



## COUNCIL

### American Society of Plant Biologists

Committee meeting, October 8, 2020; 11:00 am EDT

Via Zoom: <https://zoom.us/j/3012960900>

#### COUNCIL MEMBERS:

<input checked="" type="checkbox"/>	Callis, Judy	Chair, Immediate Past President
<input type="checkbox"/>	Axtell, Mike	Mid-Atlantic Section Rep
<input checked="" type="checkbox"/>	Brusslan, Judy	Western Section Rep
<input type="checkbox"/>	Burch-Smith, Tessa	Chair, Science Policy Committee
<input checked="" type="checkbox"/>	Chapman, Kent	Treasurer; chair, BoT
<input checked="" type="checkbox"/>	Chapple, Clint	Elected member, by ballot
<input checked="" type="checkbox"/>	Dehesh, Katie	President-elect
<input checked="" type="checkbox"/>	Dharmasiri, Nihal	Southern Section Rep
<input type="checkbox"/>	Dinneny, José	Chair, Membership Committee
<input checked="" type="checkbox"/>	Farre, Eva	Chair WIPB
<input checked="" type="checkbox"/>	Foyer, Christine	Elected member, by ballot
<input type="checkbox"/>	Friedman, Erin	Chair, Education Committee
<input checked="" type="checkbox"/>	Geitmann, Anja	Chair, International Committee
<input checked="" type="checkbox"/>	Heaton, Emily	Environmental and Ecological Plant Physiology Section Rep
<input checked="" type="checkbox"/>	Lee-Parsons, Carolyn	Northeastern Section Rep
<input checked="" type="checkbox"/>	MacIntosh, Gustavo	Midwest Sec Rep
<input checked="" type="checkbox"/>	Masalia, Rishi	ECPS Section Rep
<input checked="" type="checkbox"/>	McCann, Maureen	President
<input checked="" type="checkbox"/>	McIntyre, Katy	Chair, Ambassador Alliance
<input checked="" type="checkbox"/>	Parrott, Wayne	Secretary
<input type="checkbox"/>	Rellán Álvarez, Rubén	México Section Rep
<input checked="" type="checkbox"/>	Theg, Steve	Chair, Publications Committee
<input checked="" type="checkbox"/>	Thornton, Leeann	PUI Section Rep
<input checked="" type="checkbox"/>	Trujillo, Josh	Early Career Representative
<input checked="" type="checkbox"/>	Vega-Sanchez, Miguel	Chair, Equity Diversity and Inclusion Committee (EDIC)
<input checked="" type="checkbox"/>	Taylor, Crispin	CEO (ex officio; non-voting)

#### STAFF/GUESTS:

- Clara Woodall (CFO)
- Nancy Winchester (director of publications)
- Jean Rosenberg (director of meetings and events)
- Sylvia Lee (executive and governance affairs administrator)
- Natalie Henkhaus (PSRN executive coordinator)
- Shoshana Kronfeld

## AGENDA

1. Judy opens the meeting 11:04 EDT
2. Approval of the agenda (Judy; 3 mins). Asks for changes to agenda. Crispin requests time to inform Council of changing status of Legacy society in light of the need to properly organize the centennial challenge
  - a. Requires motion, second, and vote. Gustavo moves, Steve seconds. Revised agenda option passes with no objections.
3. Introductions (Judy; 10 mins)
  - a. Members introduced themselves.
4. Agenda and Minutes formats for committee chairs (Judy; 10 mins). Judy shared with the Council the forms request for use by committees and the place on the website where they will be placed. Chairs are to work with staff to see that they get uploaded. Leeann asked whether there is an equivalent place for Sections, and Shoshana showed that each section has a location for posting information via the ASPB website. It was agreed that posting on Plantae is OK, but that the best scenario is to post to both places.
  - a. See files [TemplateAgendaForASPBCommitteeMeetings.docx](#) and [TemplateMinutesForASPBCommitteeMeetings.docx](#)
5. Council Action Item. Request for approval that Council actions voted on by email and during virtual meetings are legitimate. Topic introduced by Crispin. He explained that ASPB needs a mechanism whereby minutes and other items can be formally approved between in-person Council meetings. It is also part of good governance practice and necessary for audit to prove we approved this mechanism. Motion by Miguel, seconded by Katie. Motion carried unanimously.
  - a. See attached file [Council Action-100820-Approval of Voting by Email-FINAL.pdf](#)
6. Council Action Item. Election of Council representative to Board of Directors (Judy; 15 mins). See process described in Judy's email of 9/22/20.

Judy gave an overview of the election process. It is a one-year renewable term. The vote was conducted in two steps as outlined in the email. From the first round, Rishi and Gustavo received the most votes, and each gave a short statement. Gustavo noted his long-term involvement and the insight from it and that he would keep an eye on EDI among other issues. Rishi stated that he would continue to advocate for EDI and ECRs and that he brings a unique perspective to the board. In the second round, Gustavo McIntosh was elected as the Council representative to the BoD.
7. Update on new ASPB-sponsored website for EDI – Changing Cultures and Climates. Judy shared the not-yet-released version. The time line for release is uncertain, but is estimated to be within ~2 weeks. Miguel informed council that there have been multiple productive discussions and hopefully it can be a hub for other societies as well.
8. Proposal to expand ECPS Section Council (Rishi; 5 mins)

Rishi presented this item. Proposal to formalize the requirement that the senior ECR member on committees serve on the ECPS Section council to facilitate communication

between ECRs and committees. Comments indicated strong support. Maureen moves, Christine seconds. Motion carries unanimously.

