

Spring 2008

Engineering for Life

Department of Biological Systems Engineering



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From the Department Chair

Welcome to our spring 2008 departmental newsletter. I hope that you will find it informative and inspirational, as we highlight activities of our faculty, research associates, graduate students, and alumni through featured stories. People in the department are excited about the future and the many opportunities in front of us to serve the state of Washington and the nation. Our research and graduate education focuses on food, energy, water, and the environment, covering the most essential and pressing societal needs on local and global

scales. Two new faculty members, Dr. Shyam Sablani (food engineering) and Dr. Manuel García-Pérez (bio-products and bio-energy engineering), joined us in 2007, and will add strength to our team.

This year, the department has made excellent progress in advancing our agenda for increased capabilities in the area of bio-products and bio-energy. In addition to new personnel serving in this area, a biological biomass conversion laboratory was completed and equipped, an analytical chemistry laboratory was updated, and plans for a thermo-chemical conversion laboratory are under way. Also completed was a building to house Washington State University (WSU) and Pacific Northwest National Laboratory personnel working in bio-products and a bio-refinery concept, located at the WSU Tri-Cities campus. This facility will greatly enhance our capabilities to deliver research and graduate education in biomass conversion.

With our graduate student numbers poised to grow above 40 students and an average of seven doctoral degrees awarded yearly during the last three years, our energetic faculty, who are highly committed to excellence and assisted by a team of about 20 postdoctoral research associates, sees a bright future. We invite you to join and participate in our efforts for a better tomorrow.

Claudio Stöckle
Professor and Chair
Department of Biological Systems Engineering

Our programs support the state,
national, and global bio-economy.

The mission of the Department of Biological Systems Engineering is to deliver high-quality engineering research, teaching, and outreach programs to support the state, national, and global bio-economy, with emphasis on applications in the agricultural, energy, and environmental sectors.

The department has an entrepreneurial faculty with the size, expertise, experience, and state-of-the-art facilities to be one of the leading research and graduate education units at WSU and to be a top performer among peer units nationwide.

Department statistics:

Number of faculty members: Eleven

Number of graduate students: Forty

Doctoral degrees awarded per year: Seven (previous three-year average)

Number of postdoctoral research associates: Twenty

Expenditures from sponsored projects: \$2.4 million to \$2.8 million (last three years)

See faculty and staff listings on the back page of this issue. For more information, visit us at www.bsyse.wsu.edu or contact us at 509-335-1578.

A Powerful Legume

As the nutritional value of snack food becomes more important, consumers demand high quality products that contain the proper blend of carbohydrates, protein, and fiber, along with other essential micro-nutrients. Chickpeas, which are an excellent source of protein, low in sodium, and contain both soluble and insoluble fiber and cholesterol-free fat, offer consumers an excellent alternative to high-calorie snacks.

Supported by the Cool Season Legume Research Program, and funded by the U.S. Department of Agriculture and the U.S. Dry Pea and Lentil Council, the Department of Biological Systems Engineering and School of Food Science at Washington State University, have worked with the USDA-ARS Western Regional Research Center, Albany, to develop processes based on high temperature and high pressure extrusion. Using twin-screw extrusion technology, the WSU-USDA research team, led by **Dr. Juming Tang**, and whose members include **Jose Berrios, Lalan Sinha, Barry G. Swanson**, and **James Pan**, has developed value-added nutritious health-snacks derived from chickpeas. “We worked with the lentil council on bringing a raw material from local farmers up to the stage where we can market and retail a high-value product,” says Tang. “We combine mostly



commodities from the state of Washington—lentils, chickpeas, peas, apple fibers, and potato starch—to deliver a healthy product for customers.”

The formulations of selected food ingredients such as starch, fruit, cereal based fibers, and other nutritional components, resulted in a product similar to conventional cereal based snacks.

Not only are the extruded products nutritional, they are flavorful, visually appealing, and convenient. The snacks have a crunchy texture and come in various shapes and flavors.

The chickpea snack was offered for consumer feedback studies during the National Lentil Festival in Pullman, Washington. Out of 354 people who sampled the product, over 80% responded positively. More than half said they would purchase chickpea snacks. Washington State Senator Maria Cantwell was on hand and also tried the product. Cantwell expressed interest in the development process and nutritional benefits of the product. In a jointly-reached agreement between WSU and the USDA, the process was awarded a patent in May 2007.

