AG2PI

Agricultural Genome to Phenome Initiative

June 15-16, 2023
Kansas City, Missouri

Facilitation and Notes Provided by:

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- The next round of genome to phenome (G2P) funding needs to support the people in research fields in addition to supporting research itself. This should include:
  - more larger scale and multi-year grants to allow for multi-year planning and staffing;
  - more funding for staff positions, graduate students/fellowships, and career development/skills training; and
  - investing in a multi-disciplinary career pipeline for students

- The next round should also focus on removing bottlenecks in research fields by investing in capacity, collaboration, and infrastructure. This should include:
  - capital support for the infrastructure of research, especially around data collection, analysis, and reporting;
  - prioritizing collaborative, cross-sector, and public-private research projects;
  - communicating the impact of G2P research publicly and raising knowledge among consumers about food systems

AG2PI

Thursday, June 15, 2023

7:45 - 9:00 PM: Small Group Discussion

Envision AG2PI at full $40 million funding - what could be accomplished?

Big Themes:

- Investment in People/Workforce Development

- Capacity Building/Reduce Bottlenecks

- Infrastructure

- Collaboration

- Transforming Agricultural Research

- Communications

- Climate Adaptation/ Resilience

Complete notes can be found in the appendix.

Friday, June 16, 2023

11:20 AM - 12:20 PM:
Expert Panel - Small Group Discussion

Where does AG2PI science need to go next?

		Group One: Needed new phenotyping technology	11:20 AM - 12:20 PM: Expert Panel - Small Group Discussion
		# of Participants in this Group: 12	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● Senor based phenotyping	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Phenotypes current being collected ○ Affordable and labor ● Terrestrial robots and for alleviating the gap of labor ● Platforms for commercial phenotyping for high quality image data	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Good quality dataset that is happening in the commercial setting ● Going around or working with intellectual property between companies in order to give realistic problems ● Cross species/ cross disciplinary → work with computer scientist for modeling technologies ● Accessibility across all levels ● Data sharing - pork industry	

Group Two: Developing and evaluating data analytics		**11:20 AM - 12:20 PM:** Expert Panel - Small Group Discussion
	# of Participants in this Group: 8	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Streamlining **image analysis** pipelines - Developing open source methods - Developing new methods for quantitative genetics **Standardization of data** - Creating good **reference datasets** - Developing cyber infrastructure for life science research, creating new algorithms for life sciences
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Tackling the tradeoffs between standardization and diversification of data collection methods - Creating computer simulated datasets - Standardizing data - Crowdsourcing data labelling - Using synthetic datasets as a proxy for downstream analyses - More communication - conferences, meetings, collaborations
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- AI driven by biologists - Large and integrated sample data and data collection methods repository (both plant and animal) - Extremely high quality sensors to gather high quality data over time with precision - Semi automatic data labelling systems - Training of students in trans-disciplinary methods - More sustainable continued sources of funding each year

		Group Three: The future of molecular genomic research	**11:20 AM - 12:20 PM:** Expert Panel - Small Group Discussion
		# of Participants in this Group: 5	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Single cell genomics - RNA seq - CRISPR - Base editing - Mapping GWAS , QTL's	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Issue of base editing in animal research. Trans-genetics can be incorporated as a bigger picture. - Synthetic DNA companies - Cell-based production for greater productivity and efficiency on different scaffolds - Plant-a-bodies and bioengineering - Connect microbiome - Idea of whole system. Modify plants-> Modify animals-> Modify Microbiome - Inducible resilience, smart Plants! - Genetic improvement , finding variance and tools which facilitate the transition of community from natural to artificial variants	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Prioritize on creation of convergence team. - Develop a plan such as NIH-Food is medicine. Addressing diseases such as diabetes - NIH, DRD and others come together to work on molecular genomics research. - Steer down steps from bigger communities to a multiagency such as data infrastructure, data quality and implementation. - Now is the time!!	