- a. See attached file [Council Action-100820-ECR Committee Members on ECPS Council-FINAL.pdf](#).

9. Proposed bylaw change for Bob Rabson award (Judy; 5 mins)

Judy introduced this proposed change to the bylaws regarding Rabson award. The committee struggled to find candidates that were within the window of eligibility, so award committee recommends changing from 5 to 10 years post-PhD. Some discussion on ensuring that early careers would be heavily considered and that the field of bioenergy be considered in the broadest terms, as would likely be supported by Bob. Katy moves; Clint seconds; motion passes unanimously.

- a. See attached file [Council Action-100820-RecommendChangeToBobRabsonAwardBylaw-FINAL.pdf](#)

10. An Introduction to the Plant Science Decadal Vision (Natalie; 5 mins)

Natalie gave an overview of the recently published white paper.

Judy- asked to council to read the decadal vision and determine what ASPB can contribute.

- a. See attached file [Decadal Vision-Safeguarding Crops from Disease Threats.pdf](#) and [Decadal-Vision-2020-ExecutiveSummary.pdf](#)

11. Any Other Business- added agenda item of update on fundraising. Crispin updated us on the activities of the Legacy Society Leadership Committee (LSLC), which is tasked with fundraising, and is thinking of a centennial fund-raising campaign as a subgroup of LSLC. This will require that the Board of Directors consider/approve a change of wording in the original LSLC charter, as well as approving a charter for a subcommittee of the LSLC that would be charged specifically to work on the Centennial Campaign

12. List Action Items

- Read Decadal Vision
- Sections – mechanism of web posting
- Look at EDI activities and prioritize activities

13. Adjournment 12:07 pm

- a. Requires motion, second, and vote

Adjourned by unanimous consent



## **COUNCIL**

### **American Society of Plant Biologists**

Committee meeting, October 8, 2020; 11:00 am EDT  
Via Zoom

#### **COMMITTEE MEMBERS:**

#### **STAFF/GUESTS:**

#### **Draft Agenda**

1. Welcome [Note time]
2. Approval of the agenda
3. Approval of minutes of previous meeting [include date/place]
4. Agenda Item 1
5. Agenda Item 2
6. Agenda Item 3
7. Any Other Business
8. List Action Items
9. Adjournment [Note time]



**[NAME OF COMMITTEE]**  
**American Society of Plant Biologists**

Minutes of Committee Meeting held [DATE; TIME]  
[LOCATION/VIA PHONE/GOTOMEETING]

**COMMITTEE MEMBERS:**

Indicate who is/isn't present

**(GUESTS):**

**Minutes**

1. Approval of agenda; moved by: ; seconded by: vote (or "by assent")
2. Approval of minutes of meeting on [date of previous committee meeting, which should have been circulated in advance/with the agenda for the current meeting]
3. Agenda Item 1; moved by: ; seconded by: vote (or "by assent")
4. Agenda Item 2; moved by: ; seconded by: vote (or "by assent")
5. Agenda Item 3; moved by: ; seconded by: vote (or "by assent")
6. Any Other Business
7. List Action Items)
8. Adjournment [Note time]
9. List any privileged/confidential items (for redaction from public version of minutes)

ASPB COUNCIL

MEETING DATE: **October 8, 2020**

AGENDA ITEM 2020-03

AGENDA REQUEST FORM

To request items be placed on the ASPB meeting agenda, complete this form.

1. Who is requesting item be placed on agenda (name, title, representing committee, board, etc.)?

**Judy Callis, Past-president; Chair, Council**

2. Agenda item title:

**Approving legitimacy of Council votes taken by email and in online meetings**

3. Rationale

**The ASPB Council has implemented the practice of regular virtual meetings, in addition to the in-person meeting typically held in conjunction with Plant Biology conferences. As a result, the Council will occasionally need to take formal action by voting on items, such as to approve previous meetings' minutes, during virtual meetings and/or by email in between its meetings. Formal approval by Council of the legitimacy of such votes is necessary.**

4. Specific motion for approval, disapproval, reference to committee, etc.  
Move that:

**ASPB Council affirm that votes taken during virtual Council meetings and via email between meetings are legitimate and actionable by the society.**

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Reserved for Personal Meeting Notes

Action taken:

Person responsible for implementation:

Project cost:

Schedule:

ASPB COUNCIL

MEETING DATE: **October 8, 2020**

AGENDA ITEM 2020-04

AGENDA REQUEST FORM

To request items be placed on the ASPB meeting agenda, complete this form.

