

LOBLOLLY PINE GENOME PROJECT

EXECUTIVE MEETING

APRIL 29, 2005

MEETING NOTES

Ann Bartuska, Opening Remarks

- Important to have viable forest products industry at home and globally when dealing with sustainability.
- USDA Forest Service is here to help convene a meeting to talk through what we should be doing in the future regarding the LPGP.
- Pursuing loblolly pine: would be first conifer, big breakthrough for other conifers.
- Scientific community has been talking about this for a few years: a firm foundation for moving forward. Now, how do we bring management and advocacy forward? What can we as a community do, in a consortium approach, to take LPGP to the next step?
- From FS R&D perspective, not able to be a huge contributor in terms of money. But we can be a cog to help get the job done. More of a convening role, jump starting what can be done. Helping figure out how to get resources together so that things can get done.
- Today, we want to leave with some outcomes, understanding this is the start of a path forward. What are major issues, what are the necessary next steps? We do not expect to nail down all of the details, but if we can leave today with some agreement as to next steps and commitments from people to help move those next steps forward, today will have been successful.

Questions: None

Jeff Bennetzen: *The Origins of the Maize Genome Sequencing Project*

- Each organism has unique characteristics that influence how sequencing should be approached.
- History of maize as model genetic species made logic target for sequencing. Situation is different for loblolly pine.
- Slide on *Arabidopsis*: international and interagency collaboration; demand and value demonstrated to date are far beyond what was expected.
- Senator Bond announced maize genome as national priority in 1997.
- Maize community said step back, take a year to plan, figure out how to use the money best.
- Rice put forward – easily transformed cereal crop; small genome for a cereal crop; highly motivated international community (Japan led); near completion.
- Maize Genetics Executive Committee: polled the community, got list of priorities, took that list to DC and met with key agencies; RFPs for public sector maize transformation followed.

Questions and Comments

What would you do to expedite the process if you had it to do again? We would know how better to line up ducks, but we would need to do what we did. Nothing extraneous or unimportant done, but should have done things in a different order.

Lobbying played a big role? Yes. Plant sciences are not on Congress' radar. Need someone to put it on the table, and industry is a good group to do that.

Bartuska: Did committee operate as an administrative body? How much time did you spend organizing? Not really. We defined tasks very narrowly, even though we were in a vacuum. We just wanted to acquire information and communicate it. Had we done more broad tasks, it would have been beyond what the group could have done. Average member's contribution was probably 10-20 hours per year; chair spent a lot more time in the first two years.

Did larger activities of global agricultural biotech influence this? Like Starlink? Did Congress question? Political perception was not one of our major goals. We were focused on hard science. Others may have been more focused, but maize geneticists were not. We thought that if we made good scientific cases along the way, things would work out.

Was international collaboration in maize less than in Arabidopsis and rice? Why is that important? International involvement is a great thing. It motivates public release of data, defrays costs, and creates a synergy of different cultures working together. Ag industry is not really involved anymore. Interesting that maize genetics community is largely, overwhelmingly U.S. in the public sector. Wasn't much of anyone to partner with internationally, but still trying.

Scott Jackson: *The Saga of the Soybean Genome*

- Executive Committee can help facilitate relationships between scientific community and others that are necessary to achieve the larger, long-term objective.
- Group discussed relationship of soybean genetics to other legumes. 2004 workshop recommended that soybean be the one to pursue. It is more ancestral to *Medicago*, *Phaseolus*, other important legumes.
- Met with people outside of the soybean world to get ideas (folks on other key genome projects). Doing so was helpful for moving things forward.
- 2003 – Soybean Genomics Action Plan. Established Executive Committee (based on effectiveness of maize). Agreed on standard map and standard populations; 'gold standard' physical map; standard BAC libraries; standard databases; organize workshop involving the broader community.
- Usual flow of genome project: genetic maps, EST project, physical map, preliminary genome sequencing, map integration, determination of sequencing approach, sequence genome, hope someone will use it.
- Rice genome slide – centers specialize in each of these steps. Organizations that specialize in certain functions that could be used so that the wheel is not reinvented.
- Executive Committee worked with commodity boards to present community's priorities and make recommendations to boards based on those priorities.
- Key learnings:
 - Decide on genotype/populations
 - Keep community involved – solve problems early
 - Use experts outside of community
 - Funding: commodity boards, larger biological question (comparative, etc.)
 - Informatics
 - Who are the end-users? Why do they need a sequence? What type of sequence?

