Grand Challenges

Crop Science Society of America

Plant Sciences for a Better World

Written by the Crop Science Society of America (CSSA) Grand Challenge Committee

Crop Science Society of America

Headquarters Offices
Phone: (608) 273-8080

Science Policy Office
900 2nd St., NE, Suite 205
Washington, DC 20002

Phone: (202) 408-5558
email: SciencePolicy@Crops.org

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.

Crop Science Society of America

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

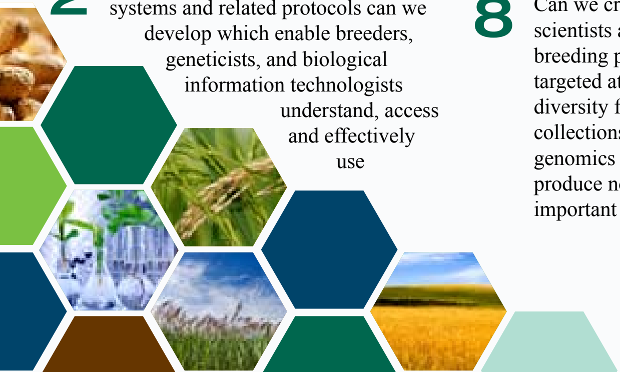
Germplasm Collections

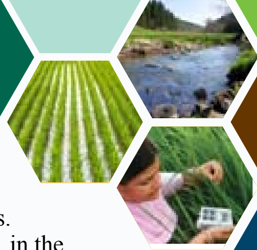
Germplasm collections are a wonderful treasure trove of genetic diversity and the foundation for all crop improvement programs. A germplasm collection for a single crop species may contain more than 50,000 distinct genetic plant types, yet the genomic profiles are not readily available, limiting application of information contained in the collections

However, new inexpensive technologies for developing detailed genetic profiles to entire collections, offering a low-cost remedy. As a result, new genomics information will enhance our ability to correlate a plant's genotype with its agricultural performance for plant breeding purposes, in a way never before possible.

Key Questions

1. Can we develop a system and the resources to employ high throughput gene chip technology to create genetic profiles of individual entries within germplasm bank collections of major crops?
2. What information management systems and related protocols can we develop which enable breeders, geneticists, and biological information technologists understand, access and effectively use extensive DNA marker profiles for germplasm collections of major crops?
3. Can we develop a system and the resources to employ high throughput gene chip technology to create genetic profiles of individual entries within germplasm bank collections of major crops?
4. Can we capitalize on the value of novel gene discoveries by developing crop specific molecular markers to facilitate rapid cultivar improvement?
5. Can improved methods for establishing genotype-phenotype relationships be developed for vital genes in all major crops?
6. Can genetic manipulation techniques and new genetic tools be customized for each major crop and incorporated into plant breeding practices (e.g. doubled haploidy, transformation, marker-assisted breeding strategies, and genome-wide selection) to accelerate the time to field evaluation stage?
7. Can the capabilities and capacities of regional and international research centers be enhanced to expedite new cultivar releases?
8. Can we create a new cadre of plant scientists and field-oriented plant breeding positions specifically targeted at 'mining' the genetic diversity found in germplasm collections and integrating new genomics information above, to produce novel agronomically important breeding materials?





Expected Outcomes

1 Intelligent sampling strategies for gene mining within germplasm collections to expand the dangerously narrow genetic base of our major crops.

2 Allow use of many genes from different sources to create multiple strategies controlling diseases, combating insects, and minimizing climate stresses to create higher crop yields.

3 Enhanced food security, greater research efficiency and production stability.

4 Efficient and sustained translation of products from gene discovery to agronomically adapted breeding materials for farmers' fields to proactively address shifts in pest dynamics and climate.

Biofuel Feedstock

Grand Challenge: Develop sustainable biofuel feedstock cropping systems that require minimal land area, optimize production, and improve the environment.

The role of crop plants as feedstock for biofuel production will increase in the coming years. Crops are a source of sugar, starch, and cellulose which can be converted to ethanol and seed oil that can be converted to biodiesel. All bioenergy crops will need to be grown in a way that optimizes biomass yield while minimizing inputs of fertilizer, irrigation, and pesticides.

It is important to minimize the competition between biofuel crops and human food crops. Therefore, in the future, ethanol–based biofuel crops likely will be non-food crops grown on land that is marginal for other crop production. Since biodiesel is the product of seed oil, this biofuel must be produced using existing seed crops. Therefore biodiesel research needs to concentrate on oil seed crops that are less used for feedstock but very productive, such as peanut. The composition of biofuel crops will need to be modified to make them easy to convert for energy use, but these modifications may make them more vulnerable to stresses and pests. As a result, there is a need:

- modify crop compositions according to processing requirements;
- to increase yield in low-input production systems;
- to understand plant response to changes in the environment, in tandem with changes to composition for accurate modification;
- to understand the ecosystem services (carbon sequestration, water quality, wildlife habitat, etc.) from perennial bioenergy crop production on arable and marginal lands; and
- to develop new production systems that thrive in low-input situations.