1. Who is requesting item be placed on agenda (name, title, representing committee, board, etc.)?

**Rishi Masalia, Chair and ASPB Council Rep, Early Career Plant Scientist Section**

2. Agenda item title:

**Proposal to approve the expansion of the ECPS Section Council**

3. Rationale

**Please see attached pages.**

4. Specific motion for approval, disapproval, reference to committee, etc.  
Move that:

**ASPB Council approve the proposed expansion of the ECPS Council to include an ECR member from each of ASPB's standing governance committees on which an ECR serves.**

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Reserved for Personal Meeting Notes

Action taken:

Person responsible for implementation:

Project cost:

Schedule:

### **Proposal to formally expand the ECPS Section Council**

**Background:** Formed in January 2020, the ECPS section has made numerous moves over the last 10 months. The section had a strong showing at PB20 with 4 well-attended events, we have started initiatives in partnership with a few committees and other sections, and have started a dialogue with the ASPB ECR community - ECRs advocating for ECRs - to increase their voice in the society. All made possible by the tremendous efforts of the ECPS Council.

The ECPS Council is made up of the ECPS Core team (responsible for the day-to-day operations of the section) and ECR representatives on committees, sections, and programs (including the Ambassador Alliance). ECPS Council meets virtually every other month to discuss what the ECR community needs and wants, how we can best achieve those goals, and how we all provide opportunities for the ASPB ECR community. These meetings provide opportunities for community building and cross-talk between representatives to ensure synergy and unity for ECR community needs and wants.

It is currently voluntary for a committee, section, or program representative to sit on this Council, as this falls outside the scope of responsibilities they signed up for when applying for the position. Fortunately, many ECR representatives saw the benefits of this section and volunteered to serve on the Council (almost all were co-authors of the original section formation proposal). Those that served on the original ECPS Council (Jan - Sept 2020) have volunteered to do so again.

However, there will come a point in time when ECR committee, section, and/or program representatives will not volunteer to serve on this body. These gaps in voice, knowledge, and position are detrimental to the ECR membership looking to have their voices heard across ASPB, and to the committees who need information on what ECRs need and want.

**Proposed Change:** The ECPS section is formally requesting that all senior ECR committee representatives be required to sit on the ECPS Council for one year (the remainder of their 2-year term). This additional service would be reflected in the position's job description so that applicants are made aware prior to applying. If a senior representative is unwilling or unable to serve, this duty could fall to the junior representative.

Functionally, this would mimic how Committee and Section chairs automatically have a seat on the ASPB Council. Similarly this would also extend the courtesy to ECR programs, mimicking what the ASPB Council has done with the Ambassador Alliance.

Given that folks have already applied in 2020, if approved by the Council and Board, this change would not go into effect until the 2021 applications.

#### **Benefits of this change:**

Having a full ECPS Council with all committees, sections, and programs represented provides numerous benefits, including:

1. *ECR membership voice reaches ASPB governance.* ECPS regularly asks the ECR community what they need and what they want from their society. This information is relayed to ECR representatives at ECPS Council meetings, enabling them to report



back these needs and wants of the ECR community to ASPB committees. Committees not represented on the ECPS Council, do not hear this information.

2. *Breakdown of silos.* Regular communication through meetings and Slack encourages synergy and catches duplicating efforts.
3. *Mentorship.* The structure of having Senior ECR representatives sitting on the ECPS Council could serve as a nice bump in leadership opportunity for representatives looking to do more. Additionally, it will naturally lend itself to increased mentorship opportunities from senior to junior reps as the juniors transition into the senior role.
4. *Community building.* Having involved ECR members interact, learn, and build together fosters good cohort comradery, encourages cooperation and trust, and creates a strong community foundation for future leads of the society.

Since ECPS was formed in January of 2020, we have already seen these benefits play out. This cohort of ECRs have formed lasting friendships, are relying on each other for future outreach and service, and are building a community that other future leaders in ASPB can latch onto. Further, we've seen a drastic increase in interaction of ECR committee representatives resulting in better, more diverse ideas and discussions as well as tangible initiative proposals such as the one-minute plant biology videos in partnership with the Education committee, as well as a call to action for video editing help for the Women in Plant Biology Committee. Finally, given the continuous interaction over Slack from all ECR reps, our social media team (@ASPB\_ECPS) has been able to advertise numerous webinars, networking, achievements, and other opportunities for all participating committees.

**Proposal Authors:**

Rishi R. Masalia, Chair ECPS Section  
Alexander "Al" Meyers, Vice Chair ECPS Section  
Laura Klasek, Programming Committee  
Steph Klein, Environmental and Ecological Plant Physiology Section  
Katie Murphy, Women in Plant Biology Committee  
Craig Schneck, Publications Committee

ASPB COUNCIL

MEETING DATE: October 8, 2020

AGENDA ITEM 2020-04

AGENDA REQUEST FORM

To request items be placed on the ASPB meeting agenda, complete this form.

