RCN: Broadening and Energizing the Maize Genetics Research Community

White Paper Year 3 — Exploring non-academic career development and opportunities to strengthen public-private partnerships

This white paper is a summary of discussions at the mid-year conference held virtually October 15-16, 2020.

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Executive Summary

The Maize Research Coordination Network (RCN) was established in 2018 with support from the National Science Foundation to broaden and energize the Maize Genetics Research Community. The "Discovery to Product" Advocacy subcommittee has since organized an annual mid-year workshop to discuss the most pressing challenges and to provide recommendations for the future. The October 2020 workshop was focused on two areas over two days, career development of the next generation of researchers (day 1) and an examination of aspects of public-private partnerships (day 2). Prior to the meeting, a survey was deployed to the maize community to understand key issues that drive and hinder public-private partnerships.

The day 1 talk and virtual workshop brought together over 85 participants (207 registrants) together with 8 diverse, non-academic plant science trained panelists. The keynote talk (Dr. Natalie Henkhaus) drew career themes from the NSF funded Plant Science Research Network "Decadal Vision'' summary followed by a two hour discussion with a diverse set of professionals from the private, non-profit and academic sectors. Recommendations from these discussions include that the Maize Genetics Meeting organizers formally incorporate career discussions and that industry visibility should be increased at the annual meeting. The community showed interest with prior subcommittee-led career workshops in 2019 and 2020, demonstrating enthusiasm about establishing new relationships and engaging with scientists from diverse career backgrounds. In addition, there was a recommendation that the maize community should participate in a mentoring program for students and post-docs with scientists in non-academic jobs. For example, a mentoring program could be organized and/or the community could engage with the Plantae Mentoring program which can assist students, postdocs and PIs in career planning.

The second day focused on public/private partnerships and attracted a similar number of participants. A series of talks prior to a panel discussion focused on key topics: a view into a product pipeline, successes and challenges in partnerships, academic and industry IP perspectives, and the growers perspectives on partnerships. In addition, a 15 question survey was sent out to the maize community prior to the meeting to understand key issues that drive and hinder public-private partnerships. The 73 respondents gave interesting insights and offered a number of helpful suggestions for committee follow up. It was clear that networking is an important driver in establishing partnerships and respondents supported the committee's effort to develop opportunities for communication between academia and industry. The panel discussion concluded that there are opportunities to maximizes the value of bringing academia and industry researchers together through the evolving Maize Genetics Meeting. The subcommittee suggests the development of workshops that focus on communications across academia and industry. Such discussion should focus on fostering internships and industry insights, encouraging the development of hands-on workshops in the latest technologies, providing exposure to how people work in academia vs. industry, and bringing perspectives on contract development and intellectual property.

Introduction

The Maize Research Coordination Network (RCN) was established in 2018 with support from the National Science Foundation Plant Genome Research Program with the aim of broadening and energizing the Maize Genetics Research Community. The "Discovery to Product" subcommittee has since organized an annual mid-year workshop to bring together researchers from U.S. academic institutions, USDA-ARS, related industries and federal funding agencies to discuss the most pressing challenges and to provide recommendations for the future. Due to the outbreak of the Coronavirus pandemic in 2019, the 2020 workshop was held virtually on October 15-16 with a focus on community building and collaborative research activities.

The first session was devoted to the career development of the next generation of researchers featuring a presentation on the Plant Science Research Network's (PSRN) Decadal Vision for plant sciences and a panel discussion with plant scientists in diverse careers. The second session examined aspects of public-private partnerships, including case studies, IP and contracts, as well as perspectives from industry, academia, and nonprofit entities. Prior to the meeting, a community-wide survey was given that raised questions regarding public-private partnerships. Both sessions consisted of presentations by invited speakers followed by panel discussions, as well as time reserved for formulating recommendations and community feedback.

One opportunity presented by hosting the workshop virtually was the ability to connect and engage with a wider audience than previously possible. Both topics generated substantial interest from the community with over 200 approved registrants for the workshop, about a third of whom were continuously engaged for at least 30 minutes each session. From this participation, an enlightening and lively dialogue was had that generated several ideas for broadening and advancing the maize research community. A summary of those dialogues along with learnings gathered from numerous participants are presented in the following report.

