paddies, it is dry, it is hot and sunny, and your rice grows very normally and you have a good yield. Contrast this to the flash flood situation. These photos were taken in Southeast Asia. The first one is from Indonesia and the second one is from Thailand. You can see how devastating this type of stress could be. In fact, this affects 20 million hectares in Asia as well as a third of the rain-fed lowland areas in Sub-Saharan Africa, which also produce a lot of rice. In terms of economic losses it causes about a billion dollars in losses in Asia every year. It is a huge problem. When we have a problem that is so severe, obviously researchers want to figure out how to deal with it.

In 2006, scientists discovered a gene that is an ethylene-response-factor gene that confers submergence tolerance to rice. Like I said before, most cultivars are not resistant to flash floods. They expend all their energy as seedlings when the flash flood comes. They wilt after the floods recede. Most of them die within one week of complete submergence. There are a few tolerant ones. The one that they studied in particular is called FR13A. It is an indica. It is not very high-yielding. It is adapted to a very different region of the world. The cool part about it is that it can survive up to two weeks of complete submergence, and so they wanted to figure out why.

They discovered in the study that there is a gene that is called Sub1A that confers enhanced tolerance in the plants. They took that gene and moved it, by using crosses, into varieties that are very popularly grown in Asia. Like I said before, FR13A is not very high-yielding. They wanted to figure out why it is tolerant. Here you can look at how a flash flood intolerant variety deals with flash floods and how a tolerant variety deals with flash floods. They are both growing normally at seedling stage. The flash floods come and the intolerant varieties elongate as a normal response. The submergence tolerant varieties rather than elongating, they go into a stunted dormant stage. Something is different about their mechanism that allows them to sort of go to sleep. After the waters recede, rather than wilting, they have all this stored energy that they have not used. Which is really cool actually.

Audience: Does that still delay heading or something else further down the line?

Diane: It does, but alternatively, you have a completely dead crop.

Susan: It is a tropical situation so delaying heading is not going to be met with frost.

Then they looked further down into the mechanism and they figured out this nice pathway. You have submergence, which is the stress, and this induces the production of ethylene, which is a plant hormone. Probably some of you are familiar with ethylene. It is the ripening hormone. If you put your tomatoes or your bananas that are still green in a brown paper bag, they will ripen a little bit faster because they are surrounded by ethylene, which is the only plant hormone that is found in a gaseous state. The ethylene promotes the expression of many genes, one of which they found was Sub1A. It is characterized as an ethylene response factor because it is induced by ethylene. What Sub1A does is it induces another gene, called slender rice-1 and that gene's function is to suppress GA signaling. GA is gibberellic acid, which is yet another plant hormone. What that normally does is it promotes growth. If you have something, Sub1A, that is inducing something else that is a repressor of something else, in the end you are going to end up repressing whatever that original function is. In this case of submergent-tolerant rice, we get plants that do not elongate and therefore do not consume energy. Some of the other traits that they have measured in these submergent-tolerant rice lines are that carbohydrate metabolism genes, such as sucrose synthase (things that would get promoted when the plant utilizes carbohydrates to do whatever it needs to do), are down regulated. Essentially, the take-home message is that the rice seedlings deal with submergence by going to sleep.

Here we see that the breeders took this gene and introgressed it into megavarieties to make them tolerant to flash floods. This is Swarna, a very popular variety grown in south Asia. This is Swarna Sub1, which is really genetically close to Swarna except for this one bit that was introgressed from FR13A. The phenotype is that it is tolerant to submergence. In this case we are growing without the stress. You can see that they look almost the same, except Swarna Sub1 is actually a little bit earlier. You can see that it is already headed and the grain is starting to grow, where this is slow, not yet headed. We do not see very many negative tradeoffs, in terms of growing a variety like Swarna Sub1 in favorable conditions, which is really important. Here we can see that Swarna Sub1A performed really well under flooding conditions. This is taken in July 31 in 2008. This is after water has receded from a flash flood and you can see how wet the fields are. They do not look so good. Most of the times we want to see our seedlings sticking up very erect and they are flopping over. But then you can see how well it recovers. Three months later, on October 31st 2008, it looks like a completely normal crop. This was a really fantastic thing to happen to the rice community in Asia.

Susan: Mention that it is a traditional variety, not a GM.

Diane: Susan just pointed out that the gene that confers the tolerance from FR13A was bred into Swarna through traditional crosses, so this is not a transgenic by any means. They made a cross and they selected for the gene.

Peter: Why would that make any difference?

Susan: Because you do not have any GM rice in the field.

Peter: If you used biotechnology to transfer that gene would it be any different?

Susan: Yes, it would be different. It would be in a different place in the genome. I just want to make the point that this is not GM rice. A, there is no GM rice anywhere in the world grown commercially. B, it is a traditional farmer variety, a traditional mechanism, and it was easy to transfer because this one gene transferred the entire mechanism. It is very rare genetically to find such a simply inherited trait that does such a profound thing and can be transferred so easily.

Diane: It is very lucky.

Audience: How long would they be able to stay under water and still recover?

Diane: Two weeks.

Susan: This is what the natural variation out there can do for us in a genetic context.
Diane: It eventually needs to do some photosynthesis.
Peter: Any longer than that and you would get into deepwater rice.
Diane: If you get any longer than that you are going to have to find a different strategy to work with it.

That brings us to the second type of flooding, which is deepwater. Again, the deepwater flooding contrasts with the flash floods in that they are much longer in duration and the water levels can be much higher. In 2009, three years after Sub1A was discovered, scientists found two other ethylene response factors and they named them SNORKEL1 and SNORKEL2. The study was done in Japan and out of Motoyuki Ashikari's group. He said that he named them that because the word snorkel sounds very similar in Japanese and in English. I do not know.

I have a photo coming up. It is amazing. Two different types of flooding and two different mechanisms, but all of them are ethylene response factors. Let us look at how the unadapted vs. the adapted varieties do. You have your normal rice growing and in this case, the rice is usually at a later stage when the floods come. They are not super, super small. In the unadapted variety the deep water comes and it is not usually able to keep up with growth, because it is already reached the point where it is at full growth. However, the deepwater varieties, they can elongate as much as the water rises just to keep their head above the surface. Just to have a few leaves up there so that they can access oxygen, because if you have a plant underwater for a long time it basically drowns. Even though plants fix carbon dioxide, they need oxygen for cellular respiration just like we do. This deepwater can last for several months, so it is pretty extreme.

This is the mechanism. You have again your stress, the submergence. Again, the same hormone is expressed. It is ethylene. In this case it induces the expression of SNORKEL1 and SNORKEL2, which are ethylene response factors. Again gibberellic acid has a role. In this case, they induce the production of gibberellic acid, which I said before promotes growth and elongation. We have rapid stem growth. The plants get really, really tall. So tall, in fact, that when people harvest, they harvest in canoes. Going along cutting the panicles off.
Susan: Twelve feet tall.
Here is a video to show you just how fast it can happen. On the left is your control, so this is the unadapted variety. On your right is the deepwater rice. It is a time-lapse video. These plants can elongate up to twenty centimeters a day.
Audience: How tall will they grow?
Diane: Really tall. I will show you a picture. This is Moto. He is the PI for the lab that published this study. In case you cannot see, that is him and that is a deepwater rice plant.
Susan: When you go out to harvest in canoes, it is like being in a pond that is twelve feet deep or twenty feet deep. You harvest those panicles from the top of the water, and they are rooted down deep.
Peter: Some of them float. They call them floating rice. When the water goes down, the plants fall down but then they rise up and form new panicles.

Audience: Is there a quality of difference if that happens consistently or does it happen consistently?
Diane: Sure. Under normal conditions, if there is no flooding, the deepwater rice behaves like a normal rice variety. There is nothing to induce that response, but this

deepwater rice is not very high yielding. It makes sense. It is putting so much energy into that growth that there has to be a tradeoff with yield. What they want to do is find out the genes that are responsible for this trait. Then they want to try to breed it into some of the varieties that have high yield or have the quality characteristics. Then maybe with the combinations, maybe the response will not be so extreme and maybe there will not be as many tradeoffs. This condition, this adaptation, is very specific to a certain part of Southeast Asia where they have a deepwater season.

Peter: In the delta.

Audience: They fall when the water recedes or can they stand up on their own?

Peter: They fall and then they sprout up.

Susan: But the way this water works, it is a fairly predictable thing. That part of the region floods every year and you harvest it before it recedes. If the water were to just rise and fall, it would be a disaster.

Peter: They do harvest after it recedes sometimes.

Susan: But it is still on top of the water.

Peter: It bends up. It depends on the variety. Then it falls on the ground and then they harvest it off the ground.

Susan: There are all these variations in regions of the world where that land is really not useful for anything else except this. Even though the yields are low and the labor is high, they depend on that as their food.

Audience: There is a big difference in the deltas. In some deltas they have put in the infrastructure so that you do not get that anymore. The deepwater areas are decreasing.

Susan: I think one of the take-homes for this group is that there is this amazing genetic variation in rice, naturally there. What we do is harness it and try to move it. Adaptation to cold climates and short season is a dramatic adaptation. That is not where rice is normally adapted. You can do a lot of things. There is an elasticity in the genetics and that is what breeders do. They harness it.

Gen: Diane, do all of these types of rices have similar characteristics? I remember one of our graduate students last year, I think, was testing in the greenhouse using deepwater, using Nipponbare and IR64. I know there was a temperate japonica in my town and when a typhoon came sometimes the rice paddy field would be completely under water, but the plants would not die. For one day, two days…

Susan: For a short time, yes, but not a long time.

Diane: If the water is not too high.

Gen: Not high, but the plants were underwater and still alive.

Audience: Does the gene prompt any corresponding growth in the roots as well or is it purely in the stems and leaves?

Diane: That is a really good question. I do not know the answer. They were mainly interested in the stem. Normally there is a tradeoff between root growth and shoot growth. Under conditions of drought, the plant will choose to send resources down to drive more root growth to access deeper water and stunt its shoot. In this case, because the stress is above the surface and it is trying to get oxygen, I imagine that there is not as much root growth going on. But I do not know.

This brings us to the second story, which is how environmental variability may affect your crop. I am sure you are all familiar with this so I might be repeating some things, but it is good to review this. One thing that I thought is important is temperature. There are positive and negative effects to high temperatures. Some positive effects are that it promotes grain filling and it can shorten the total growth duration, which might be important for a region that has a short growing period as it is. It enhances general metabolism, so when things are hotter, enzymes work a little bit faster. It induces remobilization of stored carbohydrate reserves in the stems and helps it move from those temporary storages into more active sinks such as the panicle. That is where my area of research is.

Here are some of the negative effects. If you have extreme heat during anthesis or the heading stage it leads to spikelet infertility. The male parts of the plant are typically really sensitive to temperature fluctuations. Too much heat might also lead to poor grain quality. There has been some preliminary research on that. If you hasten grain filling too much it happens too fast and then it might lead to chalkiness. Then of course, hot, wet environments generally promote proliferation of fungus, which causes diseases. Here are a few photos of too much heat. Here are rice plants that are suffering from extreme heat and drought. You can see that is not an enclosed canopy. The leaves are completely rolled as a response to drought and heat. I do not know if you have seen that in your crops because they are probably very well irrigated. Then panicle or spikelet infertility in the right picture. They have the really flat, unfilled grain.

Moving on to cold, which is the other extreme. I could not come up with too many positive effects of cold, but it has been shown that relatively lower night temperatures have been associated with higher historical yields. There was a study that did a bunch of modeling across maybe twenty years of historical data, and their conclusion was that rising night temperatures were what caused lower yields in the same varieties across time. I have not found a lot of research relating cold to spikelet infertility, but then Mia says that there is and it does occur in the Northeast U.S. It is just that most research is not done in the Northeast U.S., so here it could actually be a problem for fertility.

Susan: In Japan and Korea there is a lot of that.

Some of the negative effects are the opposite of heat. Metabolism and energy balance are affected and everything sort of slows down. You probably do not want this to happen if you have a short growing season and things are slowing down already. You have slower grain filling and this could last 1½ to 2 months, whereas if you had a hot condition it could be 30 days. This might lead to an inability to utilize stored carbohydrates, so that at harvest time a lot of the carbohydrate that the plant already took from the atmosphere is stuck in the stem and you cannot use it.

Audience: Relatively lower night-time temperatures is what, high 50s, low 60s, something like that?

Diane: They did this study in the Philippines, on an indica variety, and optimal night-time temperatures would be around 21 degrees Celsius.

Susan: That would be seventy-something degrees Fahrenheit. It is not cool in your mind. The highest yields in the world are coming from temperate regions where they have cool nights. California and Australia have some of the highest yields in the world, and they are growing temperate japonicas with cool nights and really high radiance during the day. Warm hot days and cool nights. That cool is not that different than your cool, expect that their days have much more luminescence.

Gen: In Japan, the mountainsides are very cold.

Susan: But 50 is too low.

