

Grand Challenges

CROP SCIENCE SOCIETY OF AMERICA

Plant science for a Better World



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The Crop Science Society of America (CSSA), founded in 1955, is an international scientific society comprised of 5,000+ members with its headquarters in Madison, WI. Members advance the discipline of crop science by acquiring and disseminating information about crop breeding and genetics; crop physiology; crop ecology, management, and quality; seed physiology, production, and technology; turfgrass science; forage and grazinglands; genomics, molecular genetics, and biotechnology; and biomedical and enhanced plants.

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Grand Challenges

Crop science is a highly integrative science employing the disciplines of conventional plant breeding, transgenic crop improvement, plant physiology, and cropping system sciences to develop improved varieties of agronomic, turf, and forage crops to produce feed, fiber, food, and fuel for our world's growing population.

During the last century, crop science has achieved feats which are now part of everyday life. Despite these scientific achievements, the world today faces ever-growing challenges of widespread food insecurity and malnutrition, negative impacts of climate change, environmental degradation, and dependence on fossil fuel energy. Solutions to these complex problems will be found, in part, with sustained funding for research teams that bring a spectrum of scientific expertise in crop science-breeders, physiologists, ecologists, and molecular geneticists- to develop solutions.



Crop Science Society of America

Grand Challenge:

Increase the speed with which agriculture can adapt to climate change by using crop science to address abiotic stresses such as drought and heat.

Drought is the number one limitation to crop productivity in the world. As climate changes, the incidence and duration of drought and heat stress on our major crops will increase in many regions, negatively affecting crop yields and food security. Solutions to this complex problem can best be found by forming research teams, bringing a spectrum of scientific expertise—breeders, physiologists, and molecular geneticists—to bear on the problem. Because the majority of the progenitors of most crops were developed under periodically dry conditions, drought tolerance genes already exist in most crop germplasm collections. These important genes have not all persisted in modern cultivars because agriculture has concentrated on breeding varieties adapted to favorable environments and responsive to irrigation. The need to incorporate genes for drought tolerance takes on new urgency with predictions of more wide-spread and severe drought. Agriculture must produce more “crop per drop” of water and develop strategies to share water resources at the rural/urban interface where water can be bought and diverted to non-agricultural uses.

Key Questions:

1. How can teams of breeders, geneticists, physiologists, and agronomists be created with sustained support to conduct research in abiotic stress tolerances through all phases of testing to produce economically viable, tolerant varieties?
2. Can we develop networks of abiotic stress-prone fields and sites and efficient screening methods to identify genotypes tolerant of drought and heat stress?
3. What economically important abiotic stress tolerant genetic resources exist in germplasm collections and in applied breeding programs?
4. What are the physiological mechanisms by which abiotic stress tolerance genes interact with each other and the environment to impart abiotic stress tolerance?
5. What are the physiological and genetic mechanisms by which temperature reduces pollen viability and seed-set, and can genetic tolerance to temperature stress be achieved?
6. How can we exploit variation in the morphology, rooting depth, and/or functionality of roots, leaves, or stems to mitigate the effects of abiotic stress?

Expected Outcomes:

1. Fundamental knowledge regarding traits, genes, and breeding stocks that conveys economically important levels of stress tolerance.



2. Cultivars genetically improved for stress tolerance will provide sustained or higher crop yields that will help stabilize crop production in the face of projected climate change.
3. Adequate infrastructure (laboratories, personnel, experience with integrated approaches) to mount a sustained long-term responsiveness to continuing abiotic stresses.

Grand Challenge:

Increase durability of resistance to biotic stresses that threaten food security in major crops.

Organisms that cause biotic stress in crop plants are continually adjusting their pathogenic mechanisms to take advantage of the plant's limited defenses. Unfortunately, with new intensive management practices being adopted and climate change altering environmental conditions, the rate of adjustment by some pathogens has accelerated. Furthermore, crop uniformity can increase genetic vulnerability to various pests. For example, U.S. soybean cultivars are almost uniformly susceptible to two relatively new U.S. biotic stresses: soybean aphid and soybean rust.

Contemporary best management practices which retain plant residues on the field result in increased soil organic matter, improved soil quality, and additional sequestered carbon; however, they also provide an environment where pathogens can prosper and cause reduced yields. Examples include pathogens such as gray leaf spot of corn whose inoculum grows on previous crop residue. Carcinogenic aflatoxins are produced by fungi whose proliferation increases in stress

environments of drought, high temperature, and/or high humidity. Thus, there is a need for plant genomic tools that can identify novel resistance genes and assist in their rapid incorporation into improved cultivars.

Key Questions:

1. What are the molecular and physiological mechanisms by which various pathogens and pests interact with plants? How can these interactions provide novel and durable approaches for defense mechanisms?
2. How do we efficiently identify novel resistance genes in our extensive germplasm collections?
3. How do we incorporate resistance genes effectively without limiting progress for improving yield?
4. How can genomic tools be used with germplasm to uncover the molecular basis for resistance to biotic stress?
5. How do we best to develop and utilize gene-specific markers to combine and deploy resistance genes so that the risk of crop loss is minimized?

Expected Outcomes:

1. Prevention of widespread crop yield and quality losses as plant diseases and pests evolve and spread due to climate change.
2. Enhanced year-to-year stability of food, feed, fiber, and bio-fuel production.
3. Improved human and animal health by increasing crop resistance to mycotoxins and aflatoxin.

Additional Grand Challenges:

The CSSA Grand Challenges Committee developed six grand challenges for crop science. The two showcased in this pamphlet are the first two in a series of six that will be released over a period of three years. The next two will be released in 2011 and the final two in 2012. For more information on the Crop Science Society of America's Grand Challenges, please visit this website: <https://www.crops.org/science-policy/grand-challenges>. There, you may comment on the CSSA Grand Challenges Wiki.

The remaining four grand challenges include:

- Create novel crop varieties and management approaches designed for problem soils and low-input farming to increase economic prosperity for farmers and overcome world hunger.
- Create novel crop management systems that are resilient in the face of changes in climate and rural demographics
- Develop sustainable biofuel feedstock cropping systems that require minimal land area, optimize production, and improve the environment.
- Genotype the major crop germplasm collections to facilitate identification of gene treasures for breeding and genetics research and deployment of superior genes into adapted germplasm around the globe.

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