CROP SCIENCES

A. Mission

Our shared vision is to have a Crop Science program with the capacity to address **local, national and global concerns of crop genetic improvement and management, natural resource conservation, as well as management and protection of the** environment.

The research mission of the Crop Science group is to conduct and disseminate results of innovative and relevant research that addresses important biological and environmental problems in crop sciences to serve the future needs of agriculture and society.

Our goal is to become the premier research and academic program in crop sciences by distinguishing ourselves in the education of undergraduate and graduate students and in the pursuit of excellence in crop research and accomplishments.

B. Where we are now

1. Overview of program

The Crop Science group in the Department of Agronomy is a multidisciplinary and collaborative team whose research and educational interests span a multitude of scales from the most upstream (basic molecular biology, genomics, and proteomics) to the downstream application of the plant sciences in field agronomy, to management of turf and farming systems in crops. Individuals are typically involved in more than one scale such as relating differences in genotype with phenotypic expression, the interactions of genotypes with environments, the interplay of biophysical and physiological processes with cultural practices, and the merging of basic research and applied research in crop improvement. More recently, the group has committed itself to placing an emphasis on translational genomics: linking information derived from research in model systems with application in commodity-based research for crop improvement.

2. Actions taken in response to 2002 CSREES review

The 2002 review had a number of significant recommendations (shown in italics below) in our three core areas that ranged from facility improvement to programmatic leadership. Since that time, nearly all of the recommendations have been implemented, which has led to the broad adoption of a systems research approach as described in the following sections.

a. *Plant breeding and genetics*

Determine the appropriate balance between molecular genetics and modern

germplasm development; assume greater leadership in the interdisciplinary programs to entice other plant scientists to work on systems/commodities of interest to the department; aggressively pursue a strategy for being major participants in the Life Sciences Initiative; form cluster group(s) with a broad but niche-product focus - corn and soybeans; develop high-throughput genotyping to facilitate plant improvement; endorse curriculum changes to include genomics, physiology and biochemistry, and bioinformatics.

The Plant Breeding and Genetics curriculum has undergone significant changes at both the undergraduate and graduate levels. For example, a graduate/upper undergraduate genomics course has been added, with additional courses being offered by the recent addition of Drs. Tuinstra and Rocheford. Agronomy faculty also have significant involvement in the Purdue University Interdisciplinary Life Science Ph.D. Program (PULSe) that consists of 11 target areas most notably Chromatin and Regulation of Gene Expression, Molecular Virology, and Plant Biology. However, not having a standalone Plant Biology program has impaired recruiting for graduate students. The most significant changes have occurred in the development of cluster groups with additional faculty whose research is centered on maize and soybean. This additional expertise has also addressed the desire to integrate molecular genetics and germplasm development and have a corresponding enhancement of the plant breeding program.

b. ***Crop physiology and cropping systems***

Engage more faculty in teaching and have new hires teach whole plant physiology; bridge the traditional disciplines in crop management, crop improvement, and molecular genetics; will likely require additional expertise in whole-plant and/or canopy physiology.

Expand collaborative ties with key faculty outside the Department and at other institutions to fill gaps in expertise; establish research goals to coalesce interdisciplinary research groups (i.e., added value, improved stress tolerance, yield increase, increase nutrient use efficiency, and land reclamation).

The desire to enhance our plant physiology expertise, as indicated in the last review, resulted in the addition of Dr. Yiwei Jiang whose research is primarily focused on physiological issues in the Turf Science arena. The Horticulture department also hired a plant physiologist and collaboration with our faculty has already begun. Yet, there is a need for a physiologist who will complement the cluster groups that have recently formed. The formation of the soybean and maize cluster groups have significantly improved the interactions across crop management, crop improvement, and molecular genetics. The Bioenergy Grand Challenge is an example of the formation of interdisciplinary research groups where Crop Physiology and Cropping Systems have a central role.

c. ***Turf sciences***

Current faculty resources (associated AP staff) are woefully inadequate; the courses dedicated to turf science are under-represented in the curriculum; the Team recommends that the Department actively seek avenues to integrate turf students into other Departmental activities; determine if graduates could benefit from additional emphasis on communications, business and management courses in the option; the Team suggests adding a curriculum mandated internship at a golf course/turf-related facility and perhaps a second internship.

