IMPACT REPORT

Name: **Alavi,Sajid**
Department/Unit: Grain Science & Industry
Reporting Start Date: 01-Jan-2008
Reporting End Date: 31-Dec-2008
Percent Effort: 100 %
Number of Volunteers: 0
Number of Volunteer Hrs: 0

Program or Project:

Extrusion Program

Additional Team Leaders:

Koushik Adhikari, Scott Bean (USDA-GMPRC), Keith Behnke, Subramanyam Bhadriraju, Yong-Cheng Shi, Praveen Vadlani and Hulya Dogan

Summarize Program:

Dr. Sajid Alavi is the supervisor of the extrusion alb in the Department of Grain Science and Industry. His research program has a strong emphasis in research, teaching and service. The extrusion lab facilities include pilot-scale processing equipment in the Bioprocessing and Industrial Value-Added Program building and lab-scale processing equipment in Waters Hall. Pilot scale equipments include single and twin screw extruders, a gas-fired dryer and a batch mixer. Lab-scale equipments include a twin screw extruder that allows time-efficient study of novel ingredients and processes in an economical manner, before scaling up for pilot runs. The extrusion lab also has access to various analytical equipments including differential scanning calorimeter, phase transition analyzer, texture analyzer, controlled humidity chamber and supercritical fat extractor, and adequate bench space for analysis of raw materials and extruded products.

In the six and a half years since April 2002 when Dr. Alavi was appointed to the Grain Science and Industry faculty, his extensive research, teaching, industry and service-related activities have transformed the extrusion lab into an internationally recognized program. Several extrusion related research projects, with food, feed and industrial applications, have been initiated and/ or successfully completed. These projects have focused on the key areas of - 1) dynamics of microstructure formation in extruded biopolymer foams, 2) use of non-invasive X-ray micro tomography (XMT) for characterizing extrudate micro-structure and structure ? texture relationships, 3) gluten-free foods based on grain sorghum, 4) starch-clay nano-composite packaging, 5) high-fiber and fruit-based healthy snacks, and 6) cellulosic ethanol. Twenty four peer-reviewed manuscripts have been published or accepted for publication since 2002, out of which 20 are based on work originating at Kansas State University. Five of these manuscripts were accepted for publication in 2008. Seven other manuscripts have been submitted and are under consideration by peer-reviewed journals. Additionally, 10 manuscripts are near completion for submission. Dr. Alavi?s research is based on strong collaborative partnerships with faculty members from K-State Grain Science, Animal Science, Agronomy and Human Nutrition, and researchers from other institutions such as USDA-GMPRC, Iowa State University, North Carolina State University, University of Tennessee and Cornell University. More than a million dollars in extra-mural funding has been secured from his efforts as the primary investigator. Three Ph.D. and one MS. level students have successfully completed their theses with Dr. Alavi as the major professor. Currently three Ph.D. students and one M.S. student are being supervised by him. He has also supervised two post-doctoral scientists for periods ranging from 1 to 4 years with support from extra-mural funding. A new post-doctoral associate was hired in December 2008.

Dr. Alavi have been responsible for developing `from scratch? two classes focused on extrusion. GRSC 720 Extrusion Processing in the Food and Feed Industry is a senior level extrusion class with emphasis on introduction to extrusion technology and hands on laboratory exercises, and GRSC 820 Advanced Extrusion Processing is a graduate level extrusion class with group-based research projects as the main focus. Both these classes have seen increased enrollment over the past 6 years.

Dr. Alavi has developed a strong partnership with industry including Frito-Lay and Wenger Manufacturing. Under his overall supervision, the extrusion lab has become a major service provider to industrial clients. In FY2008, close to 700 hours, 53% industrial, 47% academic (65% graduate student work, 35% class labs,) were devoted to performing extrusion runs for industry, research and teaching purposes. Industrial clients included 16 different entities such as coops and companies involved in pet food, aqua feed and food production and also other research organizations. At an average, approximately $150,000 in annual revenue is brought in by the service-related activities of the extrusion lab, which go towards operations, maintenance, and salaries of one full-time operations manager and hourly wages of several students who help in the labs and also gain valuable hands-on experience. The `Extrusion Processing: Technology and Commercialization? short course has become an annual event for training participants from industry and academia. In the latest edition (August 2008), there were 33 participants from the U.S., India, Brazil and Mexico. Dr. Alavi has also focused on international activities and collaboration. He travels annually to India to conduct short courses and strengthen linkages with agricultural universities, government institutions and private industry. Another important part of service-related contributions is Dr.Alavi?s leadership role in AACC International. He was the Engineering and Processing division Secretary/ Treasurer for 2007-08 and Chair-Elect for 2008-09. He is also a member of the 2009 Annual Meeting planning committee and Scientific Initiative Chair for Engineering, Rheology and Processing.