Chickpeas provide a healthy alternative to junk food and offer essential vitamins and minerals.

Alumni Profile

Sarah Lewis

Biological Systems Engineering, 1999 B.S., 2003 M.S.

Sarah Lewis works for the U.S. Forest Service Rocky Mountain Research Station in Moscow, Idaho, as a civil engineer. In the short time since her graduation, she has risen to a position of leadership and assembled an impressive record of peer-reviewed work.

Lewis’s graduate research focused on evaluating the Hayman fire in Colorado, and she performs similar work in Washington, Montana, California, Alaska, and Colorado. Her research team uses hyper-spectral imaging technology to survey the damage caused by forest fires. Forest rehabilitation teams use this information to determine which mitigation treatments to prescribe to the damaged area, such as seeding an area or applying a straw mulch to reduce erosion. Lewis and her team then return to the area and collect field measurements to see how well the area is recovering.

Lewis began working for the U.S. Forest Service in spring 2000, for one semester between undergraduate and graduate school. Through dual funding from WSU and the Forest Service, she continued working at the research station during graduate school, before being hired on permanently after she graduated with the master’s degree in 2003. “One thing that I really liked about my undergraduate education was its interdisciplinary nature,” says Lewis. “I had a fellowship through an interdisciplinary national science foundation program, and worked with other engineers, biologists, and chemists on many different projects that had key environmental themes.”

On April 16, 2008, Lewis was honored with the College of Agricultural, Human, and Natural Resources Sciences’ Women’s History Recognition Rising Star Award.

BSysE Welcomes New Faculty

Manuel Garcia-Pérez, Ph.D. Bioenergy Engineering

Dr. Manuel Garcia-Pérez's research addresses ways to alleviate the environmental burden associated with the world's declining petroleum resources.

He is currently working on new thermo-chemical conversion concepts—a process that converts biomass waste, such as triglycerides, sugars, and starch, into transportation fuels and chemicals.

Garcia-Pérez and his research partners have worked for more than eight years in novel approaches to characterize bio-oils produced from diverse agricultural and forest feedstocks. "Major contributions have been

made in the use of thermal analyses and UV fluorescence to characterize these complex liquids," he says. "Instead of using analytical techniques targeting individual compounds, our research targets characterization approaches that emphasize chemical groups or fractions. This approach is very useful for creating a rational platform for new refineries."

As the importance of biomass for fuels, chemicals, building materials, and clothing continues to increase, students must learn how to integrate thermal, biological, chemical and mechanical conversion

approaches that utilize these resources. "University professors must be motivators and use available opportunities to tell stories of success and to introduce great researchers and business people as models. We must also recognize the achievements of our students and encourage them to work for their dreams," says Garcia-Pérez.



Dr. Garcia-Pérez conducts research in the department's Analytical Chemistry Lab, one of many department labs where researchers study some of the most pressing environmental problems.

Faculty Research Update

Our scientists continually look for innovative solutions to some of the most pressing environmental issues. Here is a list of current research projects:

Dr. Shulin Chen: innovative design of high solids digestion plants for economic and renewable energy production; **Dr. Pius Ndegwa:** characterization and quantification of bioaerosols in confined animal feeding operations; **Dr. Claudio Stöckle:** generalized assessment of the impact of climate change on the agricultural sector of Washington state; **Dr. Juming Tang:** microwave sterilization for meal ready-to-eat rations in pouches; **Dr. Joan Wu:** synthesis of post-fire treatments for BAER teams.

Shyam Sablani, Ph.D. Food Engineering

Dr. Sablani's research focuses on the physical and chemical changes that occur in food products during processing and storage. He collaborates with thermal and nonthermal processing engineers in order to improve food quality and increase shelf-life. He says, "I am looking at how we can maximize the retention of nutraceuticals in food."

He is also developing bio-based packaging made from biodegradable and environmentally friendly materials derived from agricultural feed stock and marine fauna. The packaging can either be

edible protective films/coatings for foods such as fruits, vegetables, and fish, or developed into bags similar to those found in grocery stores. Both packaging products are easily biodegradable and will help reduce the amount of synthetic plastic that ends up in landfills. The edible films and coatings alter the transport of oxygen, moisture, carbon dioxide, aroma, and taste compounds in food systems, thus improving food quality and prolonging shelf life.