The Turf Science program continues to attract a significant percentage of the students within the Crops Science program. These students have been more fully integrated into the department as members of the Agronomy Department Ambassador program and the Agronomy Club, and integration into common courses. Additional faculty have been added (Drs. Bigelow and Jiang) to enhance the capacity for turf-related research and courses. The curriculum includes several communications, business and management courses, and all turf students usually have two internships before they graduate.

3. Program focus

a. ***Accomplishments and impact***

The Plant Breeding and Genetics program in the department has had a great international reputation for its excellence in research and graduate education in the breeding and genetics of important agronomic crops such as maize, sorghum, wheat, and soybeans. The group's record of achievement in generating new genetic information, improvement and design of new breeding approaches, development and release of crop germplasm, and educating/training of plant breeders with balance and depth in the science and application of crop improvement has been outstanding. These activities continue to be important areas of foci in the department. Germplasm and cultivar development efforts have been strong in small grains, sorghum, and soybean breeding programs. With the addition of two maize breeder/geneticists, contribution from the department in the development of useful genetic stocks in this important crop will ensue. A strong team of scientists has been added to the basic genetics program in the department. The program has been strengthened in the last several years through the addition of faculty with a research emphasis in a number of areas including genome organization, chromosome structure and maintenance, functional genomics, and plant developmental biology. Collaborations among and within sub-programs in the department, college, and the university take place often and readily.

The Crop Physiology and Cropping Systems program has made significant contributions to understanding the basic principles of crop responses to inputs and management of cultural practices in field crops. The program has emphasized understanding crop adaptation and performance in the context of fundamental,

meteorological, biophysical, and physiological processes. Basic crop physiology research has included identification of genes and gene products, cloning of genes important in plant development, adaptation, and establishment. Work in the cropping systems area has mainly been in evaluating benefits of forage production, nutrient use efficiency, assessment of environmental impact of long-term no-till rotation, and evaluating organic amendments and their impact on water quality.

The Turf Science program enjoys an excellent state and regional reputation and visibility as a result of its active efforts in teaching, research, and extension programs. It has maintained excellent collaboration with the turf industry via the Midwest Regional Turf Foundation (MRTF). A particular strength of the Turf program has been in undergraduate education and outreach resulting in a steady supply of well trained turf managers to the industry. The research emphasis of the Turf program has been applied and focused in pest management, pesticide/nutrient fate evaluation/establishment of alternate turf grass species, and fertilization. A basic thrust in stress tolerance has been added with our most recent faculty hire (Dr. Yiwei Jiang).

b. ***Current efforts***

The Crops Group consists of 26 faculty members, five of whom hold adjunct appointments; their areas of expertise are listed in Tables 3.17 and 3.18. These tables highlight a departmental and college focus as well as a natural national trend in linking basic and applied research. Since the last review, this focus has been implemented in the types of faculty that have been hired (Table 3.19.) as well as facility and equipment improvements (Table 3.20). For example, the newest faculty members hired (Drs. Rocheford, Tuinstra, Ma, and Jiang) are expected to focus on translating information derived from model systems on traits important to their various crops in their germplasm enhancement programs. Drs. Rocheford and Tuinstra have strengthened the maize research team whose research now ranges from corn management, plant nutrition, generating new genetic stocks for starch digestibility, nutritional composition traits, to grain yield.

C. Where we want to go

1. Overview

Since 2000, the overall expertise in the Crop Science group has broadened. We are now better positioned to take advantage of knowledge gained from model systems, to generate new knowledge for application in specific crops of interest, to utilize the rapidly developing genomic approaches and platforms, and through innovative translational approaches to apply this body of knowledge to solving local, national, and international problems of crop improvement and utilization.