1. Who is requesting item be placed on agenda (name, title, representing committee, board, etc.)?

**Ken Keegstra, Chair, Rob Rabson Award Committee**

2. Agenda item title:

**Proposed Change to Bylaw Relating to the Robert Rabson Award**

3. Rationale

**The Robert Rabson Award – a biennial award established by ASPB in 2012 – was last given in 2018. None of the relatively few nominations that were received in 2020 were deemed sufficiently stellar by the Robert Rabson Award Committee to warrant making the award this year. Given the attributes and achievements expected of nominees and the requirement that their research be in fields related to bioenergy, the dearth of appropriately qualified individuals is likely to be related to the current tight 5 years post-PhD eligibility requirement for this award. It is therefore proposed to modify the bylaw as indicated on the next page to specify a 10-year post-PhD time limit for eligibility.**

**Please see the highlighted cells in the attached spreadsheet for indications of the current eligibility time limits for other ASPB awards.**

4. Specific motion for approval, disapproval, reference to committee, etc.  
Move that:

**ASPB Council recommend to the Board of Directors that the Rabson Award bylaw be changed as indicated to specify a 10 year post-PhD eligibility time limit for this award.**

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Reserved for Personal Meeting Notes

Action taken:

Person responsible for implementation:

Project cost:

Schedule:

American Society of Plant Biologists  
Bylaws  
(Updated August 2019)

Section 6:

*Awards and Prizes*

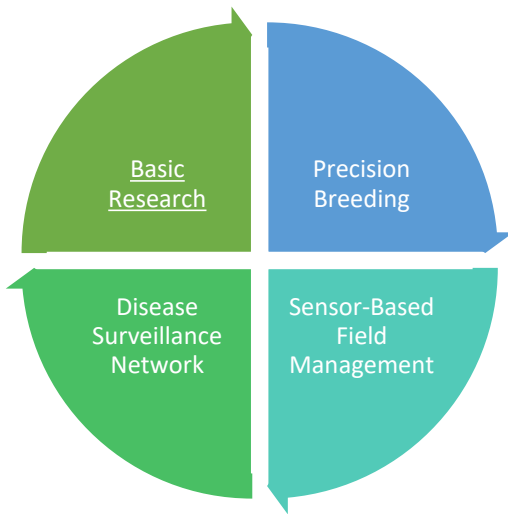
n. Robert Rabson Award. The Robert Rabson Award, first given by the Society in 2012, recognizes Bob Rabson's steadfast advocacy of plant biology through creation of funding programs in the Department of Energy for research in basic energy sciences. The award recognizes postdoctoral scholars and faculty-level early career scientists, whether or not members of the Society, in academic, government and corporate research institutions who have made excellent contributions in the area of bioenergy research. The award is made biennially to a researcher who is no more than ~~five~~ten years post-PhD on January 1st of the year of presentation, with consideration of breaks in career relative to this time-frame. The award recipient is given a monetary award and a one-year membership in the Society.

\*considered early career.

Award	Criteria	Career stage limitations	ASPB membership
1 Adolph Gude jr	recognition of outstanding service to the science of plant biology.	none	not required
2 Innovation Prize for Agricultural Technology	outstanding work of industry scientists in companies of all sizes who translate discovery research into real-world outcomes that benefit agriculture. The award additionally acts as a vehicle to increase the awareness of the highest quality science performed by industry scientists, and showcases the opportunities and rewards of this career path.	none	not required
3 Leadership in science public service award	advanced the mission of ASPB and its members through significant contributions to plant science and public policy leadership. Awardees generally have made contributions to the broader society that are relevant to the work of plant biologists; recipients need not be plant scientists themselves.	none	not required
4 <b>Charles Albert Shull*</b>	outstanding investigations in the field of plant biology by a member	YES, under 45 OR fewer than 10 years post PhD. Breaks in careers will be considered when addressing the age limit of this award.	required
5 Charles F. Kettering Award	excellence in the field of photosynthesis.	none	not required
6 Charles Reid Barnes	It is an annual award for meritorious work in plant biology; it provides a life membership in the Society to an individual who is at least sixty years old	?? Get membership if at least 60, but not requirement to be at least 60!	not required
7 Dennis Hoagland	is for outstanding plant research in support of agriculture.	none	not required??
8 <b>Early Career*</b>	exceptionally creative, independent contributions by an individual	YES, 7-years post PhD. Breaks in careers will be considered when addressing the age limit of this award.	not required
9 Enid MacRobbie Corresponding Membership Award	provides life membership and Society publications to distinguished plant biologists from outside the United States.	none	required
10 <b>Eric Conn Young Investigator Award*</b>	recognizes not only outstanding research but also demonstrated excellence in outreach, public service, mentoring, or teaching by plant scientists at the beginning of their careers.	YES, not more than five years post-Ph.D. Breaks in careers will be considered when addressing the age limit of this award.	required
11 Excellence in Education	outstanding teaching, mentoring, and/or educational outreach in plant biology.	none	not required
12 Fellow of ASPB Award	distinguished and long-term contributions to plant biology and service to the Society by current members in areas that include research, education, mentoring, outreach, and professional and public service.	Current members of ASPB who have contributed to the Society for at least 10 years are eligible for nomination.	required
13 Lawrence Bogorad	plant scientist whose work both illuminates the present and suggests paths to enlighten the future.	none	not required
14 Martin Gibbs Medal	pioneered advances that have served to establish new directions of investigation in the plant sciences.	none	not required
15 <b>Robert Rabson*</b>	postdocs and faculty-level early career scientists, whether or not members of the Society, in academic, government, and corporate research institutions, who have made excellent contributions in the area of bioenergy research.	YES, no more than five years post-PhD. Breaks in careers will be considered when addressing the age limit of this award.	not required
16 Stephen Hales Prize	served the science of plant biology in some noteworthy manner.	none	required