Questions and Comments

At some point someone in Congress has to care. What was driver for soybeans that pushed it forward? Sequencing has not yet begun, but lots of money is going to other things required so that sequencing can be done. Hard to know what impacts are going to be beyond scientific advances.

Have genetic resources been a limiting factor in soybeans? It helped facilitate corn. Soy has not been as important as corn for as long. Genetics of soy is much harder, so we don't have much on gene maps. We have a few dozen; maize has a book full (100s). As we keep moving forward, other tools will follow.

Federal government was off to the side in your slide? Why? And how did different groups getting involved happen in the project life cycle? Wanted to show how soy 'deck' has been important for moving things forward. Have certainly interacted with feds – they play a role on the whole length. NSF funded genetic maps, microarray work, other things. Commodity board has been stepping in when we come to them with need for a key step in the plan. Helps keep process moving along.

Jerry Tuskan: *The Populus Genome: Creating a Publicly Available Genomics Resource*

- Most complex plant genome yet, sequenced in 18 months.
- Proposed as model hardwood by Europeans and North Americans
- Slide of sequencing and annotation process: probably ~\$30M
- International *Populus* Genome Consortium (listed several information pieces they are putting together in one central location)
- Outstanding international collaboration made it possible.
- Informatics is critical; develop tools early; flood of information is tremendous.
- Don't let positions we're in now prevent you from thinking big– where we will be is hard to know.

Questions and Comments

How were ESTs brought into public domain? Swedes invested in EST resource. All of that was in their domain. We could only access through collaborative/cooperative work. Once the project was up and running, groups with small sets of ESTs saw benefit in contributing their small part to the bigger picture.

How is the project coordinated? Consortium is open to anyone. From consortium there is a steering committee and other committees are organized on *ad hoc* basis. Very bottom up, all volunteers.

Any business community involvement? Congress? Not a commodity organization to work with as in maize example. DOE has long used poplar as model for biofuels, carbon sequestration, etc. We were at right time when DOE was winding down commitment to human genome project. DOE convened meeting in 2003 to review a proposal to get a 4x library and helped get money from Genome Canada, which helped with Europe, Israel, and other countries. Scientists did all of this cobbling together.

David Neale: *The Loblolly Pine Genome Project*

- The need: See graphs in presentation.
- The goals: Breed a better tree and gene resource management in forest ecosystems. These are complementary, not antagonistic, goals.
- Major investment in genomics research needed.
- Feel like there is a need to emphasize single species, but can think more broadly.
- Angiosperms are not going to be a good learning model for conifers. Need a model conifer.
- Reviewed history of loblolly genomics efforts. Funding, long-term leadership, long-term direction not clear.
- Groups in other countries already have significant investment and interest in pines upon which their domestic industries depend.

Questions and Comments

What degree of heterozygosity do you really have? If you look over 30 populations, how much diversity? At the haplotype level, to the far right of the heterozygosity distribution for all plants. Nucleotide diversity is close to but less than maize.

How would you select one individual for sequencing to represent the taxa, how would you do that? A decision has been made for the BAC library construction. Not easy to inbreed. Good opportunity to side step heterozygosity and start with DNA template with haploid.

Purpose and Need

Tim Mealey: What else needs to be said re statement of need?