Over the next 5-10 years, the Crop Science faculty and staff are committed to

strengthening our translational capabilities to provide a critical link between genomic technology and crop improvement. We will utilize a diversity of approaches to advance and promote sustainable crop management practices in modern agriculture. We will strive to build integrated interdisciplinary research approaches that recognize and exploit the essential tools and skills that our diverse and talented faculty and staff possess. We aspire to develop greater linkages with local, national, and global stakeholders and build effective partnerships with both public and private institutions to serve humanity. We will maintain open dialogue to shape our educational and research mandates and pursue new research directions based on new advents in science and driven by market trends and societal needs. Our research efforts will embrace trends dictated by climate change, environmental disruptions, changes dictated by market forces, and social pressures brought about by demographic changes.

The educational mission for both our undergraduate and graduate students will continue to focus on the scientific processes that underpin plant development along the continuum of basic biology, genetics, breeding, physiology, and agronomy of crops. Particular attention will be given to the application of genetic information and physiological processes to the understanding and exploitation of abiotic stresses, pest and pathogens, water and nutritional use efficiency of crops, and environmental sustainability of crop production systems as well as the dimensions of food safety and human nutrition components. We will seek to further expand and fine-tune our curriculum at the graduate level in crop physiology and genetics (genomics and bioinformatics) and devise interdisciplinary educational and research programs to further enrich the education of our current crop of students and to attract a new generation of students. We will strive to secure increased funding that will enable and support these enhanced aspirations in collaborative research and the associated recruitment and education of outstanding students.

2. Program focus areas and goals

a. ***Advance our knowledge base in the crop sciences:*** We will continue to develop our current crop research and educational programs to further the disciplinary strength of our component programs of plant molecular biology, genetics, genomics, and breeding as well as plant physiology, cropping systems, and turf management. This array of disciplines vary from the most basic to the more applied and address issues of plant health, nutrition, and performance of several crops. Each is capable of generating fundamental information that lays the basis for furthering of our research and development efforts. Our capacity to solve key problems of agriculture, natural resource, and the environment would depend on how well we integrate our collective arsenal of technologies. The foundation for the generation of appropriate technologies that solve problems is, however, the basic science advances we each would make in our respective disciplines.

b. ***Develop integrated programs for greater impact (systems approach):*** There is need to increasingly function in multidisciplinary “cluster” type groups whose

faculty/staff make-up may vary depending on the issues being addressed. Problems of agriculture and natural resources are getting increasingly complex requiring multiple tools and new interdisciplinary approaches. Fortunately, recent technological and scientific developments have created new subdisciplines that provide useful information to various area of research. This has led to the current sentiment among research funding agencies that advocates "systems approaches" as a way to build teams and communities of scientists that find solutions to the more intractable problems of agriculture and natural resources. This new direction differs from the tradition of single investigator, reductionist approaches. Our challenge is to find a functional mechanism for engagement in this new mode, to learn how to define and structure a research agenda of complex issues in a systems approach, and formulate new sets of hypothesis that bring together multiple scientific tools and skills towards solving these more bundled sets of biological and physical problems. Our crop science group has held well-spaced meetings and retreats over the last four years which helped develop a collective vision for such an approach. Our group proposed "translational genomics" as one avenue to bringing together advances in plant molecular biology, genetics, genomics, and breeding as a way to channel advances in basic research to developing germplasm products and crop management practices. Traits that invite such approaches could vary from the more perennial abiotic stresses such as drought and heat tolerance to those around value addition via modifications of the chemical composition of seed and plant biomasses of array of crops.