Diane: At some point if it is too low at night, everything slows down and the sugars that are created in the leaves during the day will not be able to get moved around where they need to go. That is what usually happens at night.

Peter: If the temperatures get below 50 when it is flowering, you are going to get sterility.

Takeshi: I think another way to see this, in the Northeast, is that there is a fine line between increasing yield and damaging the grain. The pollen may die. I think around 12 degrees Celsius for more than 24 hours in the field and your pollen may be damaged permanently. Then we do not get any yield.

Jim: When it gets that cold, what kind of buffer does the paddy provide? The water level is down here and you have your flowering up here. Does that help at all?

Susan: It does help.

Takeshi: One way to deal with that problem is to increase the water level as high as possible during that time. The water will warm up to 80 degrees during the day, and even if a cold spell comes of 50 degrees for two days, maybe it will help a little bit.

Susan: If you have that level of water control.

Audience: Are there any studies on consistently altering or keeping the water at the same temperature in a paddy?

Diane: I do not personally know any study that has looked into water management in controlling the effects of temperature. This is something that people should really look into.

Gen: What is the water source, from a river or ground water? The temperature will be different depending on the source.

Diane: I do not think that it has been done, but that is something that you could experiment with yourself as well.

Audience: We had a question for the other growers. We were wondering if anyone has used row-cover earlier on to extend the season?

Susan: If you had a really high value crop and you could justify the labor and the expense. You would have to put it down and pull it off and you would have to have the arcs and everything. I see it done in seed production environments where the seed is so high value that people will be willing to do it, but I cannot imagine in a production environment that it would be economical.

Linda: Too hot, also. I think Mia mentioned it. With the temperate japonicas in the early stages, if the temperatures are too warm you will get premature heading. You will get a couple heads that are coming out and the rest are way behind. You have to worry about the temperatures early on.

Susan: What is very interesting is that something like Nipponbare, which has almost no temperature, well photoperiod sensitivity. Photoperiod sensitivity puts a brake on temperature sensitivity. The two are linked. On this planet temperature and photo-period are related. You have long days in summer and high temperatures. You have short days in winter and colder temperatures. The two are linked in the plant world as well. When you knock out photoperiod sensitivity, the plant becomes more susceptible to temperature variation, and since all of you are working with things that are non-photoperiod sensitive, they are hyper-sensitive to temperature. That is what Linda is mentioning. We sometimes see in our greenhouse this crazy situation. We have seen Nipponbare plants this high, with ten leaves but really, really, really, small, young plants, shooting up panicles. Crazy, bizarre stuff, because our greenhouse is

hot, but our light is very low. You do have to be careful in the way in which those two balance out and they are more sensitive to temperature because they are photo insensitive.

Diane: I have a photo up here of what cold stress in a young plant looks like.

I would like to quickly discuss solar radiation. We all know that sunshine is really important to grow a good rice crop. They love the sun. There are tradeoffs here too. There have been tons of studies about what the optimal solar radiation for rice is. I think it is just a lot, a lot more than other crops. They have found associations with high yields and good light, but then there are also some studies on how there is a relationship between high solar radiation and other things, like methane production. It appears, at least in one study, that you get more methane emissions when you have lots of sunny days than if you have gloomy days. I am not sure if that can be mitigated that much, because you probably want higher yields in the end.

Susan: Do not forget that what is emitting the methane is the microbial population not the rice plant. There is a lot of work going on to shift the microbial population, which is the methane emitters, through root exudates. What emerges from the roots can mitigate what the soil bacteria produce. It is wrong to associate methane with rice. Methane comes from the microbes that grow in the flooded paddy in which we grow the rice, and we may be able to use the rice to shift that microbial population so it is not emitting methane. I think that is really cool.

Diane: It is not emitted in an upland situation?

Susan: No. In an aerobic situation, it is not.

Jim: Sorry, you are looking at adjusting the rice so that the exudates that are coming out of the root will feed a different form of microbiology?

Susan: Yes.

Jim: Wow.

Susan: Yes, there is a lot of that going on all over the world. It is one of the big ones under the sustainability initiative that I mentioned. It is very cool and it is mainstream research.

Why I wanted to bring this up is because everything has tradeoffs. It just boils down to how the physiology works mechanistically. Everything is networked. If you tweak something, you are going to end up adjusting other things.

Then I wanted to go into one more specific response of the rice plant to light. This is how rice plants, or plants in general, respond to their neighbors. This is through the ratio of red and far red light. These are not rice plants. I could not find pictures of rice plants. It is easier to see in this plant, Arabidopsis, which is our lab rat of plants. We have two Arabidopsis plants, and if you hit it with light that has a high ratio of red to far red, it will respond one way, and if you hit it with a low ratio of red to far red light it will respond in a different way. This is what it looks like. Under conditions with high red to far red ratio the plants will be short, and in the opposite condition they elongate. The reason they do this is that this is the mechanism by which they sense their neighbors. In open fields without any neighboring plants, you will get sturdier, bushier plants. In conditions where the plants are in shaded undergrowth, or if you can imagine a crop field that is really crowded with lots of plants neighboring each other, you are going to get this response unless you breed it out. For plants that are capable of shade response, crowding may affect plant height. They will try to get taller to compete better for light, and there has been reported a tradeoff between plant height and the

number of tillers that a plant can put out. It is all a matter of resource allocation. Are you going to grow taller or wider?

Susan: I would like to connect this with SRI. SRI is typically trying to encourage people to have wide spacing between plants, because they are assuming that the variety of plant is going to tiller and fill in that space. In rice we know that some plants do not do that. It is a genetic response to environment. In some plants, if you space them widely they fill in. That is typically an indica response. Tropical indica does that all the time. For Northeast growers working with temperate japonica, usually the plant response is not to keep tillering. Because the only way a temperate japonica plant can get seed on it in a short season is to stop tillering and shoot itself up into grain production quickly. It puts out a minimum number of tillers. Even when spaced widely as you saw last year in the paddy, it does not continue to tiller. The temperate genetics tell it not to tiller but to go for grain production. We have this tradeoff, which Lucy [Hill Fisher] and I have been discussing, that is the "appropriate spacing for the appropriate variety." What Diane is talking about is sort of the reverse. If you want a certain spacing, we could breed the plant that would accommodate that, but it might not get seed in a temperate environment. It cannot both tiller and produce a lot of seed in the space of time that you have for that plant to grow. It is likely that your best spacing in the temperate zone is going to be a little narrower than it would be in the tropics for even the SRI system. There is an adjustment that needs to be made based on the genetics of what you are working with.

If you look out in the fields, it is the paddy that Sandy will be talking about, which has the breeding project that we are working on. The parents for the breeding project are Della, which is a tropical japonica that is commonly planted in the southern states of the U.S., and Yukihikari, which is a temperate japonica. If you look at the parents, you will see that under that spacing the temperates are really erect and they do not fill in that space at all, whereas Della or some of the other plants might not necessarily tiller more but they spread a little bit more. They have a spreading response, which I have seen pretty commonly in the tropical japonicas. It is really cool. I was in Ghana a few weeks ago and I met these rice farmers, and they are experimental. They were like, "Oh we want to try this thing with spacing" and so they tried 20x20 centimeters and they had a whole other field at 30x30. For their varieties they found that they really liked the 20x20 more, because with the 30x30 there was too much space and weeds filled right in. It is all about the right management practice for your variety.

This brings me to my last part, and I thought it was a tall order to give my vision for climate-ready rice. I think I have more questions than answers in the end. What can we expect in the future? Well, the climate scientists have not really come to any agreement from all their models. It appears that there will be changes in precipitation, and temperature, perhaps the mean and variance. They are not totally clear on the variance because the models are not agreeing. Perhaps also in the frequency of weather events, and then all those three above will affect growing season length as well as perhaps the geographic locations that will be optimal for certain crops. Right now we grow rice in the southern parts of the U.S., Arkansas, Texas, and Louisiana for the most part. Whatever happens in the future, maybe some crops move more north and some might move more south. It totally depends. It is really hard to predict these things.

My second thought or question is whether an ideotype really exists. A lot of the questions that I am hearing and where the research is going, it seems that people are trying to find what the right type of

plant is. This leftmost plant, in the photo, is a representation of what traditional landraces for rice looked like prior to the Green Revolution. You see lots of tillers but not a whole lot of productive tillers, and so there are not that many panicles. They are tall and they are skinny. After the Green Revolution we have something that looks more like the plants in the middle, which are the semi-dwarfs. They are short and they are erect. They have lots of tillers. Maybe not a huge percentage of productive tillers, but many, many tillers and they are responsive to inputs. What people are thinking now is that maybe we should go for more of a moderately tillering plant, but 100% productive tillers. And a little bit taller because with such a short plant you cannot possibly get enough biomass to do enough photosynthesis to generate enough carbohydrate to fill all the grain that you would want. I think that is a good approach. I also think that we have to think in different ways. If the future is not really predictable, you cannot predict a good ideotype for that situation and indeed tolerance to stresses do come from unexpected sources.

Here is a really cool story. We already talked about the submergence tolerance gene, Sub1A, that was discovered, and that protected seedlings from flash floods. Here are a couple plants grown in a pot, and one of them has the Sub1A gene. They drought tested them, so totally the opposite of having too much water. They took away water and they actually found out that the Sub1A plant all the way on the right, that is the green one, that is the only one that recovered. This is a study done at UC Riverside and the researchers proposed that the pathways that lead to tolerance to submergence and to drought, that the Sub1A is a convergence point. Sometimes you just cannot predict what you are going to find, so it is probably best not to limit ourselves right from the get-go.

Lastly, I want to ask, "What can you do?" Many of the questions that we have been getting are, "What is the best way to do this?" or "Can we utilize the growing degree days that the maize community has generated or their decision-making tools?" The answer is that we do not have the decision-making tools for the Northeast U.S. because rice is such a new crop. You are the information source that we can use to inform the models and the decision-making tools that will come. That is why interactions between growers and consumers and researchers will create benefits for all parties, because actually our incentives are all aligned. I imagine that growers are interested in making a living, promoting their product, and probably they are specifically interested in marketability and reliability of that crop. Consumers are probably interested in price, satisfying their taste preferences, and maybe novelty. Whereas from our side, of course we are interested in basic research, but we are also very focused on the applicability of our results and working in ways that can create impact. I think Genevieve will talk more about this, but maybe we could initiate some sort of small-scale citizen science interaction and collect some on farm data, because the answers to all the questions that you are asking will be generated from this type of interaction. It involves making observations, taking notes, and probably later on some more systematic way of data collection. Obviously we know that not everyone has time to go out and collect heavy-duty data, but a little bit goes a long way and it can help us inform hypotheses that we can use to write grants and just do more in general.

Glenn: In the root studies, with respect to deep roots versus shallow roots and aerobic versus anaerobic, were you able to conclude any simple fun fact?

Diane: The question was, "Have there been any studies on root growth in anaerobic versus aerobic conditions?"

Glenn: Yes and whether deep root versus shallow root systems are preferable in this plant design? If you have more height do you have deeper roots as well?

Diane: No, not necessarily. Usually it is a negative tradeoff between the two. In the upland rices, such as the tropical japonicas of Latin America, we tend to see deep root systems because they are growing in upland conditions. The limiting factor for them is water acquisition, whereas in a flooded paddy that is not going to be an issue. The plants will have a larger root to shoot ratio. If the plants do not need to produce it they are not going to make it. It will not be the optimal design, probably.

Susan: It is a really interesting question whether you could breed for a trigger that would allow them to shoot out roots the way they shoot out shoots in the SNORKEL example, right? That work is ongoing. We have a collaboration with a group in Japan, and our group is doing quite a lot on root growth in response to triggers because there are many ways in which that can happen. They have recently cloned a gene called DRO1, which is a drought one, and it is a root-related gene about root angle. You could invest the same amount in roots, but if they grow out rather than down you do not access the same water. If they grow out, they are really adapted to irrigated conditions. If they grow down, they are really adapted to dry land conditions. They have found in this study that the relationship and the trigger is the sensing of gravity. If that plant senses gravity and sends its root down instead of out, the same amount of expenditure gives it much more drought tolerance. We are working on the genetics of that right now. You can redirect the plant to take its roots and grow it down. That is not what we used to think about when we thought about deep roots. It is an interesting thing. The way the plant knows that is based on the way it relates to gravity. By the way, the way that we know this is because we have sent plants up into outer space where there is no gravity and we have done the genetics on what happens to those plants under no gravity. When they do that, they can send their roots any old way.

Glenn: One additional question, in conjunction with looking at tall straw/deep roots, shoot/root ratios, and the overall plant having a larger root system, more verticality as far as gravity-sensitivity and height, and with the symbiotic osmotic reactions and micronutrient uptake, is there a food science profile being done on any of this yet or is it too early?

Susan: Not yet. It is a good question.

Audience: Did he just ask if it is it related to nutrition?

Susan: Yeah, in a way he did. Good point. We do not know yet.