		Group Four: New tools for genetic improvement	**11:20 AM - 12:20 PM:** Expert Panel - Small Group Discussion
		# of Participants in this Group: 10	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• ssGBLUP (single-step genomic best linear unbiased prediction) • Requirement: public sector capacity to use information • IoT generated data for phenotyping (Limitation: accessibility, knowledge, cost)	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Lipka's example of multiple sources of information • G-by-E extrapolation • Integrating biological knowledge/models from other disciplines (e.g., nutrition)	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	• Models that address new climate and select for organisms that will thrive there • Gene editing, especially for generating new variation • Requirement: tools to predict trade-offs based on changing variants via gene editing	

Group Five: Optimizing the AgSTEM workforce pipeline		11:20 AM - 12:20 PM: Expert Panel - Small Group Discussion
	# of Participants in this Group: 9	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● Youth empowerment about AgSTEM career paths ● Extending AgSTEM education to minority groups(African-american groups) ● Getting college kids excited about AgSTEM career paths ● Guiding undergrads in choosing a career path that is suitable for them in agSTEM ● Training grad students on grant writing and making them aware of funding opportunities
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Systematic review of what careers are available in AgSTEM ● Role of professional societies to advice institutes about what career opportunities are available to grad students ● Partnerships between funding agencies and community colleges to decide what courses may be beneficial to the career advantages of the students ● Encouraging stakeholders to voice out, put out applications to tackle obstacles in AgSTEM workforce pipeline
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Giving value to mentors of undergrad students ● New careers involving training people who can interface with new technologies ● New multidisciplinary programs should be introduced at departmental levels ● Introducing certification courses to undergrad levels to intrigue their interest in AgSTEM ● Co-funding is under utilized, should be addressed ● Joint master programs between partner universities for AgSTEM ● Avoid silos and develop collaborations ● Seek fundings from diverse sources and mentor more and new students

Group Six: Application of intermediate phenotypes in Ag G2P		**11:20 AM - 12:20 PM:** Expert Panel - Small Group Discussion
	# of Participants in this Group: 7	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- All the -omics - Breaking down phenome- how do we break it down and quantify it? - Quantitative environomics, including the microbiome and time/space sampling *transcriptome*
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Looking into what intermediate phenotype is relevant and in which tissue for prediction - Need to add in more pieces of the puzzle for prediction, not just using the intermediate phenotypes (use additive models) - Get underlying variants from annotation and other available data
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Predictive biology, including indirect consequences - Differentiating between cause and effect - Optimizing breeds/lines for the environment without concern of losing diversity - Monitoring the physiology as a whole as an early warning system of unintended byproducts of selection/breeding - What combination of phenotypes are viable under realistic limits

Group Seven: Maximizing data interoperability to make new discoveries		11:20 AM - 12:20 PM: Expert Panel - Small Group Discussion
	# of Participants in this Group: 9	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Integrating Genomics data with Phenomics data across all livestock and crops - Animal genetics converged on data standards and made data exchange straightforward - Plant database at UT - forestry genomics - meaningful data from - Grants from 20 ya rewarding data interoperability, all federal funding agencies require shared data, synthesis - Pangenome, had success - Animal and plant genome databases, external databases - Abiotic stress, 125 genomes, global partners - Drone data from high throughput P
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Gene expression, functional annotation in different silos, aware of API's to sythen data, Knowledge bases query data from one place. API's have failed in this way - Submit assembly buy annotation not shared, wrong format, nomenclature - Genome free interpretation, FastQ should be interpretable in ref genome free way - Kmers to build filters to identify data types on unprocessed data sets - Universities build infrastructure for research data, NCBI could marshall agencies to index data, becoming hub for links between disciplines - Hard to get data out from NCBI, raw and not analyzed (only 3 plant spec) - Best practices (fill the gaps) - Compliance is a problem - controlled by publishers and funding agencies - Data produced outside the US needs to be standardized by publishers