c. ***Ready to address emerging societal concerns:*** An effective service-oriented educational and research program is one that is able to respond to emerging societal issues. An appropriate mechanism for engaging in such big-problem research platforms is finding willing partners with essential tools for a systems research approach. Developing these integrated programs is key to addressing emerging concerns that we have termed "Grand Challenges." Of the six Grand Challenge areas that we have identified for a systems-approach the Crop Science group can participate and/or take leadership in four of the topical areas. Crop Science faculty could lead initiatives in Harnessing Genetics through "translational approaches" for a number of traits including genetic resistance against biotic and abiotic stresses. It is conceivable that we can provide leadership or serve as major partners in the areas of Bioenergy, International Agriculture, as well as Climate Change. A potentially defining character for attaining success in Integrated Systems Approach or attacking Grand Challenge research agendas is designing them with appropriate levels of complexities, and with partnerships that have a proper division of labor to allow the attainment of research goals and results. Grand Challenge research agendas could have potentially broad domains requiring that we build and strengthen local, national, and international partnerships. When choosing partners we should focus on strategic collaborations that offer complementarities as well as synergy with skills and resources that are available to us from within.

d. ***Further strengthen our educational (learning and engagement) efforts:*** Our educational mission for both undergraduate and graduate students will continue to focus on scientific processes that encompass crop development between the extremes of molecular dissection of biological processes to field application of new crop science technologies. The importance of a broad education in which students will see the application of genomic information and physiological processes to sustainable crop production systems is critical at both local and global scales. Students at both the undergraduate and graduate level will directly benefit from the development of integrated cluster type programs that will give them exposure to the latest approaches to purpose-driven research, which generally involves interdisciplinary teams of researchers. Generating a new generation of professionals well versed with technical scientific knowledge and skills and with exposure to the systems research approach for addressing complex societal problems would be a vital function of a premier global institution such as Purdue University.

e. ***Strengthen international foci for each departmental mission area:*** Several members of our faculty have had significant experience in the conduct of collaborative research in the international arena with funding from both federal and foundation sources. With the greater interest generated among our faculty and the new potential sources of funding for global engagement, there may emerge international outreach opportunities for our faculty and students in each of the primary areas of education, research, and extension. International travel opportunities around student-exchange and study-abroad programs for undergraduate and graduate students in both developed and developing countries can be expanded to enhance the global experience of our faculty and students. Attracting highly qualified international students into our graduate and undergraduate program from a variety of nations and geographic areas would add great value to our educational efforts here at home. We could enrich our curriculum by adding international agricultural issues into our educational efforts. Excellent opportunities for global engagement in collaborative research linkages exist in the agricultural arena. Because of our past experience and our basic plant science strength, we can become a significant partner in international agricultural research addressing some of the pressing problems of the developing world through global partnerships. We can create an atmosphere of an even more open, more globally engaged faculty and department that is recognized internationally for its successful research initiatives and accomplishments. There is a renewed interest in developing countries for an organized technology dissemination program along the path of the agricultural extension programs in our Land Grant University systems. However, there is not a concomitant investment of resources to make that possible as a long-term technical assistance program. There is some focus and discussion around the concept of public-private extension models, although the *modis operandi* for it needs to be thought out more clearly and developed further.

D. How we will get there

In an era of very stiff competition for scarce resources, our educational and research programs in crop sciences will need to develop a balance between disciplinary rigor and a strong interdisciplinary focus to be recognized as a center of excellence with core strength by alternative donor agencies. Also important is balance in perspective and mission of service to be counted upon as having the capacity to respond to local problems and address global concerns. Such capabilities require a solid scientific foundation, a broader outlook, and the resilience to engage in a variety of approaches. The Agronomy Department has identified six Grand Challenges that will form the focal point of our future educational and research vision and direction. These grand challenges were chosen because they were found to be the most relevant to the greater societal need. They matched the general expertise available within the department as well as the assessed expectations of potential opportunities for collaborative engagement that can be brought to bear. Identification of these grand challenges demonstrates that the faculty has expressed an earnest collective desire to move from a strictly disciplinary approach to an interdisciplinary research and education program with a careful balance and mix of science. We have had considerable discussions within the department through which we have captured both the breadth and depth of our current research and our future goals. Future discussions will focus on the careful selection of the most appropriate and timely sets of challenge problems, development of teams and partners with complementary skills, and effective leadership as these are essential to kick-start such ventures. Perhaps the most significant need is funding resources to get the plan moving.