## Protecting American Agriculture: Safeguarding Crops from Disease Threats

Authors: Jane Silverthorne and Bridget Krieger



The ability to do more with less will become the hallmark of American agriculture in the years to come--a growing population and limited resources will demand it. However, we have taken for granted the reliability of our food systems and do not fully recognize the significant vulnerabilities that threaten agricultural outputs.

Crops are a critical contributor to a healthy economy as well as an essential component of a safe and secure food supply for the Nation. Plant diseases are a constant, and growing, threat to crop production and this threat has increased with the impacts of a changing climate. Wheat, rice, maize, and soybeans each lose more than 20% of their yield from pests and diseases.

A new integrated, multipronged, science-based approach is needed to track and stay ahead of emerging and evolving pathogens, as well as to provide targeted cost-effective management of disease outbreaks. This effort will require investment in understanding the most basic function of plant genetics, as well as implementing new practices in the field.

An integrated, sustainable approach to staying ahead of major crop disease threats would include:

- Comprehensive understanding of crop genetics and function.
- Comprehensive mechanistic understanding of plant-pathogen interactions.
- Development of new crop varieties that carry durable resistance to current and emerging plant pathogens using precision breeding.
- New sensor-based field management strategies to minimize the impacts of disease outbreaks.
- Linking of regional pathogen tracking national to international networks. Plant pathogens that can lead to major US crop losses do not respect state or national borders and a major disease event can emerge rapidly from a new source of infection. Advance knowledge of disease outbreaks as they move across the globe is an essential complement to effective development and deployment of new resistant varieties.

The combined impact of these investments would be the ability to anticipate major disease outbreaks allowing farmers to plant resistant germplasm and use sensor-based field management techniques to minimize devastating losses.

### **Specific Requests:**

- The establishment of an OSTP interagency working group including NSF, USDA, and DARPA representatives to coordinate investments and craft joint funding opportunities that anticipate and address crop threats.
- Increased funding for basic research into understanding plant-pathogen interactions relevant to key crops, for example, through the joint NSF-NIFA Plant Biotic Interactions Program.<sup>1</sup>
- Increased funding for Agriculture and Food Research Initiative (AFRI)<sup>2</sup> precision breeding programs at NIFA focused on major diseases and crops.
- New funding to extend existing ARS disease surveillance networks and integrate them into an emerging international network, The Global Surveillance System (GSS)<sup>3</sup>.
- New funding for DARPA Biological Technologies Office (BTO)<sup>4</sup> to support development of innovative sensors capable of detecting pathogen-specific signatures in the field.

### **Potential Impacts**

Tracking of existing and new outbreaks of **Citrus Greening** or **Huanlongbing**, a bacterial disease of citrus, which was responsible for the decrease in the production of oranges for processing in the United States from 7.98 to 2.22 billion tons (72.2% reduction) from 2007–08 to 2017–18<sup>5</sup>. This disease is now present in all citrus growing regions of the US. Citrus Greening has decimated citrus production in Florida and could lead to the end of citrus production in this state within the next seven to twelve years<sup>6</sup>. Low cost, disease resistant germplasm is urgently needed.

While outbreaks of the fungal disease, **Wheat Stem Rust**, have been controlled successfully using resistant germplasm, new races of the pathogen emerge periodically, for example, ug99, that overcome existing plant resistance genes<sup>7</sup>. It has been estimated that a hypothetical US outbreak would result in four-year losses of between \$1.7 and \$11.6 billion. Tracking of emerging outbreaks, analysis of new strains and development of resistant germplasm will be required to avoid future crop losses as well as their devastating impacts.

The fungal disease, **Soybean Rust**, first arrived in the US in 2004 in a hurricane<sup>8</sup>. Current management practices include the use of resistant germplasm, tracking of disease outbreaks using sentinel plots, and application of fungicides in the event of a disease outbreak. While there has not been an outbreak in the US to date, the potential economic impact has been estimated to be as high as \$1.3 billion in the first year of infestation<sup>9</sup>.