Audience: We might be going for fertility horizontally, or are you saying you are not?

Susan: I mean it is a relationship between where the fertility is. In a flooded paddy system going deep does not help you with that. In a flooded paddy it is all in a small area of soil, you do not want to bother to put roots down deep. You put roots down deep where you do not have all that nutrition in the upper layers of the soil, and you need to get water. It is a relationship between the environment in which you are growing it and the plant genetic system that tells it what to do.

Audience: So when you top dress with manure or something like that as they often do, is that going to have an influence on it? Then how can you say it is gravity?

Susan: It is gravity that tells the plant whether to grow down or out.

Audience: It is looking for food.

Susan: Well there is that response too. The plant is responding to lots of things, not just one system. It is responding to a lot of things. Like your skeleton is also responding to gravity, but if you are lying down all the time then it affects you. It is responding to many things, but the one thing that we know that has been cloned is a gravity-

response factor. We have not cloned the things that are responding to the nutrients. Those are usually the smaller roots, secondary, tertiary, and root hairs.

Audience: The more typical flooding that we have here is the shorter, like we do not usually have 2-3 week flash floods but usually two days to a week. I was curious as to whether you have done any research on which varieties are more resilient to those shorter floods in terms of maybe being sturdier so they would not fall over or whether the Sub1A plays any role?

Diane: The Sub1A is particularly good for the plants when they are at seedling stage, because they are completely submerged. At later stages, if you are already post-heading and you have a flood, then you are going to be more concerned about lodging. Those are different mechanisms. There are lots of studies that are working on defining regions of the genome that confer lodging power. There are different types of lodging too. I am sure you have seen before. The thing with stress physiology is that depending on what time the stress occurs, the strategy to cope with that is completely different.

Audience: I guess what we are going to see here with climate change is more and more of these short floods, sudden and short, because we are getting all this intense rainfall. In the course of a day we are getting 3", 4", 5", 6" of rainfall. I am curious as to whether there are any varieties that are looking good in terms of being resilient to that.

Diane: That is part of what as growers you can do, too, is to track the frequency of when these flash floods come. If you know this one variety is doing really well and the others are not looking good, make a note of it.

Susan: The key is usually whether it is got a growing tip above that flood. If it is an older plant it can withstand that 6" of water no problem. But if it is a small plant, that 6" could completely drown it.

Audience: Then in our interest we should try to get our plants to grow faster.

Susan: And temperate japonicas do exactly that.

Diane: Although tropical japonicas have nice study stems too.

Linda: I have another interesting story about the sunlight part of it. We have been selling rice at the farmer's market since 2008. I am there every Saturday and people are always asking, "When is the rice coming? "When is the rice coming?" They talk to me about rice and ask how the rice is doing. We have had some rainy years, and the most common comment I get is, "Oh, all this rain is good for the rice." And I, as nicely as possible, say that, "Yes, it is nice to have the water, but they need sunlight." A period of rainy days is not good for the rice either. Dealing with the public, the consumer, they think all this rain is good for the rice.

Lunch

Lunch included rice dishes prepared by local chef and Vermont State Representative Tristan Toleno of Entera Artisanal Catering.

Breeding of Purple, Aromatic Rice for the Northeast: Sandy Harrington

Thanks for coming to listen to this. I grew up on a farm. I love to be in a lab and I love to be in a greenhouse. This is not one of those places, so bear with me while I try and give a talk here.

We have been working for the last three or four years, introgressing some interesting characteristics to the Yukihikari, as was mentioned earlier. The first characteristic is aroma. We call it fragrance. You just experienced it, if you smelled your jasmine rice. One gene trait and it is the same gene in the jasmine as what we are going to talk about here. We are also going to talk about trying to get a purple pericarp. This purple pericarp has a light-colored hull, surprisingly. The dark pericarp and if you break the grain of rice open it is bright white in the middle. It is a beautiful seed.

In nature genes move and change naturally. We all know that. Bees spread pollen and the wind blows pollen around. Nature also makes its own transgenics. Agrobacterium tumefaciens was discovered and now is used in bacterial mediated plant transformations. But that is not what we are doing. We are going to work with manual cross-pollination. It is a mechanical way of doing something for nature that it could do itself. I brought my equipment if anyone wants to look into this further.

The process of cross-pollination involves physically cutting every single spikelet on a panicle of rice. If you have never counted them, there are quite a few. Then, beyond that, pulling six anthers from every single spikelet that we have cut open on all the panicles. You want to do this at a certain time of day. You want to do this in the morning, right before they are about to have anthesis. The anthers come out easily. We do this with a little vacuum emasculator in our lab. It has a pipette tip and it is a very gentle vacuum. We can pull all six of those anthers right out of each one of those. This is the vacuum emasculator. It is a toolbox with a small motor. You take this to a high school and talk about emasculators. It is fun. We have instructions for it on the web and we can actually hook it up and people can play with it if you want.

Susan: This is the system. It is transportable and our blueprint for it is on line. Parts list and things like that.

After the plant has been emasculated, you basically have a female plant. You take that female plant and put it in proximity to a plant that has not been emasculated, whose pollen is coming out. That is the right stage when the pollen is viable. We put them together and put a little bag over them, like this one. We slip it down over, and this is what that looks like on a plant. We have to tie it together so they do not fall apart. Then every fifteen to thirty minutes we have to do that [flicks the bag] for two to three hours a day for two or three days. It is a pretty labor-intensive process but it is really rewarding when you see the beautiful new rice coming that you have helped to create. This is a picture of Gen actually doing it. We have these lovely magnifying glasses that we all enjoy wearing to see the spikelets better. You can see that we had to put the plants at different levels. For instance, the PSA plant, which is the purple parent that we are using in this cross, is this tall in the greenhouse. It does not do that in the field. The Yukihikari plant is down here. We have to stack and make this work for us in the greenhouse in any way we can.

We do this by a backcross conversion method. I know some of you have heard this before, so I will go through a little quicker than I did the first time. We have a recurrent parent, which in this case we are going to use Yukihikari, and a donor parent, which is the one we want to donate a particular characteristic. When you cross those two together, initially we are going to get the F1 seed, the initial

offspring like the child of two people, and exactly half of the DNA comes from each parent. If we cross that progeny to the same recurrent parent, the next time we will only have a 1/4 of the DNA from the donor parent in the progeny. We call that the BC1F1. If we keep going with this, as many generations as we like to, next time we get 1/8 of the genome being from the donor parent. By the BC3F2 we get only 1/16. That is what you are going to see we have today here, that a 1/16 of the DNA has come from a donor parent in the last rows.

These are the parents we used. The one in the center is the Yukihikari with the short grain, the temperate japonica. Della is kind of an antique variety here in the U.S. It is not grown too much anymore, but it has the aroma gene. The amount of 2AP, which is the chemical released to produce aroma, is quite high in the Della. That was why we chose this particular parent as the donor. The other cross we made was to the PSA, which is not a fancy name for anything other than purple sticky aromatic, because it did not have a name. It is PSA rice and it comes in a nice golden hull, which is surprising to me and a lot of people, but it is a beautiful black underneath.

Jim: Quick question. That black rice is it white on the inside?

Sandy: Yes, it is white on the inside.

Jim: How does it cook up?

Susan: If you cook it with the pericarp on, it will color the water pink and all the rice will look pink. Inside it is perfectly white. If you were to polish it, it would just cook up as white rice, but you are not going to polish it. You are going to cook it in its purple juice and the whole thing will become pink. It is quite lovely. The pericarp is really hard. Colored pericarp is really impenetrable and really hard, full of all kinds of health benefits, but hard. You may have to cook it much more than even typical brown rice. You boil it in a lot of water and boil it for forty minutes and it will still be a little bit more like American wild rice. It will have that slightly hard pericarp. It will look quite purple on the outside and because it opens a little bit with the water, the inside will look a little pink.

This was our starting point a few years ago. I am going to talk a little bit about an allele. Alleles are variations of a gene and an offspring always gets one allele from each parent. There are dominant, recessive, and co-dominant alleles. Some examples: a widow's peak hairline is dominant to a straight hairline in humans and non blue eyes are dominant to blue eyes. A blue-eyed person must have two recessive blue alleles in order to have blue eyes. Blood types: you can be A or B or AB. AB is co-dominant; both alleles from each parent are expressed equally. None masks another. You can also have traits that are gender linked.

Purple is a dominant trait. If we have our initial cross and we get our F1 seed, every one of these seeds will appear purple but they will not carry an allele. They could potentially when crossed with something else produce a white pericarp child/offspring/seed. This is what that cross actually looked like. This is a beautiful picture that I love because Gen was gazing lovingly at it in the greenhouse. It was the first time that Gen had made a purple cross. It was very exciting to us. Aroma on the other hand is recessive, so we need two doses of a recessive allele in order to get aroma. All the F1 seeds will carry the potential to cross and become aromatic. This is what our first aromatic cross looked like. Let us continue with the recessive trait down the line here, for aroma. We backcrossed again to get our BC1F1 and at this point, half of the seeds will have no potential to ever be aromatic. While the other half will be heterozygous and will have the potential to cross and produce aromatic seeds.

Susan: But 100% are non-aromatic at this point.

We cannot see aroma. Some of the plants will smell in the field. You can stick your face in some of the aromatic plants and it is lovely, but generally no. We have been using some marker-assisted selection to help us get rid of some of the plants we do not need to keep, because greenhouse costs and labor are high. This is an agarose gel, that we have run a molecular marker that detects whether something has an aroma allele or not. You can see where I have a small a, small a, [aa]. That is the Della. It is fully aromatic. It has two recessive alleles, a small "a" and a small "a". The Yukihikari has neither. It only has the large "A"s [AA], which means it will never be aromatic. When you see two bands, that means it got one from each parent. When we see just the one band, you are seeing this in the progeny here. The homozygous lines, which means it has inherited both alleles from the same parent. We are going to get rid of all those plants. We do not even transplant them out of the seedling stage. We will keep these plants and we are going to backcross these again, and allow self-fertilization. Once that happens, we do not know ahead of time which ones are going to be aromatic, and we want to get rid of some more plants. We run some more gels, and we find 25% are fully non-aromatic. They are homozygous, nonaromatic. 50% will be heterozygotes, but at this point we are looking for something that is aromatic. 25% of these plants will be aromatic, and that is all we keep at this point in time.

Susan: And you can determine that how early?

Sandy: We can determine that when they are about two to three weeks old.

Susan: Before they have seeds. Before you would know that they were aromatic.

Sandy: We plant them in 96-well trays, and we take about three mm of tissue and we can get enough DNA to tell whether they are aromatic or not.

Why do we combine this lab and greenhouse work with field trials, which we have been doing here with the Akaogis? I am very excited to come here and see the plants in the field for the first time. In the greenhouse we can get up to three growing seasons per year if we try. It is a struggle, but we do it, especially with Gen's very good help. Markers allow us to use less space, less money, less time, and we can get the early detection. But, we need field trials because plants and specifically certain genes like aroma are expressed differently in different environments. Our greenhouse is very tropical. It is certainly not like growing out in Vermont. We want to see what they will do here. Because we cannot see aroma, I am going to ask you to pretend that aroma is a car. I have two cars. My lovely electric car does not have the potential to make aroma or exhaust. My mustang, could make exhaust, when I drive it here nicely. If I take them to the racetrack, I get exhaust from my mustang because it had the potential all along to make that exhaust, the aroma, in a certain environment. My electric car never did. If I put the pedal down, it still is not going to make that nasty smell. Or, in the case of plants, that wonderful smell. By bringing the plants here, or to Maine, or to Pennsylvania, we are hoping we can find the differences in their production. They all have exactly the same gene, but how will the environment affect that aroma? If it is colder, they may produce, when cooked, a more beautiful more pungent aroma. When you grow the plant, actually the warmer it is the more pungent it seems to be. Aroma is expressed to different degrees in different environments under different stresses, such as temperature. This rice is now growing outside this tent.

This is a little mockup of the field that Ogi has planted so beautifully out there. The parent rows are here, in the middle. If we talk about the aroma first, we start with the Yukihikari and the Della. The Della you can see is a lighter green color. It is bushier. It is not as erect, and it is certainly not flowering at this time. It is a tropical and it is not really happy here. The F2 seed, first generation selfed. We cannot plant F1 seeds here. There are just not enough of them. We have to let things self

and then we generated enough seed for Ogi to do some trials with. The F2 seed is a mixture. Some have a little different color. Some are a little more spread out. You can see differences between them. If we go yet another generation, they start to look more and more like the Yukihikari. They are 75% Yukihikari at this point in time. The BC2F2 generation is 87.5% Yukihikari and they look more and more like Yuki parent. The last row that you will see out there is our selected row. We sent Takeshi and Linda 98 seeds to try. They planted them in 72 well trays. When they were about four weeks old, they sent me about this much tissue, Federal Express in a little foam with some ice. We got it in the lab and I extracted some DNA from it and ran some PCR with the aroma marker. Ran it on a gel. I am going to show you some of the plants that we got. This is the actual data from the field, about half the plants. You can see the ones that only have the band from Della. We do not want those. The ones that have both bands are still heterozygous and we do not want these. These have two recessive alleles, which is going to cause the plants to have the potential to be aromatic when cooked. There are 21 of these out of 98.