- Need to invest in most economically important tree species in U.S., fear that we are going to lose forest industry in U.S. A competitiveness situation.
- Value to research doesn't go to why? Why should we have an interest in maintaining global competitiveness of our industry?
- Why is it going to tip over if you don't go to genetics? When do traditional breeding techniques not get you ahead any more?
- Argue for importance of the conifers if not loblolly pine in the ecosystem. There is something bigger – it will be the first complex organism that has that type of importance. Global change. Can start to understand how we manage our way through that.
- Long-lived organism. Important to whole globe, not just our economy. Breeding cycle is slower in conifers (7-8 years at best). If genomic project could deliver more structured approach to breeding, would be very helpful.
- Ann Bartuska: Loblolly pine are being brought into plantations in Brazil. Taking over native grasslands. So global questions about characteristics such as invasiveness.
- From DOE perspective (carbon sequestration), some will say that the pine forests are out there, why would the genome help? Need to pull out DOE points.
- Ann Bartuska: It's a good biomass generator.
- In terms of carbon sequestration, many people assume that forests will be there. In South, not so. NIPFs at the edge of converting to development. If we could improve value, could address that issue.
- Forest health issues. Some gains have been made on fusiform rust challenge through traditional breeding, but this project may have lots of potential. Also concerns with resistance to southern pine beetle
- Loblolly pine is just the example of conifers or pines in general. Lots of other places where it is grown – Argentina, China, etc.
- Link to DOE agenda and where USDA is. Biorefinery concept – trees with different chemical properties, etc. to make useful products.

Scope

- Back up one notch and say is *Pinus* the right genus. If so, then loblolly is the hands down winner. It's 10% of the world's annual regeneration. *Clarification – which one to focus the project on or to sell the program?*
- Loblolly and radiata pines are very close in their genomes. If could do two and marginal costs of doing so is less, may want to think about it. If you did two how much more would it be?
 - In first 5 years period, don't have to be absolutely focused on one. Some questions better addressed in radiata than they are in loblolly. At that level, we need to think more broadly. But at some point a big decision has to be made about a specific choice.

- Makes sense that given all in loblolly so far, that's a good focus. Want to have a comparative framework for other species in place from the beginning though. I would call it conifer project. Envision hierarchy – loblolly gets most effort, other gets a smaller amount, etc.
- As I hear this, the only thing that keeps popping up is selling this – passion and draw to do this. I'm looking at a product in 1-2 years. Fear that if gets too broad, too diffuse. If too diluted, do you pull yourself off target for delivering something in 5 years.
 - Dave: Think there is value of focusing on one of great economic importance, but that doesn't mean that you can't include radiata or slash pines in a Request for Proposals (RFP) to help support that project. I think more people are going to want to do the legwork for loblolly pine.
- You can sell loblolly very easily. That is the target. But wrong scientific target – need to switch b/c genetics so unknown. Need to leave the door open.
- You need to make decisions early in order to be clear early on. **CLARITY**. What in maize we said is that useful for maize primarily, but others will get something out of this, too.
- Focusing on one species, loblolly pine, is good. We've been breeding 4 generations now. Three major university/industry co-ops waiting to use the information. Loblolly pine has the most advanced tree improvement program of any species in the world. From pragmatic standpoint, would allow supporters to see tangible products.
- Be careful for what is picked from that fourth generation.
- In my region (Pacific NW), harder to advocate for a loblolly pine genome project.
- Maybe a pine domestication project where sequencing is an essential part. We're at the point in breeding where sequencing is the next important piece of discovery.
- If you are after significant, dedicated, yearly funding, need to manage expectations. If define broadly and come in with narrow product, some will perceive that as failure? If define narrowly and produce what you said you would plus some broader things, you are viewed as a winner. You can work on other species to advance mechanics of underlying science, but need to advance loblolly in front of the others.
- Most inclusive sell is forest health sell, and you pick your species based on that particular goal.
- *What is a national genomic infrastructure?* Structure of cooperating institutions, strategic science plan for what components are, working to enable individual partners through their institutions – putting people and buildings and machines together.

Implementation Strategy

Tim Mealey: What steps need to be taken, what is already in place, what should be done?