Sablani believes in a multi-dimensional

teaching approach and incorporates team-based learning and creative problem solving. "I'm not just giving the students the fundamentals; I'm also teaching them how to apply what they've learned."



Dr. Sablani in his lab with a graduate student, researching the properties of raspberry powder.

Expanding Food Engineering Knowledge

Professor and food engineering scientist **Gustavo Barbosa-Cánovas** has always been fascinated with the accumulation and dissemination of knowledge. As a mechanical and industrial engineering student at the University of Uruguay, “Students would get together in the library and share a textbook,” he says. Over the past seventeen years at Washington State University, Barbosa-Cánovas has engaged students in ground-breaking research, developed a world-class nonthermal food engineering program, and made significant contributions to food engineering.

“When I believe in something strongly, I go for it,” says Barbosa-Cánovas. “We don’t want to be unique in terms of just the center, we want to be useful to the University and optimize what we can offer.” He incorporates this philosophy into all aspects of research and teaching. His passion and motivation for compiling information on food engineering has helped a new generation of food engineering students and supports his innovative research.

As part of WSU’s commitment to making a positive global impact, Barbosa-Cánovas has developed a diverse nonthermal food engineering program,

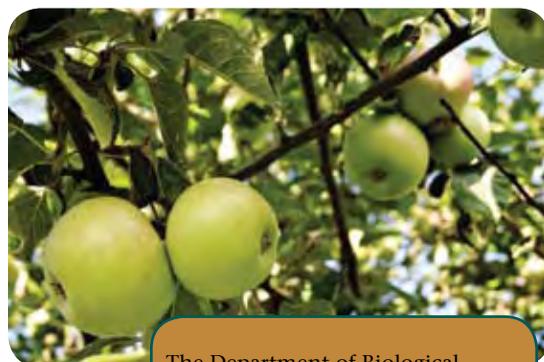
called the STAR program, that focuses on five areas: scholarship, teaching, research and development, publications, and consulting. It also provides students with mentorship opportunities.

Barbosa-Cánovas feels strongly about this program because of the advice that he received from his advisor when he was a graduate student. When a position opened at WSU in 1989, Barbosa-Cánovas was working at the Department of Chemical Engineering at the University of Massachusetts and not actively seeking other employment opportunities. His advisor, **Dr. Micha Peleg**, saw this as an opportunity for Barbosa-Cánovas and sent him a note: “This could be very good for you, Gustavo.” Barbosa-Cánovas said that he learned so much from Dr. Peleg and tries to pass on the golden points of Peleg’s advice to his own students. “He told me that I would be successful if I worked on non-conventional technologies.”

Barbosa-Cánovas is an editor and contributing author for several reference book series on food engineering. These books are the cornerstone of the food engineering profession, and a valuable resource for food engineers and multidisciplinary researchers. He

has also contributed to the *Encyclopedia of Life Supporting Systems (EOLSS)*, a collection of works published by the United Nations that features research in food engineering.

Ongoing research includes high-pressure pasteurization, pulsed electric fields, ultrasound, ultraviolet, and oscillating magnets. Barbosa-Cánovas’s contributions to the field have significant positive impacts on food engineering.



The Department of Biological Systems Engineering, under the direction of **Dr. Marvin Pitts**, is developing an automation and mechanization research emphasis. The research is part of WSU’s commitment to sustainable agriculture.

Alumni Profile

Dr. Yifen Wang

Food Engineering, 2003 Ph.D.

Dr. Yifen Wang works for the Department of Biosystems Engineering at Auburn University. His research group focuses on the applied and fundamental study of food engineering and safety. Research projects include developing value-added products and by-products usage in fisheries processing, exploring the nanostructures of fish gelatins, and food supply chain management and traceability systems using Radio Frequency Identification.

Wang has over seventeen years of food engineering and food safety experience and has held positions with food institutions and industry, government agencies, and universities since graduating with a bachelor’s degree in food engineering from Shanghai Fisheries University in 1990. Over the course of five years, from 1998 to 2003, he earned his master’s degree in environmental engineering from the University of Washington and his doctorate in food engineering and MBA from Washington State University.