Susan: By the way, that is exactly what you would expect.

Right, It is exactly what you would expect. The proportion was just about perfect there. This set on the end, two rows I think, are the selected lines. I think Ogi planted the rest as well, just to see, because other traits are segregating in these plants. There might be something else that he likes there. Just because it was not what we were looking for in the first place, does not mean it is not a lovely thing that he might like to keep.

If we look at the purple pericarp, the same thing happens. The plants are different, but not nearly as different as I expected them to be. Like I said, in our greenhouse, Yukihikari is about this tall and the purple is taller than I am. I was shocked to see how much smaller the purple parent plant is in the field. Ogi has some he grew in his greenhouse, in a bucket I believe, and they are actually taller. They are still not what you see in our greenhouse but they are taller than the ones in the field. The same thing happens here, half of the genome is recovered in the first generation. In the next generation we are down to 75%. Here we go to 87.5%. It is interesting, if you do go out to the field and look, you will see that there are two plants here that are flowering early. You can see some segregation. It is harder than I thought to see the physical distinctness of the plants in the fields, but it is very interesting to see the differences in flowering time.

Finally in this row, we have our 93.75%. We went through the same process, but the problem here is there are at least 3 genes we found controlling this character trait. We know what two of them are, and we can screen for two of them. We are in process of sequencing and doing some other molecular analyses to try and figure out what that third gene is exactly. We are only able to tell Ogi and Linda that two of these plants have the potential to be purple. We will see what happens. The others will be a variation from white to brown to really variegated seeds. I actually brought some of these seed if anybody would like to see them up here. These are some of the offspring, we grew 18 in our greenhouse. You can see this one is just white. These have some variegated seeds.

Audience: Sandy, you sent them each of these backcrosses?

Sandy: We sent them this as a demo so we could see how the differences looked in the field. This is the parent. You can see that one is absolutely black. Feel free to come up here as well and take a look.

In the future, we would like to continue having Ogi and Linda work with us. This year they will be able to make some selections on the plants we selected that have both recessive alleles for aroma, and decide if they would like to carry on all or some of those plants. Ogi tells me there will not be enough to cook and see what it smells like this year, they will have to plant out more next year to try

that. We have never been able to produce enough in our greenhouse to actually cook and smell it. We are still waiting anxiously for that.

Secondly, the purple pericarp lines, we have already advanced them in the greenhouse. Gen has already got them to the BC4F1 stage. We are doing this so we will have a cleaner background. That is important when we are trying to identify a gene, because anything that came from the donor parent could potentially be the third gene. We want to get rid of as much as we can and find a purple plant that is mostly Yukihikari background. It makes identification easier. That is why we kept on going with the backcross there. The next step is to seek funding to continue our work, which we are in the process of doing, and Genevieve is going to tell you a little bit more about that later on today.

Audience: I have two questions. First of all, I get the impression that Thai Jasmine and Basmati are grown in rather specific environments. You cannot take Thai Jasmine and grow it in the Mekong Valley. You will not have the aroma.

Sandy: Well that is exactly what I have been trying to say; the environment also interacts. I would bet that the only thing preventing those plants from growing in the opposite place, like you were saying, is not that one gene. There has to be some other interaction with the environment and other genes in that plant that are also contributing to that reaction. Texmati is grown in Texas.

Audience: I have a good friend in the Philippines who grew some aromatic rice. The problem was that the rats liked the aromatic rice more than the people so he gave up.

Sandy: I have not heard that.

Audience: That is important.

Sandy: It is important.

Audience: I was curious, most of us know that certain plants have dormancy periods before we can plant the seeds again. Is there any kind of waiting period with rice before you plant it again in the greenhouse?

Sandy: It depends on the rice. We learn as we go. We usually save some seed and hold it for a while. If we need it again in a hurry, we will try it. We will give it a shot and see if it will go within a few weeks. Another way we do it is to put it in a seed dryer and heat it. My seed dryer is a food dehydrator, which is turned up high for about five days. If you give it some heat it will break the dormancy period.

Susan: Keep in mind, for rice to break dormancy it is heat.

Sandy: Generally, it is better to let it rest for a few months.

Susan: Another thing if germination is a problem, dehulling is usually very helpful, because often it is in the hull. If you can hull it, and then scarify it, it will often go faster. Finally, you can always soak it in a weak gibberellic acid treatment and that will induce germination.

Audience: Does Texmati have the same aroma as Basmati?

Susan: It is not the same aroma in terms of how you sense it, but it has the gene that allows the aroma to be expressed. Yes, it has the same gene that allows aroma to be expressed. What we call the aroma gene is actually the gene that is broken in a pathway, which allows that aroma to be expressed. The aroma is actually a conglomeration of all the other things.

Edible Education and Rice at Randall's Island Park: Phyllis Odessey, Nick Storrs, and EunYoung Sebazco

Phyllis:
Thanks to Mia for inviting us. I am Phyllis Odessey. I am the Director of Horticulture for Randall's Island Park. This is EunYoung Sebazco. She is the Horticulture Manager. Nick Storrs is our Urban Farm Manager. I am going to talk very briefly, just an overview about where we are in the world and how big the farm is. Then EunYoung is going to talk about the inspiration for why we are growing rice and Nick is going to get into the nuts and bolts of the whole business.

We are in a New York City public park, but we do not work for the parks department. We are not city employees. We work for Randall's Island Park Alliance, which is a non-profit that administers the park. That non-profit raises all the money, pays our salaries, etc. This is basically what I just said and our organization's mission. We are on an island in the East River. We are part of Manhattan. That is our zip code. You can get there over the Triborough Bridge or walking bridge for those of you who know Manhattan. Basically you can see the whole skyline of Manhattan from the island that we are on. This is all Randall's Island, which is half the size of Central Park. The farm is 1 acre, maybe a little bit more. Here are some statistics about what we have growing. We have a little apple orchard; we have 72 raised beds; 4 rice paddies; 15 chickens, and a bunch of thematic gardens as well and a very low-tech outdoor kitchen. This is a schematic of the farm. We are a non-profit. We are not trying to grow anything commercially. Our only mission is to teach. It is a free program to any kid in New York City. It is edible education of a big variety.

The kids actually harvest food at the farm and they make some kind of a salad, a kale slaw, or sometimes pesto. People always ask us because the farm is very productive, "What do we do with the food after the kids have used whatever they use in class?" Basically we have done two things. One, we give it to a very small soup kitchen run by a bunch of nuns that is a couple blocks away from us, which is not supported by the city. This year we are involved with something called Drive Change, which is a social enterprise. It takes kids, ex-offenders, and they have a series of food trucks. They have a chef and they teach the kids how to cook, and they use local food. Every Monday they come and whatever we have (e.g. eggplant, tomatoes, etc.) they take and then they figure out what they are going to make for the week.

Then we have some partnerships, which have helped us a lot in the rice project. The Japanese Consulate has been very, very supportive and has helped us in terms of bringing people out from the consulate to work with kids and be at different events. GrowNYC, which is a huge organization in New York and is involved in all kinds of community gardens, school gardens, composting, and recycling. Momofuku, which is a very well known restaurant in New York, has also sent chefs. The Melotti Farm that Davide [Mantovani] is a part of, who is right there, and who has been with us for two months. He has given us Italian rice seed and has come for almost two months day in and day out and worked with the kids. Cooking risotto every single time, which has been great.

We also have great friends who are interested in the rice project. There is Davide, Yoshi, MiHyun Han, and also some of the owners and people from the restaurant that Melotti has in the East Village, the Risotteria. Tea master, Souheki, has also come, and Nick will talk about that a little later, about how she has been involved in the rice festival that we have at the end of the season. We have

actually gotten a lot of press. One of the reasons to love New York was that we are growing rice that was a fun article.

Eunyoung:
As you see, we have been getting lots of attention in New York City and also out of state. This is a very unique project that we have been working on. I am going to briefly explain how we got into the project. I think I have a different background than many of you. I am not a farmer. I am not a scientist. I have trained in landscape architecture in Korea and Japan, and now I am here for the horticulture field. Back to four or five years ago, I had a question about what was a sustainable gardening practice. I started digging up a couple books and ended up with this book. It is written by Azby Brown. It is in English and says, "Just Enough". There is a story in it about the Edo period in Japan before they opened up to Western Culture. It is a couple hundred years ago. It is a story about how they live, how they manage a house, field, and forest. All the details about their innovative designs before they were influenced by Western Culture. In one chapter it shows how they prepare the rice paddy. It captured me and I thought, "Oh, this is very interesting maybe I can do it." I called up my grandmother, she is Korean, but later I found out that she grew up in a rice paddy. I know that Susan has a lot of good resources and research, but I had only this book and my grandmother's advice. That is how we started. I asked Phyllis, "Can we start a rice paddy?" and she said, "Why not?" I went through all the step-by-step illustrations for how to prepare a rice paddy, how to sow, how to transplant, and also it showed you how ecology really helps the rice paddy in the environment. The last chapter says how to use the byproduct, so that there is no general waste to use rice. This is basically based on the book and my grandmother's advice, how we did it in a year. This is March. We collected recycled bricks in an alley in the park. We basically built a man-made pond. I am sure Nick is going to show you how we propagated and transplanted all of this. In November, we started cutting it and hanging outside, but shortly after we had to move it inside because we started having problems with birds. Then this is the rice threshing day. As Phyllis said we have a partnership with the Momofuku restaurant. The chef and other employees came out, and participated in the program with the school groups. They are threshing it and milling it, and winnowing it. I am sure that Nick is going to show you a winnowing basket. They had a really great time later in November. Then the following year, Nick joined the program.

Nick:
I sort of inherited this project to some degree. Came in after the first year when everything was up and running. What was great was it worked the first year, so I knew it could work. This is a very brief where we are and how we are growing. We are in New York City. You can see between 3000 and 3500 growing degree days. Our latitude and part of the inspiration for this was realizing that we are on a similar latitude to North Korea and that might give us a chance. We are growing in raised beds, rather than forming in-ground beds. The way we have done this is by leveling a portion of the farm, laying out the first course of cement blocks, as perfectly as we can, as levelly as we can. We have been lucky enough to have a lot of volunteers. Corporate volunteers who come out to the farm, want to be involved, and help out. You can see them over here on the far end. They are great. They are the ones that built it up from this stage to a finished product. You can see we have taken painter's tarp. Really it is just the cheapest stuff we can find at Home Depot, but it is about 6 millimeters thick. We have lined the paddy with that and then filled it with compost. This is Aneal, right here. This picture is Aneal right here, watching somebody else work while giving the thumbs up. But then to make it look pretty we edged it with bamboo.

With the kids we are propagating the rice in little plastic cups and then setting that in a greenhouse or using the empty rice paddies with plastic over the top as sort of a hothouse. We have been transplanting in the beginning of June. We correspond that with the lessons. The kids are involved in that transplanting. We will take a little bit of a closer look at that later on. This is some of the transplants that we did last year. We did it in 50s. Here are some of the kids putting it in. Then we add fish to our paddies as we keep the water level up during the growing season. We have been harvesting in October. Up until last year we have been growing just Koshihikari, and then this year we have started working with Mia's rice panel, bringing in some other varieties that way, and also the Melottis have been generous in donating some of the Vialone Nano and some of the Carnaroli rice that they have. This year we really got a whole spread, which is cool but will probably make the harvesting a little more erratic. It will be a little bit more complicated in timing that. So far we have been draining the paddies in the middle of September and then harvesting in October. We hung it up to dry, and like EunYoung said, the first year it was all hung outside and the birds learned that we were growing rice and came for a visit so we had to move it indoors. Now we are doing most of our drying indoors.

Then we process it. This is our winnowing basket that EunYoung brought from Korea. This is awesome. We have been using a mortar and pestle and forty fifth graders. That is the real key. You can see the guys at work right here. It is a little bit hard to see in the light. This is all done indoors and we are doing this in November, early December. The whole room is lined with plastic because this takes practice. We do a good deal of sweeping everything up and doing it again, after. It works pretty well.

That is where we are and the tools that we are using for this program. But, the goals of the education program are what is most important here. What we really want to do is make sure that the farm is drawing kids into a better understanding of where their food comes from, how it is grown, and ideally how to eat better so that this effects change throughout their life. We also want to prove that an outdoor education is worth it, that it is a viable place for kids to spend learning time. This can be difficult. It can be hard to prove to a principal that sending kids to a farm is not going to make them do worse on standardized testing.