Day 1: Non-academic Career Development

The first day of the workshop focused on non-academic career development and attracted 207 approved registrants, 85 of whom joined the workshop for at least 30 minutes. Natalie Henkhaus, Executive Coordinator for the Plant Science Research Network (PSRN) and the American Society of Plant Biologists (ASPB), opened Day 1 with a presentation entitled "Plant scientific careers-preparing for the spectrum of non-academic careers". With support from the NSF awarded Research Coordination Network program the PSRN was able to grow involvement from 9 to 15 societies. They produced the 2020-30 decadal vision (Henkhaus et al., 2018) which includes priorities for research, people and technology. The vision includes four distinct research goals, three people goals and two cyberinfrastructure goals. A 2016 workshop produced a document, Imagining Science in 2035 (Plant Science Research Network, 2013) that utilized scenario thinking. The goals focus on people and technology in a workplace that nurtures adaptive and diverse scientists. The vision also recognizes that it is important to build capacity and interest to engage the public with plant science.

A major suggestion of the decadal vision is that career training needs to expand. Career planning should include individual development plans, reflection and consultation with mentors. The NSF is starting to support post-graduate training through workshops and other professional society efforts for older and younger scientists. There is emphasis on careers as more of a journey rather than a prescription for a specific, primarily academic path. A basic framework for one example is published (Henkhaus et al. 2018) and breaks skills into technical and transferable within the area of specialization. There is both an emphasis and desire for more training on public engagement. Another possibility is to prepare students for flexible careers, since every career path is unique and destinations can be reached in different ways. The ability to adapt to a changing work environment is important to long-term success.

A panel discussion followed that covered several career development topics, career planning, training opportunities, large and startup company experiences, career transitions and community engagement. The discussion highlighted how careers develop through planning, and perhaps some serendipity. Students and postdocs should focus on science, technical training and building skills. At the same time, they should stay alert and look for opportunities, no matter how vague. Each step is one of many, and routine reflection can be used to define the next big step. Continuous learning and well-defined goals are important objectives in effective career planning. Professional networks are widely recognized assets with respect to career development. It can be challenging for young scientists to get a foothold and there is room to improve opportunities, examples include the Plantae Mentoring Program (jobs.plantae.org/ementor) and Skype a Scientist (skypeascientist.com). Primary Investigators should support student/postdoc participation in meetings, workshops, leadership courses and networking to open doors. They should encourage engagement in professional societies by supporting membership dues and travel to society events. The National Corn Growers Association is planning to develop a program for students to interact with farmers to learn about their operations, connect with the various

professionals they work with, and create opportunities for students (and faculty) to do policy and advocacy work with growers. In private research settings everyone takes a unique path, and there is no formula.

Many early career training opportunities are available in the private sector. Some companies offer training programs for young scientists. These include internships and/or coops, and large companies like Bayer have internships throughout their organization, for which they continuously recruit. Many universities offer cooperative education programs that place students with local participating employers for a semester/summer to gain practical experience in their field. For industry companies, these programs reflect business needs/opportunities within teams as well as the organization. In some instances they are designed to encourage training in specific skill sets. The interview process can be stressful, and candidates should prepare to make sure the interviewer gets what they need to make an informed decision. It may be counterintuitive but most questions are behavior based. Companies want individual success, but need and encourage collaboration.

The work experience at companies depends on the company. Many companies are concerned with talent retention, especially young people, and it is important to appreciate all the elements required to bring a product to market. Culture is a critical success factor in most companies. The most effective teams reflect inherent and acquired diversity. Research shows that diversity improves innovation and company performance, but diversity is half the story. Culture must also be inclusive and without both, teams tend to fail. This is why many companies have culture initiatives which include defined behaviors for interviews and building teams. Company employees are encouraged to network, but the most important relationship with respect to career development is with their mentor(s), which is typically voluntary. Startup companies aim to make a huge impact, but the work environment can be a roller coaster. Startups are built on sound science and science applications, which requires money, a place to work and people to do the work. Early on each person wears different hats every day, for example a career manager may need to return to the lab every day. Large seed companies also continue to invest in new science, but must focus on short term goals. The work that will go into products in the next 10-20 years will be done outside of big companies.