Continued on following slide

Group Seven: Maximizing data interoperability to make new discoveries		11:20 AM - 12:20 PM: Expert Panel - Small Group Discussion
	# of Participants in this Group: 9	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Work Through Current Phenotypic Metadata needs to be analyzed ● This data needs to live somewhere for ever for future accessibility ● As tech develops, go back and analyze old data ● Funding cycle to treat data as library ● Nelson memo - put all data where it's all available and shareable ● 5 year funding cycle does not work for cyber infrastructure ● Intercommunity talk at genome level, but needs work at phenotype level ● New funding model needs to exist ● Non competitive funding sources ● Big Data librarians ● National ag library must be expanded and anyone in the world can access and have standardized depositories - needs domain specialists - division working on specific data sources ● Corporations die, change fees ● Data management plans

Group Eight: Cross-disciplinary collaboration		11:20 AM - 12:20 PM: Expert Panel - Small Group Discussion
	# of Participants in this Group: 2	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• No competition for time and acknowledge the needs of other collaborators' knowledge • Give opportunity for collaborators to do there work and reward them accordingly • Understanding the common problems and ensuring teams commit to it • Rethinking incentive structures
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Building interdependent knowledge linkages • Making broader impact • Universities becoming open to professor of practice
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	• Extending temporary dynamics • Engaging professional project manager at the beginning of interdisciplinary research • Increasing the duration of research to give room for social interactions • Core capacity needed for research e.g Data standardization

		Group Nine: Engaging animal researchers with NSF	**11:20 AM - 12:20 PM:** Expert Panel - Small Group Discussion
		# of Participants in this Group: 11	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Facilitates the discussion about need from funding - Creates specific questions that come from collaborative discussions - Identifying bottlenecks from different agencies - Finding solutions to reduce costs - Networking-getting reviewers to get to know you and your work	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Multitemporal data collected in previous years. Needs to continue been collected - Agriculture people to collaborate. Cross-disciplinary collaboration	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Need for increased investment in Biotech - Synthesis Center (Historical data needs to be digitized and analized) - Low cost cloud storage for public data - Standardized data - Centralized platform for collaborative updates in research and technology	

Group Ten & Eleven: Other topics/open conversation		**11:20 AM - 12:20 PM:** Expert Panel - Small Group Discussion
	# of Participants in this Group: 5	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● The panel discussion provided background information, research scopes, and possible directions for research in plant breeding, genetics, data integration, etc. ● Looking at where limited resources/investments need to be based on the AG2PI discussion ● Trying to figure out roles of government, academia, and industry as individual groups → how do these 3 sectors work together to tackle AG2PI focus areas? ● The problem isn't global warming or growth in global population - the problem lies in our inability to keep up with the drastic influx of its effects → need to find methods of coping
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● How can we prioritize topics/research focuses based on resources (available funding)? ● Thinking about sustainability of the investment (funding) → when will society/community see the net benefits of that scientific investment? ○ Land grant institutions can play a unique role in researching areas specific to those areas ○ However, state funding isn't necessarily matching that
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● What are "actions" that Ag2PI members, stakeholders, and researchers need/should take? → how do we think about that for guiding future research? ● How can today's discussion shape our $40 million question? ○ We want that investment to be sustainable, long-term, circularization of that investment ● Bridging connections and sharing information between the three big sectors of science: industry, academia, and the government → capitalizing on the unique opportunities that each are able to offer ○ Focus on hiring individuals that do research at universities and bridge connections from land-grants to industries/companies that have shared interest

Friday, June 16, 2023

2:30 PM - 3:30 PM:
Stakeholder Panel - Small Group Discussion

What are priorities of future funding/research?

Group One: Optimizing the AgSTEM workforce pipeline		2:30 PM - 3:30 PM: Stakeholder Panel - Small Group Discussion
	# of Participants in this Group: 2	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• **Training programs** for graduate students and postdoc
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• **Translate our science** into classroom curriculum **as exposure** • **Career background and journey** and sharing it **with the community** • **Prepare the consumer and future researches** for technology with already establish curriculum as a way to be visible to the community
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	• High School and middle school **outreach** ○ **High school** research **apprenticeships**- introduce AG stem • **Ag education courses** involvement with current scientists • **Training future students** through **undergraduate research** as an **research and financial opportunity** • **Post docs** should be trained to mentor graduate students, graduate mentoring undergrad research • **Ag application** with multiple tracks **such as genetics and biotechnology** through integration **into curriculum** • **Extensions of agriculture:** civil science (stakeholder) and other team science **innovation with community science**