The research, teaching and service-related activities of the extrusion lab are not conducted in isolation but overlap with each other. A unique example of integration of these activities is an engagement project that was started in 2008 focused on educating Manhattan-area (Phase 1) and wider north-east Kansas area (Phase 2) middle school children on the processing, sensory aspects and nutritional quality of healthy snacks. The project involves collaboration with multiple departments across campus and health teachers from Anthony and Eisenhower Middle Schools. As part of this project, day-long visits were made to the middle schools in October to interact with children, followed by visits by the school children (about 100 from each middle school) to KSU labs.

Summarize Impact:

Agricultural products which utilize extrusion technology constitute approximately a $40 billion annual market in the U.S. alone. This includes breakfast cereal, snacks, pasta, pet food, aquatic feed, and bio-based industrial materials. The extrusion lab in the Department of Grain Science and Industry is an invaluable asset to the ongoing quest for enhancing the value of Kansas agricultural commodities like wheat, corn, sorghum and soybean. Some measures of the impact of Dr. Alavi?s research include the adoption by industry of flow-based characterization of phase transition properties of ingredients and finished products as a rapid testing method, and widespread recognition in scientific and industry circles of the utility of XMT-based non-invasive imaging for understanding process-structure-function relationships in foods products. He has received prestigious USDA-FAS grants under the Cochran, Borlaug and AKI programs. He has been invited to speak at international forums in countries including U.S.A., Italy and India, and several visiting scientists from countries such as Brazil, Egypt, Jordan and India have spent time in the extrusion lab engaging in collaborative research. The lab works very closely with regional and national agro-industry and provides services and consultancy to a range of companies like pet food and human food manufacturers (example, Frito-Lay, AFB, Doannes Petcare), ingredient companies (example, Cargill), government organizations (example, NASA) and equipment manufacturers (example, Agrichem and Wenger Manufacturing). The relationship with Wenger especially is very beneficial to the state of Kansas as a whole, as it serves as both a catalyst and a testing ground for new processing technologies, and shines a spot light on the industrial and technological prowess of the state. This vital partnership involves collaboration on a broad range of areas include research, teaching, short courses, industrial clients, and international activities. Another example of the widespread recognition of the services provided by the extrusion lab is the fact that a strong partnership has been developed with Pepsico/ Frito-Lay, which is by far the largest snack food manufacturer in the US and an international leader as well. This partnership is not limited to one or two scientists, but involves working relationships with several R&D personnel, production and operations staff, and top management as well. The partnership encompasses short term projects for raw material and finished product analyses, longer term sponsored projects, annual recruitment visits and other R&D related visits to K-State, and participation as adjunct faculty in Grain Science. The teaching aspect of the extrusion lab ensures that Grain Science, Animal Sciences and Food Science graduates from the University are well versed with latest processing technologies. K-State is now among a select group of only 3-4 universities which have an extrusion-based teaching program, which strives to meet an ever-increasing industry demand for graduates trained in operations and R&D. The extrusion program is well-aligned

with the mission of the Bioprocessing and Industrial Value-Added Program (BIVAP) and leads to a very unique integration of various disciplines across the University, including Agronomy, Biological and Agricultural Engineering, Electrical Engineering, Food Science, Grain Science and Industry, Human Nutrition and Communication.

Summarize Next Steps:

In the coming years, the extrusion lab will continue its strong emphasis on the above mentioned thrust areas for research, teaching and extension. In addition, we will continue efforts towards community engagement projects and collaboration with other K-State researchers in the areas of nutritious foods, biofuels, value-added industrial products, petfood and animal feed research.

Important needs of the extrusion lab in the near and long-term future:

1) Continued departmental support for 2-3 graduate students.
2) More laboratory/ analytical equipment for extrusion and rheology-related research. This will tentatively cost about $200,000.
3) Several more processing equipment including pilot-scale flaking rolls, puffing gun and cooking kettles. These will tentatively cost around $500,000.

Strategies to meet goals and needs:

The extrusion lab will work aggressively towards fulfilling the above mentioned goals and needs by ? 1) strategic partnership with major industry partners like Wenger and Frito-Lay and 2) extensive solicitation of funding from external agencies such as U.S.D.A., N.S.F., and regional commodity organizations. Collaborative arrangements with other institutions and universities will be actively sought to increase the chances of extra-mural funding. Public-private and international partnerships will also be pursued for obtaining funding from programs such as the US-India Agricultural Knowledge Intitiative (AKI), and agencies such the Bill and Melinda Gates Foundation and USAID.

End of Report