Iowa State University—Graduate Assistantships in Plant Breeding. Two Ph.D. assistantships available on campus in Ames, Iowa.

Primary advisors: Lance Gibson and/or Pam White

Research and training collaborators: Jean-Luc Jannink (USDA - U.S. Plant, Soil and Nutrition Research, Cornell University), Paul Scott (USDA-ARS), Pam White (ISU, Department of Food Science and Human Nutrition), Lance Gibson (ISU, Department of Agronomy)

Description of the research opportunity: Participants in this project will enhance the security and nutritional value of grain consumed in the United States by 1) contributing to the genomic and methodological knowledge base needed to efficiently improve grain for functional food attributes, 2) devising, refining, and disseminating efficient breeding methods that optimally use data conferred by cutting-edge biotechnologies, and 3) developing educational materials and programs to stimulate the curiosity and invite the next generation of plant breeders to become involved in this profession. Participants will do this through the enhancement of β-glucan content of oat using new marker-assisted selection methods and creating materials for recruiting and educating the next generation of plant breeders. The importance of β-glucan to the health impact of oat has long been appreciated. β-glucans are classified as a water-soluble dietary fiber. Significant potential exists for β-glucan from oat to help avert or mitigate a number of diseases of Western civilization associated with a highly refined diet. A diet high in soluble fiber from whole oats (oat bran, oatmeal and oat flour) and low in saturated fat and cholesterol may reduce the risk of heart disease by decreasing total serum cholesterol concentration. In addition to lowering cholesterol, β-glucan consumption has other benefits. 1) It can slow the release of glucose into the blood stream, 2) can assist with weight loss by increasing satiety after food consumption, and 3) has anti-tumor and immune stimulating properties.

The objectives of the project are to 1) identify loci affecting health-promoting β-glucan through association genetics on elite oat and use these loci to compare competing marker-assisted selection (MAS) methods, 2) identify loci affecting β-glucan in oat from the National Plant Germplasm System (NPGS) and determine whether NPGS alleles can complement elite germplasm and 3) teach professionals association-based MAS and draw intelligent students toward plant breeding as a rewarding career.

Description of the training opportunity: Students participating in this research and education program will work in partnership with scientists in genetics, plant breeding, food science and human nutrition, resident and distance education. They will have access to excellent field, greenhouse, laboratory, and teaching facilities through the Departments of Agronomy and Food Science and Human Nutrition. The project will involve significant interaction with USDA research geneticists at Iowa State University and the US Nutrition Lab at Cornell University. The students will interact with a diverse set of faculty in a multi-disciplinary environment. Skills will be developed in areas crucial to future success in research and academic settings. Taken as a whole, the plant breeding, genetics, human nutrition, and educational components of this program will provide all the necessary elements to prepare students to excel as scientists and educators.

Benefits: Students selected for these assistantships will receive full tuition from Spring of 2008 to Fall of 2011. In addition, students will be paid a stipend (currently $17,850 per year) for work associated in participating in research projects and developing and presenting educational materials. Graduate assistants also receive medical benefits. A higher stipend is available through the Agronomy Research and Training Fellowship program for highly qualified students. Visit the following web site for more details on the RTF program. http://www.agron.iastate.edu/academic/graduate/endowmentfellow.aspx
Desired skill set: Proven aptitude in the biological and physical sciences, including biology, genetics, chemistry, agronomy, food science and/or human nutrition. Excellent written communication skills and the capacity to work both independently and within a team environment are essential. Demonstrated skill in problem solving, data collection, hypothesis testing, and data analysis is preferred.

Funding plan: Funding has been received from USDA-CSREES for this project.

Background Information (taken from grant proposal):

**β-glucan is a healthy food ingredient.** β-glucans are classified as a water-soluble dietary fiber and occur in certain cereal grains, such as barley and oats. Significant potential exists for β-glucan from oat and barley to help avert or mitigate a number of diseases of Western civilization associated with a highly refined diet. On January 21, 1997, the U.S. Food and Drug Administration (FDA) approved a health claim that “a diet high in soluble fiber from whole oats (oat bran, oatmeal and oat flour) and low in saturated fat and cholesterol may reduce the risk of heart disease” (21CFR101.81). After review of 37 studies in which oats were consumed as hot and cold cereals or used in a variety of other foods, the FDA concluded that ≥ 3 g of β-glucan from oats should be consumed daily to achieve a clinically relevant decrease in total serum cholesterol concentration. Barley, also contains β-glucan soluble fiber, and the FDA just approved a health claim for it’s consumption (FDA URL). These health claims can have enormous economic impact: the retail volume of a nearly one-hundred year-old traditional food product, Cheerios®, jumped 11% in 1999 after marketing based on this claim!

In addition to lowering cholesterol, β-glucan consumption has other benefits. 1) It can improve glycemic response when consumed before high-glycemic foods (Braaten et al. 1994b, Wood 1990, Bourdon 1999, Pick et al. 1996). In a 50-g carbohydrate portion each gram of β-glucan reduced the glycemic index by 4 units, making it a useful functional food for treating diabetes (Jenkins et al 2002). 2) β-glucan can assist with weight loss by increasing satiety after food consumption, thus reducing the temptation to overeat (Anonymous 2006). 3) β-glucan has anti-tumor and immune stimulating properties. β-1,3-D-glucans exert potent effects on the immune system by stimulating anti-tumor and antimicrobial activity (Estrada et al., 1997, DiRenzo et al., 1991). The β-glucans act by binding to receptors on macrophages and other white blood cells that may be pre-adapted to fight yeast whose cell wall contains glucans {Lavigne, 2006 #2138}. Because of their effects on the immune system, some physicians currently prescribe β-glucan preparations to speed healing after surgery. 4) Daily ingestion of β-glucan may offset the increased risk of upper respiratory infection associated with exercise stress (Davis et al. 2004). For these benefits, most studies have been conducted on β-glucan associated with oats; however, the β-glucan from barley has been shown to have many similar effects (Bengtsson et al 1990).

The integrated project detailed here directly addresses CSREES Goal 4 of improving the Nation’s nutrition and health. It supports Goals 1) by providing economic opportunity to oat producers, 3) by increasing food security by boosting domestic food supply and training plant breeders, and 5) by increasing demand for oat, a sustainable crop that can reduce pest problems and chemical use. The activities proposed address three emerging trends: the distancing of the public from the practice of plant breeding; increasing attention to the genetics of a crop’s nutritional value; and the advent of marker systems and analyses enabling population-wide association between markers and alleles that improve valuable traits. Our long-term goals are to enhance the security and nutritional value of grain consumed in the United States by 1) contributing to knowledge needed to improve grain for nutrition, 2) devising and disseminating breeding methods that optimally use biotechnological data, and 3) developing education to stimulate and invite the next generation of plant breeders.