Group Two: Developing new phenotyping technology			**2:30 PM - 3:30 PM:** Stakeholder Panel - Small Group Discussion
	# of Participants in this Group: 3		
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Diversification of phenotype collection methods - Image based collection (Drones/hyperspectral imaging/video)	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Being able to track thousands to millions of objects in a video or image and translate that technology across both plants and animals. - Cells, chickens - Limitation - chicken houses are dusty and resolution of particles is tough over time	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Investing in the development of advanced **sensors** that are affordable integrate into either plants or animal systems. (collect similar data that can be shared between sectors) - Investing in better **data storage strategies** - eg. images or video data over a long period of time **Incentivize computer scientists to work for ag.** who can write data analysis algorithms, scripts, and improve research efficiency (offer higher salaries, create more opportunities for employment) - Work with our agencies to ensure **regulations** for research tools are appropriate (certain brands of drones and foreign made items)	

Group Three: Advancing big data tools		**2:30 PM - 3:30 PM:** Stakeholder Panel - Small Group Discussion
	# of Participants in this Group: 8	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Multi omics data - Reduce cost of genotyping - Accessible to sequence and genotype. Fuzzy areas! - Power of robots - Large amount of data, little amount to inhale. - Education on graduate students such as training programs - Collaboration between engineers and biologists. - Digital agriculture
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Production of data in different time scales. - Group of animals to provide meaningful metrics - Structure and format of genotype and phenotype data. - Dumping of databases into one so that they talk to each other - Sequence plant and animal species and enhance coverage of more data. - Development and creating advanced tools to target infrastructure and species agnostic resources.
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- A BUTTON! : Automatic analysis of raw data. Integration,imputation, annotation and infrastructure of pipelines and put AI on top of all the things. How many times we all do the same thing. Re-analyse the data which all of us do. - Funding for storage of big chunks of data. - Give what we want in one format or one language. - Similar to FAANG, which gives high throughput phenotyping data side and prediction based tools. - Data for phenotypes. For instance, collect/ integrate data of all cattles in just USA. - Invest $5 million out of $40 million to find out what to do! - Use ML/AI so that we can revisit the data and update anytime we want.

Group Four: Public-private partnerships opportunities and challenges		2:30 PM - 3:30 PM: Stakeholder Panel - Small Group Discussion
	# of Participants in this Group: 10	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Breeding companies provide animals and funding for research (companies are competitive, so the data can't be shared easily; however, they come together because the goal is important for all them) - Certain data is restricted for specific purposes - Red tape hurdles - dependent on proprietary software and independent organizations - Establishing adequate legal support between partnerships
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Structures for data sharing and agreements both between and within public and private organizations would streamline project launches. Standard data transfer agreement and standard operating procedures - Training documents for how to generate public-private relationships - Trust doesn't necessarily go beyond the person that you are working with
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Necessary to expand public to private partnerships (required to do research) - Advancements in "in-kind" cash matching so public and private groups are on a more even footing and projects can be larger - Need for data standardization - Diversify and expand the types of partnerships that are formed - More integrated public sector to approach the private sector with more brain power and grander ideas - Involve non-profit organizations as the bridge between public and private sectors - Data storage: do you build your own or do you buy access into what already exists?

Group Five: Future of genetic improvement		**2:30 PM - 3:30 PM:** Stakeholder Panel - Small Group Discussion
	# of Participants in this Group: 8	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• Treating the polyploidy situation in specialty crops (Genomic selection) • High risk and cost associated with specialty crops • Rent a scientist initiative to collaborate and help on projects • Collecting phenotypes on less established species is challenging • The problem of implementation and interpretation of research results at the company and farmer levels
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Accessibility and guidance with statistical methods for researchers in genomic selection • Sensitizing the niche market on the products of genomic selection(eg. what to do with a breeding value) • Economic assessment of breeding program establishment based on management systems(organic, conventional) • Re-assessment of GWAS analysis-improve methodology- GWAS impact on prediction accuracy??
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	• People will have to evolve to learn new ways of breeding • Concern for the loss of genetic diversity- responsibility of researchers and companies to be concern with genetic diversity loss • Anticipating future traits to breed for and climate conditions is a challenge - more emphasis on simulation studies • Infrastructures to store genetic resources is necessary