Career transitions encompass new roles and moving from maize/plant science to new fields like health/animal science. Various factors move people to rethink their career path, and some companies support career transitions through direct training or continuous education initiatives. The key for individuals is flexibility, for example an individual trained in wet-lab techniques can harness these techniques for a career of successful research but there are other opportunities that draw on these experiences if the passion to do lab work subsides. In addition, the jobs in 5-10 years are going to be different, which demands a commitment to lifelong learning. Advice to manage role transitions includes follow your passion, take initiative, look up, embrace your network and listen to others. Circumstances may force scientists to look outside their field for new opportunities, and the ability to do this depends on skills. A maize genetics background can help in some instances, and bioinformatics skills are highly transferable to other life science sectors. Transition to a new field is influenced by past success, common ground with others who

have already transitioned and a desire by others to bring a different perspective into their organization. Interest should drive job applicants to pursue roles in fields outside their training.

International assignments can be very rewarding. Several factors contribute to the desire to work internationally, including motivation, curiosity and the lack of in-country options. Relocating abroad carries risks and rewards, and it helps to not have too many expectations. The surprises are usually positive. It is important to focus on what you can contribute when joining an international team. The rest can be learned on the job. There are several programs designed to attract international scientists to the United States. Universities like Cornell University have a strong track record of success, as do many other land grant universities. The smallholder farmer cohort is growing and cannot be ignored. The Maize Genetics Corporation should continue to find creative ways to help their institutions become part of the solution. This work is underway but much remains to be done.

There are several facets to community engagement. It goes beyond academic boundaries and encourages scientists at any stage to connect their work with society. Entrepreneurial skills can contribute to this. Students should find ways to help their communities. Events like the World Food Prize offer opportunities to reflect on how one might contribute to the broader community. Look at what others are doing. Find more ways to work across disciplines. Learning how to teach in a second language can be disorienting but is a true growth opportunity. It is important to forge partnerships that encourage people, particularly those who are under-represented to share knowledge and skills. Resources to support this include Minorities in Agriculture, Natural Resources and Related Sciences (MANRRS), the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), Annual Biomedical Research Conference for Minority Students (ABRCMS), the American Indian Science and Engineering Society (AISES), and Pathways to Science (pathwaytoscience.org) It is important to think outside the academic box.

Partnership Survey

A 15 question survey was sent out (October 2020) to the maize community to understand key issues that drive and hinder public-private partnerships. The committee wanted to use this input, along with the workshop discussions, to guide the next steps in fostering and advancing partnerships. The full results of the survey can be accessed at:

https://iastate.ca1.qualtrics.com/results/public/aWFzdGF0ZS1VUl9iZlRBajJSQ1ZORHBIbnYtNWY1ZmFhMWQ2YjIyMmQwMDBmNTE2NDY4#/pages/Page_3a588705-8ad0-4361-add4-99580bb320f5

Data was collected from 73 respondents, nearly all of whom were a part of the maize community. Approximately two thirds of the respondents were from academia (university faculty, student, postdoc, administration) while nearly all the rest (15% and 13%, respectively) were split between industry and government employees. The shared information is particularly enlightening since more than half of the respondents (39), including industry and academic respondents, are currently involved in a shared research project. It was clear that preexisting relationships or conference follow ups among scientists (accounting for 58% of the projects) were important in establishing these types of projects, whereas only 24% were driven by university or company sponsored programs. Once a project was established, there was often a high level of involvement between partners (58% of the projects). This reinforces the need to establish early and maintain strong working relationships, including conference interactions, across academic and industry scientists.

There was not a keen awareness of potential programs that facilitate or support projects involving academic and industry partners across the respondents. More than half (52%) of the people stated that they did not know of any supporting programs while a quarter of the respondents listed at least one program such as NSF-GOALI, FFAR, government SBIR or industry (Bayer Crop Sciences, Corteva Agriscience and others) grants as a potential source of funding. A method to communicate opportunities on both the industry and academia sides may increase awareness and possibly reduce barriers for partnerships.

The most important benefits of partnership projects appeared to be academic research funding, logistical/technical support and mentorship for trainees. Additional comments by respondents indicated the importance of exposing trainees to industry careers, the leveraging of industry's technical capacity, and the importance of innovation and translational science to connect science and products.