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<sup>1</sup> [https://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=505267&org=IOS&from=home](https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505267&org=IOS&from=home)

<sup>2</sup> <https://nifa.usda.gov/program/agriculture-and-food-research-initiative-afri>

<sup>3</sup> M. Carvajal-Yepes et al. *Science* **364**, 1237 (2019)

<sup>4</sup> <https://www.darpa.mil/about-us/offices/bto>

<sup>5</sup> B.M. Dala-Paula et al. *Frontiers in Plant Science* **9**, 1 (2019)

<sup>6</sup> <https://www.washingtonpost.com/climate-environment/2019/11/09/end-florida-orange-juice-lethal-disease-is-decimating-its-citrus-industry/>

<sup>7</sup> <https://www.apsnet.org/edcenter/disandpath/fungalbasidio/pdlessons/Pages/StemRust.aspx>

<sup>8</sup> <https://www.apsnet.org/edcenter/disandpath/fungalbasidio/pdlessons/Pages/SoybeanRust.aspx>

<sup>9</sup> <https://www.ers.usda.gov/amber-waves/2004/september/economic-risks-of-soybean-rust-in-the-us-vary-by-region/>

# Plant Science Decadal Vision 2020–2030

Reimagining the Potential of Plants for a Healthy and Sustainable Future



## Authors

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# Executive Summary

## Impetus Behind the Decadal Vision

Plants, and the biological systems around them, are key to the future health of the planet and its inhabitants. Plant science—and the life sciences in general—is at a crossroads. On the one hand, plant science research and technology breakthroughs have enormous potential to address pressing global issues such as food insecurity, climate change, species extinction, degraded water resources, and increasing pollution. On the other hand, public engagement is lagging, and severe funding limitations often discourage risk-taking. Therefore, realizing the potential of discoveries will require an imaginative and robust combination of communication, investment, and training.

In this spirit, the *Plant Science Decadal Vision 2020–2030* describes a holistic vision for the next decade of plant science that blends recommendations for research, people, and technology. Going beyond discoveries and applications, we, the plant science community, must implement bold, innovative changes to research cultures and training paradigms in this era of automation, virtualization, and the looming shadow of climate change. This document frames our ability to perform vital and far-reaching research in plant science as deeply interwoven with how we integrate and value participants and emerging technologies. Our vision and hopes for the next decade are encapsulated in the phrase reimagining the potential of plants for a healthy and sustainable future.

Behind the 2020 Decadal Vision is the Plant Science Research Network (PSRN), composed of 15 scientific and professional organizations. The PSRN was assembled to develop an inclusive, common vision across the plant science research community to promote interdisciplinary integration of ideas and approaches. The Decadal Vision culminates four years of community engagement that has already led to reports on how different futures might shape science in 2035, how cyberinfrastructure must evolve, and how a new vision for postgraduate training could change

science.<sup>1</sup> The 2019 Plant Summit<sup>2</sup> brought together a diverse coalition of plant scientists to outline and conceive the Decadal Vision.

The Decadal Vision recognizes the vital intersection of human and scientific elements and demands an integrated implementation of strategies for research (Goals 1–4), people (Goals 5 and 6), and technology (Goals 7 and 8). This report is intended to help inspire and guide the research community, scientific societies, federal funding agencies, private philanthropies, corporations, educators, entrepreneurs, and early career researchers over the next 10 years.

## Recommendations

### 1 Harness Plants for Planetary Resilience



Planetary resilience, including the resilience of our food systems, is utterly dependent on plants, which have evolved to survive and thrive in virtually every environment, including some of the most extreme condi-

tions on Earth. Unlocking the secrets of their success and putting that knowledge to use, in agriculture and other applications, will require a detailed understanding of interactions among plants and their associated biota. To set the stage, we must accelerate activities to describe, catalogue, classify, and map the diversity and evolutionary history of plant populations, communities, and ecosystems. These efforts will lead to the necessary deeper insight into the intricate web of interorganismal signaling that occurs among the millions of largely unstudied plants and their associated symbionts, from microorganisms to pollinators. Then, this multifaceted information will be used to build and test computational models that accurately reflect ecological

and evolutionary changes from deep time to the present, and from genes to ecosystems, to predict organismal and ecosystem behaviors under novel conditions. These models will have a dramatic societal impact by informing decisions for developing species conservation strategies, sustaining ecosystem services, and improving agricultural systems and environmental health. Achieving this goal by drawing heavily on natural history and living collections will afford a rich opportunity for public engagement through community science.

## 2 Advance Technology for Diversity-Driven Sustainable Plant Production Systems



As needs for food, feed, and fiber continue to increase, we must be able to meet these demands in a manner that is both productive and sustainable.<sup>3</sup> Sustainability will be embodied in production systems that

feature greater crop diversity, efficiency, productivity, and resilience while improving ecosystem health by integrating digital technologies into crop and livestock management. Priming this paradigm shift will be emerging tools in gene editing, synthetic biology, and advanced breeding used to target a broad array of consumer, producer, and sustainability traits. New knowledge will also underlie more effective incorporation of ecological concepts, such as biodiverse cropping systems (i.e., polycultures) and biosequestration (e.g., carbon capture), into agriculture. We must also take advantage of our emerging understanding of how phytobiomes—systems encompassing plants, their environments, and the microbes and other species they interact with—impact crop production and human health. Data science and engineering breakthroughs will be major drivers of this goal, allowing us to better predict, measure, and understand plant performance in the laboratory and field.