- First thing is to form an umbrella group to take a lead here. Lots to do: science plan, coordination. Need someone to kick things off.
- On science end, community already exists and has been moving forward.
- What I'm seeing is a lack of coordination on the political piece. Seems the scientific piece is in place. That's the piece that this group can talk about. If selling is to agencies on a competitive grant basis, scientists are the right ones. If it goes to Congressional funding, the scientists are not the right people.
- Need to decide what resource you're going to and what is needed to get those resources. May need to broaden team base beyond the scientists.
- Something different here: don't have a commodity board here. AF&PA is an association of industry. Community is smaller, so networking to bring resources to bear will be smaller.
- Scientific advisory board is absolutely critical. Gives credibility. People who have talked about this are not the same as being organized as a science advisory board. All political folks are always going to come back to the science people for grounding.

- The Loblolly Pine Genome Project science group does have an exec committee and several members are here. A community website exists in which goals etc. can be found.
- Agree about scientists running the project, but I think some effort at institutions (university administration) is going to be needed. Important piece for getting to the Hill. What kind of funding plan is in place? Is this about going to Congress, or is it about trying to get it to the Forest Service and have them allocate it, or is it earmarks for NC State University? What's the funding plan?
- Bartuska: Part of the reason for this meeting is to get execs and people who can help form opinions together. We've done some house calls with NSF, CREES. Enthusiasm there, with some caveats. Need to take those caveats and what we've heard today into a funding strategy. An important thing we heard is that there needs to be a user out there who will take what you have produced and use it.
- Need to create a structure that folks want to participate in like we heard with other presentations. Suggested the Institute of Forest Biotechnology (IFB) as home institution.
- Bob Kellison, President of the IFB: We are an organization that convenes scientists and tries to get information out more broadly. Model I've heard here today may fit that. Our board contains industry, government/academic, and environmental communities.
- *Can IFB take a direct appropriation?* Yes. Our funding from industry, government, foundations.
- Tat Smith mentioned process through DOE where they have four or five different pathways. Need linkages there. I can't go to our delegation with what I've got today. Need small group to come together to develop a plan that links back to what delegations care about. Put the story together for me. Tie to energy would be good.
- This group needs to decide who does that sort of task. There are some different models out there: membership organization, etc. for how resources get down to scientists. Institutional arrangements and funding need to flow from that. A group needs to look at models and choose which one to go forward with.
- I don't think the exact model is that important, but you need to have something active. For funding, need to go broadly to all potential sources. Arguments about industry and environmental health – that won't work.
- Would like to see a positive spin.
- Societal interest in *Arabidopsis* was zero. So a group so scientists was fine to go lobbying. Sounds like Senator Bond was key, USB was key. Who are the champions? There are lots of folks beyond scientists interested in forests. Understand how and why public dollars should be spent to obtain the loblolly genome.

Anne Bartuska: 1. Science Advisory/Plan 2. Policy – why? Who are users? Societal value? Added value of this genome project? 3. Communication and marketing – resources? Coalition? Strategy for obtaining funding?

Tim Mealey: These are a group of tasks. Does this seem about right? *Lots of yes.*

Tim Mealey: Does it need an umbrella? Or can they do okay on their own right now? Help me on organizational piece.

- Rather than define a structure, need to say what you want from that structure. 1. Establish and keep momentum; 2. Ongoing dialogue among the scientists and the policy people and the communications people. Can be done informally, don't need a formal structure. We could come up with a steering committee from this group and have some scientists on as liaisons.
- Could overall org not be the chairs of those three committees?
- Two groups: Meld the second and third mentioned above. The leaders of each could work together as a steering committee.