Partnerships do not come without obstacles and respondents voted the top three in order as 1) intellectual property issues including results needing to be publicly accessible (from academic viewpoint) 2) difficulties in contract negotiations and 3) funding. Competition among industry could limit the ability to fund a project through multi-industry consortia. Importantly, respondents were also concerned about the stability of a corporate commitment; Oftentimes

reorganization within a company will change priorities which could affect the support of a project. A large portion of the described barriers to a partnership project comes down to the lack of communication, understanding and acceptance of the different goals that the groups (academic/industry) come to the table with. For those successful projects there was a willingness, from both parties, to create a partnership that could be a benefit to both. It should also be understood that only a limited number of projects may have such an opportunity due to how goals are set and some immovable needs of the participants. This should not stop researchers from continued efforts to build new partnerships in the future.

How can this subcommittee assist the maize community on academic/industry partnerships? The survey respondents offered a number of helpful suggestions for the committee to follow up on. Many of the responses supported the committee's already established effort to develop opportunities for communication between academia and industry. This could be expanded from the career discussion to 1) fostering internships and industry insight workshops, 2) providing hands on workshops in the latest industry technologies, 3) providing exposure to how people work in academia vs. industry 4) provide a platform (website) for academic/industry networking, shared interests and info on funding opportunities for partnerships. Some also suggested going further by developing and providing guidelines on IP and contracts for partnerships as well as building commitments across industry (and government) to pool funds into a single innovation granting source.

Day 2: Public-Private Partnerships

The second day of the workshop focused on public private partnerships and attracted 76 participants. The aim was to understand how such partnerships are established and how they function, and what makes a successful partnership, so that recommendations to facilitate them could be made to the Maize Genetics Meeting Steering Committee, and to enable community resources to help in building such partnerships. Maize genetics research has a long history in academia and in industry; maize was one of the first genetic systems to be characterized, starting in the early 1900s, and early discoveries in maize included heterosis, linkage of genes on chromosomes, and controlling elements or transposons. In part spurred by the academic discovery of heterosis, breeding companies were established as early as the 1920s, and nowadays most maize breeding is done in the private domain, however maize research in academia continues to be at the forefront of plant genetic and genomic research, in part because of the wonderful genetic tools available, its great diversity, and the relevance to agriculture.

An important aspect of the discussion was about what makes product development successful. Academics may have a simplified view incorporating three phases; discovery, leading to development, leading to commercialization. However, the process is much more complicated and broken out into many more steps, such as early and late development, regulatory, precommercial, etc. Companies see the value of collaboration at different stages because they seek out unique expertise, and while partnerships are valued by companies, they have to be careful about collaboration, and data release, for example if some public lines are characterized alongside private lines. At the same time, a discovery from academia may not be relevant to an industrial application. For example, a transgene solution to a fungal disease in soybean, although on the surface appearing very useful, was of no interest commercially because the disease coexists with another disease that needs the same agrochemical treatment, so the resistance transgene gives no added value to farmers.

From an academic perspective, some aspects of industry partnerships work well, and some not so well. For example, short term undergraduate internships with companies are relatively easy to set up and can be very productive. However, graduate student internships are more difficult because graduate students often have time limits on their thesis work, and longer research visits are complicated by the need for nondisclosure agreements and intellectual property concerns. In general, academics may not understand stewardship and regulatory issues, and licensing or legal teams in academic settings often have limited knowledge of agricultural issues and technology. Sharing of materials between industry and academia can also be problematic, because of the need to track materials, especially transgenic events that have to be carefully regulated to prevent release. Product development is another major issue and can cost hundreds of thousands to millions of dollars, so universities often favor initial licensing as the best way forward for generating income.

Initial interactions between academia and industry are often at the scientist level, but this can be inefficient, as ideas may not be aligned with the company goals, however maize should be a leading model due to its active academic and industry research programs.

A major factor is intellectual property; companies need to turn discoveries into value, and to do so need to protect them, and often patents can be a major asset when valuing a company. The claims of a patent need to describe the invention, its utility and its novelty, and the ideas have to be non-obvious. It's also critically important that there be no public disclosure, even in some way that seems trivial to an academic, as this can block the patent. Patents take many years to issue, and are expensive, and academics live on funding timelines of 3 to 5 years where they need to publish to be able to renew grant funding, so all of this can bring tension into the relationship. Furthermore, a major limitation in bringing an academic discovery to product is that academic researchers may work in older varieties, and discoveries that benefit yield or other traits in those lines may not work in elite varieties.