To build a momentum behind a new set of initiatives or to attain greater success with our ongoing learning, discovery, and engagement efforts, our departmental programs need to have the following critical set of research culture and infrastructure:

1. ***Sustain a productive work environment***

   We do have a good work environment in the department and the college with an administrative policy that encourages interdisciplinary linkages across programs and departments. Available facilities are readily shared and the logistics for getting in-schedule to be included in a list of shared user-facilities is not complex. Within the department, the Crop Science group has worked hard toward developing a common vision and goal and there has been an open dialogue that led to increased communication and information exchange. Success in interdisciplinary research hinges around defining a research agenda that allows a proper division of labor and effective sharing of responsibility; making adjustments as needed, and paying closer attention to the needs and schedules of team members. Many of our faculty members are experienced in interdisciplinary and multi-institutional collaboration in current and past joint efforts. These experiences have shown the synergy and advances that can be made by combining skills and resources with like-minded scientists. Facilities in the department are generally good and improving. Infrastructure improvements such as developing a state-of-the-art seed and tissue handling facility are currently in planning stages, and will greatly enhance our capacity when completed.

2. ***Pursue opportunities for creative new initiatives***

The grand challenges we have identified are creative new initiatives based on the likelihood of success in addressing emerging societal needs. Each of the grand challenges has potential research outcomes that can be of significant societal benefits. For instance, developing models that assess scenarios around climate change or evaluating the potential adaptation to changes in climate needed relative to both abiotic stresses and pest and pathogen variations are visionary outlooks that can pay dividends down the road. In this particular example, much of the linkages necessary can be obtained from expertise available on campus. In others, we may need to find key essential partners from outside the university, and even with partners beyond the national borders. There are likely to be more such opportunities both nationally and internationally. An open-minded perspective for seeking and engaging in partnership is important for an institution that aspires to be truly global. The concept of seed money, mentioned above is particularly relevant to developing a "cluster type" systems programs necessary for meeting these grand challenges. As part of identifying these grand challenges at the department level we see this as a way to move to the college and university levels to work with Purdue University administrators relative to overlaying our vision with theirs towards a common goal. Such an investment in interdisciplinary research, education, and engagement programs can position Purdue University as a significant player on a global scale.

3. ***Enhance competitive ability for extramural funding***

Our collective vision for advancing our science and for addressing emerging societal needs have been fairly well thought out having filtered them through several months of dialogue. We have held foresight discussions for several years and agreed to embark on new research approaches and addressing selected grand challenges. We have also agreed that we would increase our chances for obtaining extramural funding for some of our ideas if we had internal seed monies to start some of these initiatives. Chances for obtaining competitive extramural funding will be enhanced if we would get preliminary results generated and we gained experiences on how to address complex interdisciplinary research that have foreseeable impact pathways. Our group has charted out linkages that are local, as well as global, that may enhance our chances and we need to work towards establishing those linkages in a meaningful way. We would need to advance these arguments with leaders in our college and the university at large to obtain seed money for some of our big-problem ideas. The rationale for venturing into our new research opportunities needs to be based primarily on the unique sets of exciting research questions that we would develop, the sets of tools we would bring to bear, and the perceived synergy we expect to derive from these engagements.

4. ***Build and strengthen national and international linkages***

The world of international agricultural research is changing. A lot more resources have come into the international agricultural research and development arena,

particularly from private philanthropic organizations such as the Bill & Melinda Gates Foundation. Federal funds are likely to follow. After a couple of decades of neglect, international agricultural research and development is receiving renewed political and public support. Discussions are under way about mobilizing global linkages at all levels to enhance impact of science for development internationally. Reorganization of the structure and governance of the international agricultural research centers that is currently under way, may provide new opportunities for new level of engagement by US and European universities. Advances in science at the newly emerging economies in China, India, and Brazil also offer new sets of collaborative linkages as well. Some of the grand challenge problems we identified are broad in scope and will require partnering with both national and international institutions in order to move from basic research components to product and technology development and implementation. Identifying specific national and international institutions as partners would significantly increase our competitiveness as well as enhance the potential for success in meeting the research and educational objectives in our selected grand challenges.