Key Questions

1. What genetic improvements to the composition and field productivity of biofuel feedstock crops optimize conversion processes while also improving production efficiency?
2. What steps do we need to take to develop/tailor biofuel feedstock cropping systems appropriate to diverse agroecosystems?
3. What crop management strategies can we develop and use to increase soil carbon, minimize production inputs, and ultimately increase economic return for the grower?
4. How do we optimize use of nitrogen-fixing plants into bioenergy cropping systems?
5. What biomass biofuel crops and cropping systems can be developed which are highly productive and reduce the total land area required to meet demand?

Expected Outcomes

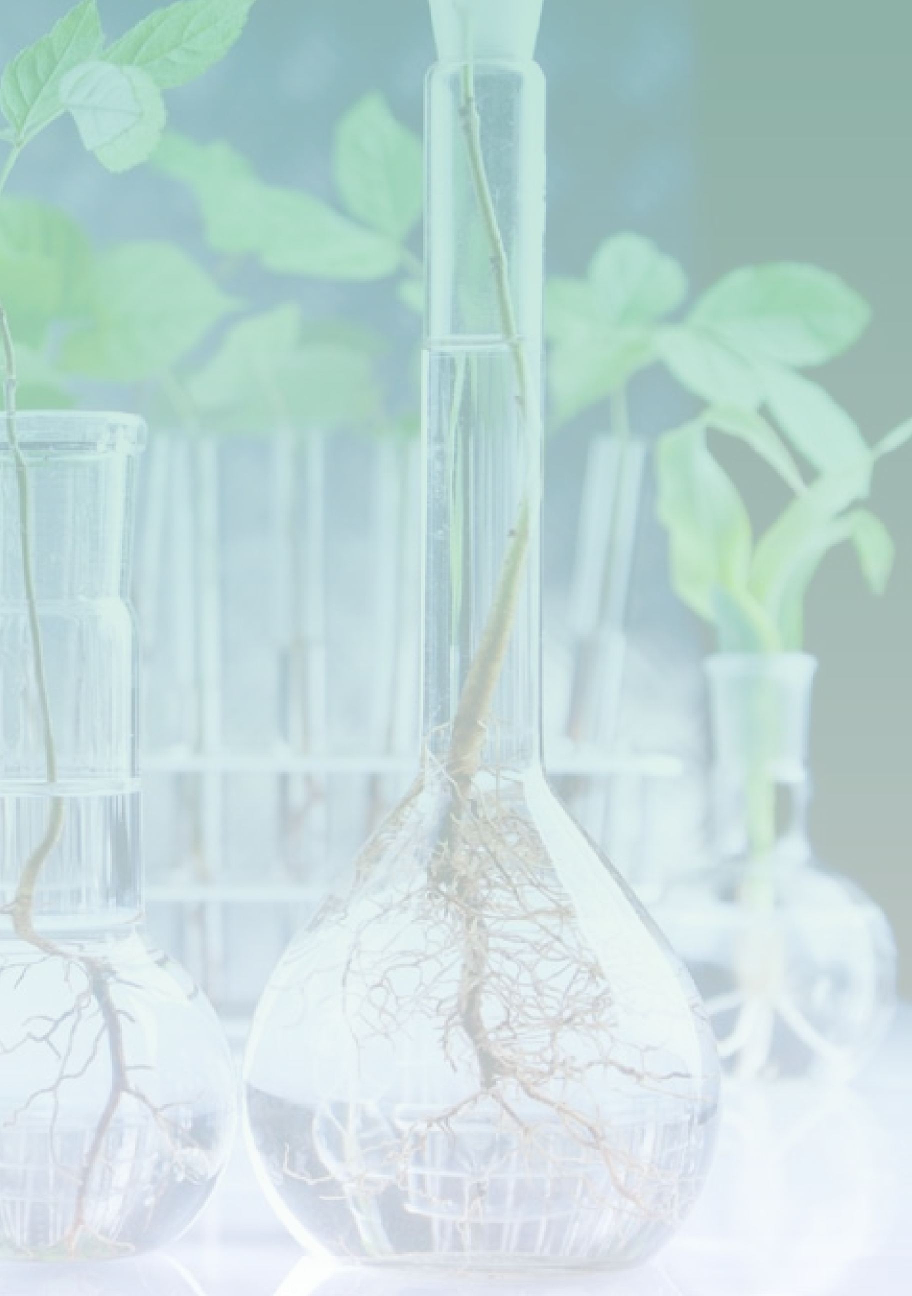
1. Reduced dependence on fossil fuels by providing sustainable renewable energy alternatives.
2. Increased number of crops and cultivars that have proven metrics for productivity and high fuel conversion efficiency rates.
3. Low-input management systems for the production of biofuel crops in diverse ecosystems.
4. Meeting the increasing global demand for food, feed, fiber and fuel on a decreasing land base with fewer inputs.
5. Increased profitability for producers of bioenergy feedstocks.