Some institutions have partner organizations that actively promote academic discoveries to companies, an example is the Wisconsin Alumni Research Foundation. They represent scientists at the University of Wisconsin, and foster interactions and technology development between academia and industry, and have some funds to support product development. They can also assist in the difficult tasks of describing inventions and knowing how to define the inventors, and advise on the different forms of patents, such as utility patents, plant patents and Plant variety protection. For each of these it's important to remember the need for nondisclosure agreements to protect inventions when discussing between academia and companies. Another organization that represents diverse groups in maize is the National Corn Growers Association (NCGA). They take a small portion of grain profits, called a check off, from farmers, and currently represent more than 300,000 check off investors and around 40,000 members. They also have a limited research funding budget to initiate new projects. The main goals of the NCGA are to maximize yield while minimizing input costs, and to identify new market opportunities, promoting sustainability, stewardship, soil and water and pollinator health. They promote partnerships with grower organizations, by facilitating communication in ways the growers can understand, and help support intellectual property discussions. One important role of the NCGA is to convince growers of the importance of academic research, sometimes growers think that all the research is done in companies, but in fact company research stands on the shoulders of academic discoveries.

The take-home messages from the survey described above were that networking is an important driver in establishing partnerships, and while there are programs that can support industry academia interactions such as federal programs- Foundation for Food and Agricultural Research (FFAR), Small Business Innovation Research (SBIR), Grant Opportunities for Academic Liaison with Industry (GOALI), non-profits, e.g. GATES foundation, and some company programs, many were unaware of these opportunities. The biggest barriers in establishing partnerships include intellectual property concerns, lack of funding, and issues around confidentiality. Most respondents were in favor of more training at the Maize Genetics Meeting in this area, and an

idea was proposed to create an open innovation initiative with different companies putting in funds to support training fellowships for students or Postdocs.

A panel discussion ensued and discussed examples of successful partnerships, while recognizing issues such as frequent reorganization of industry priorities that can rapidly terminate projects. Companies also face liability issues in releasing materials. For successful partnerships, initial agreements are very important, and there may be flexibility in negotiations, for example some partnerships require that everything should be published by the academic investigators. Another suggestion is to build in a period of salary protection, for example for a Postdoc if the agreement is terminated suddenly by the company. Tension can also arise over negotiation of overhead, as companies may not want to pay the high rates of federal grants, but this can cause a problem for the University who need to defend their overhead rate in federal negotiations. Despite these issues, there are many advantages to such partnerships, for example projects can proceed very rapidly when working with industry once the resources are allocated.

Outcomes and future directions were also discussed, some ideas include encouraging the maize community to enhance training in this area, investing in people and developing relationships, and including more activities at the Maize Genetics Meeting, such as company booths or talks, or a "speed networking" event, where students and postdocs in academia can find out more about what research in industry entails, and industry can hear about the latest advances in academic research. Another suggestion is to work with the NCGA to bring farmers and students or Postdocs together, to convince them of the importance of academic research. If the growers are on board, this could encourage the NCGA to support more academia-industry partnerships, or lobby for funds to do so. As always, professional development such as training in diverse skills and in management, and maintaining a sound networking relationship with colleagues is critically important for success.

Summary and action points

Collaborations and partnerships across the community are often initiated through a person's network or established relationships. Within the scientific community, many relationships are established and maintained through regular attendance at scientific conferences. We recommend that the Maize Genetics Meeting organizers formally incorporate career discussions and industry visibility at the annual meeting. In 2019 and 2020 the RCN Discovery to Product subcommittee organized and led events for networking and career discussions that were well attended, suggesting that the community is interested and ready to establish new relationships and engage with scientists from diverse career backgrounds. Developing a mentoring program and/or encouraging participation in existing programs (such as the Plantae Mentoring program) will also sustain the ability for students, postdocs and PIs to foster career planning.

Several scientific conferences have offered various levels of visibility and engagement with the scientific conference for sponsoring industry partners. Efforts such as waived or reduced registrant fees, recognition for sponsoring specific sessions or coffee breaks and booths for networking and job recruiting have been used in the past as ways to advertise corporate involvement. As funding grows tight across all scientific sectors, it's important to think about the value and partnership that is gained through sponsorship and evolve the Maize Genetics Meeting in a way that maximizes the value of bringing academia and industry researchers together.