Group Six: Future of phenomic research	2:30 PM - 3:30 PM: Stakeholder Panel - Small Group Discussion
# of Participants in this Group: 3	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	Phenomics is a new philosophy, not a destination and will most likely jumpstart in the plant community ● Collecting as much phenome data as possible ● Start by taking all the advances in genomics in the last 30 years and apply it to phenomics ● Phenomic prediction can be more accurate than genomic prediction
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Connect phenome info to health of the individual ● The concept of a phenome is less expensive than individual phenotypes ● Phenotype for biomarkers in real time- that's a logistical issue ● Establish NCBI-like database for phenomic data ● Start thinking about technologies to help "saturate" the phenome- specific cameras
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Pan "phenome" -> We need champions of this! ● Have such a well documented database that when you find a new biomarker, it will be linked to an already well known parameter ● spatial temporal measurements ● Utilize image analysis via AI ● Move toward models and simulations rather than physical observation ● Forget "big data", we need "mega data"!

Group Seven: Successful team science		2:30 PM - 3:30 PM: Stakeholder Panel - Small Group Discussion
# of Participants in this Group: 4		

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● Smaller departments are required to collaborate, larger institutions still won't have every skill set ● Go outside of comfort zone to answer new question ● Get engineers, breeders to talk together ● Faculty can relate to one another if given opportunity
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Farmers collecting critical data on uniquely managed operations ● Competitive Ideas labs for bringing together diverse minds to solve complex problem that get funded ● Grants for collaborative research ● Provide resources to apply for and administer grants ● Setting official ground rules for authorship, clear expectations
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Need funding mechanisms to incentivize teamwork, collaboration ● Scientists must collaborate with other actors (farmers), stakeholder support ● Understand what producers really need ● Shared will to think outside of each disciplinary box ● Deconstruct silos between and within disciplines ● Reintegrating all aspects of biology ● **Developing methods for describing individual contribution to team projects** ● Allocating overhead on projects with multiple funding sources ● **More leadership training opportunities, science of team science** ● Team management plans

		Group Eight: Maximize data interoperability and/for sharing	2:30 PM - 3:30 PM: Stakeholder Panel - Small Group Discussion
		# of Participants in this Group: 4	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Publishers are driving data sharing among researchers - Limited re-usability of genomic data and availability of phenomic data in public repository - Formatting of data by curator for interoperability is still required - Need to standardize phenomic data structures - Establishing phenomic definition across species and kingdom	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Building phenomic data repository - Creating standards for phenomics data for interoperability and sharing - Automating data curation using AI/machine learning - Using supplementary data from research articles - Creating data DOI to enable effective data sharing	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Enabling community to build meta-data standards - Increasing data repository funding beyond a stipulated 5 years and ensuring stability of its management - Building capacity in phenomic data curation - Understanding the needs from cross-disciplines and developing structure accordingly - Funding researchers to re-use available data (meta-analysis) - Increasing education on AgBio data among undergraduates and graduates e.g FAIR, open access, etc - Creating funding to increase the mechanism for data sustainability	

Group Nine: Building Trust Among Sectors		**2:30 PM - 3:30 PM:** Stakeholder Panel - Small Group Discussion
	# of Participants in this Group: 3	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Need for collaboration across industry and research - Industry comes with questions, data, ideas - Industries reluctant to share data with universities that work with competition companies. - Companies might benefit from collaboration - Need to connect between public and academics - Appropriate communication will facilitate work. Only available if there is trust among all parties
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Reduce research cost by sharing work. Preventing duplicated research between academics and industry - Image annotation (CAPTCHA). Help from public to annotate data - Validation of data/response obtained from AI tools such as ChatGPT
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Collaborative projects that merge different 'cultures' - Common tools development (example: single cell) - Sharing of analysis/process pipelines 'Extra credit' from inclusive work. Work with someone new. Helps to bring new ideas - Individual responsibilities. If one falls of, work still gets done - Fully trustworthy collaboration between extension and research - Integrated grants between consumers, minorities, under represented groups, academia and companies - Field days where farmers, researches and extension all participate together

		Group Ten: Funding and other capacity resources	2:30 PM - 3:30 PM: Stakeholder Panel - Small Group Discussion
		# of Participants in this Group: 0	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?		
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	No group discussion	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?		