In 2002, under the guidance of Dr. Juming Tang, Wang directed two research and development projects on novel thermal processing technologies funded by the U.S. Army Natick Center and the Combat Rations Network for Technology Implementation (CORANET). In 2005, Wang was invited to serve as visiting professor at Shanghai Fisheries University where he helped establish the Food Logistics/Supply Chain Education Highland. Wang was selected as a member of the Food Safety Expert Board for the 2008 Summer Olympic Games in Beijing, China, sponsored by the Food Safety Committee of Beijing Municipal Government and the Olympic Organizing Committee.

Developing Tools for a Cleaner Environment

In an effort to reduce greenhouse gas emissions and provide alternative revenue sources for growers, Washington State University's biological systems engineering scientists are using agricultural systems modeling software to study carbon sequestration in soil.

The Department of Energy (DOE) reports that carbon sequestration is one of the most promising ways to reduce greenhouse gases. Based on the popular CropSyst Suite developed at WSU's Department of Biological Systems Engineering, Professor **Claudio Stöckle** and his research team are working on analytical software to evaluate the potential for soil carbon sequestration. This helps control the amount of carbon dioxide in the atmosphere by storing it in the Earth's biosphere, underground, or the in oceans in order to reduce the buildup of carbon dioxide in the atmo-

sphere. According to the DOE, "atmospheric levels of CO₂ have risen from preindustrial levels of 280 parts per million (ppm) to present levels of 375 ppm." By identifying ways to maximize the amount of carbon stored in soil, growers could participate in carbon trade markets, which provide economic incentives for controlling carbon emissions.

"In cooperation with **Dr. Armen Kemanian** [department alumnus and assistant professor at Texas A&M University] we have now developed C-FARM, a spin-off version of CropSyst that interacts with users—growers in particular," says Stöckle. Researchers have been working with the Pacific Northwest Direct Seed Association to "see how they could possibly utilize C-FARM and have some sense whether they could sequester carbon and be eligible for carbon exchange credits."

Stöckle, a member of WSU's Climate Friendly Farming research team, continually analyzes the environmental impact of agricultural systems. With the CropSyst Suite being used on five continents, many institutions around the world rely on Stöckle's models for advanced agricultural research. In addition, his research has a positive impact on Washington's agricultural community because it offers growers new tools for evaluating environmentally-friendly management strategies.



Claudio Stöckle is widely recognized for his work in the development of computer-assisted tools for the analysis of agricultural systems. His research includes analyzing the environmental impacts of natural and human processes such as climate change, greenhouse gas emissions, and soil carbon sequestration.

Stöckle recently conducted a CropSyst training course in Bonn, Germany. The event attracted 22 participants from 10 different countries. (Photo by Becky Phillips, WSU Today)

Research Update

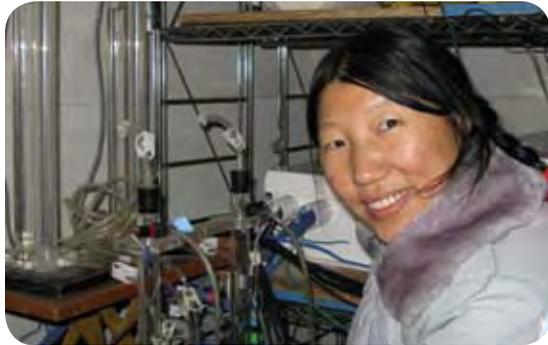
Biological systems engineering scientist **Dr. Juming Tang** recently received recognition for his work in thermal pest control in California almond production.

Over the past ten years, Tang and his research team have been developing a method for post-harvest bug control that will replace the use of methyl bromide, a colorless gas that has been linked to ozone layer depletion.

In 2005, the EPA began phasing out the use of methyl bromide and researchers have been looking for alternative treatment solutions. Using radio wave frequency treatment, Tang and his research team were successfully able to control pests in almonds. This treatment method provides a safe alternative to chemical fumigation. As a result, consumer products will be high quality without added pesticides.

Bioenvironmental engineering professor **Dr. Pius Ndegwa** continues his research on dairy farm emissions as part of a nationwide research effort led by Purdue University. Ndegwa monitors and records real-time data transmitted from a dairy farm in Washington. His work has been featured in research articles and magazines.