## 3 Develop 21st-Century Applications of Plant Science to Improve Nutrition, Health, and Well-Being



Many new tools applicable to plant production systems can also be harnessed to enhance human health through advances in nutrition and the discovery and engineering of plant-based medicines, including new

classes of therapeutics. The effects on humans of interactions with plants must also be explored: what influences our responses—and those of our associated microbiomes—to plant-derived products? We point to additional potential for plant systems in non-agricultural functions such as bioremediation, urban farming, and many other managed landscapes.<sup>4</sup> To achieve the potential of these opportunities to improve human nutrition, health, and well-being, we need investment in rapid assessment tools, enhanced knowledge of the chemistry and physiology of plants and their associated biota, and research into how plant products interact with human genomes. We also need to increase public appreciation for how plants benefit humans and the environment from the landscape to the global scale.

## 4 Launch the Transparent Plant, an Interactive Tool to Discern Mechanisms and Solve Urgent and Vexing Problems



The Transparent Plant, an advanced computational tool, will deliver a full understanding of the inner workings of plants, breaking down the phytobiome into a “parts store” that supports tinkering and reveals the connections

and signals that underpin plant characters. The ability to convert simulation rapidly into action would revolutionize how we think about and utilize plant systems. The Transpar-

ent Plant tool will be designed for both query and prediction. Its accuracy and utility will be derived through automated integration of massive new data sets that scale from the behavior of individual molecules to cells, organs, and ultimately whole plants. To develop a user-friendly and enterprising data warehouse will require a coordinated community data acquisition and utilization effort in this era of ever-expanding computational power. As it is progressively refined, Transparent Plant will be a platform that both enables exploration of the unknown through simulations and serves as an action-oriented knowledge base for rapid-response problem solving to address challenges presented by new invasive species, pathogens, and other natural phenomena.

## 5 Reimagine the Workplace to Nurture Adaptive and Diverse Scientists



Equity, diversity, and inclusion (EDI) are the cornerstones of greater participation and richer perspectives and thus are indispensable for fully realizing our vision for plant science. Although there is much to admire about

the plant science research culture, it has resisted the major changes that we believe are needed. For example, some of the same incentives that will foster EDI will also incentivize, support, and reward collaborative and transdisciplinary research—the research of the future—in lieu of rewarding individual achievements. These incentives include direct funding and team mentoring for early career researchers, along with systems that support professional development through flexible and modular credentialed learning. This approach will balance emphasis on research productivity with development of pertinent transferable and cultural skills. In all organizational settings, a balanced system of professional rewards is recommended that recognizes and values both individual and undissected collaborative achievements. Open-source technologies can be used to support virtual workplaces and facilitate global collaboration.

## 6 Build Capacity and Interest to Engage with Plant Science



Plant life supports all life, yet people frequently take plants for granted. Plant awareness is an essential antidote that relies on effective engagement with the public by plant scientists and robust communication

training in various forms. We must convey the excitement and relevance of participating in plant science to as many audiences as possible, and we need to stimulate imaginations with the limitless potential of plant science to address their needs. Using new technologies and media, community scientists—that is, students, citizen scientists, and lifelong learners who participate in research efforts—will increasingly contribute to databases of living collections, identify species in natural environments, and reinforce outreach activities. Technology development that enables virtual or distributed research must be coupled with incentives for equitable distribution and democratized access. Plant awareness activities should target everyone, from young learners to policy makers and scientists across the many disciplines that will contribute to our goals, creating societal momentum for support of plant science research.

## 7 Develop New Technologies to Revolutionize Research



Transformative technologies will overcome what today might appear to be insurmountable obstacles as they improve the depth and rigor of plant systems knowledge. Although plant scientists alone

will develop some technologies, most technologies will arise and be perfected through alliances with technology developers, engineers, physicists, and other life scientists. Emerging technologies that best support our research

goals will focus on improving noninvasive imaging, such as above- and below-ground sensors for monitoring environmental, metabolic, and microbial activities, and on increasing the selection of plug-and-play portable lab technologies. Some devices will rely on automated image recognition that can be achieved only with major advances in speed, sensitivity, resolution, and portability, coupled with lower cost. In addition, advances in field-based (edge) and quantum computing, 5G and 6G wireless networks,<sup>5,6</sup> and data processing algorithms based on machine learning will help bring rapid computation to remote and rural sites for data collection and analysis by farmers, researchers, and community scientists.