Friday, June 16, 2023

4:50 PM - 6:00 PM:
Multi-agency Panel - Small Group Discussion

Recommendations for future investment

Group One: Big data tools		**4:50 PM - 6:00 PM:** Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 1	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● Creation of datatools ● More accurate predictions
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Measuring and generating big data ● Generating more big data tools ● Repositories fully accessible ● Procedurally generated data ● New technologies (AI) will be able to make use older, unused data ● Understanding how do you balance the need to only collect relevant data vs collected all data that allows historical analysis later down stream

3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)*
	
	 Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?
		● **User experience:** <u>Collaboration</u> to **identify specific needs** to help **optimize the data collection tools** and process us
		 ● **Data Standards** (and extensions) - accounting for new technologies to be added into the processing
		 ● **Storage infrastructure**
		    ○ What is really needed to be stored – how much detail do we need
		    ○ Optimize the resolution of our data to maximum storage efficiency
		 ● **Processing data** - More access to data

Group Two: Democratizing access to science	4:50 PM - 6:00 PM: Multi-agency Panel - Small Group Discussion
# of Participants in this Group: 5	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Open access journals/free public access to scientific publications - GitHUB and other public access code repositories
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Apply tech advancements to more diverse species - Train students in underprivileged areas in technologies that may not be accessible to them.
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	**Introduce technologies developed in major crops into underrepresented, specialty crops** in ag (cranberries, blueberries) **Create species agnostic tools**. - R and other data analysis software has a high barrier to entry, so **develop tools that will make data analysis more accessible to a wider audience** (Improved GUIs) **Deploy science communicators**, graphic designers, and illustrators to spark public curiosity in science and enable and understanding of complex science topics. **Participate in community engagement** and organize events that enable citizen science. Talk to the people, build trust in science, show them that we are here to help. **Minimize risk** via willingness to collaborate and share knowledge

Group Three: Facilitating interdisciplinary approaches		**4:50 PM - 6:00 PM:** Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 3	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• Functional genomics,bioinformatics approaches ,molecular genomics and understand model systems, knock-down genes to understand the regulation • Image analysis, sensor based technologies , develop high precision phenotyping. Merge cross kingdom, feed efficiency and other aspects. • Synergistic approaches for plant and animal science- >related to economic trait, production or disease. • Climate change and other sciences are required - crop identification, GWAS-based information help adapt extensive conditions.
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Establish collaborative project with plant scientists and understand insect interaction. • Address society level,climate changes and nutrition security to develop urban agriculture. • Develop infrastructure in different fields such as software based, cloud based and support systems. • Change the view. For instance, let farmers ask and collect data from us. Use their knowledge and use them for advancing science. • Develop impact farmers and think challenges of new crop incorporation without competing with other crops using the help of economists, public private partnerships and industry level people.

Group Three: Facilitating interdisciplinary approaches		**4:50 PM - 6:00 PM:** Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 3	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Establish and expand collaborative projects (sc functional genomics, Insect and image analysis, crop production) ● Stakeholder engagement. For instance, satellite drones to collect field data. ● Price of sc would be low. Every lab would be able to sequence millions of cattle and develop sequences for many genes. Understanding the data in population level. ● Bioenergy and grow bioproducts from crop based on genetic modifications. ● Let's all combine our hands together- Evolutionary biologists, molecular geneticists, economists, climate people, anthropologists, ecologists, social scientists and all other disciplines. ● Public- private partnerships and industrial collaborations. ● Generate fingerprints and change the whole dynamics of the world. Play role in modern STEM related disciples.