When I first came in, Phyllis, EunYoung, and I sat down and were talking about the program and what we want to do with it. We really made the decision that what we want to do is reach as many kids in our neighborhood, or in New York, as possible. There is a lot of demand for this. A lot of kids have no contact with where their food is coming from. As a result our program focuses on essentially a field trip style of education. Kids usually come once, especially the summer camps. If they keep going back to the summer camp, they will end up coming a second or third time. But the program is really designed to reach kids in one day. The way it is set up is that kids usually come to the farm. We schedule it between 10 and 12:30/1:00 usually, because the public schools get their buses for free during that time. This works into the idea of the program being a free program for schools. We want to make sure that it is accessible to all the schools.

When the kids come, we do an introduction, do a little bit of a walk around, and then usually break them into three or four groups, depending on how large the class is. Usually we get about forty kids at once, but we only want to teach ten at a time. Ten is kind of the high end of what we want to deal with, because otherwise we start losing kids. The kids break into four different groups. We do four different activities. Every twenty minutes or fifteen minutes the kids will rotate activities. We do not have a lot of time to get into depth about some of these issues. We try to hit on a couple main

topics. One of them is biology and science. This goes into proving that the program is a viable place for kids to spend school time. We do everything from anatomy to root growth to biomass growth. We also want to introduce culture. We are introducing a lot of East Asian culture. Davide has been working a lot with the kids on Italian culture. Then also the cultures that they are coming from. New York, especially, is so diverse. A lot of these kids, their parents or even the kids themselves grew up in Arkansas or the southern United States, and many of the foods that we are growing on the farm are sort of touching on those cultural heritages no matter where they are coming from. This is Souheki braiding with the rice stalks. We are introducing culture that way. We will see more of it a little later on. Another important aspect of it is nutrition. We want the kids to learn to eat better. Eat a more varied diet. Eat with a little more intention, not just put food in their mouth and swallow, but think about the food that they are eating, enjoy it, and therefore eat better food. We also want it to be age and ability adaptable. Please notice the milk crates down below.

What is interesting and makes it a lot of fun for me, is a lot of times these kids get off the bus and I have no idea what I am about to get. I know the grade they are coming from but the level of food literacy is really different. Almost immediately we start feeling out where are they. What do they already know? What can we build upon? Or do we need to go right back to basics? A carrot is a root. You do not eat the leaves at the top. You eat the bottom. Then in order to make it more viable we are starting to try to play around with education standards. Scope and sequence I think is New York specific, but Common Core standards are starting to be a national standard and we want to make sure that the lesson plans that we are following are aligning with these standards. So that when teachers do want to come, they can go to their principal, they go to the superintendent and say, "Look this is a viable thing. This is worth sending our kids to." That also makes it more open to more kids. It is often the most financially-strapped and impoverished schools that feel like they cannot justify doing anything except for sitting in straight rows, reading, because they need to get their test scores up.

One of the main ways we do this and one of the things we got out of the scope and sequencing common core standards that we are bringing in to incorporate throughout the lesson is the ability to observe what you are seeing. What is in front of you? Really take a look at it and then describe it. Pay attention to those details. Pay attention to how you are thinking about it. Pay attention to the conclusions you are coming to and express those to others. A lot of what we are doing is trying to get kids to express what they are seeing. These are skills that are applicable all across the board, but the farm is a great place to do it. The rice paddies specifically are great places to do it.

We teach with propagation. These are the kids propagating in our cups. Compost, water, seeds, and again we are talking about what are the needs of the rice, why we are doing this in cups. Notice the snow on the ground. This is in April. We talk a lot about the temperature needs, why we are going to bring this into a greenhouse. What does the greenhouse service? What purpose is it facilitating? Also, having fun while we are doing it. I think most of you know, we are propagating it in April. We are in a greenhouse for about a month and then we are transplanting in June and transplanting starts to introduce a lot of cool variables. We have a little bit more to look at when we are planting. Kids are breaking apart the root ball, and seeing those roots at work and what role they are forming. You have anatomy at play. The kids get to do a lot of the work on the farm, and being hands on and being active on the farm is an important part of it. Here I am using twine to lay out the rows, in an attempt to get straight rows. It works pretty well. It also works well to get the kids to plant, stand up, take a look behind them and say, "Do you guys think you just did a good job? You know what we are looking for. We are looking for straight rows. Was your row straight? Did it work with all your

buddies next to you as they were planting." I mean somebody might have been straight, but if everyone else is wonky you need to make sure it fits together. But evaluating their own work and either correcting it or just appreciating it, is an important aspect of this as well. Here they are at work, right now, putting in the transplants. This is over a couple of years. I think this is from last year. We are still using some of the flats and then again getting the kids to actually take a look at what they are doing. Observe what they are doing. Explain it back to their friends. Explain it back to me. All these are important aspects of the education.

We also want the kids to get dirty. This kid is being pushed by his friend to actually touch the water. So many of these kids are afraid to touch anything dirty. They have had thirteen years of education not to touch dirty things. Getting the chance to break that, to say, "No, if we are going to learn about this, you need to go in elbow deep and do this." It is very cool. Then usually once we get all our hands in, planting is no problem and it is fun. It is an activity they can do with their friends, and an activity where work gets done with their friends, and they get to look back and appreciate that work at the same time.

Then here we are adding goldfish. These are again super cheap fish. These are the feeder fish that we use to give to octopuses to eat. We are adding these to the paddy and starting to introduce the idea of the rice paddy as a whole ecosystem. What are they seeing as elements of that ecosystem? How do those elements support each other? How do they work contrary to each other? Getting kids to pay attention to this, and to pay attention to the details that might give them the clues to those answers is a really important part of this. Looking at these reciprocal relationships. How do the fish support the rice? They are pooping. They are fertilizing. They are acting as pest management. They are starting to eat some of the insect larva. They are starting to eat some of the mosquito larva that might prey on us. But then the rice also supports the fish in turn. It provides shade. It helps even out the temperatures and provides protection from predators. We lost a lot of fish to a heron when we first put them in and the rice is nice and small. Our paddies are three feet wide, thirty feet long. They are tiny little things and we have four of them. They are just wide enough that if a heron walks up the middle it can strike at the whole paddy. We saw a lot fish with no bellies afterwards, but we kept adding fish to it, and that itself is an important lesson. As the kids come onto the farm and see dead fish, those fish are decomposing and thereby feeding the rice. They are also feeding other animals in the whole ecosystem. We really want to introduce the idea that the farm is primarily a managed ecosystem that produces for people, among everything else including the herons. Now we have bird netting so the herons are out.

Again, we want this to be hands-on. We want kids to see, feel, taste, touch, and be involved with the farm on all sensory levels. The kids are the ones putting the fish into the rice paddies. That is Brianna. It took easily forty-five minutes of coaching to get her to touch the fish. But again, only 45 minutes to break down fourteen years' worth of education. That felt good, you know? Part of teaching with habitat is we are introducing things. We have lilypads, papyrus, other aquatic plants as well as the rice involved. Snails. Yes, snails are always a part of the game here. We are looking at things like invertebrates versus vertebrates inside that ecosystem.

Actually, this is a poster that the Melottis used back in Italy, and we took a crack at translating. This shows many of the animals that we find in the Italian farms. With the illustrations we can start looking for many of these animals here in our New York paddies. Then we start introducing the rest of the growing season. Again, what we are trying to do is get kids to start observing, paying attention to the rice as it starts to head out, find where the rice is just beginning to head out. Sometimes they

catch it before I do and that is a good thing. Using all of those senses. We are not only standing back and watching, but we are putting our hands in it. We are feeling it. The rice, especially the Koshihikari, has that really classic feature where it is very smooth when you pull along the rice blade, the leaf blade, but then as you push against it, it is very rough. It has that dentate structure to it. It is introducing kids to sensory surprises like that. It is not what it looks like. You do not understand what it is until you not only see it, but you touch it and you smell it. All of that is important.

Then telling it back to me. What are you feeling when you put your hands on that? Talking to their friends about what they are feeling. Especially what they are tasting. Some of them taste a sweetness or bitterness that I am not. Paying attention to what you are tasting is important. Here we are all paying close attention. This is probably the hardest part for me, if only because we have so little time with each kid, but it is important to give the kids a chance to discover it on their own. To not lead them into exactly what they are supposed to find or what I want them to find when they come. But to give them the space to poke around and discover what they find most interesting about the rice. It is hard for me not to talk, and that is what I need to do in those circumstances. I need to recognize when it is happening, and stand back from that. Maybe talk to the rest of the group, while I let one do his/her own thing.

This is actually a fantastic illustration of the other benefit of doing the rice paddies the way we do. She can get her nose right in it, and see it, smell it, touch it, without being in mud up to here. Her parents probably very much appreciate that she did not come home with three pound of soil on her. This style of paddy works really well for an education program because it allows you to get that close to it.

Here are more kids paying attention. What I do not get to teach enough and what I would like to teach more, is the development of the rice. The kids do not get to come back once a week, twice a week, for the whole growing season. In many ways this is one of the reasons why we are trying to act as a resource for schools so that they can bring these ideas, these paddies back to their schools and kids can pay attention to it over the long term. Here are some that are in flower right now. What is very cool, especially now with Davide at the farm, is he has started to bring back all of the levels of processing the rice. What the kids are looking at here is a bowl full of the paddy rice that was harvested last year; a bowl full of the rice hulls; a bowl full of the brown rice; the refined white rice; the broken grains from the refining process; then some of the rice flour; the bran; and the green grains. This is very cool because even if the kids do not get to see what take place over time, they still get to see it all in one spot.

We start to talk about that process of turning what they are seeing in the field into something that they see on their plate. In the end we do want to bring it all back to their diets and what they are actually eating. What is great is that when we are teaching, we are also able to incorporate a lot of chefs in the farm. This is a group on the left hand side that was working with a pretty amazing sushi chef named Yoshi who came up and he is making rice balls wrapped in nori [seaweed]. Yoshi gets to cook with the kids and the kids get to do a lot of the cooking under advisement from a professional chef. Here is Davide making a bowl of risotto. It is a lot of risotto. The kids can eat what they are seeing in the fields. This is Midori, who is working with some fermented rice bran. We are also starting to incorporate culture through the food as well. Then this is MiHyun Han working with two of our high school students who are making spring rolls. These are the proud chefs.

Then we get to teach about the harvesting. The kids are involved in all aspects of rice growing. They help us harvest. They help us evaluate when the rice is ready to harvest by squeezing the grains and making sure they are plump. Making sure they are ready. They can see the development and that the grains on the very end are mature first, and try to catch that at the right level of maturity. This all comes back to paying close attention, to observing what is going on and describing it to others.

After we harvest and after we dry it, we get to have a big rice harvest day. The kids will get to see the rice as it is harvested. They are the ones helping to strip the rice. They grind it with a mortar and pestle. Here they are. This is amazing. If you can get forty kids to do your rice processing for you, I strongly recommend it. They are using the winnowing baskets to winnow it. What is really cool about this is that they are really starting to connect with that traditional culture of how rice is being processed. What we also want to do is start introducing ideas on how rice is processed on a commercial scale. How the rice that they are eating is often processed. This is a diagram of a basic rice roller/huller. From last year, you might remember, this is Don Brill and his bicycle-powered huller. I saw that and greed just jumped right at me. Over the winter we talked to Don about building one for the farm, and we did a Kickstarter campaign to raise the money to finance it. Here is our rice huller at work. The kids get to be on the bike, hulling the rice, seeing this process. Don did a great job of incorporating a lot of plexiglass panels into it so that the kids can watch the rice fall through the machine, so they can watch how that process is working. Then with all of the bits and pieces very visible, very exposed on the side, we can trace how the work of rotating the pedals moves through the machine to move rollers at different speeds. It is very much an engineering lesson, it is very much a cultural lesson, and a nutrition lesson all at once. It is very cool.

This is Ken Green. I do not know how many of you know him. He is in charge of the Hudson Valley Seed Library. This was at the NOFA New York conference last year. The way that they process some of their seeds, because they are working on a smaller scale, is with this seed column. They drop the seeds down through the top funnel, attach a shop vacuum to the side and it sucks the hulls out as the seeds are falling down through. This is how they are cleaning their seeds and we want to build one as well. Again with a plexiglass front so that you can see this process happen, and the kids can very easily understand what is involved in taking something from the field and developing it so that it is ready for their plate. The idea is that they will be able to see this happen. They will be able to play with this and talk about what is similar about it. What is different about it? This requires a lot more skill. Is that a good thing? Is that a problematic thing? Is it great that just about anyone can stick a shop vacuum in the top there and make that machine work or that this is something that takes practice? To see someone who has been doing that for thirty years and it is a beautiful to watch because it is so smooth and so efficient. How do we compare them? Is it worth comparing them? Can we have both?

Here is a layout of the whole process right in front of us. With any luck this fall when we do the rice processing with the kids they can be involved from the paddy rice, up in the far right corner, down to the refined Carnaroli and Vialone Nano. I feel really good that the Vialone Nano has just headed out so I am really excited. The Carnaroli, I got my fingers crossed. We will see what happens. Then taking that rice and being able to work with professional chefs, to present it to kids, is really cool. Is super awesome. Yoshi and MiHyun Han both do a great job of that. They do a good job with the kids. This is Suhiki Mori and I am sorry for the blurry photos, but she was able to introduce a lot of the culture that surrounds not only eating rice, but with all of the rice products. She is taking the rice straw and weaving it into rope. Being able to make that rope, to understand the importance of it, and understand the importance of using the entire rice plant is very cool with the kids.