## **8** Manage and Realize the Potential of Big Data



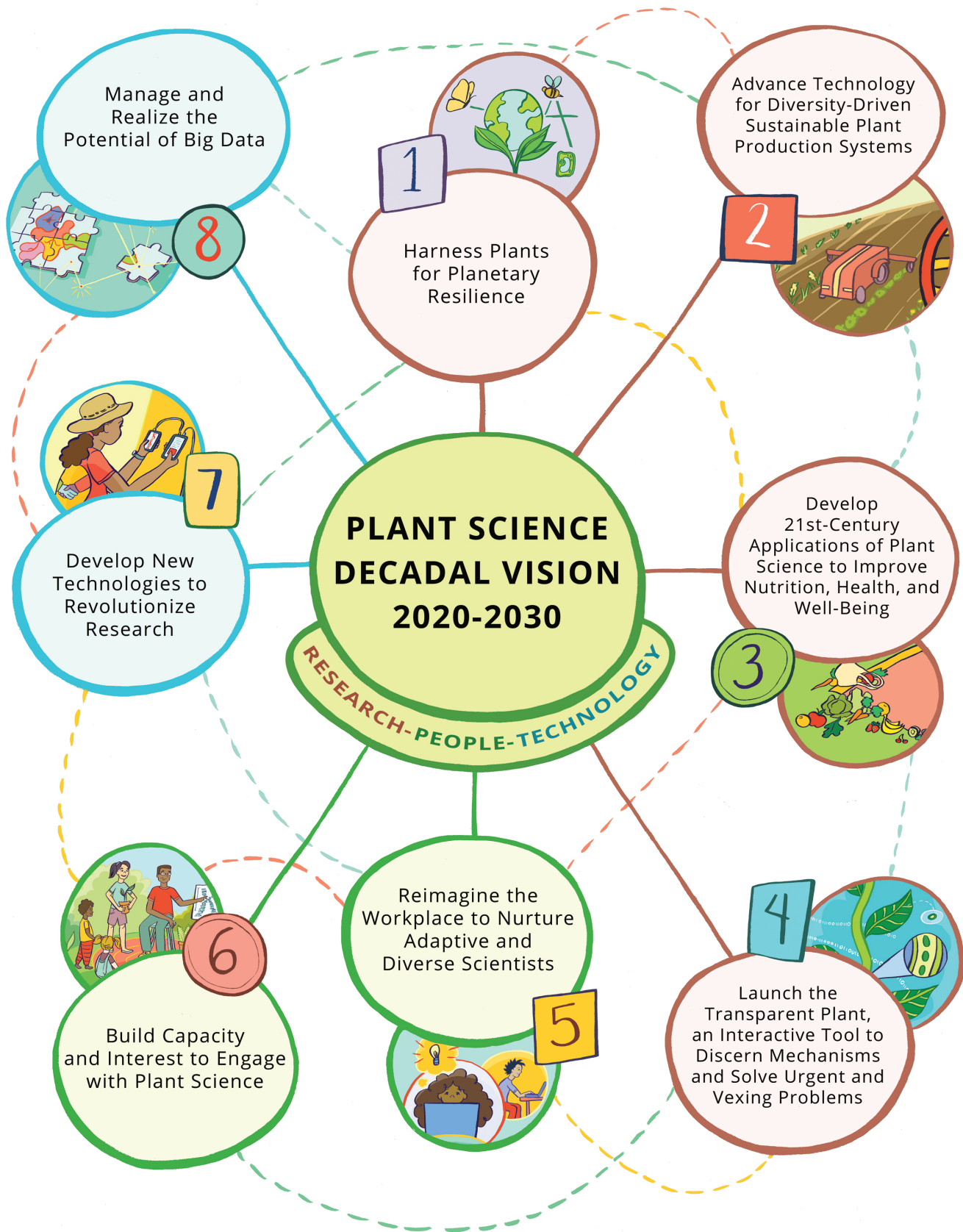
Growing capabilities for massive data generation and analysis must be balanced with oversight of data management and quality. Although the prevalence of spotty, error-ridden, or poorly annotated data and

methods is sometimes overlooked, these weaknesses can have huge negative consequences. Data management in plant science must adhere to the FAIR principles<sup>7</sup>: ensuring that data are Findable, Accessible, Interoperable, and Reusable. This behind-the-scenes structure is essential if plant scientists are to piece together complex puzzles using ever-improving and increasingly automated techniques such as machine learning, natural language processing, and artificial intelligence–assisted data integration, pattern identification, and decision making.

## Impacts on Society

Implementation of this bold Decadal Vision will transform the immediate field of plant systems science and ripple outward through society and across the globe. We will deepen our understanding of plants and their environments, advance agricultural sustainability, and develop entirely new uses of plant systems to promote nutrition, health, and well-being. The research goals will also lead to a far deeper holistic understanding of biodiversity and ecosystem services, generating improved knowledge for preserving the natural world and improving the human condition. Discoveries will result in a surge of entrepreneurship, leading to positive economic returns and other new opportunities. The spread of new technologies will only accelerate, increasing access to plant systems science and expanding research possibilities.

We view people as the foundation and motivation for discovery, research, and applications. Our recommendations therefore promote cultural changes that support the diversification and well-being of plant scientists and encourage community engagement. One mechanism to stimulate cultural change is the infusion of plant awareness across society, which is urgently needed in the era of climate change. Plant awareness efforts will play into people's natural curiosity about and desire to prepare for the future, leading them to seek fuller information about food, health, climate, and ecological systems and, in some cases, to join the scientific community.



The Plant Science Decadal Vision describes eight specific and interconnected goals in three areas: **Research (red)**, **People (green)**, and **Technology (blue)**.