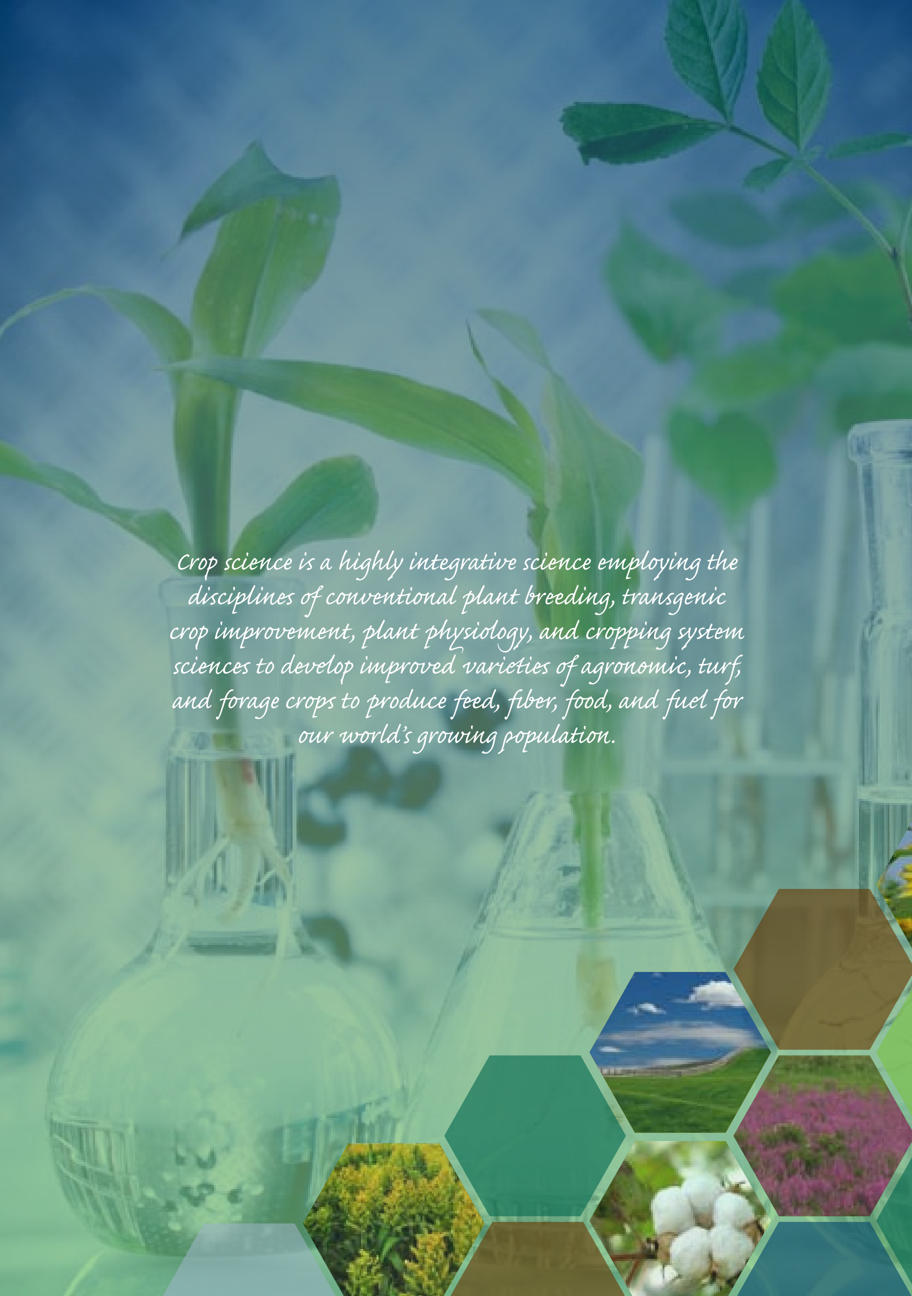
The CSSA Grand Challenges

The CSSA Grand Challenges Committee developed six grand challenges for crop science. The first two were released in 2010; the next two will be released in 2012. The four other 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.
- Increase durability of resistance to biotic stresses that threaten food security in major crops. (Released in 2010)
- Increase the speed with which agriculture can adapt to climate change by using crop science to address abiotic stresses such as drought and heat. (Released in 2010)

For more information on the Crop Science Society of America's Grand Challenges, please visit https://www.crops.org/science-policy/grand-challenges. There, you may comment on the CSSA Grand Challenges Wiki.





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.