Then comparing it to Italian rice, and Italian culture. This is an awesome risotto pot. It is waist high. It weighs a ton and to bring it in and out of the closet is a pain. Davide has been making usually very basic risottos (e.g. a basil risotto, a mushroom risotto) and that is so we can make sure that we include as many kids in it as possible. We are afraid that if we include meat or something that might be an allergy that kids would get excluded. It is a lot of fun to work with Davide. It is also fun to incorporate adults too. Most of the people that come to the farm are between kindergarten and sixth grade. After sixth grade you start playing with hormones. Sixth grade is fun. We have a lot of high schoolers. Usually we have high schoolers come during the summers as interns so they get a little bit more in depth with the rice. Our intern right now is amazing. Julia is the one who has chosen and marked all of the rice that we are tracking for the rice trials. Getting her to do real science is very cool. She does experiments back at school because those are the experiments you are supposed to do and everyone knows what results you are supposed to get. Doing the real thing where you do not know what is going to happen is very cool to involve kids with, and I think really inspiring for them. It is also really inspiring for adults. Not nearly as often, but we get to bring adults to the farm to take a look at what is going on. This is actually a group of professional horticulturalists through the MetroHort group. We were just talking about it. Some of this rice is so ornamental. Is this something that could be incorporated into gardens as well, even if it is not eaten? There are a lot of things to play with and a lot of different reasons why people are interested in it.

Then where do we take this in the future? We definitely want to include more cultural aspects of the rice. Everything from tapas, to include more of the Hispanic culture, to using fermentation, to the usu and kine, which are the mallets over here, and pickled bran. There is so much rich culture centering around rice. Bringing kids into that culture or reconnecting them with culture that they have been disconnected from by a move is very cool. The paddies themselves, we definitely want to do more trials. We are having a lot of fun playing around with the different varieties and we are always interested in what will work next. I think the raised rice paddy itself presents many interesting opportunities. What will happen if we paint it black and it is absorbing more sun? Does that allow for an earlier season? Does it burn it out and kill it? Could we build something like a hothouse that would just fit over the top of the paddy and be able to see what effect that would have on the rice as well. From the programming standpoint, what we really want to do is codify and start sharing our rice lesson plans in order to help schools grow their own rice and be able to do something back at the schools. Many times we have teachers that say, "I would love to have a school garden, but I have no idea how to grow anything." Therefore we are not going to do it, rather than treating it as a chance to experiment with their students and learn how to grow with their students. Giving them some of those lesson plans, giving them some of the basics on how you propagate rice, where do you put it, things like that. If we can provide that resource, that would be great. That is our message. What we are really trying to do with the farm is educate, inspire, and innovate.

Audience: I missed what is in the center. You put down the bricks, but what is inside? Do you have a plastic liner and what kind of dirt do you use?

Nick: We have cinder blocks that we try to level out as perfectly as we can.

Audience: A base of cinder blocks as well?

Nick: Not a base of cinder blocks. It is sitting on gravel and sand. The sand allows us to fine-tune the level of that first course. We put a lot of effort into getting that first course perfectly level. Then we bring the volunteers in and they can build the rest of it very quickly. In two hours they have done a great job. If that first course is perfectly level, then the whole thing is hopefully perfectly level. We go to Home

Depot and buy the thickest painter's tarp that they have. We usually do three layers of it just so that we do not pop it by accident. Then we fill it with mostly compost. It is from the Long Island Compost Company. It is 70% compost and 30% mineral soil. It is all organic. The whole farm is organic. The whole farm is grown in these raised beds with a landscape fabric underneath because, especially in an urban setting, we want to be very careful about what is in the soils that we are growing with. Although we have run soil tests on everything (we did the heavy metals all through Cornell) and they came back within acceptable ranges, if I am feeding it to kids I want it to be perfect. I want there to be no question that this is safe and okay. Doing it in raised paddies allows us to do that.

Audience: The water is just municipal water?
Nick: It is New York City tap water.

Audience: The fish. When you drain it, the fish just die?
Nick: We tried giving it to a school one year. I think that worked. Sometimes they just become fertilizer for the next year's crop.

Audience: How do you drain them since they are raised beds?
Nick: In the past, we have ended up moving the paddies. Last year we had them in a great spot, but then we were building a new solar-powered composting system, and that was the right spot to do the composting system, so everything got moved. What we have done in the past is just pop a hole in the wall.
EunYoung: The first year we just stopped adding water.
Nick: The first year we just stopped the water and that worked pretty well.
Mia: That is usually the traditional way to dry down a paddy. If you stop adding water, it will evaporate.
Nick: Through transpiration and evaporation. That is probably what we will do this year. I do not want to move them again. I really do not want to move them again.

Glenn: Have you thought about doing a check system with moist ground versus flood in one of these paddies?
Nick: Yes and it definitely occurred to me this year when we were trying all the varieties. What we wanted to do this year is compare all the varieties in the same conditions. I think next year we will try some new things. The other paddies all have direct irrigation. What will happen if we bring some of that rice out into the other paddies and start using the drip irrigation system? They are all four by eight beds. What will happen when we have one bed with black plastic mulch? What will happen when we have one bed with heavy straw mulch? Start playing around that way. That is a great way to start introducing the topic of how different mulches affect crops. It branches out into larger lessons about how we grow throughout the farm.

Audience: In the schools on Martha's Vineyard, we are doing all dry land because there are concerns about having standing water on school grounds. I wondered if any of the New York Schools are doing rice paddies on school property.
Nick: It does not sound like it. I am pushing pretty hard, but it is difficult. This looks and feels like a very permanent thing to principals, and principals or school administrators are very hesitant about building permanent structures in playgrounds

that they feel will only be used for two months of the school year and then just take up space, especially in New York City where space is at such a premium. We have been working with schools because we have the milk crate garden. There is another grower in the city that introduced us to the idea of milk crates lined with landscape fabric filled with soil. These are places you can grow and what is very cool about that is in November after the growing season is finished, you can stack them up against the wall. They are out of the way. You can play hopscotch where there used to be a farm and in spring you can bring it back out. I like them because each kid can get their own milk crate. This is my farm. It is one foot by 18 inches and they can choose what they want to grow. There are a lot of possibilities with that. What I think we will have more luck with is the rice equivalent of that, which is maybe five gallon buckets. This year when we were transplanting, we had extras. I stuck four in each five gallon bucket of each variety. That has worked really well, hopefully we can push that at schools. Look, you can try it in this and if it does not work, if I am completely wrong, you have lost nothing. You can just throw it out at the end of the year. It might be a way for schools to get their toes wet before they actually commit to something.

Audience: But no concerns have been raised about standing water?

Nick: It does not seem like it.

Audience: We do have little solar panels to aerate the water, little solar panels that you can buy from Amazon. It is not totally standing. It cannot be.

Audience: What is the problem with the standing water? Mosquitoes?

Audience: Mosquitos. West Nile Virus.

Nick: A lot of schools are regulated against having standing water on the property. All of the buildings in the city are regulated against having standing water on the property.

Audience: I thought there was a drowning hazard too, but because the paddies are raised that solves that problem.

Nick: That did not even occur to me. I had always assumed it was a health thing.

The Future of Northeast Rice: Genevieve DeClerck

Hi, I am Genevieve. Pretty ambitious title to my talk. I will give it a moderate stab, and then as Mia stated it is kind of a group discussion that we can have. You can help us plan and facilitate. I am a programmer and I spend most of my working days sitting at a terminal building databases and building web applications and things like that. How I got involved with this project on a technical level is that I am maintaining the website. The www.ricenortheasternus.org website. A few months ago, Sandy, Susan, and I sat down and drew up an outline for what a proposal would look like to extend this work. It is sad to see that this would close. We would want to see the work continue, the breeding continue, and the field testing continue. We are looking for funding.

I also have a personal interest in rice. I am deeply curious about gardening and growing plants and this year I created a paddy and planted some Akitakomachi from seedlings that Gen provided for me. And actually built it from wood that Gen provided a few years ago. This is my third attempt and we are doing pretty well. This is a few days ago, and I have panicles that are just starting to emerge.

This project started in 2006, I think, with the first planting here by Takeshi and Linda. They actually got funding from SARE for the first grant that funded Northeast rice work, to identify suitable

varieties, to make very interesting observations about wildlife, and study water management issues. They also produced a very nice, first of its kind, growing guide for rice in the Northeast, which is posted on the ricediversity.org website. They also held a summer conference. That funding cycle ended and by then the McCouch Lab was involved. We are able to extend funding through an NSF grant, the rice diversity grant, to continue the work. To continue to identify suitable varieties for the Northeast and to start doing some breeding, which is all the work Sandy described to you earlier. Develop additional educational information. Then build the project website and continue these annual conferences, compiling all that information on the project website. Again, we are seeking funding for the next phase.

I am going to outline the basics of the proposal that we are looking to get funding for. The largest component of it is the germplasm development and continued field testing, data gathering from growers. Extending the participatory breeding program. We would like to see these materials grown in other locations. Right now, it has just been in the Akaogi paddies. Continue work on aroma and purple pericarp, and then start to figure out how we could facilitate some kind of solution for the seed increase and seed distribution issue. Of course educational information resources are really important. Continuing to build the website. I would like to see some kind of growers' forum created where people can ask questions to each other like they do at this meeting today. I think it is really useful to talk to other growers and you can often get good solutions in with brief conversations. Expand the how-tos and growing guides. Then expand information about the relevant germplasm; the adapted germplasm; which we might actually work on a little bit sooner, before we get additional funding. Then of course, I think an annual conference of some variety is important for networking and sharing ideas. This might end up being more easily done at say a NOFA conference or some other conference of the like in the region.

A little more detail about the germplasm development part of this. Again continued field-testing. We would like to see materials growing in as many areas reliably as we can. Identify people who are experienced and have gotten through the debugging of the process to get this going on their farm or in their garden. Evaluate the breeding lines as they continue to develop in a participatory breeding program. Get people educated on how the breeding program works, like what Sandy was talking about, and more bought in to the process. Then collect data and evaluate. Most of these types of things are not difficult to collect, but having the breadth of data from the breadth of locations will help us place some numbers and evaluations on lines, so that people in certain regions can select varieties that will work well for them.

We want to continue introducing new characteristics in the Northeast adapted rice. Temperate japonica is mainly a kind of sticky rice, but what if we can get aroma and purple pericarp. Deal with identifying the better cold-tolerant lines and dealing with photoperiod sensitivity. After today's dessert I would like to go the risotto direction too with this and possibly other traits. A small project cannot deal with all characteristics that people might want, just the ones that have one or two genes that are easy to introduce into a breeding program. Agronomic characteristics are important: general plant health, yields, characterizing starch content, and response to environmental stresses. Again, as Sandy mentioned, the role that Cornell could play here could be key. We can accelerate a project like this by growing seeds produced from the field in the greenhouse. Ambitiously it would be two seasons that we could get from fall through spring, and then have more advanced lines to introduce in the field the following season. Then we can use the molecular markers as a microscope, a genetic microscope, to understand the genetic material that we have and make more accurate selections. Then evaluation of the advanced lines in three distinct locations. We want to get reliable statistics.

Another important problem I allude to, which you folks are aware of, is sourcing of seed. It is fairly standard and easy to get small quantities of seed from the USDA but they can only provide five grams of seed samples at a time. Actually, Anna McClung at Dale Bumpers National Rice Research Institute in Stuttgart, Arkansas has been a key player in this. There are lines in addition to the set of four that Mia mentioned, which were distributed this year to some people. Anna scoured the library, the GRIN system, and her own grains databank. She has been in rice breeding for a long time and she came up with a few other varieties to try. She has been an important component, as well as Susan's knowledge about specific germplasm and what might work. A lot of it is just trial and error. Two of the lines that were distributed this year to the few folks who requested them, Presidio and Sierra, were lines that Anna was involved in developing.

Identify growers who can provide a volume of Northeast-adapted seed. Could this be in the form of a grower community ad hoc exchange or network? Or should this be in the form of some kind of seed cooperative or association that seeks funding and then has some kind of manager and website? Or is this really a problem that we should be talking to regional seed companies about? Maybe these are things we can discuss in a few minutes or over time. I want to mention that quality seed is important and that if folks are considering growing larger scale and distributing to other folks in the community, you may want to consider not necessarily certification but having certification standards in mind when you produce seed. What is certification? There are two main ones. Most states have a seed certification agency that uses a standard set forward by the Association of Official Seed Certifying Agencies. There are steps taken in seed handling and in the field to maintain pedigree and purity. Being careful of no or very few weed seeds in a specific sample of seed. Obviously no disease found on seeds. Also, checking the germination rate. In order to get officially certified you need to engage an inspector and there are fees involved, but I think it is worth thinking about these kinds of issues if you are thinking about having an ad hoc seed distribution network. Maintaining quality, not introducing disease or problems, and then not having germination issues, which could set a project back. Then of course organic seed. We barely have enough non-organic seed, but at some point thinking about organic certification for seed distribution.

