Grand Challenge

Harnessing plant breeding and genetics to identify and develop economically important crop traits

CSREES Review
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Challenges

- increase water use efficiency
- improve crop disease resistance
- increase tolerance to abiotic stresses
- develop plants with new & improved food, feed and energy qualities
- harness soil microbes for greater crop productivity
- increase nutrient uptake & nutrient use efficiency of crops
- exploit useful applications of knowledge from model systems

Overview of Activity

Reflective of funding opportunities (industry investment & national needs):

- plant breeding research diminished: especially maize and soybean
- increased research in genetics, molecular biology, genomics
- excellent interdisciplinary collaborations

Overview of Activity: Past 5 yrs

- 4 new faculty (Hudson, Ma, Rocheford, Tuinstra)
- Educated 25 BS, 25 MS and 29 PhD graduates
- Released 9 wheat, 4 oat, 5 soybean cultivars, and 20 sorghum lines were distributed to commercial companies
- ID'd several DNA markers in corn, wheat, oat, sorghum and cowpea that co-segregate with important genes/QTL

Overview of Activity: Past 5 yrs, cont'd

- Developed genetically diverse popns of maize, soybean, sorghum: TILLING
- Developed VIGS to study & engineer traits in wheat & likely other crops
- Expanded high throughput genotyping & phenotyping, DNA sequencing, 454 transcript profiling, NIR reflectance spectroscopy, SNPs
- ACRE: added irrigation, GPS-guided planting equipment

Research Projects: Past 5 Years (selected)

Numerous (100s) collaborations among faculty, departments, nationally, internationally ($52 M)

Research Projects: Past 5 years, cont'd

- **Crop biotic stress resistance** (8+ faculty + Depts, Univs, USDA, Intl)
- **Improved food/feed quality** (5+ faculty +FS, USDA)
- **Improved biofuel feedstock quantity and quality (**10+ faculty + AnSc, ABE, AGEC)
- **Improved abiotic stress tolerance** (7 faculty + HLA)
- **Genomics** (5 faculty + wide array of coll's)
- **Improving nutrient use efficiency** (3 faculty + coll's)

Current Situation

- Urgent need in industry, gov't, academia for plant breeders, geneticists, and plant physiologists
  - phenotyping skills
  - new interdisciplinary skills
  - broad-based knowledge
- Changing climate, >'g world population, <'g resources:
  - more demand for food, fiber, fuel
  - will need more metabolic energy per unit area

Fundamental Issues: Next 10 Years

- Develop capacity to educate/train more BS, MS, PhD, postdocs with comprehensive education in genetics and plant breeding, and (in collaboration with other departments) related areas of science, and (in collaboration with industry) internship experiences
- Increase our research capability in plant physiology at the whole plant and molecular levels
- Increase soybean breeding, teaching, competitiveness for federal grants

Fundamental Issues: Next 10 Years, cont'd

- Accurate phenotyping of plant traits to maximize efficiency of DNA marker technologies
- Develop a better understanding of the physiology of complex traits:
- Integrate molecular genetics into real-world crop improvement
- Research on cover crops, 'trap crops' for N, legumes, fix N, alternative crops
- Department and College: build capability to provide funding for new research initiatives
- More competitive for federal and other sources of funding in developing areas of research

Department Capabilities

- Dynamic plant breeding programs in maize, sorghum, soybean, small grains
- Strength in genetics, genomics, molecular biology, bioinformatics
- Strength in related areas: cropping systems/management, soil science
- Can take the lead, and collaborate, in multidisciplinary initiatives to develop crop plants that have new traits

Potential Project Areas

- Integrate knowledge from model systems, plant physiology, genomics, and marker-based plant breeding to develop plants with new traits efficiently
- Mine the explosion of data/information from genome sequencing
- Analyze plant-microbe and plant-insect interactions, plant development, and plant physiological/biochemical processes
- Explore new crops and crop systems to > grain and biomass productivity

Vision for the future

- Be an important source of new knowledge and of crop plants with new traits
- Educate/train students with BS, MS, PhD degrees, and post-doctoral experience that are well-prepared for successful careers in crop improvement
- Be competitive for funding from multiple sources for innovative research
  - that integrates education and engagement
  - that is competitive for funding by new emerging federal programs like AFRI,
  - and leverage federal funding by collaborations with industry
- Expand available seed funds at the university and college levels to invest in and stimulate new or high risk areas of research to improve our competiveness for funding