5. ***Strengthen staff and student recruitment and retention***

Recruitment of outstanding faculty and providing them with opportunities that enhance their success is crucial to sustaining a strong program. While it is important to retain faculty, it is equally important to retain our excellent staff as they are integral to the success of the research and teaching programs. This will require providing competitive salaries and benefits and a positive work environment. The bulk of the research in academia is performed by graduate students and postdoctoral fellows. Students can be brought in through programs that allow direct admittance to the department or through interdisciplinary programs. It is a challenge to recruit highly qualified students and research fellows, but it is a key element of a successful program. While graduate students and postdocs are often attracted by specific research programs a successful recruitment also requires a competitive salary and quality working conditions.

E. Summary

The above paragraphs describe the trajectory of programmatic visioning we have developed for our Crop Science Program at Purdue University. The collective vision and aspiration that we developed arose out of a series of regular meetings we held over the last several years in which we examined our educational, research, and engagement programs, revised our curricula, and aligned our science and service goals with societal changes and demands that have been emerging at the national and international level.

The tables below that are provided to indicate the disciplinary research areas in which the faculty are engaged in, complement the Grand Challenge Programs presented elsewhere in this document. Table 3.17 shows the activity within seven core discipline areas of the Crops Faculty. Table 3.18 has a more expanded view identifying the specific research problem areas the faculty are focused on. As indicated in Sections B and C, the faculty have shown

an interest and ability to work across a broad array of challenges. Table 3.21 places this into context with the faculty identifying the Grand Challenges in which they have a primary and secondary interest. Development of the Grand Challenges and the new emphasis on systems research was significantly enhanced by hiring seven new faculty as well as critical equipment purchases and facility improvements since the last review. These changes are shown in Tables 3.19 and 3.20, respectively.

Table 3.17. Discipline areas represented by the Crop Science faculty

Table 1. Discipline Areas
● = primary focus
• = secondary focus

Faculty	Applied Meteorology	Crop/Plant Physiology	Cropping Systems	Genomics	Plant Genetics	Plant Breeding	Turfgrass Science
Bigelow, C.			•				●
Brouder, S. M.		•	●				
Camberato, J.			●				
Open - Soybean Ext.			●				
Doerge, R. W.				•	●		
Ejeta, Gebisa				•	●	●	
Grant, R. H.	●	•					
Housley, T. H.		●			•		
Jackson, S. A.				●	•	•	
Jiang, Y.		•					●
Johnson, K. D.		•	●				
Ma, J.				●	•		
Nielsen, R. L.			●				
Niyogi, D.	●	•					
Ohm, H. W.			•		●	●	
Reicher, Z. J.							●
Rocheford, T.				•	•	●	
Schweitzer, L. E.		•	●				
Snyder, L.		•	●		•		
Szymanski, D. B.				•	●		
Tuinstra, M				•	●	●	
Volenec, J. J.		●	•		•		
Vorst, J. J.		•	●				
Vyn, T. J.		•	●				
Weil, C. F.				•	●	•	
Christmas, E Emeritus		•	●				
Anderson, J. M.			•	•	●	•	
Hudson, K.		•		•	●		
Scofield, S.				•	●		
Vierling, R.A.				•	●	●	

Table 3.18. Primary and secondary research problem areas of the Crops Science faculty