Generally, Northeast rice has a lot going for it. It is a great crop for marginal farmland as has been discussed. Soggy parts of fields, hilly farms with thin topsoil where you can build terraces quite nicely. Ben Falk has a really impressive farm up in the Mad River Valley of Vermont that he talks all about in this really cool book that he recently published. Paddies of course increase biodiversity. I think it would be important to keep the ecological benefits of the paddy in mind if you are going to be doing this. It could attract beneficial insects to a vegetable operation that may not be there. It could also attract birds that may attack your rice, but that is a different problem I guess. Frogs and other important species. It is a unique product that is highly marketable. There is a lot of potential for unique value-added products. The Northeast is generally water rich and generally low disease pressure for the things that matter to rice. Seize the day now. It is also an opportunity to demonstrate lower-input, healthier cultivation of U.S. rice, in contrast to conventional Southeast rice, which has a lot of chemical additives and very input intensive. I visited the rice-growing region in Arkansas and these dive-bomber planes are just everywhere dusting crops. Once their paddies are flooded, there are no tractors that go in. They do everything with planes. I fear for the people who live near these fields. Maybe we can set a different model forward.

We have been talking about some of the challenges. Paddy construction is labor intensive and/or money intensive if you want to hire an excavator. It can take two or three years for a good harvest. I have actually experienced this myself. I started three years ago with a bucket of rice and got empty

panicles. I tried dry land last year in my vegetable garden and I got nothing. This year is my third year and I am seeing potentially a good harvest, but it takes some hands in the soil, hands on the project, figuring it out yourself. For processing there is an opportunity for special equipment to be developed and sold to people. Possibly a regional tool cooperative where people could share these tools and share the expense of these tools. An obvious challenge that I have talked about already is the sourcing of a quantity of seed for planting. This is actually a pretty common theme in most organic crops. Organic Seed Alliance has a report on it from 2011 detailing all the concerns people have about that and possible solutions. They are working on another report now to update that. It is an interesting reference for this project in terms of producing seed for a community.

Here is some food or rice for thought. Stuff that I thought of in the context of looking to the future. In this context, on the Akaogi Farm, we talk a lot about paddies. I think possibly more work and characterization of dry land production would also be useful or wet-dry irrigated situations, which is basically what my situation is now because my tarp blew a leak in my paddy. I do not have a paddy anymore so I am watering it like a garden now. Targeting specific product types, like infant food and gluten free needs. No-till and various rotation schemes that you could have such as the barley/rice rotation that Fukuoka talks about in One-Straw Revolution. He believed that you did not need to do a lot of flooding to have an effective harvest. Perennial rice or self-seeding situations so that you can have no-till. Lowering labor where you can. Simplifying the crop because it is an advanced technique. I look at it that way for rice paddies. Could rice be used to soak up excess nutrients in their environment? Could there be paddies installed at the edges of farm fields that are susceptible to high nutrient run-off or associated with livestock operations with lagoons or on the edges of tributaries that feed into the Mississippi at some point. There are many possibilities.

Here are some topics for discussion. I wanted to open it up. I have a few ideas, but every time we have an opportunity to talk as a group there is a productive conversation. We could start with these, or if people want to talk more about what they are growing or have any questions. What information do people need? Characteristics, what do you want to see? How do we deal with the seed situation?

Glenn: Who is working on perennial rice in the U.S., anyone?
Susan: Rice is a perennial.
Glenn: I am sorry. I meant annual rice.
Susan: What are you talking about? It is an annual if it is produced in this climate. It is a perennial if it is produced in the South.
Glenn: I have rice that persisted from last fall and re-seeded itself and came up through the straw. Mine is not supposed to do that.
Susan: From seed that fell in the paddy?
Glenn: Came up from right in the middle of the straw from the prior crop and did it on a seven-acre field.
Susan: As a perennial? As a ratoon, rather?
Glenn: Yes. We had freezing temperatures. It was under flood all winter.
Susan: Which variety was it?
Glenn: Carolina Gold. It is not supposed to do that, I do not think.
Susan: That is interesting. Mulched heavily?
Glenn: Flooded. We had to re-flood the field because they wanted to shoot ducks on it. We left full rice standing in lanes and then, that one quarter was just cut and flooded.
Susan: Are you practicing no-till? Is that what you are doing?

Glenn: We did not do anything to that 1/4 acre and it is now about this tall and it is heading out.

Susan: Boy you better write that up. Go talk to The Land Institute and tell them that you have perennial rice.

Glenn: Is there anybody working on that in the U.S.?

Genevieve: The Land Institute is the one I was thinking of.

Glenn: They are not doing rice are they?

Susan: They are working on temperate perennials. Rice is already perennial, it is just how you manage it. I mean it is an interesting question. I am not sure how you would want to frame it. Yeah it is an interesting question. Is it good or bad that it comes back up?

Glenn: In my case it is a good thing. No diesel.

Susan: If there is disease and it comes back, then it is problematic.

Glenn: Yeah that is not good.

Michael: Last year I think we got about 100 pounds of Duborskian rice, maybe 150. I do not know how much we are going to get this year, but it is clear that it is not enough to fulfill my fantasy, which is to sell it at Whole Foods or have that much. I am still a little upset with Fedco for having the gall to charge $100 for 4 ounces of Duborskian seed from stunted plants. I cannot think of anything more outrageous. Ryan Karb is the guy who grows the rice for Many Hands Farm Corps in Amherst, Massachusetts. From our perspective, for what we got selling it as food in the local coop, we could do better selling it to other people as seed. We would want to make sure that we are not spreading anything bad.

Ryan: Check for disease and insects, just in case.

Audience: At least Duborskian is one variety that seems to have grown well and we are certainly prepared to sell the seed for a reasonable price. That is at least one thing maybe that we can contribute. We have the machinery by the way. We have a treadle-powered thresher. This is in Amherst, at Amethyst Farm. We have a clipper seed cleaner, and we have two laboratory size husking machines. I think we have basically all the equipment. We do not have a dryer. I have yet to find a small enough dryer. You have to hang the seed up. If you can dry it yourself by hanging it up in a safe place, we have machinery with a heck of a lot more capacity than we have rice to run through it. I do not know how many thousands of dollars are sunk into that machinery, but it is a fair amount and somebody might as well get some use out of it. Maybe we could recover at least a little bit of our cost. Those are two things that we can contribute.

Glenn: Does Duborskian grow in the South?

Susan: Give it a whirl. One thing I like about this suggestion is that it is exactly what we are hoping, that the responses will come from the community of people who have been trying things. If you are interested, Michael, I think it would be really good for you to try to see if you could grow three different varieties in the same way you have grown Duborskian. One stop shopping is going to be more attractive than if people have to go shopping for different varieties from different groups. Do you think you can try that?

Michael: Ryan is the one who does the work.

Ryan: I am trying to push Michael away from increased production and to decrease production, but to increase processing abilities. I would like to talk Michael or

someone else into investing some money into drying, hulling, cleaning equipment. Our seed cleaner seems to be pretty good size, but our hulling equipment is small and the threshing ability is timely and not cost effective for over 100 pounds. I like to hear feedback about what is the most commonly sought after hulling equipment for certain scales.

Susan: Drying is essential for all potential to keep and distribute, and then how you package and how you store it. It is extremely important so that you are shipping good quality seeds. Our concern on the quality side is weed seeds and they are usually different sizes than your rice. The ability to do a little bit like what Nick was showing, one of these seed trappers with the breeze that allows different size seeds to fall.

Michael: That is probably the most functional high-volume machine we have. It was like 2-3000 dollars. It was American made and it was brand new. I think that problem we have covered pretty well.

Ryan: The seed cleaner is great. For the huller, I would love to get emails or feedback about what would be the best option.

Susan: If you are going to sell seed, you are not going to hull it. For me, the drying would be critical and then storage of the dried seeds.

Ryan: There is a drier in town that would be a potential.

Susan: I was at Seed Savers Exchange two weeks ago, at the annual meeting. One of the things I was impressed about with the seed savers is that after all the years that they have done a very non-professional job, they have really geared up for a professional capture of value, at the end of this value change. They distribute seeds and they now sell them. They have invested in the ability to pack into foil and seal foil containers because that is the guarantee to the person who is buying it. I would say that for me, if you dry the seed adequately and you have some sort of sorting that would be good. You would have to have some sort of manual sorter or one of those machines, but I think it might be more expensive than it would be worth. At the very least, some sort of visual check on discoloration because disease is often picked up as discoloration or passed bodies that look like rice seeds. You need to make sure you are doing that thing that I showed you from the IRRI test catalog. That would help you a lot. If you are doing that, at least visually, and then packaging into some kind of sealed foil or sealed bag you might be able to distribute. You are not trying to be certified. You are not trying to get a certified seed. I would feel that you would be in a better position because you could store it a little bit. I do not know how many users there will be, but if you are really giving quality seed and you have invested in that, you are going to want to be able to store that quality after it comes out of the field. Some people will not think about it, and you will have too much one year and not much another. If you stored it well, it is worth something. My feeling is drying is essential and being able to package it in some way so you do not lose the quality that you have already worked so hard to achieve. Those would be the two steps.

Glenn: Dick, at NOFA, has a list of resources for medium scale growers. They have a white conical thing that you can screw into a 1600-pound canvas tote. From the top down it is about four feet high. It has 1/3 horsepower engine in the top, and it actually pulls air from the rice up through that tube once you have screwed it in the tote. You can use the tote as a drying mechanism. NOFA has a ton of experience in that particular technology and it costs like $320. With 1600 pounds at a time in a tote, you can get 3 of them for $1000 and you are up to forty some hundred, two tons of rice paddy.

Susan: How long do you store yours Glenn? Your seed?

Glenn: Well, multiple years. We go up to four years, but we have refrigeration. We have 200 skid, 200-ton refrigerators, at twenty-thirty feet tall.

Susan: At 4 degrees?

Glenn: No. We are -10 degrees Fahrenheit on chest freezers and we have 140 or 150 of those. That is for poor stock. Then we have mid-temps on farm, for the year storage.

Susan: A cold room is obviously more expensive, but again if you are really going into seed production, you really have to. I would start out without anything like that, because I do not think your clientele is enough to warrant it. I would start out with making sure you dry it down and then you seal it. If you dry it and seal it so that the moisture does not get back in, you will have the minimal but important guarantee I think.

Audience: Jim, how do you store your seed?

Susan: Jim do you want to talk about those bags?

Jim: They are hermetically sealed bags. I think it was a couple years ago, I said, "How the heck can we store our grain?" All I did was go online, I ordered them and I just had a brief conversation with this guy and he shipped them to me. I am sorry. I cannot remember a name, but I am sure if you go online and look up "hermetically sealed bags," you will find these guys. I think he was outside of Boston and I think his manufacturing is in the Philippines.

Susan: The IRRI website will have all the information about how that works and they may even have the suppliers in the U.S.

Glenn: You can get an inexpensive heat sealer and a pacific bag costs nothing. You can get those foil bags Susan is talking about and they are drop dead cheap.

Audience: What is the right temperature to store? 4F or 4C?

Susan: Four degrees Celsius is fine. That is a refrigerator. At Cornell we store ours for a couple of years as long as they are dried down. You have to go below zero only if you are trying to store for more than two years.

Glenn: Everybody know what a CoolBot is? If you do not, you can look it up online. They take a standard air conditioner and put a CoolBot on it and you can get 4 Centigrade or low-temp refrigeration, which keeps you below insect and other thresholds. I think that there are mechanisms where you can control the humidity as well. Ken Green at the Hudson Valley Seed Library is a genius with all these very inexpensive technologies for seed storage. The Hudson Valley Seed Library has some resources there, too.

Michael: Ryan just confirmed that he has a CoolBot.

Susan: I think it is really worthwhile to go around and visit some of these seed banks, the Hudson Valley one and certainly if you have not been out to Seed Savers, to go out there. Have you been out there before?

Ryan: No I have not.

Susan: Next year it is not until July again, out in Iowa. I think this group would benefit a lot just seeing the way they operate because they are citizen driven group, but they are very professional. They have moved very far in the last five years in terms of operating at a much more professional level because they are trying to give a really quality product and now they have competition. Ten years ago they had no competition. I really feel like I learned a lot from being out there. They were really open and they were really excited to learn about this group. If any of you want to take a trip to Iowa, it is expensive to fly but driving across in a van or something would be really fun. You bring your sleeping bag and everybody camps on the farm.

There are all these really interesting workshops and wonderful group of people much like yourselves. They are Midwesterners by and large, but they are starting to attract people from a little further away.