Group Four: The integration of genetic and phenomic research		4:50 PM - 6:00 PM: Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 11	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• Working definition of phenomics: all phenotypes of interest • Incorporation of novel phenotypes into genomic prediction • Mapping of genetics for phenotype • Certain types of data can be used a both a phenotype and predictor
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Pieces of networks • **Requirement:** storing various -omic data • Opportunities to relate meta-data of measurements • Statistical methods to leverage -omic data for prediction
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	• Comprehensive network biology • Integration of molecular biology and statistical genetics • Interpretation of outcomes of phenomics to actionable decisions • Shift from reactive breeding to proactive breeding (e.g., climate change)

		Group Five: Public policy around genetic improvement	4:50 PM - 6:00 PM: Multi-agency Panel - Small Group Discussion
		# of Participants in this Group: 4	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Not harmonized policies around gene-editing techniques - Poor public knowledge of genetic improvement techniques - Poor public perception, misinformation and conspiracy theories regarding genetic improvement - Livestock and plant welfare concerns - Concerns regarding antibiotic resistance in various gene-editing techniques - The science is being done- problem is with communication	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Education on the impact of climate change and the need for transgenic robust plants and livestocks - Education at the lower levels about the values of any kind of genetic improvement techniques - Destigmatizing the fear around genetic improvement techniques through proper communication and prioritizing transparency in all communications - Stakeholder meetings involving government agencies, companies and members of the public to re-look at the current policies regarding genetic improvement techniques	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- Long term risk assessment of all-ready available genetic improvement techniques(CRISPR, genomic election)- but cost regarding these risk assessments must be taken into account - Commitment to depoliticize policies that are of interest to people regarding genetic improvement - Involving neutral research institutes as mediators and assessors of the safety and use of products of GI techniques - Defining the concept around "the consumer is always right"- have to rethink this phrase if we are looking at bridging the gap between companies, government agencies and the public - Redefining what livestock welfare is	

Group Six: The AgSTEM workforce pipeline (beyond existing programs)		4:50 PM - 6:00 PM: Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 2	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Increase graduate (pre, during, and post) funding, for example PhD funding for at least 5 years • Outreach to high and vocational schools to make the students aware of the career possibilities through counselors and other administration and add a course to the curriculum • Reach out to liberal arts colleges to those who are undecided or undecided sciences for similar reasons stated above
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	• EXPOSURE • Integrated courses on data, genomics, statistics, agriculture, etc and draw the connections between the possible career paths • Find out why we cannot close the deal on prospective students • Increase salaries • Post AP exam project incorporating team science

		Group Seven: Data interoperability	4:50 PM - 6:00 PM: Multi-agency Panel - Small Group Discussion
		# of Participants in this Group: 0	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?		
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	No group discussion	
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?		

Group Eight: Relieving bottlenecks		**4:50 PM - 6:00 PM:** Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 3	
1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● Recruiting and retaining graduate student capacities ● Funding for supporting staff e.g Post-Docs ● Need for data repository for re-usability and sustainability ● Lack of continuity of project from both the PI and funding agencies ● Lack of linkage between projects that impact research goals ● Contradictory voices and lack of administrational support for researchers ● Responsiveness of grant administrators
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Increase in incentives ● Increase in human capacity and appropriate benefits ● Career plan for staff members ● Recognizing and appreciating faculty members
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Continuity of research funds ● Establishing mechanisms for the recruitment and retention of students ● Improving institutional policies that support team and collaborative science ● Creating collaboration between R1 and R2 institutions by the funding agencies ● Leadership stability ● Establishing environment that creates educational tools for data analysis e.g MOOCs

Group Nine: Infrastructure needs		**4:50 PM - 6:00 PM:** Multi-agency Panel - Small Group Discussion
# of Participants in this Group: 8		

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	● Reuse genomics data. Help annotate data ● Breeding tools ● Computational genomics. Storage capacity (human, computational, research) needed ● Use of databases to facilitate breeding discussions ● Data archive. Preserving, synthesizing, presenting data ● Cyber and knowledge infrastructure
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	● Subsidy support for phenotyping ● Internet of Things to facilitate data collection for goat producers for example ● Availability of funds for training personnel in handle, maximization, and use of data ● Bring data centers to places that do not have the resources. There is benefit when obtained data from new sources
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	● Connecting people to available resources. Increase training capacity ● Development of user friendly tools for data storage and analysis ● Programming training in the curriculum since early stages (R, command line, python) not only for engineers, but also for biologist for example ● Sharing of computational resources ● Facilite storage for long term usage data

