Name: **Alavi,Sajid**
Department/Unit: Grain Science & Industry
Reporting Start Date: 01-Jan-2007
Reporting End Date: 31-Dec-2007
Percent Effort: 100 %
Number of Volunteers: 0
Number of Volunteer Hrs: 0

Program or Project:

Extrusion Program

Long Term Intended Outcomes:

Code	Description
ENQFS	Enhanced Nutritional Quality of Food Supply
NEPA	New and Enhanced Products from Agriculture

Additional Team Leaders:

Koushik Adhikari, Scott Bean (USDA-GMPRC), Keith Behnke, Subramanyam Bhadriraju, Hulya Dogan, Tom Herald, Buddhi Lamsal and Yong-Cheng Shi.

Summarize Program:

Dr. Sajid Alavi, is the supervisor of the Extrusion Program in the Department of Grain Science and Industry. This research program has a strong emphasis in research, teaching and service. The extrusion program is based on pilot-scale processing equipment in the Bioprocessing and Industrial Value-Added Program facility and lab-scale processing equipment in Waters Hall. Pilot scale equipment include single and twin screw extruders, a gas-fired dryer and a batch mixer. Lab-scale equipment 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 program also has access to various analytical equipment 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 five 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 peer-reviewed manuscripts have been published or accepted for publication since 2002, out of which 15 are based on work originating at Kansas State University. At least 12 other manuscripts are near completion or under consideration by peer-reviewed journals. 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. Approximately half 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 are being supervised by him. Additionally, he has supervised two post-doctoral scientists for periods ranging from 1 to 3 years with support from extra-mural funding.

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 5 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 FY2007, close to 600 hours were devoted to performing extrusion runs for industry (68%), research (12%) and teaching (20%) purposes. An average of approximately $100,000 in annual revenue is brought in by the client-related activities of the lab which go towards paying the salary of one full-time operations manager, partial salary of another classified staff, and hourly wages of several students who help in the labs and also gain valuable 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 2007), there were 46 participants from the U.S., India, Brazil, Australia, France, Ecuador, Columbia 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.

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 Program 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 have spent time in his lab engaging in collaborative research. The extrusion program 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, Industrial Microwave Systems, 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. The teaching aspect of the extrusion program 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 lead to a very unique integration of various disciplines across the University, including Agronomy, Biological and Agricultural Engineering, Computing and Information Sciences, Electrical Engineering, Food Science, Grain Science and Industry, and Human Nutrition.

Summarize Next Steps:

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

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

1) Continued departmental support for 2-3 graduate students.
2) Funding support for at least one full-time post-doctoral associate costing about $40,000 a year.
3) More laboratory/ analytical equipment for extrusion and rheology-related research. This will tentatively cost about $200,000.
4) 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 Program 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 Initiative (AKI), and agencies such the Bill and Melinda Gates Foundation and USAID.

End of Report