Audience: Is High Mowing Seed worth talking to?

Susan: Yes, I think so. Our weakness is that we are so isolated. We are a very sparse group. We need to connect with these groups. They have been doing it longer, and many of them are just mimics of us doing something exciting. The larger that group of citizens in this country, the more information moves, the more our conferences are exciting, the more impact we have politically, and the more the USDA and the NSF and others will come to our meetings. Right, they do not come to this meeting. They think it is just too small for all the other things they have to do. It is not that we need to grow. It is not numbers. It is ideas that move around and help. I feel like I learned a lot going to Seed Savers and I would learn a lot if I had time to go around to any of these. If you go to them and bring ideas to us that is another great way to share information.

Sandy: I wanted to share one thing as well. Genevieve and I were trying to learn all the locals in the certified scene. We visited with someone at Cornell at the facility where the New York State seed inspection happens to occur. He told us that anybody can send a bag of seed to him for inspection. It does not have to be certified. It was incredibly inexpensive, $20 or something. They inspect the seed for normal pests. He has never done rice before. He guessed he could do that. They packaged it into the small quantities that you want and it was incredibly inexpensive.

Linda: I called up the State of Vermont for soybean seed, which I sell at the Farmer's Market, and he sent me the state regulations about seed. He was not concerned because I was so small, and I sold directly at the Farmer's Market. He said if you get bigger and make more money then you are going to have to send it out to get certified and it is going to cost more than you make. You have to be at a certain level to pay the fees, like Fedco and others. He also said if you go across state lines, if you are shipping across state lines then they are going to be regulations. That is a whole different thing. That is why I was wondering how Seed Savers Exchange has two parts. They have their seed catalog. Then they have their exchange, which is small people selling directly to other people.

Susan: They do not sell.

Linda: Oh, there must be some way to do that.

Susan: Listen to this because this might actually interest you. This is an option. It is a model. The Seed Savers model is that they have members, and members pay $40 a year and they get access to all 1,300 different accessions within Seed Savers as an exchange. You can bring seed and you can take seed and you can exchange seed. Then they sell only a very small fraction outside to the public as a commercial venture. It is not really certified, but you pay for it and they stamp on what they think the expected germination rate is. There is a differential. You could have a founder group that contributes something every year to maintain the core, access to certain facilities like seed or whatever, that is run by a board of trustees. It is run by a group of its own citizens. Because there is money, membership fees are used to buy whatever the equipment investments that they have made to upgrade. They go after grants as an organization.

Linda: In that case it would not be the individual. It would not be guaranteed. There would be certain regulations that the organization would write up?

Susan: There is.

Linda: But at the Seed Savers Exchange you do not know what kind of seeds you are getting.

Susan: They have the exchange there. It is several tables. People who brought seeds show you their seeds. Some of them are packaged beautifully all professionally done and some of them are just in old medical vials that say something on them. Then they will usually show you a picture or tell you about that variety because there is always a story. It is always a heritage variety of some kind. They just give you that seed. They say, "Oh, I think it will germinate fine." But you do not know. There is no money. The exchange has no money.

Audience: The exchange that they have on the Seed Savers Farm is totally different than the catalog that once you become a member, you can get sent to you. Everyone who is a member can add to that catalog. You can also write to any other member or email or use whatever contact information is included. Not the seed catalog that Seed Savers has for products they sell. That is totally different. That is inspected. That is state certified, because they ship all over the whole country and the world. Out of their main member catalog, that is just people like all of us right here. You do not know the germination rate and you do not know the quality of the seed. A lot of people that maintain a lot of the seed are involved in the seed business in some way, and it is really high quality. I have gotten some that had 10% germination too.

Susan: They are focusing on a lot of different species, so they have all kinds of issues where even the propagation is quite challenging. At least our crop is easier to maintain I think. I do not think we are ready to go into some kind of formal alliance. I am just saying I think there are different models. If there is a core investment that has to be made to keep the whole thing going, there needs to be a community effort to make that investment and ensure that it works. Or you can hope that some private individual steps up and provides what the community needs. Maybe for this size community that should work fine.

Nick: Is there a place where we can facilitate that conversation? I mean even as simple as a Google group or whatever. Where we can say, "I have Vialone Nano and if you want 5 grams of it, give me a shout, and then we will figure it out."

Genevieve: We can make an e-mail list.

Susan: We are trying through the growing-degree days, to be able to say I have Carnaroli but I do not know if it will grow in your area, check the growing degrees day site. Then you might be able to get an idea. Because it is crazy for them to ask seed for let us say, Glenn has that Chinese Black, and we know it is not going to set anything up here. We do not want to waste ordering seed and putting it in paddies and investing in time. We would like to know beforehand. We are interested in all of that. The ability to use information that you can share and share seed. All of it. We could put it up as a listserv where people could easily contact each other. We do not need to mediate any of it. That is an opportunity.

Audience: I have some information that I do not think you have covered. One is, our paddies are no-till. We do not till. We never till. He has Duborskian in the field, actually in a dry land condition in the garden that no one has looked at. It looks quite different. When we started with the grants we actually calculated yield per acre to be able to convince others that this is possible. You can get over two ton an acre. To get

funding, to get people to look at it, you have to show that it is worth the farmers' effort and investment. It does make over two ton an acre. It is twice as much as wheat. There is a huge wheat group, but rice is more profitable. I would like to see information from the growers. I would like to see instructions on how to calculate yield and have the whole group start reporting yield too so that we can prove that this could be profitable. It is not a niche market. It is not a cute little thing. It can help a farmer make money.

Susan: Although it can also sink a farmer.

Audience: When you did that equation, what was your baseline for price per pound for selling the rice? Because there is quite a difference in price that I have been hearing people are selling it for.

Takeshi: We were only talking about how pounds you can grow. Price depends on other factors.

Audience: I just mean it in reference to writing a grant. What was your assumption that you could sell it for?

Takeshi: It has just started and there is no evidence yet. We are selling and other people are selling very small quantities. We can say the price but you cannot generalize that price.

Sandy: I think that maybe you are asking how do you calculate what you thought you would get per acre.

Takeshi: I just said production in poundage per acre.

Audience: What if the person that is going to approve the grant wants to see a number for acre profit?

Michael: I can give you the number that Whole Foods gave us. I spend a lot of time. The woman's name is Rachel Hackett. She is the local forager for Whole Foods Market in Hadley, Massachusetts. It took her a while to warm up to it. For example, she went from saying, "We are not going to go near rice in a plastic bin in our bulk department unless you can guarantee it is filled the whole year round. Then she went to say, "Okay, as we think about it and talk about it, we think being able to sell New England rice would be a big enough draw that if you can only fill that bin for even weeks or months, we will use it as part of a marketing effort." When I started talking, it looked like maybe break even for us was about $6 a pound. What she said is, "Okay, that is a niche, gourmet, high-end market." People maybe will buy it because it is grown within ten or fifteen miles in what is called The Pioneer Valley, which is the Connecticut River valley of western Massachusetts, Hampshire and Franklin County. She said people will pay a premium. In Hadley, for example, they have Maine grown oats, which I think are almost a dollar plus more a pound than even their organic rolled oats. The closer you can get to say three dollars a pound, even two dollars a pound, that market is going to get bigger and bigger. She thought there would be at least a dollar a pound, maybe more, over the other organic rice that people would pay if it was New England grown. That may not be as specific as you want, but in a year of puzzling over that very question that is the best I have come up with.

Ryan: I have another answer that might be in a different format. It is a big topic. You could have a whole conference on it. I talk to a lot of farmers, and a lot of the farmers will say that for mixed vegetables, they need to get at least $20,000 per acre, gross, to make it profitable. Any crop that does not hit that line is tossed aside. I think if you are selling at $10 a pound, which is a very high price for rice, and you are getting two

tons per acre. That is $40,000 per acre, which is doubling it. You can count rice more like a vegetable, because most grain crops are getting far less per acre than vegetables. But if you have to do a lot more work to keep it growing with flooding or whatever else, then a lot of us seem to treat it more like a vegetable than a grain.

Glenn: We have a person in the audience with a national career in upscale ingredient merchandising and I wonder if he has any ideas on this?

Jim: I would not go to Whole Foods. That would be the last place I would go to. I would go to the local chefs. I would sell to my local smaller natural foods store. Usually in my neck of the woods, there are plenty of them around. They are very successful, they move a lot of product, and they really will get behind a locally grown rice. One thing you have to understand is, you have a really different product. You have a freshly husked rice. When Glenn sells his rice, he husks it and then he ships it immediately. I do not know about you, but in my experience rice much of the time is rancid. We just did this the other day at a friend's house. All the Italians have their rice vacuum packed and there is a reason for that. It is oxidative rancidity. When I open a bag of Lundberg, and I have been eating Lundberg since the eighties, when I open a bag now and I put my nose there and it is on its way out. I mean it is going. I do not think your liver enjoys that too much. I do not think your digestive tract is really enjoying all those rancid oils.

Michael: Based on what you are saying, Ryan was a lot smarter than me because he sold some of our rice to a place called the All Things Local Coop. I walked in there one day and was totally stunned to find a picture of myself, and the rice was sealed in plastic bags with a label he designed, and he created all of that while I was, as it turns out, basically fantasizing with the Whole Foods people.

Jim: If you only have a couple hundred pounds, you will move that in no time. Even at a high price, you will move it. I would not even think about talking to somebody like Whole Foods. They are on a totally different level. Chefs, local stores, I think are where you would start first, small operations.

Audience: There is a couple down in North Carolina that are growing rice and they have been selling it just to their CSA. They sell out every year within 24 hours. They are selling it for $16 a pound.

Glenn: May I weigh in on this, because on the board of our foundation we have three national boutique/artisan, whatever cheesy language you want to use to describe whatever we are. We are very small, but if you add everyone up, it is actually not so small. The contracts that the guys on our board have with Whole Foods, those prices going in on the shelf in a two-pound bag, are between $6.95 and $7.95 a pound. You are looking at between $13 and $15 for a two-pound bag walking and they bring in probably three or four thousand bags, set them up in a display at the front of the store during rice harvest. Just like you said, it is very reasonable, but it goes all the way from where we are in Charleston, to Atlanta, and to Raleigh/Durham and down south. The problem with that is that Mackey is not going to stand behind the program. As soon as you get online with them, they start trying to find a way for you to make less money. That is what Jim did not say, but that is actually the truth. We are setting our own floors nationally. Bulk wholesale direct to chefs, not including freight, is $5.95/pound for fresh-milled rice from us, nationally. Then you have to buy a minimum of 50 pounds and you have to pay shipping and pack. That is the raw rice you are paying for. As Jim mentioned, it is highly perishable. It goes in a CO_2 envelope. It is vacuum packed and it is also cold-milled at -10 and goes straight

into a bag. We learned this from the Lundbergs by the way. Jessica, back in those days, was really open and she actually talked about her cold-milling line. They do not do it any more. They had chill tubes and all that stuff. If you want to get Dr. Science and you can deliver that sweet bran finish on rice that is also partially white, you have a nutritional brown rice. That rice at $6 a pound wholesale, nationally, is easy. We have grown every year since we started. We are on year number 18. For local retail, our floors are what I just said on Whole Foods, pretty much whatever you say up front and then you have to mitigate it. You have to be able to be there year round. Whole Foods is like cocaine, you will get a little happy for a while, but then they are going to move on. In the case of trying to set a long-term sustainable program for merchandising, what Jim is saying is use your local community. Dig in, speak to everyone, keep your prices in line with the way you are milling and providing rice. If you can provide fresh-milled rice that is honestly fresh-milled and tastes like it and the bran is still sweet, you pretty much have a line out the door.

Audience: You say this is national. Are you including where they are already growing rice, like California and Arkansas?

Glenn: The marketing models for these things are like a boutique California winery. We are working it from the opposite coast. We are allocating what we sell nationally, but it is the same everywhere. The shipping is a lot more to get to the West Coast from us, and we actually build food hubs to mitigate against that, and advocate people growing their own rice locally.

Audience: What is the name of your company?

Glenn: Well our foundation is Carolina Gold Rice Foundation, but my personal company is Anson Mills?

Audience: That is the brand? If I wanted to buy your rice online that is what I would look up?

Glenn: Yes, Anson Mills.

Linda: It is like other things. Once there are a few growers, you can raise your prices and make a lot of money. Then everyone says, "Oh you can make so much money." and does the same thing. Right now the rice growers are very small. Christian [Elwell] in 2009 had a nice chart. He actually got figures from the local coops. How much rice the coops are actually buying in Vermont. You can see that chart. I think with a half-acre you could supply the Putney Coop for a year. Rice is so productive at two ton an acre that you do not need many growers for the price to go down. Right now you can make your prices $12 or $16, but eventually it will go down. Yeah, I cannot imagine $16.

Glenn: I like $16.

Mia: I think we had a pretty productive discussion. Thank you.

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.

Fifth Annual Northeast USA Rice Conference Group Photo