	Bigelow, C.	Brouder, S. M.	Camberato, J.	Open - Soybean Ext.	Doerge, R. W.	Ejeta, Gebisa	Grant, R. H.	Housley, T. H.	Jackson, S. A.	Jiang, Y.	Johnson, K. D.	Ma, J.	Nielsen, R. L.	Niyogi, D.	Ohm, H. W.	Reicher, Z. J.	Rocheford, T.	Schweitzer, L. E.	Snyder, L.	Szymanski, D. B.	Tuinstra, M	Volenec, J. J.	Vorst, J. J.	Vyn, T. J.	Weil, C. F.	Christmas, E Emeritus	Anderson, J. M.	Hudson, K.	Scofield, S.	Vierling, R.A.
Table 2. Problem Areas																														
● = primary focus **• = secondary focus**																														
Applied Meteorology							●							•																
Climatology							●		●					●																
Comparative genomics					•							•					•			•	•				•		•			•
Corn Management				•									●											•						
Crop/Plant Physiology		•						●		•												●						•		
Crop Production		•		●							•							●	•				•	●		•				
Cropping Systems				•							•		●		•			●	●				●	●		●				
Disease Resistance												•			•												●		●	
Forage Management											●											•								
Maize Breeding													•				●				●				•					•
Plant Cell Biology																				●	●									
Plant Genetics					•	•		•	•						●		•			●		•			●		•	•	•	
Plant Nutrition		●	•				•															•								
Small Grains Breeding															●												•		•	
Sorghum Breeding						●																								
Soybean Genetics/Breeding									●			●																●		●
Statistical Genomics					●																									
Translational/Functional Genomics			●		•				•			•					•			•	●				●		•	•	●	
Turf Physiology	•									●																				
Turf Production	●									●						●														

Table 3.19. New faculty positions since the 2002 review, the individuals hired in these positions, and their departmental appointments.

Discipline Area	Individual	Appointment
Turf	Cale Bigelow	Agronomy 100%
Turf & Whole Plant Physiology	Yiwei Jiang	Agronomy 100%
Soybean extension*	Shawn Conley	Agronomy 100%
Soybean Genomics/Genetics	Jianxin Ma	Agronomy 100%
Maize Genetics/Breeding	Torbert Rocheford	Agronomy 100%
Crop Science	Lori Snyder	Agronomy 100%
Maize Breeding/Genetics	Mitch Tuinstra	Agronomy 100%

* Position currently vacant. Active search occurring.

Table 3.20. Major equipment and facilities obtained since the 2002 review, including the year in which they were purchased and their approximate cost.

Equipment or facility	Year	Cost
Long term Cold Seed Storage	2003, 2009	$500,000
FT-NIR Spectrometer	2007	$65,000
454 Roche Sequencer*	2008	$500,000
ABI SOLID Sequencer*	2008	$500,000
Illumina Bead Station – Genotyping*	2008	$200,000
Irrigation at ACRE	2008	$215,000
Precision maize planter with GPS	2008	$180,000
Seed and tissue handling facility renovation	2008/2009	$250,000

*Equipment purchase by College of Agriculture and installed in Core Genomics Facility in Whistler Hall

Table 3.21 Identification of Grand Challenge topics as major or secondary interest by Crop Science faculty

	Bigelow, C.	Brouder, S. M.	Camberato, J.	Open - Soybean Ext.	Doerge, R. W.	Ejeta, Gebisa	Grant, R. H.	Housley, T. H.	Jackson, S. A.	Jiang, Y.	Johnson, K. D.	Ma, J.	Nielsen, R. L.	Niyogi, D.	Ohm, H. W.	Reicher, Z. J.	Rocheford, T.	Schweitzer, L. E.	Snyder, L.	Szymanski, D. B.	Tuinstra, M	Volenec, J. J.	Vorst, J. J.	Vyn, T. J.	Weil, C. F.	Christmas, E Emeritus	Anderson, J. M.	Hudson, K.	Scofield, S.	Vierling, R.A.
Table 3. Grand Challenges																														
● = major interest or focus **• = secondary interest or focus**																														
Landscape Mgmt. & Systems	●	●	●							•	●		•	•		●		●	●			•	●	●		•				
International Agriculture		•				●			•	●				●	•		•		●	●	•			•		•	•			
Chemicals in the Environment		•					●							•																
Bioenergy		●	●		•	●		●		●	•		●	•	•	•	•	•	•			●		●			•	•	•	
Plant Breeding & Genetics	•				●	●	•	●	●	●		•	●	•	●		●		•	●	●	•		●	●	●	●	●	●	●
Climate Change		•				•	●		●			●		●						●		•			●		•			