Group Ten: Building capacity		4:50 PM - 6:00 PM: Multi-agency Panel - Small Group Discussion
	# of Participants in this Group: 3	

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	- Building capacity = ability to collaborate with the aim to expand - Having land, faculty, infrastructure, data sharing abilities, researchers (need knowledge to make advancements and be able to collaborate in a meaningful way) need funding and policies that enable meaningful collaborations - AG2PI and U.S. agriculture = big foundational capacity for the present and future! - Phenotyping is happening now but there is a bottleneck in the ability to collect and analyze phenotypes over long-time research: need the infrastructure and people to make that happen
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	- Growing building capacity: new and improved collaborative team science that engages stakeholders and funding agencies - New programs for new workforce developments will increase the number of people (especially new incoming students - undergrads, grads, and post-docs) who are aware and interested in various science opportunities - Improved data managements and sharing platforms will result as there is an increase in collaboration
3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)* Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?	- What needs to happen: better communication between funding agencies and researchers (establishing/discussing new policies that support and encourage data sharing and collaboration) - Need people to be open and willing to make connections and understand each others perspectives: share impact stories - Better research synergies (access to diversified perspectives) - Looking into the future, we want to see multi-institutional collaboration where all institutions increase their own collaborative capacities along the way - Everything takes more money and effort than you expect so collaboration is going to be key! (especially for long-term research projects that require multi-disciplinary collaboration)

Group Eleven: Arts, sciences, and communication in AG2PI		**4:50 PM - 6:00 PM:** Multi-agency Panel - Small Group Discussion
# of Participants in this Group: 4		

1	**CONTEXT** *(Think about what is happening now)* How does this connect to your current work/research?	• Trying to apply show to share research to a broader audience ○ To get a better idea on relevancy of research and applicability of new knowledge, we have to get that information out to consumers, stakeholders from different areas, etc. • How can we think about applying novel ways of communicating research in the topics of AG2PI to the public?
2	**ON THE GROUND** *(Think about what is happening in near future)* In the next year or two, what are 'shovel-ready' opportunities?	• Produce document (more than technical report) → that is visual/contextual effort that makes research understandable to farmers/producers • Value needs to be placed on every person working within the project/system (especially on the university level) ○ E.g., if a student is an illustrator, they need to be compensated

3	**BIG THEME** *(Think about what is happening sector-wide in the next decade)*
	
	Related to the panel we just heard, what are themes, cross-sector collaborations, and scalable recommendations for future funding over the next decade?
		• Artist in residency → thinking about how to graphically/visually represent research
		    ○ Who is our audience? → College students? 4H groups? Scientific conferences? Legislators? Admin officials? Stakeholders?
		    ○ How to share possible careers (i.e. plant breeding) to a broader audience
		• Science communication has changed
		    ○ Who is responsible for accurately teaching the public/consumers?
		    ○ Add extra emphasis on universities' role in science communication (beyond extension)
		    ○ We need dedicated people who focuses on communication with the public

WRAP-UP REFLECTION:

What one thing must be in the next $2.5M RFA?

What one thing must be in a future $40M RFA?

- *Does not need to be something we discussed this week*
- *Be as specific as possible*
- *Leave your post-its on corresponding posters in hallway*

AG2PI

Agricultural Genome to
Phenome Initiative

Final Observation from Bold Bison

- Climate change is a perceived challenge to agricultural production, but the G2P research community is questioning how it will impact crop yields and livestock rather than moving with urgency to decarbonize agricultural production

- <u>Thursday Evening Group Conversation Themes</u>

- <u>Post-it Note Transcriptions</u>

- <u>Post-it Note Transcription (Counts for $2.5M)</u>

- <u>Post-it Note Transcription (Counts for $40M)</u>