- *Is FS willing to provide continued leadership in this project?* Ann Bartuska: We are if that is what the community supports. We have a little money to help facilitate. We are very committed as an agency. Resources is a more difficult and complex situation.
- The Forest Service as a convener is a natural to me.
- If user community is not stepping up to make this happen, it's not going to go forward. *Lots of yes.*
- Importance of a unified front so that everyone is saying the same thing, representing the community accurately.
- I'm not sure what's driving this – the science or the policy? I'm not clear what the final product is, which will influence how this goes. It seems that none of the needs mentioned today argue for loblolly pine and not one with a smaller genome if it exists.
 - It's laid out in our white papers on website. But that was the decision of one group of people at one point in time. I didn't want to lay that out as a done deal today, but to let it be open and have it talked about by a different group.
- Want to second non-forestry forest users. USDA and DOE represent some of that, but other constituencies would be good. Second thing – There is an association of deans of forestry schools.
- A compelling reason for loblolly pine is that we can use the information for this work – most trees are genetically wild. Loblolly is probably the most domesticated (except Sugi, *Cryptomeria japonica*). Have a lot of pre-work. FS leadership – will have to be careful of not getting caught up in making plans for funding that we might then receive. We can help convene, but would be good in having a neutral party that we could support as the lead.
- 1. There is something that resembles commodity group – various breeding and research cooperatives that exist for different tree species. 2. Potential users – genome project is unifying for biology of an entire organism. In terms of scientific input, maybe should be some ecosystem folks, who would be scientific users; not just non-scientific users. Somewhere in the process.
- The science group is open, maybe we need to do more outreach.
- And those who come have money to do so; others may want to, but don't have a reason to come yet. Don't see anything there.
- You have to have the very best scientific foundation for what you want to do. If it had not been for corn growers saying that this is the most important thing, would have never happened. Industry, and maybe enviros, should come to this with a unified voice, won't get by on basic science.
- This is high priority, brings everyone together. Industry, as far as I can gather, is going to be firmly behind it.
- Policy group needs science person (and other way around) to ground, be resource.

Tim Mealey: So from the list of organizations we've made, who to go to: FS (can choose among themselves), AF&PA, NAPFSC (or complement – Council of Environmental Deans [CEDD]), IFB, users (who?), southern forest assessment partners, National Association of State Foresters, Non-industrial private forest landowners (NIPF) community.

- We are not trying to select, we are trying to solicit.
- We're talking about something radically different than what we've done in the past. We've pulled together multi stakeholder groups for 20 years and our funding stinks. The model stinks. We need to step out and look toward something different. I think the key here is finding a sponsor – someone willing to say I like this and am going to make sure this is successful. Need to begin to interact with and understand where agency missions are – try to fit those together. Go for deeper pockets.
- If you go back to human genome project, big pharma was in there lobbying and being effective, but didn't sell to Congress because of them. It sold on human health implications. So first part of human genome project was to understand societal implications of what we are doing. Here, I don't think we have why this is important to society. Need to broaden group of people who are in the room, conceptualize more. IFB is not a stakeholder. I don't think we're ready for the marketing plan yet.
- I don't see anything wrong with the structure if it things big and broadly.

- The vision of more paper and more paper products doesn't excite me. Arguments I hear for this project is the same as others, except for genome. Bioenergy, industrial intermediates – those are the types of things that get some excitement.
- Don't think business as usual – big, exciting, different, compelling.
- Concern about loblolly pine genome – first thing you think of is industrial forestry. It is going to have to span economics, forest health, some of these other issues to bring in something big.

Tim Mealey: Summary

- Need to do some work on creating a compelling vision.
- Keep science group in tact, but doing some outreach to get some ecosystem folks involved now.
- Group 2 works in parallel with science group, designate liaisons.
- Bring groups together, determine institutional strategy, move forward.

Ann Bartuska: Closing Comments

- If there is something in this discussion that intrigues and excites, please share your thoughts or nominate someone we can go after.
- What I heard was somewhat of a validation that we are on the right track. Not totally off base. Heard both healthy skepticism and healthy enthusiasm.
- I don't want to pursue this in small amounts. \$20-30M a year. We are getting “yes” nods from funding agencies that that is the correct approach.
- Getting user communities nailed down to be part of this is an important idea that emerged.
- This is and has to be a coalition.
- This is about sustainable forests – have to recognize that economics is part of that, but not all of it.