Graduate Student Spotlight



Shuhui Dunn
Ph.D., Land and Water Engineering

Doctoral student **Shuhui Dunn** works under the guidance of biological systems engineering professor **Dr. Joan Wu** on winter hydrology research, part of the department's ongoing improvement of the Water Erosion Prediction Project model (WEPP).

Dunn conducts laboratory testing in order to see how quickly water infiltrates frozen soil, and then programs the results into the model. Dunn says the research is "both challenging and rewarding. You

never observe the same thing twice." Her work will help researchers improve the WEPP model's ability to predict erosion in areas where freezing temperatures are common.

Dunn's dedication to hydrology research makes her a valuable asset to the research team. After she graduates, she would like to continue being involved with the WEPP model research. "You can always find something to improve on," she says. "There are always new discoveries."

John Foltz
M.S., Land and Water Engineering

Graduate student **John Foltz's** research focuses on exploring the toxicological aspects that occur in salmon at different stages of life. "In recent years, technology has gotten to the point where we can measure different chemicals in the water at very low levels," he says. Chemical compounds, such as xenoestrogens, may have multi-generational impact. "We don't know for sure, but it is something that we look at."

As an undergraduate at Ohio State University, Foltz started as a business student. "It wasn't really what I was looking for," he says. A summer internship with the Rocky Mountain Research Station in Moscow, Idaho, convinced him to switch to a fishery science major. "I loved that experience and started to look into natural resources. I have always been interested in water resources and the biological aspects of that led me into fisheries."

After graduating from Ohio State in December 2006, Foltz returned to Moscow and enrolled at WSU in fall 2007. "I was looking to go to a land-grant institution and, of course,

I was looking for a fisheries program." Foltz was contacted by **Dr. Jeff Ullman** who was looking for a graduate student with a background in biology and fish. Foltz's research incorporates hands-on field and laboratory work, such as rearing fish and regulating their exposure to chemicals. The chemicals can have an impact on fish that people eat, and the water used for irrigation. "From a fisheries aspect, it is something that I am very interested in."

When he graduates with his master's degree in biological systems engineering, Foltz plans to continue his fishery research. "I can see myself working for the U.S. Geological Survey or the U.S. EPA," he says. "I would like to keep working in the Pacific Northwest with salmon research."



Food Engineering Student Wins College of Engineering and Architecture Graduate Student Excellence Award

Congratulations to **Luz Daniela Bermudez-Aguirre**, who was awarded the College of Engineering and Architecture Graduate Student Excellence award. Bermudez-Aguirre, a doctoral candidate in biological systems engineering with a food engineer emphasis, received the \$5,000 award made possible by the Alfred Suksdorf Memorial Fund and the Harold P. Curtis Scholarship Fund.

The award recognizes engineering and architecture graduate students who excel in their field, and who show a profound commitment to scholarly productivity, interdisciplinary research, outreach activities, and professional recognition and development. Bermudez-Aguirre was nominated by her advisor, Gustavo Barbosa-Cánovas. "She always combines enthusiasm with the utmost excellence in both quality and quantity of work," he says.

Faculty

Gustavo V. Barbosa-Cánovas	Food Engineering
Shulin Chen	Biomass Processing and Bioproduct Engineering
Manuel Garcia-Pérez.....	Bioproducts and Bioenergy
Donald K. McCool	USDA Adjunct Faculty
Pius M. Ndegwa.....	Environmental Engineering
R. Troy Peters.....	Land and Water Engineering
Francis Pierce.....	Land and Water Engineering
Marvin J. Pitts	Food Engineering
Shyam Sablani.....	Food Engineering
Brenton Sharratt.....	USDA Adjunct Faculty
Claudio O. Stöckle	Land and Water Engineering
Juming Tang.....	Food Engineering
Jeffrey Ullman.....	Environmental Engineering
Joan Q. Wu.....	Land and Water Engineering

Staff

John Anderson	Administrative Manager
Bill Bowe	Engineering Technician
Wayne DeWitt.....	Engineering Technician
Vince Himsl.....	Information Systems Coordinator
Eric Hollenbeck.....	Communications
Patricia Huggins	Administrative Assistant
Pat King.....	Fiscal Specialist II
Jonathan Lomber	Laboratory Manager
Joan Million	Administrative Assistant
John Morse.....	USDA Affiliate
Gail Poesy.....	Fiscal Specialist I
Frank Younce.....	Pilot Plant Manager



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