We also suggest the development of workshops that focus on communications across academia and industry. Such discussion should focus on fostering internships and industry insights, encouraging the development of hands-on workshops in the latest technologies, providing exposure to how people work in academia vs. industry, and bringing perspectives on contract development and intellectual property.

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Links to videos of the workshop:

Day 1: https://us02web.zoom.us/rec/play/Dd0sRoSoJjFu4--0oKNREJ4Eta1xqHZZLq-7nS-aaV5Qa_QUglbJchAChZyV2p9wRR4S7Z9Gc63zWUbB.WDR2t3auQKm0NTsf

Day 2: https://us02web.zoom.us/rec/play/LUmlOZS5_L3DJQYeDGD6TNsm_cnCAS-XaNGPQTk9hnqWh_3JmQ0LO5GvhPy52dM3NubNGUZzthQB5_kQ.T1Go0K7EBCNCAz6h?startTime=1602863732000&_x_zm_rtaid=2o2lU5KGR12Jaor_cOuv2g.1611851497859.de2680f5a73f96d35738c3c6cd495f24&_x_zm_rhtaid=153

Appendix A: Meeting Agenda

Day 1: Thursday Oct 15 Noon-4pm EDT

Non-Academic Career Development

Time	Type	Title	Presenter/Panel
10 Min	Talk	Welcome and Overview of D2P focus area: career development and partnerships towards maize improvement	Paul Chomet (Chomet Consulting, LLC), Ruth Wagner (Bayer)
30 Min	Talk	Plant scientific careers- preparing for the spectrum of non academic careers- link into the Decadal Vision in plant sciences	Natalie Henkhaus (American Society of Plant Biologists)
15 minute break			
2 Hrs	Workshop	Panel discussion with diverse, non academic plant science trained professionals. Career introductions followed by Q&A.	Moderator: Alex Brohammer (Bayer); co-moderator Paul Chomet (Chomet Consulting, LLC) Panelists: Martha Dunn (Syngenta), Hajime Sakai (NAPIGEN), Bree Champagne (Bayer), Alina Ott (Genus PLC), Maria Muschitiello (BASF), Stella Salvo (Bayer), Jennifer Mach (Peridot), Maria Sanclemente (Utrecht University)
1 Hr	Discussion	Recommendations to enhance career development and establishing/strengthening student/industry and PI/industry relationships	Community Participation

Day 2: Friday Oct 16 Noon-4:30 EDT

Public-Private Partnerships

Time	Type	Title	Presenter/Panel
10 Min	Talk	Introduction to public/private partnerships	Ruth Wagner (Bayer)
20 Min	Talk	What does a Product pipeline look like and where can public/private partnerships help?	Ryan Rapp (Pairwise)
20 Min	Talk	Successes and Challenges in Public-Private Collaborations	Shawn Kaeppler (University of Wisconsin-Madison)
20 Min	Talk	Intellectual Property from the Industry Perspective: Down the rabbit hole?	Karen Bruce (Retired, Syngenta)
20 Min	Talk	University perspective and how can we all work with IP and contracts?	Beth Werner (WARF Foundation)
20 Min	Talk	Grower Association Perspective on Public-Private Partnerships	Robyn Allscheid (National Corn Growers Association)
10 Min	Break		
20 min	Talk	Survey summary	Mike Nuccio (Inari Agriculture)
1.5 Hrs	Workshop	Focal areas for partnerships today Story on public/private partnership pros/issues- success stories for full product What are the key tool/product/process that would assist academic maize research and industry for product development?	Moderator- Wes Bruce (BASF), co-moderator Mike Nuccio Panelists: Barbara Mazur (Pontifax Ag Tech), Karen Bruce, Phil Benfey (Duke University), Dirk Inze (Ghent University), Hajime Sakai (NAPIGEN),

			Brea Hutchcraft (Bayer), Beth Werner, Rob Horsch (Retired, Gates Foundation), Robyn Allscheid
40 Min	Discussion	Outcome summary- what are steps this group can take to assist public/private partnerships for the maize community?	Community Participation

Appendix B. Subcommittee Members and Meeting Organizers

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